Tivoli Workload Scheduler LoadLeveler

Using and Administering

Version 3 Release 5

SA22-7881-08

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Note
Before using this information and the product it supports, read the information in "Notices" on page 745.

Ninth Edition (November 2008)

This edition applies to version 3, release 5, modification 0 of IBM Tivoli Workload Scheduler LoadLeveler (product numbers 5765-E69 and 5724-I23) and to all subsequent releases and modifications until otherwise indicated in new editions. This edition replaces SA22-7881-07. Significant changes or additions to the text and illustrations are indicated by a vertical line (|) to the left of the change.

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About this information

IBM® Tivoli® Workload Scheduler (TWS) LoadLeveler® provides various ways of scheduling and managing applications for best performance and most efficient use of resources. LoadLeveler manages both serial and parallel jobs over a cluster of machines or servers, which may be desktop workstations, dedicated servers, or parallel machines. This information describes how to configure and administer this LoadLeveler cluster environment, and to submit and manage jobs that run on machines in the cluster.

Who should use this information

This information is intended for two separate audiences:

- Personnel who are responsible for installing, configuring and managing the LoadLeveler cluster environment. These people are called LoadLeveler administrators. LoadLeveler administrative tasks include:
  - Setting up configuration and administration files
  - Maintaining the LoadLeveler product
  - Setting up the distributed environment for allocating batch jobs
- Users who submit and manage serial and parallel jobs to run in the LoadLeveler cluster.

Both LoadLeveler administrators and general users should be experienced with the UNIX® commands. Administrators also should be familiar with:

- Cluster system management techniques such as SMIT, as it is used in the AIX® environment
- Networking and NFS or AFS® protocols

Conventions and terminology used in this information

Throughout the TWS LoadLeveler product information:

- TWS LoadLeveler for Linux® Multiplatform includes:
  - IBM System servers with Advanced Micro Devices (AMD) Opteron or Intel® Extended Memory 64 Technology (EM64T) processors
  - IBM System x™ servers
  - IBM BladeCenter® Intel processor-based servers
  - IBM Cluster 1350™

  Note: IBM Tivoli Workload Scheduler LoadLeveler is supported when running Linux on non-IBM Intel-based and AMD hardware servers.

  Supported hardware includes:
  - Servers with Intel 32-bit and Intel EM64T
  - Servers with AMD 64-bit technology
- Note that in this information:
  - LoadLeveler is also referred to as Tivoli Workload Scheduler LoadLeveler and TWS LoadLeveler.
  - Switch_Network_Interface_For_HPS is also referred to as HPS or High Performance Switch.

Table 1 describes the typographic conventions used in this information.

Table 1. Summary of typographic conventions

Typographic	Usage
Bold	• **Bold** words or characters represent system elements that you must use literally, such as commands, flags, and path names. • **Bold** words also indicate the first use of a term included in the glossary.
Italic	• *Italic* words or characters represent variable values that you must supply. • *Italics* are also used for book titles and for general emphasis in text.
`Constant width`	Examples and information that the system displays appear in `constant width` typeface.
[ ]	Brackets enclose optional items in format and syntax descriptions.
{ }	Braces enclose a list from which you must choose an item in format and syntax descriptions.
|	A vertical bar separates items in a list of choices. (In other words, it means "or.")
< >	Angle brackets (less-than and greater-than) enclose the name of a key on the keyboard. For example, **<Enter>** refers to the key on your terminal or workstation that is labeled with the word Enter.
...	An ellipsis indicates that you can repeat the preceding item one or more times.
<Ctrl-*x*>	The notation **<Ctrl-*x*>** indicates a control character sequence. For example, **<Ctrl-c>** means that you hold down the control key while pressing **<c>**.
\	The continuation character is used in coding examples in this information for formatting purposes.

Prerequisite and related information

The Tivoli Workload Scheduler LoadLeveler publications are:

- *Installation Guide*, GI10-0763
- *Using and Administering*, SA22-7881
- *Diagnosis and Messages Guide*, GA22-7882

To access all TWS LoadLeveler documentation, refer to the **IBM Cluster Information Center**, which contains the most recent TWS LoadLeveler documentation in PDF and HTML formats. This Web site is located at:

`http://publib.boulder.ibm.com/infocenter/clresctr/vxrx/index.jsp`

A **TWS LoadLeveler Documentation Updates** file also is maintained on this Web site. The **TWS LoadLeveler Documentation Updates** file contains updates to the TWS LoadLeveler documentation. These updates include documentation corrections and clarifications that were discovered after the TWS LoadLeveler books were published.

Both the current TWS LoadLeveler books and earlier versions of the library are also available in PDF format from the IBM Publications Center Web site located at:

`http://www.elink.ibmlink.ibm.com/publications/servlet/pbi.wss`

To easily locate a book in the IBM Publications Center, supply the book's publication number. The publication number for each of the TWS LoadLeveler books is listed after the book title in the preceding list.

How to send your comments

Your feedback is important in helping us to produce accurate, high-quality information. If you have any comments about this book or any other TWS LoadLeveler documentation:

- Send your comments by e-mail to: mhvrcfs@us.ibm.com

  Include the book title and order number, and, if applicable, the specific location of the information you have comments on (for example, a page number or a table number).
- Fill out one of the forms at the back of this book and return it by mail, by fax, or by giving it to an IBM representative.

To contact the IBM cluster development organization, send your comments by e-mail to: cluster@us.ibm.com

Summary of changes

The following sections summarize changes to the IBM Tivoli Workload Scheduler (TWS) LoadLeveler product and TWS LoadLeveler library for each new release or major service update for a given product version. Within each information unit in the library, a vertical line to the left of text and illustrations indicates technical changes or additions made to the previous edition of the information.

Changes to TWS LoadLeveler for this release or update include:

- **New information:**
  - Recurring reservation support:
    - The TWS LoadLeveler commands and APIs have been enhanced to support recurring reservation.
    - Accounting records have been enhanced to have recurring reservation entries.
    - The new **recurring** job command file keyword will allow a user to specify that the job can run in every occurrence of the recurring reservation to which it is bound.
  - Data staging support:
    - Jobs can request data files from a remote storage location before the job executes and back to remote storage after it finishes execution.
    - Schedules data staging at submit time or just in time for the application execution.
  - Multicluster scale-across scheduling support:
    - Allows a large job to span resources across more than one cluster
      - Scale-across scheduling is a way to schedule jobs in the multicluster environment to span resources across more than one cluster. This feature allows large jobs that request more resources than any single cluster can provide to combine the resources from more than one cluster and run large jobs on the combined resources, effectively spanning resources across more than one cluster.
      - Allows utilization of fragmented resources from more than one cluster
        - Fragmented resources occur when the resources available on a single cluster cannot satisfy any single job on that cluster. This feature allows any size job to take advantage of these resources by combining them from multiple clusters.
  - Enhanced WLM support:
    - Integrates TWS LoadLeveler with AIX Workload Manager (WLM) virtual memory and the large page resource limit support.
    - Enforces virtual memory and the large page limit usage of a job.
    - Reports statistics for virtual memory and the large page limit usage.
    - Dynamically changes virtual memory and the large page limit usage of a job.
  - Enhanced adapter striping (**sn_all**) support:
    - Submits jobs to nodes that have one or more networks in the failed (NOTREADY) state provided that all of the nodes assigned to the job have more than half of the networks in the READY state.

- A new **striping_with_minimum_networks** configuration keyword has been added to the class stanza to support striping with failed networks.

– Enhanced affinity support:
  - Task affinity support has been enhanced on nodes that are booted in single threaded (ST) mode and on nodes that do not support simultaneous multithreading (SMT).

– NetworkID64 for Mellanox adapters on Linux systems with InfiniBand support:
  - Generates unique NetworkID64 IDs for adapter ports that are connected to the same switch and have the same IP subnet address. This ensures that ports that are connected to the same switch, but are configured with different IP subnet addresses, will get different NeworkID64 values.

- **Changed information**:
  – This is the last release that will provide the following functions:
    - The Motif-based graphical user interface **xloadl**. The function available in **xloadl** has been frozen since TWS LoadLeveler 3.3.2 and there are no plans to update this GUI with any new function added to TWS LoadLeveler after that level.
    - The IBM BladeCenter JS21 with a BladeCenter H chassis interconnected with the InfiniBand Host Channel Adapters connected to a Cisco InfiniBand SDR switch.
    - The IBM Power System 575 (Model 9118-575) and IBM Power System 550 (Model 9133-55A) interconnected with the InfiniBand Host Channel Adapter and Cisco switch.
    - The High Performance Switch.
  – If you have a mixed TWS LoadLeveler cluster and need to run your job on a specific operating system or architecture, you must define the **requirements** keyword statement in your job command file specifying the desired Arch or OpSys. For example:

    ```
    Requirements: (Arch == "RS6000") && (OpSys == "AIX53")
    ```

- **Deleted information:**

  The following function is no longer supported and the information has been removed:
  – The scheduling of parallel jobs with the default scheduler (**SCHEDULER_TYPE=LL_DEFAULT**)
  – The **min_processors** and **max_processors** keywords
  – The **RSET_CONSUMABLE_CPUS** option for the **rset_support** configuration keyword and the **rset** job command file keyword
  – The API functions:
    - **ll_get_nodes**
    - **ll_free_nodes**
    - **ll_get_jobs**
    - **ll_free_jobs**
    - **ll_start_job**
  – Red Hat Enterprise Linux 3
  – The **llctl purgeschedd** function has been replaced by the **llmovespool** function.
  – The **lldbconvert** function is no longer needed for migration and the **lldbconvert** command is not included in TWS LoadLeveler 3.5.

Part 1. Overview of TWS LoadLeveler concepts and operation

Setting up IBM Tivoli Workload Scheduler (TWS) LoadLeveler involves defining machines, users, jobs, and how they interact, in such a way that TWS LoadLeveler is able to run jobs quickly and efficiently.

Once you have a basic understanding of the TWS LoadLeveler product and its interfaces, you can find more details in the topics listed in Table 2.

Table 2. Major topics in TWS LoadLeveler: Using and Administering

To learn about:	**Read the following:**
Performing administrator tasks	Part 2, "Configuring and managing the TWS LoadLeveler environment," on page 39
Performing general user tasks	Part 3, "Submitting and managing TWS LoadLeveler jobs," on page 177
Using TWS LoadLeveler interfaces	Part 4, "TWS LoadLeveler interfaces reference," on page 261

Chapter 1. What is LoadLeveler?

LoadLeveler is a job management system that allows users to run more jobs in less time by matching the jobs' processing needs with the available resources. LoadLeveler schedules jobs, and provides functions for building, submitting, and processing jobs quickly and efficiently in a dynamic environment.

Figure 1 shows the different environments to which LoadLeveler can schedule jobs. Together, these environments comprise the *LoadLeveler cluster*.

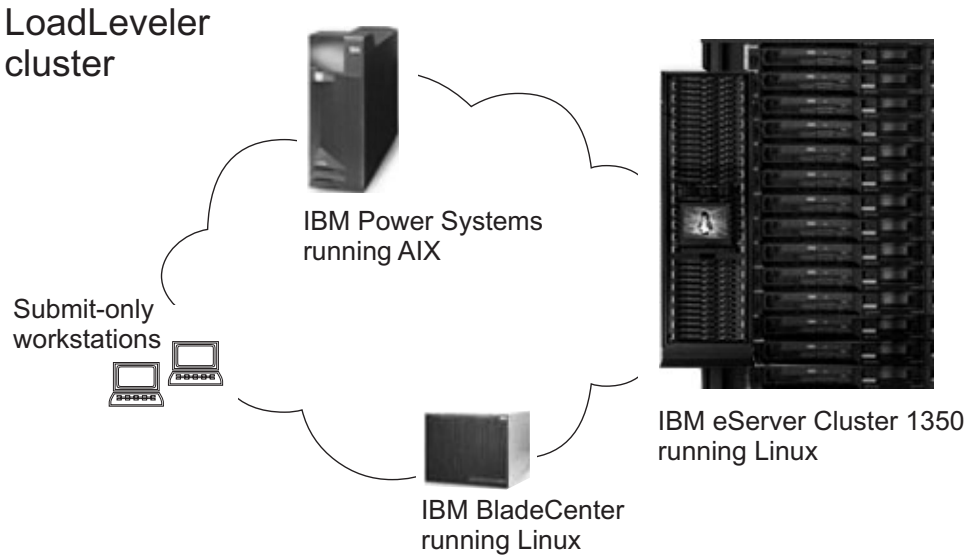

Figure 1. Example of a LoadLeveler cluster

As Figure 1 also illustrates, a LoadLeveler cluster can include *submit-only* machines, which allow users to have access to a limited number of LoadLeveler features.

Throughout all the topics, the terms *workstation*, *machine*, *node*, and *operating system instance (OSI)* refer to the machines in your cluster. In LoadLeveler, an OSI is treated as a single instance of an operating system image.

If you are unfamiliar with the TWS LoadLeveler product, consider reading one or more of the introductory topics listed in Table 3:

Table 3. Topics in the TWS LoadLeveler overview

To learn about:	Read the following:
Using the default configuration for getting a quick start	Chapter 2, "Getting a quick start using the default configuration," on page 29
Specific products and features that are required for or available through the TWS LoadLeveler environment	Chapter 3, "What operating systems are supported by LoadLeveler?," on page 35

LoadLeveler basics

LoadLeveler has various types of interfaces that enable users to create and submit jobs and allow system administrators to configure the system and control running jobs.

These interfaces include:

- Control files that define the elements, characteristics, and policies of LoadLeveler and the jobs it manages. These files are the configuration file, the administration file, and job command file.
- The command line interface, which gives you access to basic job and administrative functions.
- A graphical user interface (GUI), which provides system access similar to the command line interface. Experienced users and administrators may find the command line interface more efficient than the GUI for job and administrative functions.
- An application programming interface (API), which allows application programs written by users and administrators to interact with the LoadLeveler environment.

The commands, GUI, and APIs permit different levels of access to administrators and users. User access is typically restricted to submitting and managing individual jobs, while administrative access allows setting up system configurations, job scheduling, and accounting.

Using either the command line or the GUI, users create job command files that instruct the system on how to process information. Each job command file consists of keywords followed by the user defined association for that keyword. For example, the keyword **executable** tells LoadLeveler that you are about to define the name of a program you want to run. Therefore, **executable = longjob** tells LoadLeveler to run the program called *longjob*.

After creating the job command file, you invoke LoadLeveler commands to monitor and control the job as it moves through the system. LoadLeveler monitors each job as it moves through the system using process control daemons. However, the administrator maintains ultimate control over all LoadLeveler jobs by defining job classes that control how and when LoadLeveler will run a job.

In addition to setting up job classes, the administrator can also control how jobs move through the system by specifying the type of scheduler. LoadLeveler has several different scheduler options that start jobs using specific algorithms to balance job priority with available machine resources.

When LoadLeveler administrators are configuring clusters and when users are planning jobs, they need to be aware of the machine resources available in the cluster. These resources include items like the number of CPUs and the amount of memory available for each job. Because resource availability will vary over time, LoadLeveler defines them as consumable resources.

LoadLeveler: A network job management and scheduling system

A network job management and job scheduling system, such as LoadLeveler, is a software program that schedules and manages jobs that you submit to one or more machines under its control.

LoadLeveler accepts jobs that users submit and reviews the job requirements. LoadLeveler then examines the machines under its control to determine which machines are best suited to run each job.

Job definition

LoadLeveler schedules your jobs on one or more machines for processing. The definition of a **job**, in this context, is a set of **job steps**.

or each job step, you can specify a different executable (the executable is the part of the job that gets processed). You can use LoadLeveler to submit jobs which are made up of one or more job steps, where each job step depends upon the completion status of a previous job step. For example, Figure 2 illustrates a stream of job steps:

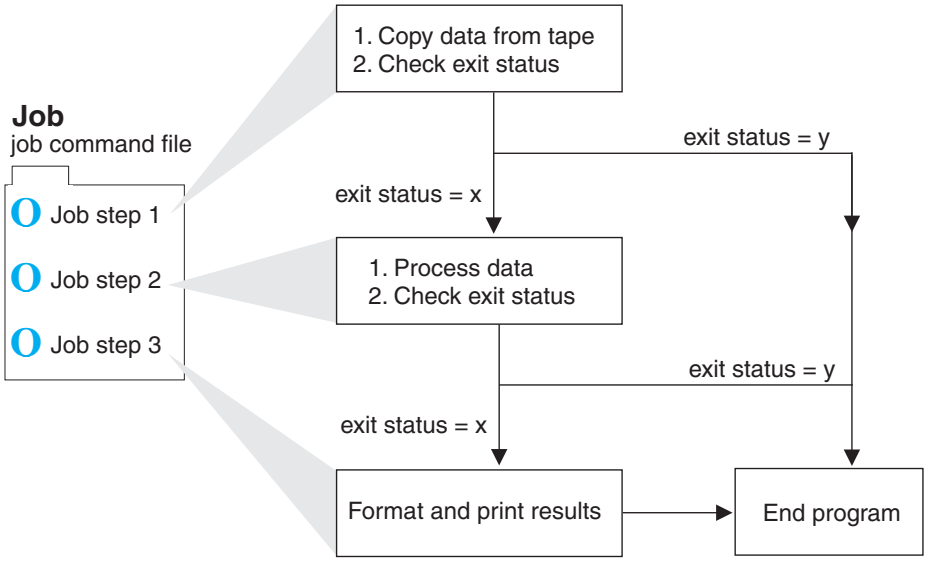

Figure 2. LoadLeveler job steps

Each of these job steps is defined in a single **job command file**. A job command file specifies the name of the job, as well as the job steps that you want to submit, and can contain other LoadLeveler statements.

LoadLeveler tries to execute each of your job steps on a machine that has enough resources to support executing and checkpointing each step. If your job command file has multiple job steps, the job steps will not necessarily run on the same machine, unless you explicitly request that they do.

You can submit batch jobs to LoadLeveler for scheduling. Batch jobs run in the background and generally do not require any input from the user. Batch jobs can either be **serial** or **parallel**. A serial job runs on a single machine. A parallel job is a program designed to execute as a number of individual, but related, processes on one or more of your system's nodes. When executed, these related processes can communicate with each other (through message passing or shared memory) to exchange data or synchronize their execution.

For parallel jobs, LoadLeveler interacts with Parallel Operating Environment (POE) to allocate nodes, assign tasks to nodes, and launch tasks.

Machine definition

For LoadLeveler to schedule a job on a machine, the machine must be a valid member of the LoadLeveler cluster.

A cluster is the combination of all of the different types of machines that use LoadLeveler.

To make a machine a member of the LoadLeveler cluster, the administrator has to install the LoadLeveler software onto the machine and identify the central manager (described in "Roles of machines"). Once a machine becomes a valid member of the cluster, LoadLeveler can schedule jobs to it.

Roles of machines

Each machine in the LoadLeveler cluster performs one or more roles in scheduling jobs.

Roles performed in scheduling jobs by each machine in the LoadLeveler cluster are as follows:

- **Scheduling Machine:** When a job is submitted, it gets placed in a queue managed by a scheduling machine. This machine contacts another machine that serves as the central manager for the entire LoadLeveler cluster. This scheduling machine asks the central manager to find a machine that can run the job, and also keeps persistent information about the job. Some scheduling machines are known as *public scheduling machines*, meaning that any LoadLeveler user can access them. These machines schedule jobs submitted from submit-only machines:
- **Central Manager Machine:** The role of the central manager is to examine the job's requirements and find one or more machines in the LoadLeveler cluster that will run the job. Once it finds the machine(s), it notifies the scheduling machine.
- **Executing Machine:** The machine that runs the job is known as the executing machine.
- **Submitting Machine:** This type of machine is known as a *submit-only* machine. It participates in the LoadLeveler cluster on a limited basis. Although the name implies that users of these machines can only submit jobs, they can also query and cancel jobs. Users of these machines also have their own Graphical User Interface (GUI) that provides them with the submit-only subset of functions. The submit-only machine feature allows workstations that are not part of the LoadLeveler cluster to submit jobs to the cluster.

Keep in mind that one machine can assume multiple roles, as shown in Figure 3 on page 7.

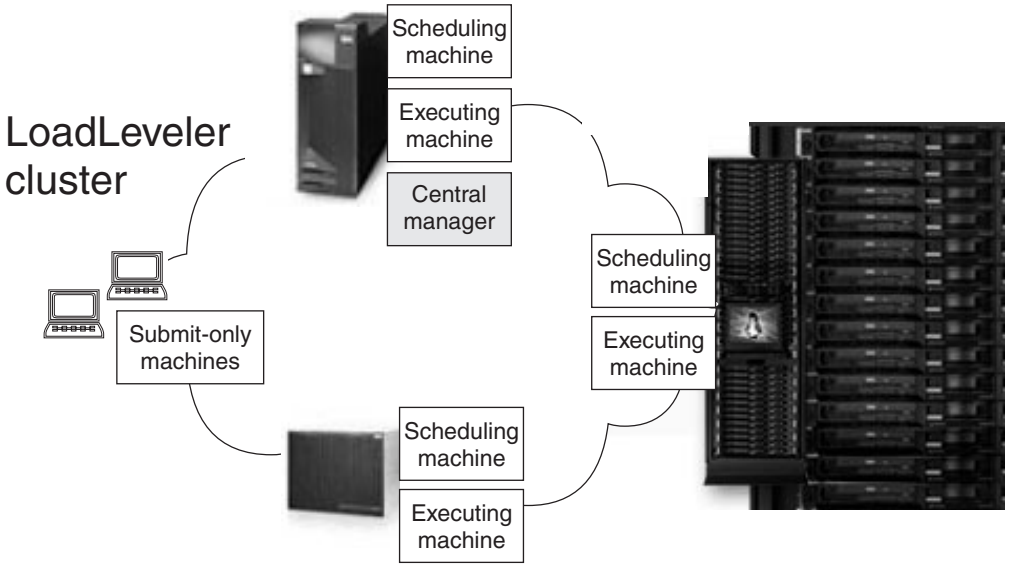

Figure 3. Multiple roles of machines

Machine availability

There may be times when some of the machines in the LoadLeveler cluster are not available to process jobs

For instance, when the owners of the machines have decided to make them unavailable. This ability of LoadLeveler to allow users to restrict the use of their machines provides flexibility and control over the resources.

Machine owners can make their personal workstations available to other LoadLeveler users in several ways. For example, you can specify that:

- The machine will always be available
- The machine will be available only between certain hours
- The machine will be available when the keyboard and mouse are not being used interactively.

Owners can also specify that their personal workstations never be made available to other LoadLeveler users.

How LoadLeveler schedules jobs

When a user submits a job, LoadLeveler examines the job command file to determine what resources the job will need. LoadLeveler determines which machine, or group of machines, is best suited to provide these resources, then LoadLeveler dispatches the job to the appropriate machines. To aid this process, LoadLeveler uses queues.

A **job queue** is a list of jobs that are waiting to be processed. When a user submits a job to LoadLeveler, the job is entered into an internal database, which resides on one of the machines in the LoadLeveler cluster, until it is ready to be dispatched to run on another machine.

Once LoadLeveler examines a job to determine its required resources, the job is dispatched to a machine to be processed. A job can be dispatched to either one machine, or in the case of parallel jobs, to multiple machines. Once the job reaches the executing machine, the job runs.

Jobs do not necessarily get dispatched to machines in the cluster on a first-come, first-serve basis. Instead, LoadLeveler examines the requirements and characteristics of the job and the availability of machines, and then determines the best time for the job to be dispatched.

LoadLeveler also uses **job classes** to schedule jobs to run on machines. A job class is a classification to which a job can belong. For example, short running jobs may belong to a job class called `short_jobs`. Similarly, jobs that are only allowed to run on the weekends may belong to a class called `weekend`. The system administrator can define these job classes and select the users that are authorized to submit jobs of these classes.

You can specify which types of jobs will run on a machine by specifying the types of job classes the machine will support. LoadLeveler also examines a job's **priority** to determine when to schedule the job on a machine. A priority of a job is used to determine its position among a list of all jobs waiting to be dispatched.

"The LoadLeveler job cycle" on page 16 describes job flow in the LoadLeveler environment in more detail.

How LoadLeveler daemons process jobs

LoadLeveler has its own set of daemons that control the processes moving jobs through the LoadLeveler cluster.

The LoadLeveler daemons are programs that run continuously and control the processes that move jobs through the LoadLeveler cluster. A master daemon (**LoadL_master**) runs on all machines in the LoadLeveler cluster and manages other daemons.

Table 4 summarizes these daemons, which are described in further detail in topics immediately following the table.

Table 4. LoadLeveler daemons

Daemon	Description
LoadL_master	Referred to as the master daemon. Runs on all machines in the LoadLeveler cluster and manages other daemons.
LoadL_schedd	Referred to as the Schedd daemon. Receives jobs from the **llsubmit** command and manages them on machines selected by the negotiator daemon (as defined by the administrator).
LoadL_startd	Referred to as the startd daemon. Monitors job and machine resources on local machines and forwards information to the negotiator daemon. The startd daemon spawns the starter process (**LoadL_starter**) which manages running jobs on the executing machine.

Table 4. LoadLeveler daemons (continued)

Daemon	Description
LoadL_negotiator	Referred to as the negotiator daemon. Monitors the status of each job and machine in the cluster. Responds to queries from **llstatus** and **llq** commands. Runs on the central manager machine.
LoadL_kbdd	Referred to as the keyboard daemon. Monitors keyboard and mouse activity.
LoadL_GSmonitor	Referred to as the gsmonitor daemon. Monitors for down machines based on the heartbeat responses of the **MACHINE_UPDATE_INTERVAL** time period.

The master daemon

The **master** daemon runs on every machine in the LoadLeveler cluster, except the submit-only machines. The real and effective user ID of this daemon must be **root**.

The **LoadL_master** binary is installed as a **setuid** program with the owner set to **root**. The **master** daemon and all daemons started by the **master** must be able to run with **root** privileges in order to switch the identity to the owner of any job being processed.

The **master** daemon determines whether to start any other daemons by checking the **START_DAEMONS** keyword in the global or local configuration file. If the keyword is set to **true**, the daemons are started. If the keyword is set to **false**, the **master** daemon terminates and generates a message.

The **master** daemon will not start on a Linux machine if **SEC_ENABLEMENT** is set to **CTSEC**. If the **master** daemon does not start, no other daemons will start.

On the machine designated as the central manager, the **master** runs the **negotiator** daemon. The **master** also controls the central manager backup function. The negotiator runs on either the primary or an alternate central manager. If a central manager failure is detected, one of the alternate central managers becomes the primary central manager by starting the negotiator.

The **master** daemon starts and if necessary, restarts all of the LoadLeveler daemons that the machine it resides on is configured to run. As part of its startup procedure, this daemon executes the **.llrc** file (a dummy file is provided in the **bin** subdirectory of the release directory). You can use this script to customize your local configuration file, specifying what particular data is stored locally. This daemon also runs the **kbdd** daemon, which monitors keyboard and mouse activity.

When the **master** daemon detects a failure on one of the daemons that it is monitoring, it attempts to restart it. Because this daemon recognizes that certain situations may prevent a daemon from running, it limits its restart attempts to the number defined for the **RESTARTS_PER_HOUR** keyword in the configuration file. If this limit is exceeded, the **master** daemon forces all daemons including itself to exit.

When a daemon must be restarted, the **master** sends mail to the administrators identified by the **LOADL_ADMIN** keyword in the configuration file. The mail contains the name of the failing daemon, its termination status, and a section of the daemon's most recent log file. If the **master** aborts after exceeding **RESTARTS_PER_HOUR**, it will also send that mail before exiting.

The **master** daemon may perform the following actions in response to an **llctl** command:

- Kill all daemons and exit (**stop** keyword)
- Kill all daemons and execute a new **master** (**recycle** keyword)
- Rerun the **.llrc** file, reread the configuration files, stop or start daemons as appropriate for the new configuration files (**reconfig** keyword)
- Send drain request to startd and (**drain** keyword)
- Send flush request to startd and send result to caller (**flush** keyword)
- Send suspend request to startd and send result to caller (**suspend** keyword)
- Send resume request to startd and Schedd, and send result to caller (**resume** keyword)

The Schedd daemon

The **Schedd** daemon receives jobs sent by the **llsubmit** command and manages those jobs to machines selected by the negotiator daemon. The Schedd daemon is started, restarted, signalled, and stopped by the master daemon.

The Schedd daemon can be in any one of the following activity states:

Available
This machine is available to schedule jobs.

Drained
The Schedd machine accepts no more jobs. There are no jobs in starting or running state. Jobs in the Idle state are drained, meaning they will not get dispatched.

Draining
The Schedd daemon is being drained by the administrator but some jobs are still running. The state of the machine remains Draining until all running jobs complete. At that time, the machine status changes to Drained.

Down The daemon is not running on this machine. The Schedd daemon enters this state when it has not reported its status to the negotiator. This can occur when the machine is actually down, or because there is a network failure.

The Schedd daemon performs the following functions:

- Assigns new job identifiers when requested by the job submission process (for example, by the **llsubmit** command).
- Receives new jobs from the **llsubmit** command. A new job is received as a *job object* for each job step. A job object is the data structure in memory containing all the information about a job step. The Schedd forwards the job object to the negotiator daemon as soon as it is received from the submit command.
- Maintains on disk copies of jobs submitted locally (on this machine) that are either waiting or running on a remote (different) machine. The central manager can use this information to reconstruct the job information in the event of a failure. This information is also used for accounting purposes.
- Responds to directives sent by the administrator through the negotiator daemon. The directives include:
  - Run a job.
  - Change the priority of a job.
  - Remove a job.
  - Hold or release a job.
  - Send information about all jobs.

- Sends job events to the negotiator daemon when:
  - Schedd is restarting.
  - A new series of job objects are arriving.
  - A job is started.
  - A job was rejected, completed, removed, or vacated. Schedd determines the status by examining the exit status returned by the startd.
- Communicates with the Parallel Operating Environment (POE) when you run an interactive POE job.
- Requests that a remote startd daemon end a job.
- Receives accounting information from startd.
- Receives requests for reservations.
- Collects resource usage data when jobs terminate and stores it as historic fair share data in the $(SPOOL) directory.
- Sends historic fair share data to the central manager when it is updated or when the **Schedd** daemon is restarted.
- Maintains and stores records of historic CPU and IBM System Blue Gene® Solution utilization for users and groups known to the Schedd.
- Passes the historic CPU and Blue Gene utilization data to the central manager.

The startd daemon

The **startd** daemon monitors the status of each job, reservation, and machine in the cluster, and forwards this information to the negotiator daemon.

The startd also receives and executes job requests originating from remote machines. The master daemon starts, restarts, signals, and stops the startd daemon.

Checkpoint/restart is not supported in LoadLeveler for Linux. If a checkpointed job is sent to a Linux node, the Linux node will reject the job.

The startd daemon can be in any one of the following states:

Busy The maximum number of jobs are running on this machine as specified by the **MAX_STARTERS** configuration keyword.

Down The daemon is not running on this machine. The startd daemon enters this state when it has not reported its status to the negotiator. This can occur when the machine is actually down, or because there is a network failure.

Drained
The startd machine will not accept any new jobs. No jobs are running when startd is in the drained state.

Draining
The startd daemon is being drained by the administrator, but some jobs are still running. The machine remains in the draining state until all of the running jobs have completed, at which time the machine status changes to drained. The startd daemon will not accept any new jobs while in the draining state.

Flush Any running jobs have been vacated (terminated and returned to the queue to be redispatched). The startd daemon will not accept any new jobs.

Idle The machine is not running any jobs.

None LoadLeveler is running on this machine, but no jobs can run here.

Running
The machine is running one or more jobs and is capable of running more.

Suspend
All LoadLeveler jobs running on this machine are stopped (cease processing), but remain in virtual memory. The startd daemon will not accept any new jobs.

The startd daemon performs these functions:

- Runs a time-out procedure that includes building a snapshot of the state of the machine that includes static and dynamic data. This time-out procedure is run at the following times:
  - After a job completes.
  - According to the definition of the **POLLING_FREQUENCY** keyword in the configuration file.
- Records the following information in LoadLeveler variables and sends the information to the negotiator.
  - State (of the startd daemon)
  - EnteredCurrentState
  - Memory
  - Disk
  - KeyboardIdle
  - Cpus
  - LoadAvg
  - Machine
  - Adapter
  - AvailableClasses
- Calculates the SUSPEND, RESUME, CONTINUE, and VACATE expressions through which you can manage job status.
- Receives job requests from the Schedd daemon to:
  - Start a job
  - Preempt or resume a job
  - Vacate a job
  - Cancel

  When the Schedd daemon tells the startd daemon to start a job, the startd determines whether its own state permits a new job to run:

Table 5. startd determines whether its own state permits a new job to run

If:	Then this happens:
Yes, it can start a new job	The startd forks a **starter** process.
No, it cannot start a new job	The startd rejects the request for one of the following reasons: • Jobs have been suspended, flushed, or drained • The job limit set for the **MAX_STARTERS** keyword has been reached • There are not enough classes available for the designated job class

- Receives requests from the master (through the **llctl** command) to do one of the following:
  - Drain (**drain** keyword)
  - Flush (**flush** keyword)
  - Suspend (**suspend** keyword)
  - Resume (**resume** keyword)

- For each request, startd marks its own new state, forwards its new state to the negotiator daemon, and then performs the appropriate action for any jobs that are active.
- Receives notification of keyboard and mouse activity from the kbdd daemon
- Periodically examines the process table for LoadLeveler jobs and accumulates resources consumed by those jobs. This resource data is used to determine if a job has exceeded its job limit and for recording in the history file.
- Send accounting information to Schedd.

The starter process

The startd daemon spawns a **starter** process after the Schedd daemon tells the startd daemon to start a job.

The starter process manages all the processes associated with a job step. The starter process is responsible for running the job and reporting status back to the startd daemon.

The starter process performs these functions:

- Processes the prolog and epilog programs as defined by the **JOB_PROLOG** and **JOB_EPILOG** keywords in the configuration file. The job will not run if the prolog program exits with a return code other than zero.
- Handles authentication. This includes:
  - Authenticates AFS, if necessary
  - Verifies that the submitting user is *not* root
  - Verifies that the submitting user has access to the appropriate directories in the local file system.
- Runs the job by forking a child process that runs with the user ID and all groups of the submitting user. That child process creates a new process group of which it is the process group leader, and executes the user's program or a shell.

  The starter process is responsible for detecting the termination of any process that it forks. To ensure that all processes associated with a job are terminated after the process forked by the starter terminates, process tracking must be enabled. To configure LoadLeveler for process tracking, see "Tracking job processes" on page 70.
- Responds to vacate and suspend orders from the startd.

The negotiator daemon

The **negotiator** daemon maintains status of each job and machine in the cluster and responds to queries from the **llstatus** and **llq** commands.

The negotiator daemon runs on a single machine in the cluster (the central manager machine). This daemon is started, restarted, signalled, and stopped by the master daemon.

In a mixed cluster, the negotiator daemon must run on an AIX node.

The negotiator daemon receives status messages from each Schedd and startd daemon running in the cluster. The negotiator daemon tracks:
- Which Schedd daemons are running
- Which startd daemons are running, and the status of each startd machine.

If the negotiator does not receive an update from any machine within the time period defined by the **MACHINE_UPDATE_INTERVAL** keyword, then the negotiator assumes that the machine is down, and therefore the Schedd and startd daemons are also down.

The negotiator also maintains in its memory several queues and tables which determine where the job should run.

The negotiator performs the following functions:

- Receives and records job status changes from the Schedd daemon.
- Schedules jobs based on a variety of scheduling criteria and policy options. Once a job is selected, the negotiator contacts the Schedd that originally created the job.
- Handles requests to:
  - Set priorities
  - Query about jobs, machines, classes, and reservations
  - Change reservation attributes
  - Bind jobs to reservations
  - Remove a reservation
  - Remove a job
  - Hold or release a job
  - Favor or unfavor a user or a job.
- Receives notification of Schedd resets indicating that a Schedd has restarted.

The kbdd daemon

The kbdd daemon monitors keyboard and mouse activity.

The kbdd daemon is spawned by the master daemon if the **X_RUNS_HERE** keyword in the configuration file is set to **true**.

The kbdd daemon notifies the startd daemon when it detects keyboard or mouse activity; however, kbdd is *not* interrupt driven. It sleeps for the number of seconds defined by the **POLLING_FREQUENCY** keyword in the LoadLeveler configuration file, and then determines if X events, in the form of mouse or keyboard activity, have occurred. For more information on the configuration file, see Chapter 5, "Defining LoadLeveler resources to administer," on page 83.

The gsmonitor daemon

The gsmonitor daemon is not available in LoadLeveler for Linux.

The negotiator daemon monitors for down machines based on the heartbeat responses of the **MACHINE_UPDATE_INTERVAL** time period. If the negotiator has not received an update after two **MACHINE_UPDATE_INTERVAL** periods, then it marks the machine as down, and notifies the Schedd to remove any jobs running on that machine. The gsmonitor daemon (**LoadL_GSmonitor**) allows this cleanup to occur more reliably. The gsmonitor daemon uses the Group Services Application Programming Interface (GSAPI) to monitor machine availability on peer domains and to notify the negotiator quickly when a machine is no longer reachable.

If the **GSMONITOR_DOMAIN** keyword was not specified in the LoadLeveler configuration file, then LoadLeveler will try to determine if the machine is running in a peer (cluster) domain. The gsmonitor must run in a peer domain. The

gsmonitor will detect that it is running in an active peer domain, then it will use the RMC API to determine the node numbers and names of machines running in the cluster.

If the administrator sets up a LoadLeveler administration file that contains OSIs spanning several peer domains then a gsmonitor daemon must be started in each domain. A gsmonitor daemon can monitor only the OSIs contained in the domain within which it is running. The administrator specifies which OSIs run the gsmonitor daemon by specifying **GSMONITOR_RUNS_HERE=TRUE** in the local configuration file for that OSI. The default for **GSMONITOR_RUNS_HERE** is False.

The gsmonitor daemon should be run on one or two nodes in the peer domain. By running **LoadL_GSmonitor** on more than one node in a domain you will have a backup in case one of the nodes that the monitor is running on goes down. **LoadL_GSmonitor** subscribes to the Group Services system-defined host membership group, which is represented by the **HA_GS_HOST_MEMBERSHIP** Group Services keyword. This group monitors every configured node in the system partition and every node in the active peer domain.

Note:

1. The Group Services routines need to be run as root, so the **LoadL_GSmonitor** executable must be owned by root and have the setuid permission bit enabled.
2. It will not cause a problem to run more than one **LoadL_GSmonitor** daemon per peer domain, this will just cause the negotiator to be notified by each running daemon.
3. For more information about the Group Services subsystem, see the *RSCT Administration Guide*, SA22-7889 for peer domains.
4. For more information about GSAPI, see *Group Services Programming Guide and Reference*, SA22-7355.

The LoadLeveler job cycle

To illustrate the flow of job information through the LoadLeveler cluster, a description and sequence of diagrams have been provided.

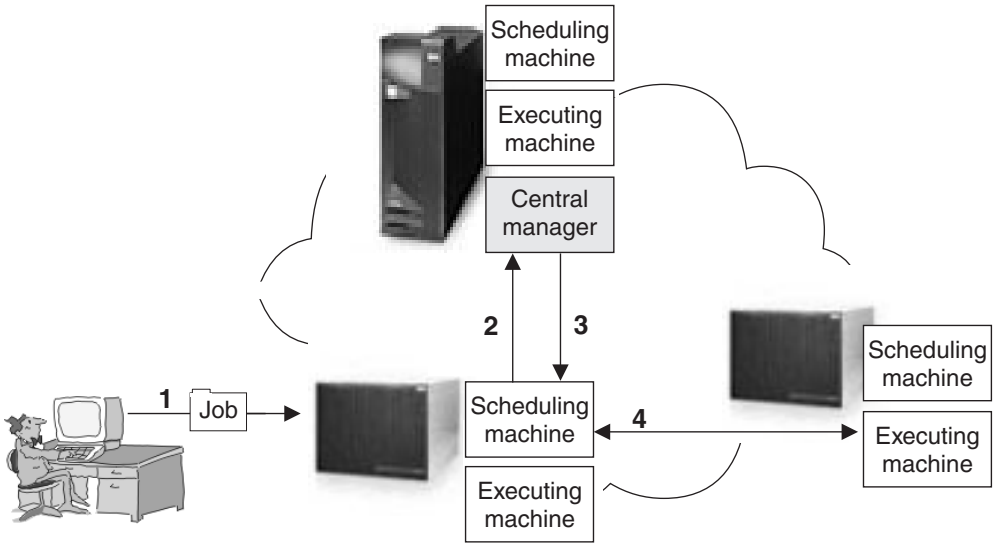

Figure 4. High-level job flow

The managing machine in a LoadLeveler cluster is known as the **central manager**. There are also machines that act as schedulers, and machines that serve as the executing machines. The arrows in Figure 4 illustrate the following:

- Arrow 1 indicates that a job has been submitted to LoadLeveler.
- Arrow 2 indicates that the scheduling machine contacts the central manager to inform it that a job has been submitted, and to find out if a machine exists that matches the job requirements.
- Arrow 3 indicates that the central manager checks to determine if a machine exists that is capable of running the job. Once a machine is found, the central manager informs the scheduling machine which machine is available.
- Arrow 4 indicates that the scheduling machine contacts the executing machine and provides it with information regarding the job. In this case, the scheduling and executing machines are different machines in the cluster, but they do not have to be different; the scheduling and executing machines may be the same physical machine.

Figure 4 is broken down into the following more detailed diagrams illustrating how LoadLeveler processes a job. The diagrams indicate specific job states for this example, but do not list all of the possible states for LoadLeveler jobs. A complete list of job states appears in "LoadLeveler job states" on page 19.

1. Submit a LoadLeveler job:

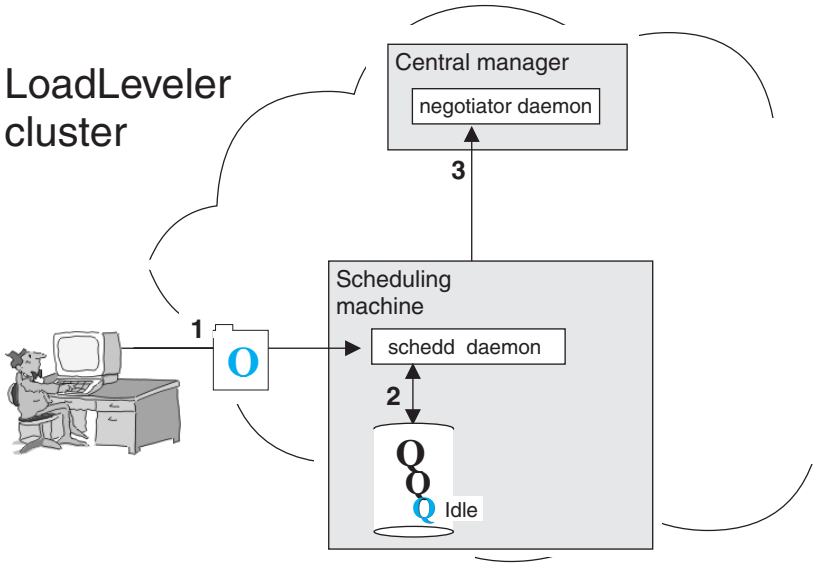

Figure 5. Job is submitted to LoadLeveler

Figure 5 illustrates that the Schedd daemon runs on the scheduling machine. This machine can also have the startd daemon running on it. The negotiator daemon resides on the central manager machine. The arrows in Figure 5 illustrate the following:

- Arrow 1 indicates that a job has been submitted to the scheduling machine.
- Arrow 2 indicates that the Schedd daemon, on the scheduling machine, stores all of the relevant job information on local disk.
- Arrow 3 indicates that the Schedd daemon sends job description information to the negotiator daemon. At this point, the submitted job is in the Idle state.

2. Permit to run:

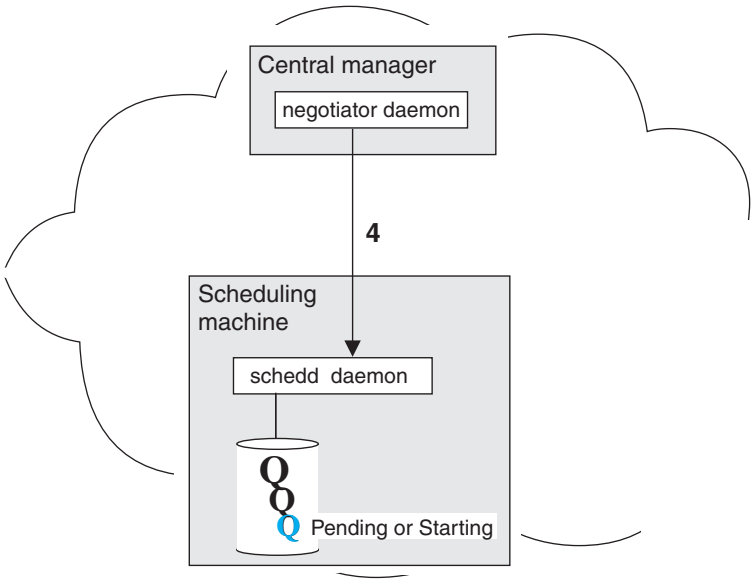

Figure 6. LoadLeveler authorizes the job

In Figure 6 on page 17, arrow 4 indicates that the negotiator daemon authorizes the Schedd daemon to begin taking steps to run the job. This authorization is called a *permit to run*. Once this is done, the job is considered Pending or Starting.

3. Prepare to run:

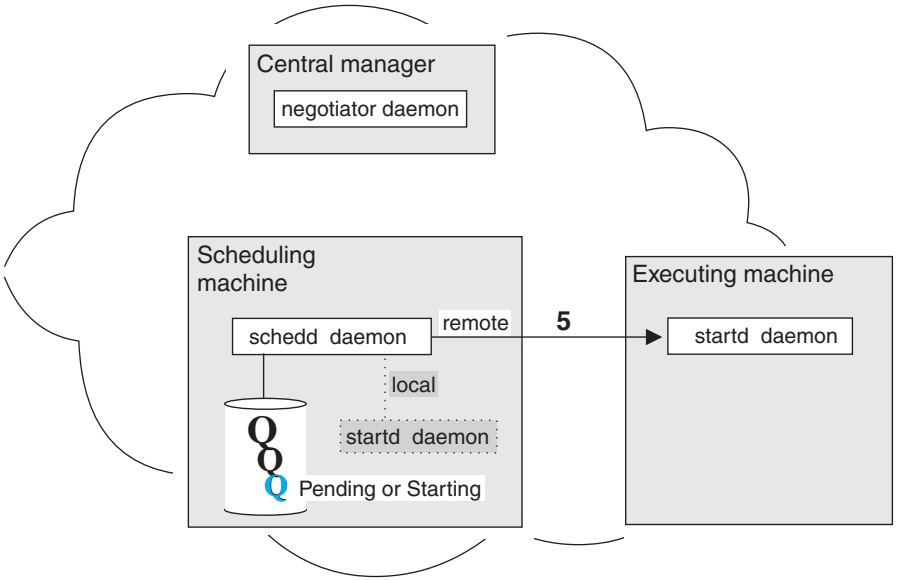

Figure 7. LoadLeveler prepares to run the job

In Figure 7, arrow 5 illustrates that the Schedd daemon contacts the startd daemon on the executing machine and requests that it start the job. The executing machine can either be a local machine (the machine to which the job was submitted) or another machine in the cluster. In this example, the local machine is **not** the executing machine.

4. Initiate job:

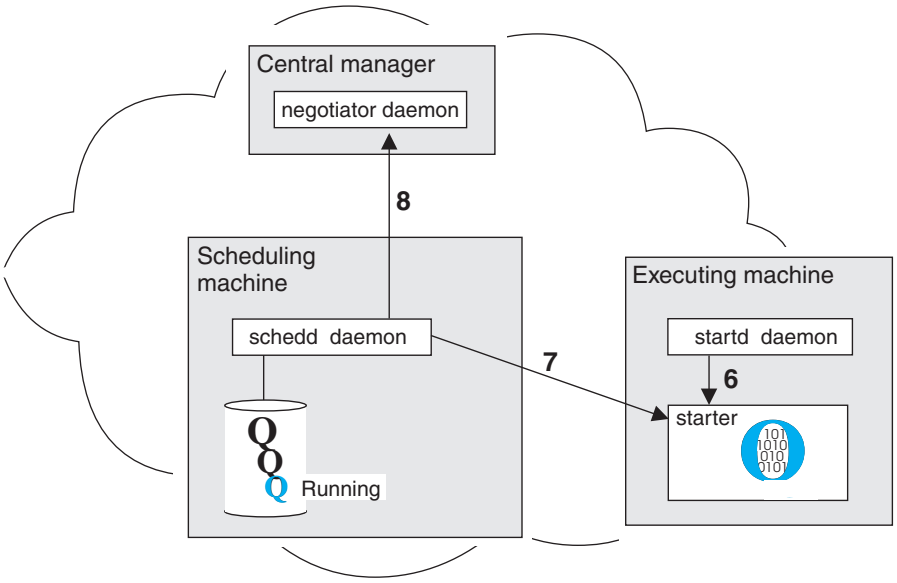

Figure 8. LoadLeveler starts the job

The arrows in Figure 8 on page 18 illustrate the following:

- Arrow 6 indicates that the **startd** daemon on the executing machine spawns a **starter** process for the job.
- Arrow 7 indicates that the Schedd daemon sends the starter process the job information and the executable.
- Arrow 8 indicates that the Schedd daemon notifies the negotiator daemon that the job has been started and the negotiator daemon marks the job as Running.

The starter forks and executes the user's job, and the starter parent waits for the child to complete.

5. Complete job:

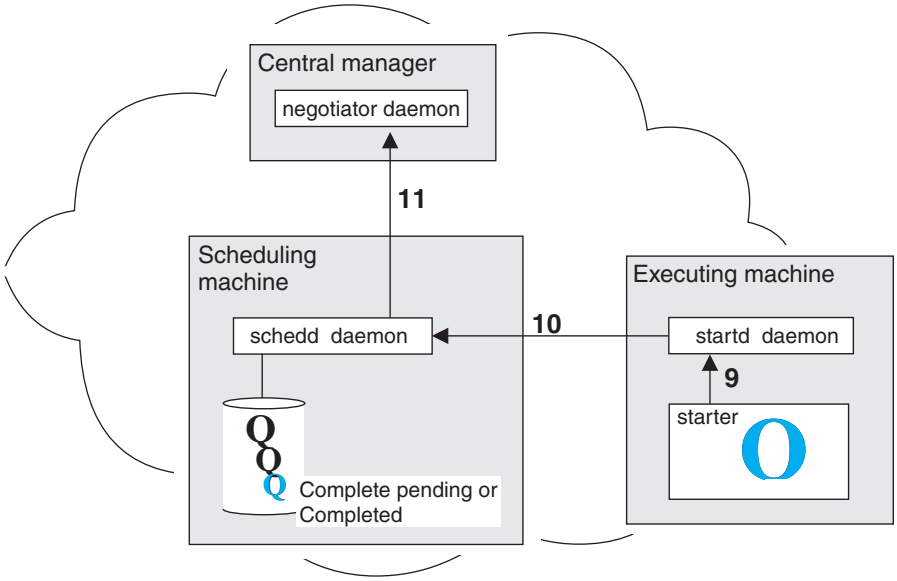

Figure 9. LoadLeveler completes the job

The arrows in Figure 9 illustrate the following:

- Arrow 9 indicates that when the job completes, the starter process notifies the startd daemon.
- Arrow 10 indicates that the startd daemon notifies the Schedd daemon.
- Arrow 11 indicates that the Schedd daemon examines the information it has received, and forwards it to the negotiator daemon. At this point, the job is in Completed or Complete Pending state.

LoadLeveler job states

As LoadLeveler processes a job, the job moves through various states.

These states are listed in Table 6 on page 20. Job states that include "Pending," such as Complete Pending and Vacate Pending, are intermediate, temporary states.

Some options on LoadLeveler interfaces are valid only for jobs in certain states. For example, the **llmodify** command has options that apply only to jobs that are in the Idle state, or in states that are similar to it. To determine which job states are similar to the Idle state, use the "Similar to..." column in Table 6 on page 20, which

indicates whether a particular job state is similar to the Idle, Running, or Terminating state. A dash (—) indicates that the state is not similar to an Idle, Running, or Terminating state.

Table 6. Job state descriptions and abbreviations

Job state	Similar to Idle or Running state?	Abbreviation in displays / output	Description
Canceled	Terminating	CA	The job was canceled either by a user or by an administrator.
Checkpointing	Running	CK	Indicates that a checkpoint has been initiated.
Completed	Terminating	C	The job has completed.
Complete Pending	Terminating	CP	The job is in the process of being completed.
Deferred	Idle	D	The job will not be assigned to a machine until a specified date. This date may have been specified by the user in the job command file, or may have been generated by the negotiator because a parallel job did not accumulate enough machines to run the job. Only the negotiator places a job in the Deferred state.
Idle	Idle	I	The job is being considered to run on a machine, though no machine has been selected.
Not Queued	Idle	NQ	The job is not being considered to run on a machine. A job can enter this state because the associated Schedd is down, the user or group associated with the job is at its maximum **maxqueued** or **maxidle** value, or because the job has a dependency which cannot be determined. For more information on these keywords, see “Controlling the mix of idle and running jobs” on page 721. (Only the negotiator places a job in the NotQueued state.)
Not Run	—	NR	The job will never be run because a dependency associated with the job was found to be false.
Pending	Running	P	The job is in the process of starting on one or more machines. (The negotiator indicates this state until the Schedd acknowledges that it has received the request to start the job. Then the negotiator changes the state of the job to Starting. The Schedd indicates the Pending state until all startd machines have acknowledged receipt of the start request. The Schedd then changes the state of the job to Starting.)

Table 6. Job state descriptions and abbreviations (continued)

Job state	Similar to Idle or Running state?	Abbreviation in displays / output	Description
Preempted	Running	E	The job is preempted. This state applies only when LoadLeveler uses the suspend method to preempt the job.
Preempt Pending	Running	EP	The job is in the process of being preempted. This state applies only when LoadLeveler uses the suspend method to preempt the job.
Rejected	Idle	X	The job is rejected.
Reject Pending	Idle	XP	The job did not start. Possible reasons why a job is rejected are: job requirements were not met on the target machine, or the user ID of the person running the job is not valid on the target machine. After a job leaves the Reject Pending state, it is moved into one of the following states: Idle, User Hold, or Removed.
Removed	Terminating	RM	The job was stopped by LoadLeveler.
Remove Pending	Terminating	RP	The job is in the process of being removed, but not all associated machines have acknowledged the removal of the job.
Resume Pending	Running	MP	The job is in the process of being resumed.
Running	Running	R	The job is running: the job was dispatched and has started on the designated machine.
Starting	Running	ST	The job is starting: the job was dispatched, was received by the target machine, and LoadLeveler is setting up the environment in which to run the job. For a parallel job, LoadLeveler sets up the environment on all required nodes. See the description of the “Pending” state for more information on when the negotiator or the Schedd daemon moves a job into the Starting state.
System Hold	Idle	S	The job has been put in system hold.

Table 6. Job state descriptions and abbreviations (continued)

Job state	Similar to Idle or Running state?	Abbreviation in displays / output	Description
Terminated	Terminating	TX	If the negotiator and Schedd daemons experience communication problems, they may be temporarily unable to exchange information concerning the status of jobs in the system. During this period of time, some of the jobs may actually complete and therefore be removed from the Schedd's list of active jobs. When communication resumes between the two daemons, the negotiator will move such jobs to the Terminated state, where they will remain for a set period of time (specified by the NEGOTIATOR_REMOVE_COMPLETED keyword in the configuration file). When this time has passed, the negotiator will remove the jobs from its active list.
User & System Hold	Idle	HS	The job has been put in both system hold and user hold.
User Hold	Idle	H	The job has been put in user hold.
Vacated	Idle	V	The job started but did not complete. The negotiator will reschedule the job (provided the job is allowed to be rescheduled). Possible reasons why a job moves to the Vacated state are: the machine where the job was running was flushed, the VACATE expression in the configuration file evaluated to True, or LoadLeveler detected a condition indicating the job needed to be vacated. For more information on the VACATE expression, see "Managing job status through control expressions" on page 68.
Vacate Pending	Idle	VP	The job is in the process of being vacated.

Consumable resources

Consumable resources are assets available on machines in your LoadLeveler cluster.

These assets are called ″resources″ because they model the commodities or services available on machines (including CPUs, real memory, virtual memory, large page memory, software licenses, disk space). They are considered ″consumable″ because job steps use specified amounts of these commodities when the step is running. Once the step finishes, the resource becomes available for another job step.

Consumable resources which model the characteristics of a specific machine (such as the number of CPUs or the number of specific software licenses available only on that machine) are called machine resources. Consumable resources which model resources that are available across the LoadLeveler cluster (such as floating software licenses) are called floating resources. For example, consider a

configuration with 10 licenses for a given program (which can be used on any machine in the cluster). If these licenses are defined as floating resources, all 10 can be used on one machine, or they can be spread across as many as 10 different machines.

The LoadLeveler administrator can specify:

- Consumable resources to be considered by LoadLeveler's scheduling algorithms
- Quantity of resources available on specific machines
- Quantity of floating resources available on machines in the cluster
- Consumable resources to be considered in determining the priority of executing machines
- Default amount of resources consumed by a job step of a specified job class
- Whether CPU, real memory, virtual memory, or large page resources should be enforced using AIX Workload Manager (WLM)
- Whether all jobs submitted need to specify resources

Users submitting jobs can specify the resources consumed by each task of a job step, or the resources consumed by the job on each machine where it runs, regardless of the number of tasks assigned to that machine.

If affinity scheduling support is enabled, the CPUs requested in the consumable resources requirement of a job will be used by the scheduler to determine the number of CPUs to be allocated and attached to that job's tasks running on machines enabled for affinity scheduling. However, if the affinity scheduling request contains the processor-core affinity option, the number of CPUs will be determined from the value specified by the **task_affinity** keyword instead of the CPU's value in the consumable resources requirement. For more information on scheduling affinity, see "LoadLeveler scheduling affinity support" on page 146.

Note:

1. When software licenses are used as a consumable resource, LoadLeveler does not attempt to obtain software licenses or to verify that software licenses have been obtained. However, by providing a user exit that can be invoked as a submit filter, the LoadLeveler administrator can provide code to first obtain the required license and then allow the job step to run. For more information on filtering job scripts, see "Filtering a job script" on page 76.
2. LoadLeveler scheduling algorithms use the availability of requested consumable resources to determine the machine or machines on which a job will run. Consumable resources (except for CPU, real memory, virtual memory and large page) are only used for scheduling purposes and are not enforced. Instead, LoadLeveler's negotiator daemon keeps track of the consumable resources available by reducing them by the amount requested when a job step is scheduled, and increasing them when a consuming job step completes.
3. If a job is preempted, the job continues to use all consumable resources except for ConsumableCpus and ConsumableMemory (real memory) which are made available to other jobs.
4. When the network adapters on a machine support RDMA, the machine is automatically given a consumable resource called RDMA with an available quantity defined by the limit on the number of concurrent jobs that use RDMA. For machines with the "Switch Network Interface for HPS" network adapters, this limit is 4. Machines with InfiniBand adapters are given unlimited RDMA resources.

5. When steps require RDMA, either because they request bulkxfer or because they request rcxtblocks on at least one network statement, the job is automatically given a resource requirement for 1 RDMA.

Consumable resources and AIX Workload Manager

If the administrator has indicated that resources should be enforced, LoadLeveler uses AIX Workload Manager (WLM) to give greater control over CPU, real memory, virtual memory and large page resource allocation.

WLM monitors system resources and regulates their allocation to processes running on AIX. These actions prevent jobs from interfering with each other when they have conflicting resource requirements. WLM achieves this control by creating different classes of service and allowing attributes to be specified for those classes.

LoadLeveler dynamically generates WLM classes with specific resource entitlements. A single WLM class is created for each job step and the process id of that job step is assigned to that class. This is done for each node that a job step is assigned to run on. LoadLeveler then defines resource shares or limits for that class depending on the LoadLeveler enforcement policy defined. These resource shares or limits represent the job's requested resource usage in relation to the amount of resources available on the machine.

When LoadLeveler defines multiple memory resources under one WLM class, AIX WLM uses the following order to determine if resource limits have been exceeded:

1. Real Memory Absolute Limit
2. Virtual Memory Absolute Limit
3. Large Page Limit
4. Real Memory shares or percent limit

Note: When real memory or CPU with either shares or percent limits are exceeded, the job processes in that class receive a lower scheduling priority until their utilization drops below the hard max limit. When virtual memory or absolute real memory limits are exceeded, the job processes are killed. When the large page limit is exceeded, any new large page requests are denied.

When the enforcement policy is shares, LoadLeveler assigns a share value to the class based on the resources requested for the job step (one unit of resource equals one share). When the job step process is running, AIX WLM dynamically calculates an appropriate resource entitlement based on the WLM class share value of the job step and the total number of shares requested by all active WLM classes. It is important to note that AIX WLM will only enforce these target percentages when the resource is under contention.

When the enforcement policy is limits (soft or hard), LoadLeveler assigns a percentage value to the class based on the resources requested for the job step and the total machine resources. This resource percentage is enforced regardless of any other active WLM classes. A soft limit indicates the maximum amount of the resource that can be made available when there is contention for the resources. This maximum can be exceeded if no one else requires the resource. A hard limit indicates the maximum amount of the resource that can be made available even if there is no contention for the resources.

Note: A WLM class is active for the duration of a job step and is deleted when the job step completes. There is a limit of 64 active WLM classes per machine. Therefore, when resources are being enforced, only 64 job steps can be running on one machine.

For additional information about integrating LoadLeveler with AIX Workload Manager, see "Steps for integrating LoadLeveler with the AIX Workload Manager" on page 137.

Overview of reservations

Under the BACKFILL scheduler only, LoadLeveler allows authorized users to make reservations, which specify a time period during which specific node resources are reserved for exclusive use by particular users or groups. This capability is known in the computing industry as advance reservation.

Normally, jobs wait to be dispatched until the resources they require become available. Through the use of reservations, wait time can be reduced because the jobs have exclusive use of the node resources (CPUs, memory, disk drives, communication adapters, and so on) as soon as the reservation period begins.

Note: Advance reservation supports Blue Gene resources including the Blue Gene compute nodes. For more information, see "Blue Gene reservation support" on page 159.

In addition to reducing wait time, reservations also are useful for:

- Running a workload that needs to start or finish at a particular time. The job steps must be associated with, or bound to, the reservation before LoadLeveler can run them during the reservation period.
- Reserving resources for a workload that repeats at regular intervals. You can make a single request to create a recurring reservation, which reserves a specific set of resources for a specific time slot that repeats on a regular basis for a defined interval.
- Setting aside a set of nodes for maintenance purposes. In this case, job steps are not bound to the reservation.

Only bound job steps may run on the reserved nodes, which means that a bound job step competes for reserved resources only with other job steps that are bound to the same reservation.

The following sequence of events describes, in general terms, how you can set up and use reservations in the LoadLeveler environment. It also describes how LoadLeveler manages activities related to the use of reservations.

1. **Configuring LoadLeveler to support reservations**

   An administrator uses specific keywords in the configuration and administration files to define general reservation policies. These keywords include:

   - **max_reservations**, when used in the *global configuration* file defines the maximum number of reservations for the entire cluster.
   - **max_reservations**, when used in a user or group stanza of the *administration* file can also be used to define both:
     - The users or groups that will be allowed to create reservations. To be authorized to create reservations, LoadLeveler administrators also must have the **max_reservations** keyword set in their own user or group stanzas.

– How many reservations users may own.

Note: With recurring advance reservations, to avoid confusion about what counts as one reservation, LoadLeveler is using the approach that one reservation counts as one instance regardless of the number of times the reservation recurs before it expires. This applies to the system wide **max_reservations** configuation setting as well as the same type of configuration settings at the user and group levels.

- **max_reservation_duration**, which defines the maximum duration for reservations.
- **reservation_permitted**, which defines the nodes that may be used for reservations.
- **max_reservation_expiration** which defines how long recurring reservations are permitted to last (expressed as the number of days).

Administrators also may configure LoadLeveler to collect accounting data about reservations when the reservations complete or are canceled.

2. **Creating reservations**

   After LoadLeveler is configured for reservations, an administrator or authorized user may create specific reservations, defining reservation attributes that include:
   - The start time and the duration of the reservation. The start and end times for a reservation are based on the time-of-day (TOD) clock on the central manager machine.
   - Whether or not the reservation recurs and if it recurs, the interval in which it does so.
   - The nodes to be reserved. Until the reservation period actually begins, the selected nodes are available to run any jobs; when the reservation starts, only jobs bound to the reservation may run on the reserved nodes.
   - The users or groups that may use the reservation.

   LoadLeveler assigns a unique ID to the reservation, and returns that ID to the owner.

   After the reservation is successfully created:
   - Reservation owners may:
     – Modify, query, and cancel their reservations.
     – Allow other LoadLeveler users or groups to submit jobs to run during a reservation period.
     – Submit jobs to run during a reservation period.
   - Users or groups that are allowed to use the reservation also may query reservations, and submit jobs to run during a reservation period. To run jobs during a reservation period, users must bind job steps to the reservation. You may bind both batch and interactive POE job steps to a reservation.

3. **Preparing for the start of a reservation**

   During the preparation time for a reservation, LoadLeveler:
   - Preempts any jobs that are still running on the reserved nodes.
   - Checks the condition of reserved nodes, and notifies the reservation owner and LoadLeveler administrators by e-mail of any situations that might require the reservation owner or an administrator to take corrective action. Such conditions include:
     – Reserved nodes that are down, suspended, no longer in the LoadLeveler cluster, or otherwise unavailable for use.
     – Non-preemptable job steps that cannot finish running before the reservation start time.

During this time, reservation owners may modify, cancel, and add users or groups to their reservations. Owners and users or groups that are allowed to use the reservation may query the reservation or bind job steps to it.

4. **Starting the reservation**

   When the reservation period begins, LoadLeveler dispatches job steps that are bound to the reservation.

   After the reservation period begins, reservation owners may modify, cancel, and add users or groups to their reservations. Owners and users or groups that are allowed to use the reservation may query the reservation or bind job steps to it.

   During the reservation period, LoadLeveler ignores system preemption rules for bound job steps; however, LoadLeveler administrators may use the **llpreempt** command to manually preempt bound job steps.

When the reservation ends or is canceled:

- LoadLeveler unbinds all job steps from the reservation if there are no further occurrences remaining. At this point the unbound job steps compete with all other LoadLeveler jobs for available resources. If there are occurrences remaining in the reservation, job steps are automatically bound to the next occurrence.
- If accounting data is being collected for the reservation, LoadLeveler also updates the reservation history file.

For more detailed information and instructions for setting up and using reservations, see:

- "Configuring LoadLeveler to support reservations" on page 131.
- "Working with reservations" on page 213.

Fair share scheduling overview

Fair share scheduling in LoadLeveler provides a way to divide resources in a LoadLeveler cluster among users or groups of users.

Historic resource usage data that is collected at the time the job ends can be used to influence job priorities to achieve the resource usage proportions allocated to users or groups of users in the LoadLeveler configuration files. The resource usage data will decay over time so that the relatively recent historic resource usage will have the most influence on job priorities. The CPU resources in the cluster and the Blue Gene resources are currently supported by fair share scheduling.

For information about configuring fair share scheduling in LoadLeveler, see "Using fair share scheduling" on page 160.

Chapter 2. Getting a quick start using the default configuration

If you are very familiar with UNIX and Linux system administration and job scheduling, follow these steps to get LoadLeveler up and running on your network quickly in a default configuration.

This default configuration will merely enable you to submit serial jobs; for a more complex setup, see Chapter 4, "Configuring the LoadLeveler environment," on page 41.

What you need to know before you begin

LoadLeveler sets up default values for configuration information.

- **loadl** is the recommended LoadLeveler user ID and the LoadLeveler group ID. LoadLeveler daemons run under this user ID to perform file I/O, and many LoadLeveler files are owned by this user ID.
- The home directory of **loadl** is the configuration directory.
- **LoadL_config** is the name of the configuration file.

For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

Using the default configuration files

Follow these steps to use the default configuration files.

Note: You can find samples of the **LoadL_admin** and **LoadL_config** files in the **release** directory (in the **samples** subdirectory).

1. Ensure that the installation procedure has completed successfully and that the configuration file, **LoadL_config**, exists in LoadLeveler's home directory or in the directory specified by the **LoadLConfig** keyword.
2. Identify yourself as the LoadLeveler administrator in the **LoadL_config** file using the **LOADL_ADMIN** keyword. The syntax of this keyword is:

   LOADL_ADMIN = *list_of_user_names* **(required)**
   Where *list_of_user_names* is a blank-delimited list of those individuals who will have administrative authority.

   Refer to "Defining LoadLeveler administrators" on page 43 for more information.
3. Define a machine to act as the LoadLeveler central manager by coding one machine stanza as follows in the administration file, which is called **LoadL_admin**. (Replace *machine_name* with the actual name of the machine.)

   ```
   machine_name: type = machine

   central_manager = true
   ```

   Do not specify more than one machine as the central manager. Also, if during installation, you ran **llinit** with the **-cm** flag, the central manager is already defined in the **LoadL_admin** file because the **llinit** command takes parameters that you entered and updates the administration and configuration files. See "Defining machines" on page 84 for more information.

LoadLeveler for Linux quick start

If you would like to quickly install and configure LoadLeveler for Linux and submit a serial job on a single node, use these procedures.

Note: This setup is for a single node only and the node used for this example is: **c197blade1b05.ppd.pok.ibm.com**.

Quick installation

Details of this installation apply tor RHEL 4 System x servers.

Note: This installation method is, however, applicable to all other systems. You must install the corresponding license RPM for the system you are installing on. This installation assumes that the LoadLeveler RPMs are located at: **/mnt/cdrom/**.

1. Log on to node `c197blade1b05.ppd.pok.ibm.com` as root, which is the node you are installing on.
2. Add a UNIX group for LoadLeveler users (make sure the group ID is correct) by entering the following command:

   ```
   groupadd -g 1000 loadl
   ```
3. Add a UNIX user for LoadLeveler (make sure the user ID is correct) by entering the following command:

   ```
   useradd -c "LoadLeveler User" -d /home/loadl -s /bin/bash -u 1001 -g 1000 -m loadl
   ```
4. Install the license RPM by entering the following command:

   ```
   rpm -ivh /mnt/cdrom/LoadL-full-license-RH4-X86-3.5.0.0-0.i386.rpm
   ```
5. Change to the LoadLeveler installation path by entering the following the command:

   ```
   cd /opt/ibmll/LoadL/sbin
   ```
6. Run the LoadLeveler installation script by entering:

   ```
   ./install_ll -y -d /mnt/cdrom
   ```
7. Install the required LoadLeveler services updates for 3.5.0.1 for this RPM.

   Updates and installation instructions are available at:

   https://www14.software.ibm.com/webapp/set2/sas/f/loadleveler/download/intel.html

Quick configuration

Use this method to perform a quick configuration.

1. Change the log in to the newly created LoadLeveler user by entering the following command:

   ```
   su - loadl
   ```
2. Add the LoadLeveler **bin** directory to the search path:

   ```
   export PATH=$PATH:/opt/ibmll/LoadL/full/bin
   ```
3. Run the LoadLeveler initialization script:

   ```
   /opt/ibmll/LoadL/full/bin/llinit -local /tmp/loadl -release /opt/ibmll/LoadL/full -cm
   c197blade1b05.ppd.pok.ibm.com
   ```

Quick verification

Use this method to perform a quick verification.

1. Start LoadLeveler by entering the following command:

   ```
   llctl start
   ```

You should receive a response similar to the following:

```
llctl: Attempting to start LoadLeveler on host c197blade1b05.ppd.pok.ibm.com
LoadL_master 3.5.0.1  rsats001a  2008/10/29 RHEL 4.0 140
CentralManager = c197blade1b05.ppd.pok.ibm.com
[loadl@c197blade1b05 bin]$
```

2. Check LoadLeveler status by entering the following command:

   ```
   llstatus
   ```

   You should receive a response similar to the following:

   ```
   Name                      Schedd InQ  Act Startd Run LdAvg Idle Arch OpSys
   c197blade1b05.ppd.pok.ibm  Avail  0    0   Idle   0   0.00  1    i386 Linux2
   i386/Linux2                  1 machines      0  jobs      0  running task
   Total Machines               1 machines      0  jobs      0  running task

   The central manager is defined on c197blade1b05.ppd.pok.ibm.com

   The BACKFILL scheduler is in use

   All machines on the machine_list are present.
   [loadl@c197blade1b05 bin]$
   ```

3. Submit a sample job, by entering the following command:

   ```
   llsubmit /opt/ibmll/LoadL/full/samples/job1.cmd
   ```

   You should receive a response similar to the following:

   ```
   llsubmit: The job "c197blade1b05.ppd.pok.ibm.com.1" with 2 job steps /
    has been submitted.
   [loadl@c197blade1b05 samples]$
   ```

4. Display the LoadLeveler job queue, by entering the following command:

   ```
   llq
   ```

   You should receive a response similar to the following:

   ```
   Id                       Owner      Submitted   ST PRI Class        Running On
   ------------------------ ---------- ----------- -- --- ------------ -----------
   c197blade1b05.1.0       loadl       8/15 17:25 R  50  No_Class     c197blade1b05
   c197blade1b05.1.1       loadl       8/15 17:25 I  50  No_Class
   2 job step(s) in queue, 1 waiting, 0 pending, 1 running, 0 held, 0 preempted
   [loadl@c197blade1b05 samples]$
   ```

5. Check output files into the home directory (**/home/loadl**) by entering the following command:

   ```
   ls -ltr job*
   ```

   You should receive a response similar to the following:

   ```
   -rw-rw-r--  1 loadl loadl 1940 Aug 15 17:26 job1.c197blade1b05.1.0.out
   -rw-rw-rw-  1 loadl loadl 1940 Aug 15 17:27 job1.c197blade1b05.1.1.out
   [loadl@c197blade1b05 ~]$
   ```

Post-installation considerations

This information explains how to start (or restart) and stop LoadLeveler. It also tells you where files are located after you install LoadLeveler, and it points you to troubleshooting information.

Starting LoadLeveler

You can start LoadLeveler using any LoadLeveler administrator user ID as defined in the configuration file.

To start all of the machines that are defined in machine stanzas in the administration file, enter:

```
llctl -g start
```

The central manager machine is the first started, followed by other machines in the order listed in the administration file. See “llctl - Control LoadLeveler daemons” on page 439 for more information.

By default, **llctl** uses **rsh** to start LoadLeveler on the target machine. Other mechanisms, such as **ssh** can be used by setting the **LL_RSH_COMMAND** configuration keyword in **LoadL_config**. However you choose to start LoadLeveler on remote hosts, you must have the authority to run commands remotely on that host.

You can verify that the machine has been properly configured by running the sample jobs in the appropriate **samples** directory (job1.cmd, job2.cmd, and job3.cmd). You must read the job2.cmd and job3.cmd files before submitting them because job2 must be edited and a C program must be compiled to use job3. It is a good idea to copy the sample jobs to another directory before modifying them; you must have read/write permission to the directory in which they are located. You can use the **llsubmit** command to submit the sample jobs from several different machines and verify that they complete (see “llsubmit - Submit a job” on page 531).

If you are running AFS and some jobs do not complete, you might need to use the AFS **fs** command (**fs listacl**) to ensure that the you have write permission to the **spool**, **execute**, and **log** directories.

If you are running with cluster security services enabled and some jobs do not complete, ensure that you have write permission to the **spool**, **execute**, and **log** directories. Also ensure that the user ID is authorized to run jobs on the submitting machine (the identity of the user must exist in the **.rhosts** file of the user on the machine on which the job is being run).

Note: LoadLeveler for Linux does not support cluster security services.

If you are running submit-only LoadLeveler, once the LoadLeveler pool is up and running, you can use the **llsubmit, llq,** and **llcancel** commands from the submit-only machines. For more information about these commands, see

- “llsubmit - Submit a job” on page 531
- “llq - Query job status” on page 479
- “llcancel - Cancel a submitted job” on page 421

You can also invoke the LoadLeveler graphical user interface **xloadl_so** from the submit-only machines (see Chapter 15, “Graphical user interface (GUI) reference,” on page 403).

Location of directories following installation

After installation, the product directories reside on disk.

The product directories that reside on disk after installation are shown in Table 7 on page 33. The installation process creates only those directories required to service the LoadLeveler options specified during the installation. For AIX, *release_directory* indicates **/usr/lpp/LoadL/full** and for Linux, it indicates **/opt/ibmll/LoadL/full**.

Table 7. Location and description of product directories following installation

Directory	Description
release_directory/bin	Part of the release directory containing daemons, commands, and other binaries
release_directory/lib	Part of the release directory containing product libraries and resource files
release_directory/man	Part of the release directory containing man pages
release_directory/samples	Part of the release directory containing sample administration and configuration files and sample jobs
release_directory/include	Part of the release directory containing header files for the application programming interfaces
Local directory	**spool**, **execute**, and **log** directories for each machine in the cluster
Home directory	Administration and configuration files, and symbolic links to the release directory
/usr/lpp/LoadL/codebase	Configuration tasks for AIX

Table 8 shows the location of directories for submit-only LoadLeveler:

Table 8. Location and description of directories for submit-only LoadLeveler

Directory	Description
release_directory/so/bin	Part of the release directory containing commands
release_directory/so/man	Part of the release directory containing man pages
release_directory/so/samples	Part of the release directory containing sample administration and configuration files
release_directory/so/lib	Contains libraries and graphical user interface resource files
Home directory	Contains administration and configuration files

If you have a mixed LoadLeveler cluster of AIX and Linux machines, you might want to make the following symbolic links:

- On AIX, as **root**, enter:

```
mkdir -p /opt/ibmll
ln -s /usr/lpp/LoadL /opt/ibmll/LoadL
```

- On Linux, as **root**, enter:

```
mkdir -p /usr/lpp
ln -s /opt/ibmll/LoadL /usr/lpp/LoadL
```

With the addition of these symbolic links, a user application can use either **/usr/lpp/LoadL** or **/opt/ibmll/LoadL** to refer to the location of LoadLeveler files regardless of whether the application is running on AIX or Linux.

If LoadLeveler will not start following installation, see "Why won't LoadLeveler start?" on page 700 for troubleshooting information.

Chapter 3. What operating systems are supported by LoadLeveler?

LoadLeveler supports three operating systems.

- **AIX 6.1 and AIX 5.3**

  IBM's AIX 6.1 and AIX 5.3 are open UNIX operating environments that conform to The Open Group UNIX 98 Base Brand industry standard. AIX 6.1 and AIX 5.3 provide high levels of integration, flexibility, and reliability and operate on IBM Power Systems and IBM Cluster 1600 servers and workstations.

  AIX 6.1 and AIX 5.3 support the concurrent operation of 32- and 64-bit applications, with key internet technologies such as Java™ and XML parser for Java included as part of the base operating system.

  A strong affinity between AIX and Linux permits popular applications developed on Linux to run on AIX 6.1 and AIX 5.3 with a simple recompilation.
- **Linux**

  LoadLeveler supports the following distributions of Linux:

  – Red Hat® Enterprise Linux (RHEL) 4 and RHEL 5

  – SUSE Linux Enterprise Server (SLES) 9 and SLES 10
- **IBM System Blue Gene Solution**

  While no LoadLeveler processes actually run on the Blue Gene machine, LoadLeveler can interact with the Blue Gene machine and supports the scheduling of jobs to the machine.

  Note: For models of the Blue Gene system such as Blue Gene/S, which can only run a single job at a time, LoadLeveler does not have to be configured to schedule resources for Blue Gene jobs. For such systems, serial jobs can be used to submit work to the front end node for the Blue Gene system.

LoadLeveler for AIX and LoadLeveler for Linux compatibility

LoadLeveler for Linux is compatible with LoadLeveler for AIX. Its command line interfaces, graphical user interfaces, and application programming interfaces (APIs) are the same as they have been for AIX. The formats of the job command file, configuration file, and administration file also remain the same.

System administrators can set up and maintain a LoadLeveler cluster consisting of some machines running LoadLeveler for AIX and some machines running LoadLeveler for Linux. This is called a mixed cluster. In this mixed cluster jobs can be submitted from either AIX or Linux machines. Jobs submitted to a Linux job queue can be dispatched to an AIX machine for execution, and jobs submitted to an AIX job queue can be dispatched to a Linux machine for execution.

Although the LoadLeveler products for AIX and Linux are compatible, they do have some differences in the level of support for specific features. For further details, see the following topics:

- "Restrictions for LoadLeveler for Linux" on page 36.
- "Features not supported in LoadLeveler for Linux" on page 36.
- "Restrictions for LoadLeveler for AIX and LoadLeveler for Linux mixed clusters" on page 37.

Restrictions for LoadLeveler for Linux

LoadLeveler for Linux supports a subset of the features that are available in the LoadLeveler for AIX product.

The following features are available, but are subject to restrictions:

- 32-bit applications using the LoadLeveler APIs

  LoadLeveler for Linux supports only the 32-bit LoadLeveler API library (libllapi.so) on the following platforms:
  - RHEL 4 and RHEL 5 on IBM IA-32 xSeries® servers
  - SLES 9 and SLES 10 on IBM IA-32 xSeries servers

  Applications linked to the LoadLeveler APIs on these platforms must be 32-bit applications.
- 64–bit applications using the LoadLeveler APIs

  LoadLeveler for Linux supports only the 64-bit LoadLeveler API library (libllapi.so) on the following platforms:
  - RHEL 4 and RHEL 5 on IBM xSeries servers with AMD Opteron or Intel EM64T processors
  - RHEL 4 and RHEL 5 on POWER™ servers
  - SLES 9 and SLES 10 on IBM xSeries servers with AMD Opteron or Intel EM64T processors
  - SLES 9 and SLES 10 on POWER servers

  Applications linked to the LoadLeveler APIs on these platforms must be 64-bit applications.
- Support for AFS file systems

  LoadLeveler for Linux support for authenticated access to AFS file systems is limited to RHEL 4 on xSeries servers and IBM xSeries servers with AMD Opteron or Intel EM64T processors. It is not available on systems running SLES 9 or SLES 10.

Features not supported in LoadLeveler for Linux

LoadLeveler for Linux supports a subset of the features that are available in the LoadLeveler for AIX product.

The following features are not supported:

- RDMA consumable resource

  On systems with High Performance Switch adapters, RDMA consumable resources are not supported on LoadLeveler for Linux.
- User context RDMA blocks

  User context RDMA blocks are not supported by LoadLeveler for Linux.
- Checkpoint/restart

  LoadLeveler for AIX uses a number of features that are specific to the AIX kernel to provide support for checkpoint/restart of user applications running under LoadLeveler. Checkpoint/restart is not available in this release of LoadLeveler for Linux.
- AIX Workload management (WLM)

  WLM can strictly control use of system resources. LoadLeveler for AIX uses WLM to enforce the use of a number of consumable resources defined by LoadLeveler (such as **ConsumableCpus**, **ConsumableVirtualMemory**,

ConsumableLargePageMemory , and **ConsumableMemory**). This enforcement of consumable resources usage through WLM is not available in this release of LoadLeveler for Linux.

- CtSec security

  LoadLeveler for AIX can exploit CtSec (Cluster Security Services) security functions. These functions authenticate the identity of users and programs interacting with LoadLeveler. These features are not available in this release of LoadLeveler for Linux.

- **LoadL_GSmonitor** daemon

  The **LoadL_GSmonitor** daemon in the LoadLeveler for AIX product uses the Group Services Application Programming Interface (GSAPI) to monitor machine availability and notify the LoadLeveler central manager when a machine is no longer reachable. This daemon is not available in the LoadLeveler for Linux product.

- Task guide tool
- System error log

  Each LoadLeveler daemon has its own log file where information relevant to its operation is recorded. In addition to this feature which exists on all platforms, LoadLeveler for AIX also uses the errlog function to record critical LoadLeveler events into the AIX system log. Support for an equivalent Linux function is not available in this release.

Restrictions for LoadLeveler for AIX and LoadLeveler for Linux mixed clusters

Several restrictions apply when operating a LoadLeveler cluster that contains AIX 6.1 and AIX 5.3 and Linux machines.

When operating a LoadLeveler cluster that contains AIX 6.1 and AIX 5.3 and Linux machines, the following restrictions apply:

- The central manager node must run a version of LoadLeveler equal to or higher than any LoadLeveler version being run on a node in the cluster.
- CtSec security features cannot be used.
- AIX jobs that use checkpointing must be sent to AIX nodes for execution. This can be done by either defining and specifying job checkpointing for job classes that exist only on AIX nodes or by coding appropriate requirements expressions. Checkpointing jobs that are sent to a Linux node will be rejected by the **LoadL_startd** daemon running on the Linux node.
- WLM is supported in a mixed cluster. However, enforcement of the use of consumable resources will occur through WLM on AIX nodes only.

Part 2. Configuring and managing the TWS LoadLeveler environment

After installing IBM Tivoli Workload Scheduler (TWS) LoadLeveler, you may customize it by modifying both the **configuration** file and the **administration** file (see Part 1, "Overview of TWS LoadLeveler concepts and operation," on page 1 for overview information). The configuration file contains many parameters that you can set or modify that will control how TWS LoadLeveler operates. The administration file optionally lists and defines the machines in the TWS LoadLeveler cluster and the characteristics of classes, users, and groups.

To easily manage TWS LoadLeveler, you should have one global configuration file and only one administration file, both centrally located on a machine in the TWS LoadLeveler cluster. Every other machine in the cluster must be able to read the configuration and administration file that are located on the central machine.

You may have multiple local configuration files that specify information specific to individual machines.

TWS LoadLeveler does not prevent you from having multiple copies of administration files, but you need to be sure to update all the copies whenever you make a change to one. Having only one administration file prevents any confusion.

Chapter 4. Configuring the LoadLeveler environment

One of your main tasks as system administrator is to configure LoadLeveler.

To configure LoadLeveler, you need to know what the configuration information is and where it is located. Configuration information includes the following:
- The LoadLeveler user ID and group ID
- The configuration directory
- The global configuration file

Configuring LoadLeveler involves modifying the configuration files that specify the terms under which LoadLeveler can use machines. There are two types of configuration files:
- *Global Configuration File:* This file by default is called the **LoadL_config** file and it contains configuration information common to all nodes in the LoadLeveler cluster.
- *Local Configuration File:* This file is generally called **LoadL_config.local** (although it is possible for you to rename it). This file contains specific configuration information for an individual node. The **LoadL_config.local** file is in the same format as **LoadL_config** and the information in this file overrides any information specified in **LoadL_config**. It is an optional file that you use to modify information on a local machine. Its full path name is specified in the **LoadL_config** file by using the **LOCAL_CONFIG** keyword. See "Specifying file and directory locations" on page 47 for more information.

Table 9 identifies where you can find more information about using configuration and administration files to modify the TWS LoadLeveler environment.

Table 9. Roadmap of tasks for TWS LoadLeveler administrators

To learn about:	Read the following:
Controlling how TWS LoadLeveler operates by customizing the global or local configuration file	Chapter 4, "Configuring the LoadLeveler environment"
Controlling TWS LoadLeveler resources by customizing an administration file	Chapter 5, "Defining LoadLeveler resources to administer," on page 83
Additional ways to modify TWS LoadLeveler that require customization of both the configuration and administration files	Chapter 6, "Performing additional administrator tasks," on page 103
Ways to control or monitor TWS LoadLeveler operations by using the TWS LoadLeveler commands, GUI, and APIs	• Chapter 16, "Commands," on page 411 • Chapter 7, "Using LoadLeveler's GUI to perform administrator tasks," on page 169 • Chapter 17, "Application programming interfaces (APIs)," on page 541

You can run your installation with default values set by LoadLeveler, or you can change any or all of them. Table 10 on page 42 lists topics that discuss how you may configure the LoadLeveler environment by modifying the configuration file.

Table 10. Roadmap of administrator tasks related to using or modifying the LoadLeveler configuration file

To learn about:	Read the following:
Using the default configuration files shipped with LoadLeveler	Chapter 2, "Getting a quick start using the default configuration," on page 29
Modifying the global and local configuration files	"Modifying a configuration file"
Defining major elements of the LoadLeveler configuration	• "Defining LoadLeveler administrators" on page 43 • "Defining a LoadLeveler cluster" on page 44 • "Defining LoadLeveler machine characteristics" on page 54 • "Defining security mechanisms" on page 56 • "Defining usage policies for consumable resources" on page 60 • "Steps for configuring a LoadLeveler multicluster" on page 151
Enabling optional LoadLeveler functions	• "Enabling support for bulk data transfer and rCxt blocks" on page 61 • "Gathering job accounting data" on page 61 • "Managing job status through control expressions" on page 68 • "Tracking job processes" on page 70 • "Querying multiple LoadLeveler clusters" on page 71
Modifying LoadLeveler operations through installation exits	"Providing additional job-processing controls through installation exits" on page 72

Modifying a configuration file

By taking a look at the configuration files that come with LoadLeveler, you will find that there are many parameters that you can set. In most cases, you will only have to modify a few of these parameters.

In some cases, though, depending upon the LoadLeveler nodes, network connection, and hardware availability, you may need to modify additional parameters.

All LoadLeveler commands, daemons, and processes read the administration and configuration files at start up time. If you change the administration or configuration files after LoadLeveler has already started, any LoadLeveler command or process, such as the **LoadL_starter** process, will read the newer version of the files while the running daemons will continue to use the data from the older version. To ensure that all LoadLeveler commands, daemons, and processes use the same configuration data, run the reconfiguration command on all machines in the cluster each time the administration or configuration files are changed.

To override the defaults, you must update the following keywords in the **/etc/LoadL.cfg** file:

LoadLUserid

Specifies the LoadLeveler user ID.

LoadLGroupid
Specifies the LoadLeveler group ID.
LoadLConfig
Specifies the full path name of the configuration file.

Note that if you change the LoadLeveler user ID to something other than **loadl**, you will have to make sure your configuration files are owned by this ID.

If Cluster Security (CtSec) services is enabled, make sure you update the **unix.map** file if the **LoadLUserid** is specified as something other than **loadl**. Refer to "Steps for enabling CtSec services" on page 58 for more details.

You can also override the **/etc/LoadL.cfg** file. For an example of when you might want to do this, see "Querying multiple LoadLeveler clusters" on page 71.

Before you modify a configuration file, you need to:

- Ensure that the installation procedure has completed successfully and that the configuration file, **LoadL_config**, exists in LoadLeveler's home directory or in the directory specified in **/etc/LoadL.cfg**. For additional details about installation, see *TWS LoadLeveler: Installation Guide*.
- Know how to correctly specify keywords in the configuration file. For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.
- Identify yourself as the LoadLeveler administrator using the **LOADL_ADMIN** keyword.

After you finish modifying the configuration file, notify LoadLeveler daemons by issuing the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the configuration file.

Defining LoadLeveler administrators

Specify the **LOADL_ADMIN** keyword with a list of user names of those individuals who will have administrative authority.

These users are able to invoke the administrator-only commands such as **llctl**, **llfavorjob**, and **llfavoruser**. These administrators can also invoke the administrator-only GUI functions. For more information, see Chapter 7, "Using LoadLeveler's GUI to perform administrator tasks," on page 169.

LoadLeveler administrators on this list also receive mail describing problems that are encountered by the master daemon. When CtSec is enabled, the **LOADL_ADMIN** list is used only as a mailing list. For more information, see "Defining security mechanisms" on page 56.

An administrator on a machine is granted administrative privileges on that machine. It does not grant him administrative privileges on other machines. To be an administrator on all machines in the LoadLeveler cluster, either specify your user ID in the global configuration file with no entries in the local configuration file, or specify your user ID in every local configuration file that exists in the LoadLeveler cluster.

For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

Defining a LoadLeveler cluster

It will be necessary to define the characteristics of the LoadLeveler cluster.

Table 11 lists the topics that discuss how you can define the characteristics of the LoadLeveler cluster.

Table 11. Roadmap for defining LoadLeveler cluster characteristics

To learn about:	Read the following:
Defining characteristics of specific LoadLeveler daemons	• "Choosing a scheduler" • "Setting negotiator characteristics and policies" on page 45 • "Specifying alternate central managers" on page 46
Defining other cluster characteristics	• "Defining network characteristics" on page 47 • "Specifying file and directory locations" on page 47 • "Configuring recording activity and log files" on page 48 • "Setting up file system monitoring" on page 54
Correctly specifying configuration file keywords	Chapter 12, "Configuration file reference," on page 263
Working with daemons and machines in a LoadLeveler cluster	• "llctl - Control LoadLeveler daemons" on page 439 • "llinit - Initialize machines in the LoadLeveler cluster" on page 457

Choosing a scheduler

This topic discusses the types of schedulers available, which you may specify using the configuration file keyword **SCHEDULER_TYPE**.

For information about the configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

LL_DEFAULT
This scheduler runs serial jobs. It efficiently uses CPU time by scheduling jobs on what otherwise would be idle nodes (and workstations). It does not require that users set a wall clock limit. Also, this scheduler starts, suspends, and resumes jobs based on workload.

BACKFILL
This scheduler runs both serial and parallel jobs. The objective of BACKFILL scheduling is to maximize the use of resources to achieve the highest system efficiency, while preventing potentially excessive delays in starting jobs with large resource requirements. These large jobs can run because the BACKFILL scheduler does not allow jobs with smaller resource requirements to continuously use up resource before the larger jobs can accumulate enough resource to run.

The BACKFILL scheduler supports:
- The scheduling of multiple tasks per node
- The scheduling of multiple user space tasks per adapter
- The preemption of jobs
- The use of reservations
- The scheduling of inbound and outbound data staging tasks

- Scale-across scheduling that allows you to take advantage of underutilized resources in a multicluster installation

These functions are not supported by the default LoadLeveler scheduler.

For more information about the BACKFILL scheduler, see "Using the BACKFILL scheduler" on page 110.

API This keyword option allows you to enable an external scheduler, such as the Extensible Argonne Scheduling sYstem (EASY). The API option is intended for installations that want to create a scheduling algorithm for parallel jobs based on site-specific requirements.

For more information about external schedulers, see "Using an external scheduler" on page 115.

Setting negotiator characteristics and policies

You may set the following negotiator characteristics and policies.

For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

- Prioritize the queue maintained by the negotiator

  Each job step submitted to LoadLeveler is assigned a system priority number, based on the evaluation of the **SYSPRIO** keyword expression in the configuration file of the central manager. The LoadLeveler system priority number is assigned when the central manager adds the new job step to the queue of job steps eligible for dispatch. Once assigned, the system priority number for a job step is not changed, except under the following circumstances:
  - An administrator or user issues the **llprio** command to change the system priority of the job step.
  - The value set for the **NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL** keyword is not zero.
  - An administrator uses the **llmodify** command with the **-s** option to alter the system priority of a job step.
  - A program with administrator credentials uses the **ll_modify** subroutine to alter the system priority of a job step.

  Job steps assigned higher **SYSPRIO** numbers are considered for dispatch before job steps with lower numbers.

  For related information, see the following topics:
  - "Controlling the central manager scheduling cycle" on page 73.
  - "Setting and changing the priority of a job" on page 230.
  - "llmodify - Change attributes of a submitted job step" on page 464.
  - "ll_modify subroutine" on page 677.
- Prioritize the order of executing machines maintained by the negotiator

  Each executing machine is assigned a machine priority number, based on the evaluation of the **MACHPRIO** keyword expression in the configuration file of the central manager. The LoadLeveler machine priority number is updated every time the central manager updates its machine data. Machines assigned higher **MACHPRIO** numbers are considered to run jobs before machines with lower numbers. For example, a machine with a **MACHPRIO** of 10 is considered to run a job before a machine with a **MACHPRIO** of 5. Similarly, a machine with a **MACHPRIO** of -2 would be considered to run a job before a machine with a **MACHPRIO** of -3.

  Note that the **MACHPRIO** keyword is valid only on the machine where the central manager is running. Using this keyword in a local configuration file has no effect.

When you use a **MACHPRIO** expression that is based on load average, the machine may be temporarily ordered later in the list immediately after a job is scheduled to that machine. This temporary drop in priority happens because the negotiator adds a compensating factor to the startd machine's load average every time the negotiator assigns a job. For more information, see the NEGOTIATOR_LOADAVG_INCREMENT keyword.

- Specify additional negotiator policies

  This topic lists keywords that were not mentioned in the previous configuration steps. Unless your installation has special requirements for any of these keywords, you can use them with their default settings.
  - **NEGOTIATOR_INTERVAL**
  - **NEGOTIATOR_CYCLE_DELAY**
  - **NEGOTIATOR_CYCLE_TIME_LIMIT**
  - **NEGOTIATOR_LOADAVG_INCREMENT**
  - **NEGOTIATOR_PARALLEL_DEFER**
  - **NEGOTIATOR_PARALLEL_HOLD**
  - **NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL**
  - **NEGOTIATOR_REJECT_DEFER**
  - **NEGOTIATOR_REMOVE_COMPLETED**
  - **NEGOTIATOR_RESCAN_QUEUE**
  - **SCALE_ACROSS_SCHEDULING_TIMEOUT**

Specifying alternate central managers

In one of your machine stanzas specified in the administration file, you specified that the machine would serve as the central manager.

It is possible for some problem to cause this central manager to become unusable such as network communication or software or hardware failures. In such cases, the other machines in the LoadLeveler cluster believe that the central manager machine is no longer operating. To remedy this situation, you can assign one or more alternate central managers in the machine stanza to take control.

The following machine stanza example defines the machine `deep_blue` as an alternate central manager:

```
#
deep_blue:  type=machine
central_manager = alt
```

If the primary central manager fails, the alternate central manager then becomes the central manager. The alternate central manager is chosen based upon the order in which its respective machine stanza appears in the administration file.

When an alternate becomes the central manager, jobs will not be lost, but it may take a few minutes for all of the machines in the cluster to check in with the new central manager. As a result, job status queries may be incorrect for a short time.

When you define alternate central managers, you should set the following keywords in the configuration file:
- **CENTRAL_MANAGER_HEARTBEAT_INTERVAL**
- **CENTRAL_MANAGER_TIMEOUT**

In the following example, the alternate central manager will wait for 30 intervals, where each interval is 45 seconds:

```
# Set a 45 second interval
CENTRAL_MANAGER_HEARTBEAT_INTERVAL = 45
# Set the number of intervals to wait
CENTRAL_MANAGER_TIMEOUT = 30
```

For more information on central manager backup, refer to "What happens if the central manager isn't operating?" on page 708. For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

Defining network characteristics

A **port number** is an integer that specifies the port to use to connect to the specified daemon.

You can define these port numbers in the configuration file or the **/etc/services** file or you can accept the defaults. LoadLeveler first looks in the configuration file for these port numbers. If LoadLeveler does not find the value in the configuration file, it looks in the **/etc/services** file. If the value is not found in this file, the default is used.

See Appendix C, "LoadLeveler port usage," on page 741 for more information.

Specifying file and directory locations

The configuration file provided with LoadLeveler specifies default locations for all of the files and directories.

You can modify their locations using the keywords shown in Table 12. Keep in mind that the LoadLeveler installation process installs files in these directories and these files may be periodically cleaned up. Therefore, you should not keep any files that do not belong to LoadLeveler in these directories.

Managing distributed software systems is a primary concern for all system administrators. Allowing users to share file systems to obtain a single, network-wide image, is one way to make managing LoadLeveler easier.

Table 12. Default locations for all of the files and directories

To specify the location of the:	Specify this keyword:
Administration file	**ADMIN_FILE**
Local configuration file	**LOCAL_CONFIG**
Local directory	The following subdirectories reside in the local directory. It is possible that the local directory and LoadLeveler's home directory are the same. • **COMM** • **EXECUTE** • **LOG** • **SPOOL** and **HISTORY** **Tip:** To maximize performance, you should keep the log, spool, and execute directories in a local file system. Also, to measure the performance of your network, consider using one of the available products, such as Toolbox/6000.

Table 12. Default locations for all of the files and directories (continued)

To specify the location of the:	Specify this keyword:
Release directory	**RELEASEDIR** The following subdirectories are created during installation and they reside in the release directory. You can change their locations. • **BIN** • **LIB**
Core dump directory	You may specify alternate directories to hold core dumps for the daemons and starter process: • **MASTER_COREDUMP_DIR** • **NEGOTIATOR_COREDUMP_DIR** • **SCHEDD_COREDUMP_DIR** • **STARTD_COREDUMP_DIR** • **GSMONITOR_COREDUMP_DIR** • **KBDD_COREDUMP_DIR** • **STARTER_COREDUMP_DIR** When specifying core dump directories, be sure that the access permissions are set so the LoadLeveler daemon or process can write to the core dump directory. The permissions set for path names specified in the keywords just mentioned must allow writing by both root and the LoadLeveler ID. The permissions set for the path name specified for the STARTER_COREDUMP_DIR keyword must allow writing by root, the LoadLeveler ID, and any user who can submit LoadLeveler jobs. The simplest way to be sure the access permissions are set correctly is to set them the same as are set for the **/tmp** directory. If a problem with access permissions prevents a LoadLeveler daemon or process from writing to a core dump directory, then a message will be written to the log, and the daemon or process will continue using the default **/tmp** directory for core files.

For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

Configuring recording activity and log files

The LoadLeveler daemons and processes keep log files according to the specifications in the configuration file.

Administrators can also configure the LoadLeveler daemons to store additional debugging messages in a circular buffer in memory. A number of keywords are used to describe where LoadLeveler maintains the logs and how much information is recorded in each log and buffer. These keywords, shown in Table 13 on page 49, are repeated in similar form to specify the path name of the log file, its maximum length, the size of the circular buffer, and the debug flags to be used for the log and the buffer.

"Controlling the logging buffer" on page 50 describes how administrators can configure LoadLeveler to buffer debugging messages.

"Controlling debugging output" on page 51 describes the events that can be reported through logging controls.

"Saving log files" on page 53 describes the configuration keyword to use to save logs for problem diagnosis.

For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

Table 13. Log control statements

Daemon/ Process	**Log File** *(required)* **(See note 1)**	**Max Length** *(required)* **(See note 2)**	**Debug Control** *(required)* **(See note 4 on page 50)**
Master	**MASTER_LOG =** *path*	**MAX_MASTER_LOG =** *bytes* [*buffer bytes*]	**MASTER_DEBUG =** *flags* [*buffer flags*]
Schedd	**SCHEDD_LOG =** *path*	**MAX_SCHEDD_LOG =** *bytes* [*buffer bytes*]	**SCHEDD_DEBUG =** *flags* [*buffer flags*]
Startd	**STARTD_LOG =** *path*	**MAX_STARTD_LOG =** *bytes* [*buffer bytes*]	**STARTD_DEBUG =** *flags* [*buffer flags*]
Starter	**STARTER_LOG** = *path*	**MAX_STARTER_LOG =** *bytes* [*buffer bytes*]	**STARTER_DEBUG =** *flags* [*buffer flags*]
Negotiator	**NEGOTIATOR_LOG =** *path*	**MAX_NEGOTIATOR_LOG =** *bytes* [*buffer bytes*]	**NEGOTIATOR_DEBUG =** *flags* [*buffer flags*]
Kbdd	**KBDD_LOG =** *path*	**MAX_KBDD_LOG =** *bytes* [*buffer bytes*]	**KBDD_DEBUG =** *flags* [*buffer flags*]
GSmonitor	**GSMONITOR_LOG =** *path*	**MAX_GSMONITOR_LOG =** *bytes* [*buffer bytes*]	**GSMONITOR_DEBUG =** *flags* [*buffer flags*]

where:

buffer bytes
: Is the size of the circular buffer. The default value is 0, which indicates that the buffer is disabled. To prevent the daemon from running out of memory, this value should not be too large. Brackets must be used to specify buffer bytes.

buffer flags
: Indicates that messages with *buffer flags* in addition to messages with *flags* will be stored in the circular buffer in memory. The default value is blank, which indicates that the logging buffer is disabled because no additional debug flags were specified for buffering. Brackets must be used to specify buffer flags.

Note:

1. When coding the *path* for the log files, it is not necessary that all LoadLeveler daemons keep their log files in the same directory, however, you will probably find it a convenient arrangement.
2. There is a maximum length, in bytes, beyond which the various log files cannot grow. Each file is allowed to grow to the specified length and is then saved to an **.old** file. The **.old** files are overwritten each time the log is saved, thus the maximum space devoted to logging for any one program will be twice the maximum length of its log file. The default length is 64 KB. To obtain records over a longer period of time, that do not get overwritten, you can use the SAVELOGS keyword in the local or global configuration files. See "Saving log files" on page 53 for more information on extended capturing of LoadLeveler logs.

You can also specify that the log file be started anew with every invocation of the daemon by setting the **TRUNC** statement to **true** as follows:
- **TRUNC_MASTER_LOG_ON_OPEN =** true | **false**
- **TRUNC_STARTD_LOG_ON_OPEN =** true | **false**
- **TRUNC_SCHEDD_LOG_ON_OPEN =** true | **false**
- **TRUNC_KBDD_LOG_ON_OPEN =** true | **false**
- **TRUNC_STARTER_LOG_ON_OPEN =** true | **false**
- **TRUNC_NEGOTIATOR_LOG_ON_OPEN =** true | **false**
- **TRUNC_GSMONITOR_LOG_ON_OPEN =** true | **false**

3. LoadLeveler creates temporary log files used by the **starter** daemon. These files are used for synchronization purposes. When a job starts, a **StarterLog.***pid* file is created. When the job ends, this file is appended to the **StarterLog** file.
4. Normally, only those who are installing or debugging LoadLeveler will need to use the debug flags, described in "Controlling debugging output" on page 51 The default error logging, obtained by leaving the right side of the debug control statement null, will be sufficient for most installations.

Controlling the logging buffer

LoadLeveler allows a LoadLeveler daemon to store log messages in a buffer in memory instead of writing the messages to a log file.

The administrator can force the messages in this buffer to be written to the log file, when necessary, to diagnose a problem. The buffer is circular and once it is full, older messages are discarded as new messages are logged. The **llctl dumplogs** command is used to write the contents of the logging buffer to the appropriate log file for the **Master**, **Negotiator**, **Schedd**, and **Startd** daemons.

Buffering will be disabled if either the buffer length is 0 or no additional debug flags are specified for buffering.

See "Configuring recording activity and log files" on page 48 for log control statement specifications. See *TWS LoadLeveler: Diagnosis and Messages Guide* for additional information on TWS LoadLeveler log files.

Logging buffer example:

With the following configuration, the **Schedd** daemon will write only **D_ALWAYS** and **D_SCHEDD** messages to the ${LOG}/SchedLog log file. The following messages will be stored in the buffer:
- **D_ALWAYS**
- **D_SCHEDD**
- **D_LOCKING**

The maximum size of the Schedd log is 64 MB and the size of the logging buffer is 32 MB.

```
SCHEDD_LOG = ${LOG}/SchedLog
MAX_SCHEDD_LOG = 64000000 [32000000]
SCHEDD_DEBUG = D_SCHEDD [D_LOCKING]
```

To write the contents of the logging buffer to SchedLog file on the machine, issue

```
llctl dumplogs
```

To write the contents of the logging buffer to the SchedLog file on **node1** in the LoadLeveler cluster, issue:

```
llctl -h node1 dumplogs
```

To write the contents of the logging buffers to the SchedLog files on all machines, issue:

```
llctl -g dumplogs
```

Note that the messages written from the logging buffer include a bracket message and a prefix to identify them easily.

```
======================BUFFER BEGIN=======================

BUFFER: message .....
BUFFER: message .....

======================BUFFER END=========================
```

Controlling debugging output

You can control the level of debugging output logged by LoadLeveler programs.

The following flags are presented here for your information, though they are used primarily by IBM personnel for debugging purposes:

D_ACCOUNT
: Logs accounting information about processes. If used, it may slow down the network.

D_ACCOUNT_DETAIL
: Logs detailed accounting information about processes. If used, it may slow down the network and increase the size of log files.

D_ADAPTER
: Logs messages related to adapters.

D_AFS
: Logs information related to AFS credentials.

D_CKPT
: Logs information related to checkpoint and restart

D_DAEMON
: Logs information regarding basic daemon set up and operation, including information on the communication between daemons.

D_DBX
: Bypasses certain signal settings to permit debugging of the processes as they execute in certain critical regions.

D_EXPR
: Logs steps in parsing and evaluating control expressions.

D_FAIRSHARE
: Displays messages related to fair share scheduling in the daemon logs. In the global configuration file, **D_FAIRSHARE** can be added to **SCHEDD_DEBUG** and **NEGOTIATOR_DEBUG**.

D_FULLDEBUG
: Logs details about most actions performed by each daemon but doesn't log as much activity as setting all the flags.

D_HIERARCHICAL
: Used to enable messages relating to problems related to the transmission of hierarchical messages. A hierarchical message is sent from an originating node to lower ranked receiving nodes.

D_JOB
: Logs job requirements and preferences when making decisions regarding whether a particular job should run on a particular machine.

D_KERNEL
Activates diagnostics for errors involving the process tracking kernel extension.

D_LOAD
Displays the load average on the startd machine.

D_LOCKING
Logs requests to acquire and release locks.

D_LXCPUAFNT
Logs messages related to Linux CPU affinity. This flag is only valid for the **startd** daemon.

D_MACHINE
Logs machine control functions and variables when making decisions regarding starting, suspending, resuming, and aborting remote jobs.

D_MUSTER
Logs information related to multicluster processing.

D_NEGOTIATE
Displays the process of looking for a job to run in the negotiator. It only pertains to this daemon.

D_PCRED
Directs that extra debug should be written to a file if the `setpcred()` function call fails.

D_PROC
Logs information about jobs being started remotely such as the number of bytes fetched and stored for each job.

D_QUEUE
Logs changes to the job queue.

D_REFCOUNT
Logs activity associated with reference counting of internal LoadLeveler objects.

D_RESERVATION
Logs reservation information in the negotiator and Schedd daemon logs. **D_RESERVATION** can be added to **SCHEDD_DEBUG** and **NEGOTIATOR_DEBUG**.

D_RESOURCE
Logs messages about the management and consumption of resources. These messages are recorded in the negotiator log.

D_SCHEDD
Displays how the Schedd works internally.

D_SDO
Displays messages detailing LoadLeveler objects being transmitted between daemons and commands.

D_SECURITY
Logs information related to Cluster Security (CtSec) services identities.

D_SPOOL
Logs information related to the usage of databases in the LoadLeveler **spool** directory.

D_STANZAS
Displays internal information about the parsing of the administration file.

D_STARTD
Displays how the startd works internally.

D_STARTER
Displays how the starter works internally.

D_STREAM
Displays messages detailing socket I/O.

D_SWITCH
Logs entries related to switch activity and LoadLeveler Switch Table Object data.

D_THREAD
Displays the ID of the thread producing the log message. The thread ID is displayed immediately following the date and time. This flag is useful for debugging threaded daemons.

D_XDR
Logs information regarding External Data Representation (XDR) communication protocols.

For example:

```
SCHEDD_DEBUG = D_CKPT  D_XDR
```

Causes the scheduler to log information about checkpointing user jobs and exchange xdr messages with other LoadLeveler daemons. These flags will primarily be of interest to LoadLeveler implementers and debuggers.

The **LL_COMMAND_DEBUG** environment variable can be set to a string of debug flags the same way as the ***_DEBUG** configuration keywords are set. Normally, LoadLeveler commands and APIs do not print debug messages, but with this environment variable set, the requested classes of debugging messages will be logged to stderr. For example:

```
LL_COMMAND_DEBUG="D_ALWAYS D_STREAM" llstatus
```

will cause the **llstatus** command to print out debug messages related to I/O to stderr.

Saving log files

By default, LoadLeveler stores only the two most recent iterations of a daemon's log file (<*daemon name*>Log, and <*daemon name*>Log.old).

Occasionally, for problem diagnosing, users will need to capture LoadLeveler logs over an extended period. Users can specify that all log files be saved to a particular directory by using the **SAVELOGS** keyword in a local or global configuration file. Be aware that LoadLeveler does not provide any way to manage and clean out all of those log files, so users must be sure to specify a directory in a file system with enough space to accommodate them. This file system should be separate from the one used for the LoadLeveler log, spool, and execute directories.

Each log file is represented by the name of the daemon that generated it, the exact time the file was generated, and the name of the machine on which the daemon is running. When you list the contents of the **SAVELOGS** directory, the list of log file names looks like this:

```
NegotiatorLogNov02.16:10:39.123456.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:42.987654.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:46.564123.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:48.234345.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:51.123456.c163n10.ppd.pok.ibm.com
NegotiatorLogNov02.16:10:53.566987.c163n10.ppd.pok.ibm.com
StarterLogNov02.16:09:19.622387.c163n10.ppd.pok.ibm.com
StarterLogNov02.16:09:51.499823.c163n10.ppd.pok.ibm.com
StarterLogNov02.16:10:30.876546.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:09:05.543677.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:09:26.688901.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:09:47.443556.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:10:12.712680.c163n10.ppd.pok.ibm.com
SchedLogNov02.16:10:37.342156.c163n10.ppd.pok.ibm.com
```

```
StartLogNov02.16:09:05.697753.c163n10.ppd.pok.ibm.com
StartLogNov02.16:09:26.881234.c163n10.ppd.pok.ibm.com
StartLogNov02.16:09:47.231234.c163n10.ppd.pok.ibm.com
StartLogNov02.16:10:12.125556.c163n10.ppd.pok.ibm.com
StartLogNov02.16:10:37.961486.c163n10.ppd.pok.ibm.com
```

For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

Setting up file system monitoring

You can use the file system keywords to monitor the file system space or inodes used by LoadLeveler.

You can use the file system keywords to monitor the file system space or inodes used by LoadLeveler for:
- Logs
- Saving executables
- Spool information
- History files

You can also use the file system keywords to take preventive action and avoid problems caused by running out of file system space or inodes. This is done by setting the frequency that LoadLeveler checks the file system free space or inodes and by setting the upper and lower thresholds that initialize system responses to the free space or inodes available. By setting a realistic span between the lower and upper thresholds, you will avoid excessive system actions.

The file system monitoring keywords are:
- **FS_INTERVAL**
- **FS_NOTIFY**
- **FS_SUSPEND**
- **FS_TERMINATE**
- **INODE_NOTIFY**
- **INODE_SUSPEND**
- **INODE_TERMINATE**

For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

Defining LoadLeveler machine characteristics

You can use the following keywords to define the characteristics of machines in the LoadLeveler cluster.

For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.
- ARCH
- CLASS
- CUSTOM_METRIC
- CUSTOM_METRIC_COMMAND
- FEATURE
- GSMONITOR_RUNS_HERE
- MAX_STARTERS
- SCHEDD_RUNS_HERE
- SCHEDD_SUBMIT_AFFINITY
- STARTD_RUNS_HERE

- START_DAEMONS
- VM_IMAGE_ALGORITHM
- X_RUNS_HERE

Defining job classes that a LoadLeveler machine will accept

There are a number of possible ways of defining job classes.

The following examples illustrate possible ways of defining job classes.

- **Example 1**

  This example specifies multiple classes:

  ```
  Class = No_Class(2)
  ```

  or

  ```
  Class = { "No_Class" "No_Class" }
  ```

  The machine will only run jobs that have either defaulted to or explicitly requested class **No_Class**. A maximum of two LoadLeveler jobs are permitted to run simultaneously on the machine if the **MAX_STARTERS** keyword is not specified. See "Specifying how many jobs a machine can run" for more information on **MAX_STARTERS**.

- **Example 2**

  This example specifies multiple classes:

  ```
  Class = No_Class(1) Small(1) Medium(1) Large(1)
  ```

  or

  ```
  Class = { "No_Class" "Small" "Medium" "Large" }
  ```

  The machine will only run a maximum of four LoadLeveler jobs that have either defaulted to, or explicitly requested **No_Class**, **Small**, **Medium**, or **Large** class. A LoadLeveler job with class **IO_bound**, for example, would not be eligible to run here.

- **Example 3**

  This example specifies multiple classes:

  ```
  Class = B(2) D(1)
  ```

  or

  ```
  Class = { "B" "B" "D" }
  ```

  The machine will run only LoadLeveler jobs that have explicitly requested class **B** or **D**. Up to three LoadLeveler jobs may run simultaneously: two of class **B** and one of class **D**. A LoadLeveler job with class **No_Class**, for example, would not be eligible to run here.

Specifying how many jobs a machine can run

To specify how many jobs a machine can run, you need to take into consideration both the **MAX_STARTERS** keyword and the **Class** statement.

This is described in more detail in "Defining LoadLeveler machine characteristics" on page 54.

For example, if the configuration file contains these statements:

```
Class = A(1) B(2) C(1)
MAX_STARTERS = 2
```

then the machine can run a maximum of two LoadLeveler jobs simultaneously. The possible combinations of LoadLeveler jobs are:

- A and B
- A and C
- B and B
- B and C
- Only A, or only B, or only C

If this keyword is specified together with a **Class** statement, the maximum number of jobs that can be run is equal to the lower of the two numbers. For example, if:

```
MAX_STARTERS = 2
Class = class_a(1)
```

then the maximum number of job steps that can be run is one (the **Class** statement defines one class).

If you specify **MAX_STARTERS** keyword without specifying a **Class** statement, by default one class still exists (called **No_Class**). Therefore, the maximum number of jobs that can be run when you do not specify a **Class** statement is one.

Note: If the **MAX_STARTERS** keyword is not defined in either the global configuration file or the local configuration file, the maximum number of jobs that the machine can run is equal to the number of classes in the **Class** statement.

Defining security mechanisms

LoadLeveler can be configured to control authentication and authorization of LoadLeveler functions by using Cluster Security (CtSec) services, a subcomponent of Reliable Scalable Cluster Technology (RSCT), which uses the host-based authentication (HBA) as an underlying security mechanism.

LoadLeveler permits only one security service to be configured at a time. You can skip this topic if you do not plan to use this security feature or if you plan to use the credential forwarding provided by the **llgetdce** and **llsetdce** program pair. Refer to “Using the alternative program pair: llgetdce and llsetdce” on page 75 for more information.

LoadLeveler for Linux does not support CtSec security.

LoadLeveler can be enabled to interact with OpenSSL for secure multicluster communications

Table 14 on page 57 lists the topics that explain LoadLeveler daemons and how you may define their characteristics and modify their behavior.

Table 14. Roadmap of configuration tasks for securing LoadLeveler operations

To learn about:	Read the following:
Securing LoadLeveler operations using cluster security services	• "Configuring LoadLeveler to use cluster security services" • "Steps for enabling CtSec services" on page 58 • "Limiting which security mechanisms LoadLeveler can use" on page 60
Enabling LoadLeveler to secure multicluster communication with OpenSSL	"Steps for securing communications within a LoadLeveler multicluster" on page 153
Correctly specifying configuration file keywords	Chapter 12, "Configuration file reference," on page 263

Configuring LoadLeveler to use cluster security services

Cluster security (CtSec) services allows a software component to authenticate and authorize the identity of one of its peers or clients.

When configured to use CtSec services, LoadLeveler will:

- Authenticate the identity of users and programs interacting with LoadLeveler.
- Authorize users and programs to use LoadLeveler services. It prevents unauthorized users and programs from misusing resources or disrupting services.

To use CtSec services, all nodes running LoadLeveler must first be configured as part of a cluster running Reliable Scalable Cluster Technology (RSCT). For details on CtSec services administration, see *IBM Reliable Scalable Cluster Technology: Administration Guide*, SA22-7889.

CtSec services are designed to use multiple security mechanisms and each security mechanism must be configured for LoadLeveler. At the present time, directions are provided only for configuring the host-based authentication (HBA) security mechanism for LoadLeveler's use. If CtSec is configured to use additional security mechanisms that are not configured for LoadLeveler's use, then the LoadLeveler configuration file keyword **SEC_IMPOSED_MECHS** must be specified. This keyword is used to limit the security mechanisms that will be used by CtSec services to only those that are configured for use by LoadLeveler.

Authorization is based on user identity. When CtSec services are enabled for LoadLeveler, user identity will differ depending on the authentication mechanism in use. A user's identity in UNIX host-based authentication is the user's network identity which is comprised of the user name and host name, such as user_name@host.

LoadLeveler uses CtSec services to authorize owners of jobs, administrators and LoadLeveler daemons to perform certain actions. CtSec services uses its own identity mapping file to map the clients' network identity to a local identity when performing authorizations. A typical local identity is the user name without a hostname. The local identities of the LoadLeveler administrators must be added as members of the group specified by the keyword **SEC_ADMIN_GROUP**. The local identity of the LoadLeveler user name must be added as the sole member of the group specified by the keyword **SEC_SERVICES_GROUP**. The LoadLeveler Services and Administrative groups, those identified by the keywords

SEC_SERVICES_GROUP and **SEC_ADMIN_GROUP**, must be the same across all nodes in the LoadLeveler cluster. To ensure consistency in performing tasks which require owner, administrative or daemon privileges across all nodes in the LoadLeveler cluster, user network identities must be mapped identically across all nodes in the LoadLeveler cluster. If this is not the case, LoadLeveler authorizations may fail.

Steps for enabling CtSec services

It is necessary to enable LoadLeveler to use CtSec services.

To enable LoadLeveler to use CtSec services, perform the following steps:

1. Include, in the Trusted Host List, the host names of all hosts with which communications may take place. If LoadLeveler tries to communicate with a host not on the Trusted Host List the message: The host identified in the credentials is not a trusted host on this system will occur. Additionally, the system administrator should ensure that public keys are manually exchanged between all hosts in the LoadLeveler cluster. Refer to *IBM Reliable Scalable Cluster Technology: Administration Guide*, SA22-7889 for information on setting up Trusted Host Lists and manually transferring public keys.
2. Create user IDs. Each LoadLeveler administrator and the LoadLeveler user ID need to be created, if they don't already exist. You can do this through SMIT or the **mkuser** command.
3. Ensure that the **unix.map** file contains the correct value for the service name **ctloadl** which specifies the LoadLeveler user name. If you have configured LoadLeveler to use **loadl** as the LoadLeveler user name, either by default or by specifying **loadl** in the **LoadLUserid** keyword of the **/etc/LoadL.cfg** file, nothing needs to be done. The default map file will contain the **ctloadl** service name already assigned to **loadl**. If you have configured a different user name in the **LoadLUserid** keyword of the **/etc/LoadL.cfg** file, you will need to make sure that the **/var/ct/cfg/unix.map** file exists and that it assigns the same user name to the **ctloadl** service name. If the **/var/ct/cfg/unix.map** file does not exist, create one by copying the default map file **/usr/sbin/rsct/cfg/unix.map**. Do not modify the default map file.

   If the value of the **LoadLUserid** and the value associated with **ctloadl** are not the same a security services error which indicates a UNIX identity mismatch will occur.
4. Add entries to the global mapping file of each machine in the LoadLeveler cluster to map network identities to local identities. This file is located at: **/var/ct/cfg/ctsec_map.global**. If this file doesn't yet exist, you should copy the default global mapping file to this location—don't modify the default mapping file. The default global mapping file, which is shared among all CtSec services exploiters, is located at **/usr/sbin/rsct/cfg/ctsec_map.global**. See *IBM Reliable Scalable Cluster Technology for AIX: Technical Reference*, SA22-78900 for more information on the mapping file.

   When adding names to the global mapping file, enter more specific entries ahead of the other, less specific entries. Remember that you must update the global mapping file on each machine in the LoadLeveler cluster, and each mapping file has to be updated with the security services identity of each member of the **administrator** group, the **services** group, and the users. Therefore, you would have entries like this:

   ```
   unix:brad@mach1.pok.ibm.com=bradleyf
   unix:brad@mach2.pok.ibm.com=bradleyf
   unix:brad@mach3.pok.ibm.com=bradleyf
   unix:marsha@mach2.pok.ibm.com=marshab
   ```

```
unix:marsha@mach3.pok.ibm.com=marshab
unix:loadl@mach1.pok.ibm.com=loadl
unix:loadl@mach2.pok.ibm.com=loadl
unix:loadl@mach3.pok.ibm.com=loadl
```

However, if you're sure your LoadLeveler cluster is secure, you could specify mapping for all machines this way:

```
unix:brad@*=bradleyf
unix:marsha@*=marshab
unix:loadl@*=loadl
```

This indicates that the UNIX network identity of the users **brad**, **marsha** and **loadl** will map to their respective security services identities on every machine in the cluster. Refer to *IBM Reliable Scalable Cluster Technology for AIX: Technical Reference*, SA22-7800 for a description of the syntax used in the **ctsec_map.global** file.

5. Create UNIX groups. The LoadLeveler **administrator** group and **services** group need to be created for every machine in the cluster and should contain the local identities of members. This can be done either by using SMIT or the **mkgroup** command.

   For example, to create the group lladmin which lists the LoadLeveler administrators:

   ```
   mkgroup "users=sam,betty,loadl" lladmin
   ```

   These groups must be created on each machine in the LoadLeveler cluster and must contain the same entries.

   To create the group llsvcs which lists the identity under which LoadLeveler daemons run using the default id of loadl:

   ```
   mkgroup users=loadl llsvcs
   ```

   These groups must be created on each machine in the LoadLeveler cluster and must contain the same entries.

6. Add or update these keywords in the LoadLeveler configuration file:

   ```
   SEC_ENABLEMENT=CTSEC
   SEC_ADMIN_GROUP=name of lladmin group
   SEC_SERVICES_GROUP=group name that contains identities of LoadLeveler daemons
   ```

   The **SEC_ENABLEMENT=CTSEC** keyword indicates that CtSec services mechanism should be used. **SEC_ADMIN_GROUP** points to the name of the UNIX group which contains the local identities of the LoadLeveler administrators. The **SEC_SERVICES_GROUP** keyword points to the name of the UNIX group which contains the local identity of the LoadLeveler daemons. All LoadLeveler daemons run as the LoadLeveler user ID. Refer to step 5 for discussion of the **administrators** and **services** groups.

7. Update the **.rhosts** file in each user's home directory. This file is used to identify which UNIX identities can run LoadLeveler jobs on the local host machine. If the file does not exist in a user's home directory, you must create it. The **.rhosts** file must contain entries which specify all host and user combinations allowed to submit jobs which will run as the local user, either explicitly or through the use of wildcards.

   Entries in the **.rhosts** file are specified this way:

   ```
   HostNameField [UserNameField]
   ```

   Refer to *IBM AIX Files Reference*, SC23-4168 for further details about the **.rhosts** file format.

Tips for configuring LoadLeveler to use CtSec services:

When using CtSec services for LoadLeveler, each machine in the LoadLeveler cluster must be set up properly.

CtSec authenticates network identities based on trust established between individual machines in a cluster, based on local host configurations. Because of this it is possible for most of the cluster to run correctly but to have transactions from certain machines experience authentication or authorization problems.

If unexpected authentication or authorization problems occur in a LoadLeveler cluster with CtSec enabled, check that the steps in "Steps for enabling CtSec services" on page 58 were correctly followed for each machine in the LoadLeveler cluster.

If any machine in a LoadLeveler cluster is improperly configured to run CtSec you may see that:

- Users cannot perform user tasks (such as cancel) for jobs they submitted.

  Either the machine the job was submitted from or the machine the user operation was submitted from (or both) do not contain mapping files for the user that specify the same security services identity. The user should attempt the operation from the same machine the job was submitted from and record the results. If the user still cannot perform a user task on a job they submitted, then they should contact the LoadLeveler administrator who should review the steps in "Steps for enabling CtSec services" on page 58.
- LoadLeveler daemons fail to communicate.

  When LoadLeveler daemons communicate they must first authenticate each other. If the daemons cannot authenticate a message will be put in the daemon log indicating an authentication failure. Ensure the Trusted Hosts List on all LoadLeveler nodes contains the correct entries for all of the nodes in the LoadLeveler cluster. Also, make sure that the LoadLeveler Services group on all nodes of the LoadLeveler cluster contains the local identity for the LoadLeveler user name. The **ctsec_map.global** must contain mapping rules to map the LoadLeveler user name from every machine in the LoadLeveler cluster to the local identity for the LoadLeveler user name. An example of what may happen when daemons fail to communicate is that an alternate central manager may take over while the primary central manager is still active. This can occur when the alternate central manager does not trust the primary central manager.

Limiting which security mechanisms LoadLeveler can use

As more security mechanisms become available, they must be configured for LoadLeveler's use.

If there are security mechanisms configured for CtSec that are not configured for LoadLeveler's use, then the LoadLeveler configuration file keyword **SEC_IMPOSED_MECHS** must specify the mechanisms configured for LoadLeveler.

Defining usage policies for consumable resources

The LoadLeveler scheduler can schedule jobs based on the availability of consumable resources.

You can use the following keywords to configure consumable resources:
- ENFORCE_RESOURCE_MEMORY

- ENFORCE_RESOURCE_POLICY
- ENFORCE_RESOURCE_SUBMISSION
- ENFORCE_RESOURCE_USAGE
- FLOATING_RESOURCES
- RESOURCES
- SCHEDULE_BY_RESOURCES

For information about configuration file keyword syntax and other details, see Chapter 12, "Configuration file reference," on page 263.

Enabling support for bulk data transfer and rCxt blocks

On systems with device drivers and network adapters that support remote direct-memory access (RDMA), LoadLeveler allows bulk data transfer for jobs that use either the Internet or user space communication protocol mode.

For jobs using the Internet protocol (IP jobs), LoadLeveler does not monitor or control the use of bulk transfer. For user space jobs that request bulk transfer, however, LoadLeveler creates a consumable RDMA resource, and limits RDMA resources to only four for a single machine with Switch Network Interface for HPS network adapters. There is no limit on RDMA resources for machines with InfiniBand network adapters.

You do not need to perform specific configuration or job-definition tasks to enable bulk transfer for LoadLeveler jobs that use the IP network protocol. LoadLeveler cannot affect whether IP communication uses bulk transfer; the implementation of IP where the job runs determines whether bulk transfer is supported.

To enable user space jobs to use bulk data transfer, you must update the LoadLeveler configuration file to include the value **RDMA** in the **SCHEDULE_BY_RESOURCES** list for machines with Switch Network Interface for HPS network adapters.

Example:

```
SCHEDULE_BY_RESOURCES = RDMA others
```

For additional information about using bulk data transfer and job-definition requirements, see "Using bulk data transfer" on page 188.

Gathering job accounting data

Your organization may have a policy of charging users or groups of users for the amount of resources that their jobs consume.

You can do this using LoadLeveler's accounting feature. Using this feature, you can produce accounting reports that contain job resource information for completed serial and parallel job steps. You can also view job resource information on jobs that are continuing to run.

The accounting record for a job step will contain separate sets of resource usage data for each time a job step is dispatched to run. For example, the accounting record for a job step that is vacated and then started again will contain two sets of resource usage data. The first set of resource usage data is for the time period when the job step was initially dispatched until the job step was vacated. The second set of resource usage data is for the time period for when the job step is dispatched after the vacate until the job step completes.

The job step's accounting data that is provided in the **llsummary** short listing and in the user mail will contain only one set of resource usage data. That data will be from the last time the job step was dispatched to run. For example, the mail message for job step completion for a job step that is checkpointed with the hold (**-h**) option and then restarted, will contain the set of resource usage data only for the dispatch that restarted the job from the checkpoint. To obtain the resource usage data for the entire job step, use the detailed **llsummary** command or accounting API.

The following keywords allow you to control accounting functions:
- **ACCT**
- **ACCT_VALIDATION**
- **GLOBAL_HISTORY**
- **HISTORY_PERMISSION**
- **JOB_ACCT_Q_POLICY**
- **JOB_LIMIT_POLICY**

For example, the following section of the configuration file specifies that the accounting function is turned on. It also identifies the default module used to perform account validation and the directory containing the global history files:

```
ACCT                = A_ON A_VALIDATE
ACCT_VALIDATION     = $(BIN)/llacctval
GLOBAL_HISTORY      = $(SPOOL)
```

Table 15 lists the topics related to configuring, gathering and using job accounting data.

Table 15. Roadmap of tasks for gathering job accounting data

To learn about:	Read the following:
Configuring LoadLeveler to gather job accounting data	• "Collecting job resource data on serial and parallel jobs" • "Collecting job resource data based on machines" on page 64 • "Collecting job resource data based on events" on page 64 • "Collecting job resource information based on user accounts" on page 65 • "Collecting accounting data for reservations" on page 63 • "Collecting the accounting information and storing it into files" on page 66 • "64-bit support for accounting functions" on page 67 • "Example: Setting up job accounting files" on page 67
Managing accounting data	• "Producing accounting reports" on page 66 • "Correlating AIX and LoadLeveler accounting records" on page 66 • "llacctmrg - Collect machine history files" on page 413 • "llsummary - Return job resource information for accounting" on page 535
Correctly specifying configuration file keywords	Chapter 12, "Configuration file reference," on page 263

Collecting job resource data on serial and parallel jobs

Information on completed serial and parallel job steps is gathered using the UNIX *wait3* system call.

Information on non-completed serial and parallel jobs is gathered in a platform-dependent manner by examining data from the UNIX process.

Accounting information on a completed serial job step is determined by accumulating resources consumed by that job on the machines that ran the job. Similarly, accounting information on completed parallel job steps is gathered by accumulating resources used on all of the nodes that ran the job step.

You can also view resource consumption information on serial and parallel jobs that are still running by specifying the **-x** option of the **llq** command. To enable **llq -x**, specify the following keywords in the configuration file:
- **ACCT** = A_ON A_DETAIL
- **JOB_ACCT_Q_POLICY** = *number*

Collecting accounting information for recurring jobs

For recurring jobs, accounting records are written as each occurrence of each step of the job completes. The reservation ID field in the accounting record can be used to distinguish one occurrence from another.

Collecting accounting data for reservations

LoadLeveler can collect accounting data for reservations, which are set periods of time during which node resources are reserved for the use of particular users or groups.

To enable recording of reservation information, specify the following keywords in the configuration file:
- To turn on accounting for reservations, add the **A_RES** flag to the **ACCT** keyword.
- To specify a file other than the default history file to contain the data, use the **RESERVATION_HISTORY** keyword.

See Chapter 12, "Configuration file reference," on page 263 for details about the **ACCT** and **RESERVATION_HISTORY** keywords.

When these keyword values are set and a reservation ends or is canceled, LoadLeveler records the following information:
- The reservation ID
- The time at which the reservation was created
- The user ID of the reservation owner
- The name of the owning group
- Requested and actual start times
- Requested and actual duration
- Actual time at which the reservation ended or was canceled
- Whether the reservation was created with the `SHARED` or `REMOVE_ON_IDLE` options
- A list of users and a list of groups that were authorized to use the reservation
- The number of reserved nodes
- The names of reserved nodes

This reservation information is appended in a single line to the reservation history file for the reservation. The format of reservation history data is:

```
Reservation ID!Reservation Creation Time!Owner!Owning Group!Start Time! \
 Actual Start Time!Duration!Actual Duration!Actual End Time!SHARED(yes|no)! \
REMOVE_ON_IDLE(yes|no)!Users!Groups!Number of Nodes!Nodes!BG C-nodes! \
 BG Connection!BG Shape!Number of BG BPs!BG BPs
```

In reservation history data:

- The unit of measure for start times and end times is the number of seconds since January 1, 1970.
- The unit of time for durations is seconds.

Note: As each occurrence of a recurring reservation completes, an accounting record is appended to the reservation history file. The format of the record is identical to that of a one time reservation. In the record, the Reservation ID includes the occurrence ID of the completed reservation.

When you cancel the *entire* recurring reservation (as opposed to only one occurrence being canceled), one additional accounting record is written. This record is based on the state of the reservation:

- If an occurrence is ACTIVE, then the end time and duration of that occurrence is set and an accounting record written.
- If there are not any ACTIVE occurrences, then an accounting record will be written for the next scheduled occurrence. This is similar to the accounting record that is written when you cancel a one time reservation in the WAITING state.

The following is an example of a reservation history file entry:

```
bgldd1.rchland.ibm.com.68.r!1150242970!ezhong!group1!1150243200!1150243200! \
 300!300!1150243500!no!no!yang!fvt,dev!1!bgldd1!0!!!0!
bgldd1.rchland.ibm.com.54.r!1150143472!ezhong!No_Group!1153612800!0!60!0! \
 1150243839!no!no!!!0!32!MESH!0x0x0!1!R010(J115)
bgldd1.rchland.ibm.com.70.r!1150244654!ezhong!No_Group!1150244760!1150244760! \
 60!60!1150244820!yes!yes!user1,user2!group1,group2!0!512!MESH!1x1x1!1!R010
```

To collect the reservation information stored in the history file, use the **llacctmrg** command with the **-R** option. For **llacctmrg** command syntax, see "llacctmrg - Collect machine history files" on page 413.

To format reservation history data contained in a file, use the sample script `llreshist.pl` in directory `${RELEASEDIR}/samples/llres/`.

Collecting job resource data based on machines

LoadLeveler can collect job resource usage information for every machine on which a job may run.

A job may run on more than one machine because it is a parallel job or because the job is vacated from one machine and rescheduled to another machine.

To enable recording of resources by machine, you need to specify **ACCT = A_ON A_DETAIL** in the configuration file.

The machine's speed is part of the data collected. With this information, an installation can develop a charge back program which can charge more or less for resources consumed by a job on different machines. For more information on a machine's speed, refer to the machine stanza information. See "Defining machines" on page 84.

Collecting job resource data based on events

In addition to collecting job resource information based upon machines used, you can gather this information based upon an event or time that you specify.

For example, you may want to collect accounting information at the end of every work shift or at the end of every week or month. To collect accounting information on all machines in this manner, use the **llctl** command with the **capture** parameter:

```
llctl -g capture eventname
```

eventname is any string of continuous characters (no white space is allowed) that defines the event about which you are collecting accounting data. For example, if you were collecting accounting data on the *graveyard* work shift, your command could be:

```
llctl -g capture graveyard
```

This command allows you to obtain a snapshot of the resources consumed by active jobs up to and including the moment when you issued the command. If you want to capture this type of information on a regular basis, you can set up a crontab entry to invoke this command regularly. For example:

```
#  sample crontab for accounting
#  shift crontab 94/8/5
#
# Set up three shifts, first, second, and graveyard shift.
#  Crontab entries indicate the end of shift.
#
#M  H d m day command
#
00 08 * *  * /u/loadl/bin/llctl -g capture graveyard
00 16 * *  * /u/loadl/bin/llctl -g capture first
00 00 * *  * /u/loadl/bin/llctl -g capture second
```

For more information on the **llctl** command, refer to "llctl - Control LoadLeveler daemons" on page 439. For more information on the collection of accounting records, see "llq - Query job status" on page 479.

Collecting job resource information based on user accounts

If your installation is interested in keeping track of resources used on an account basis, you can require all users to specify an account number in their job command files.

They can specify this account number with the **account_no** keyword which is explained in detail in "Job command file keyword descriptions" on page 359. Interactive POE jobs can specify an account number using the **LOADL_ACCOUNT_NO** environment variable.

LoadLeveler validates this account number by comparing it against a list of account numbers specified for the user in the user stanza in the administration file.

Account validation is under the control of the **ACCT** keyword in the configuration file. The routine that performs the validation is called **llacctval**. You can supply your own validation routine by specifying the **ACCT_VALIDATION** keyword in the configuration file. The following are passed as character string arguments to the validation routine:

- User name
- User's login group name
- Account number specified on the Job
- Blank-separated list of account numbers obtained from the user's stanza in the administration file.

The account validation routine must exit with a return code of zero if the validation succeeds. If it fails, the return code is a nonzero number.

Collecting the accounting information and storing it into files

LoadLeveler stores the accounting information that it collects in a file called *history* in the spool directory of the machine that initially scheduled this job, the Schedd machine. Data on parallel jobs are also stored in the *history* files.

Resource information collected on the LoadLeveler job is constrained by the capabilities of the wait3 system call. Information for processes which fork child processes will include data for those child processes as long as the parent process waits for the child process to terminate. Complete data may not be collected for jobs which are not composed of simple parent/child processes. For example, if you have a LoadLeveler job which invokes an rsh command to execute a function on another machine, the resources consumed on the other machine will not be collected as part of the LoadLeveler accounting data.

LoadLeveler accounting uses the following types of files:

- The local history file which is local to each Schedd machine is where job resource information is first recorded. These files are usually named *history* and are located in the spool directory of each Schedd machine, but you may specify an alternate name with the **HISTORY** keyword in either the global or local configuration file.
- The global history file is a combination of the history files from some or all of the machines in the LoadLeveler cluster merged together. The command **llacctmrg** is used to collect files together into a global file. As the files are collected from each machine, the local history file for that machine is reset to contain no data. The file is named *globalhist.YYYYMMDDHHmm*. You may specify the directory in which to place the file when you invoke the **llacctmrg** command or you can specify the directory with the **GLOBAL_HISTORY** keyword in the configuration file. The default value set up in the sample configuration file is the local spool directory.

Producing accounting reports

You can produce three types of reports using either the local or global history file.

These reports are called the *short*, *long*, and *extended* versions. As their names imply, the short version of the report is a brief listing of the resources used by LoadLeveler jobs. The long version provides more comprehensive detail with summarized resource usage, and the extended version of the report provides the comprehensive detail with detailed resource usage.

If you do not specify a report type, you will receive the default short version. The short report displays the number of jobs along with the total CPU usage according to user, class, group, and account number. The extended version of the report displays all of the data collected for every job.

- For examples of the short and extended versions of the report, see "llsummary - Return job resource information for accounting" on page 535.
- For information on the accounting APIs, refer to Chapter 17, "Application programming interfaces (APIs)," on page 541.

Correlating AIX and LoadLeveler accounting records

For jobs running on AIX systems, you can use a job accounting key to correlate AIX accounting records with LoadLeveler accounting records.

The job accounting key uniquely identifies each job step. LoadLeveler derives this key from the job key and the date and time at which the job entered the queue

(see the QDate variable description). The key is associated with the starter process for the job step and any of its child processes.

For checkpointed jobs, LoadLeveler does not change the job accounting key, regardless of how it restarts the job step. Jobs restarted from a checkpoint file or through a new job step retain the job accounting key for the original job step.

To access the job accounting key for a job step, you can use the following interfaces:

- The **llsummary** command, requesting the long version of the report. For details about using this command, see "llsummary - Return job resource information for accounting" on page 535.
- The **GetHistory** subroutine. For details about using this subroutine, see "GetHistory subroutine" on page 545.
- The **ll_get_data** subroutine, through the **LL_StepAcctKey** specification. For details about using this subroutine, see "ll_get_data subroutine" on page 570.

For information about AIX accounting records, see the system accounting topic in *AIX System Management Guide: Operating System and Devices*.

64-bit support for accounting functions

LoadLeveler 64-bit support for accounting functions includes several features.

LoadLeveler 64-bit support for accounting functions includes:

- Statistics of jobs such as usage, limits, consumable resources, and other 64-bit integer data are preserved in the history file as rusage64, rlimit64 structures and as data items of type int64_t.
- The LL_job_step structure defined in llapi.h allows access to the 64-bit data items either as data of type int64_t or as data of type int32_t. In the latter case, the returned values may be truncated.
- The **llsummary** command displays 64-bit information where appropriate.
- The data access API supports both 64-bit and 32-bit access to accounting and usage information in a history file. See "Examples of using the data access API" on page 633 for an example of how to use the **ll_get_data** subroutine to access information stored in a LoadLeveler history file.

Example: Setting up job accounting files

You can perform all of the steps included in this sample procedure or just the ones that apply to your situation.

The sample procedure shown in Table 16 walks you through the process of collecting account data.

1. Edit the configuration file according to the following table:

Table 16. Collecting account data - modifying the configuration file

Edit this keyword:	To:
ACCT	Turn accounting and account validation on and off and specify detailed accounting.
ACCT_VALIDATION	Specify the account validation routine.
GLOBAL_HISTORY	Specify a directory in which to place the global history files.

2. Specify account numbers and set up account validation by performing the following steps:
   a. Specify a list of account numbers a user may use when submitting jobs, by using the **account** keyword in the user stanza in the administration file.
   b. Instruct users to associate an account number with their job, by using the **account_no** keyword in the job command file.
   c. Specify the **ACCT_VALIDATION** keyword in the configuration file that identifies the module that will be called to perform account validation. The default module is called **llacctval**. You can replace this module with your installation's own accounting routine by specifying a new module with this keyword.
3. Specify machines and their weights by using the **speed** keyword in a machine's machine stanza in the administration file.

   Also, if you have in your cluster machines of differing speeds and you want LoadLeveler accounting information to be normalized for these differences, specify **cpu_speed_scale=true** in each machine's respective machine stanza.

   For example, suppose you have a cluster of two machines, called A and B, where Machine B is three times as fast as Machine A. Machine A has **speed=1.0**, and Machine B has **speed=3.0**. Suppose a job runs for 12 CPU seconds on Machine A. The same job runs for 4 CPU seconds on Machine B. When you specify **cpu_speed_scale=true**, the accounting information collected on Machine B for that job shows the normalized value of 12 CPU seconds rather than the actual 4 CPU seconds.
4. Merge multiple files collected from each machine into one file, using the **llacctmrg** command.
5. Report job information on all the jobs in the history file, using the **llsummary** command.

Managing job status through control expressions

You can control running jobs by using five control functions as Boolean expressions in the configuration file.

These functions are useful primarily for serial jobs. You define the expressions, using normal C conventions, with the following functions:
- START
- SUSPEND
- CONTINUE
- VACATE
- KILL

The expressions are evaluated for each job running on a machine using both the job and machine attributes. Some jobs running on a machine may be suspended while others are allowed to continue.

The START expression is evaluated twice; once to see if the machine can accept jobs to run and second to see if the specific job can be run on the machine. The other expressions are evaluated after the jobs have been dispatched and in some cases, already running.

When evaluating the START expression to determine if the machine can accept jobs, **Class !=** "**Z**" evaluates to true only if Z is not in the class definition. This means that if two different classes are defined on a machine, **Class !=** "**Z**" (where Z

is one of the defined classes) always evaluates to false when specified in the START expression and, therefore, the machine will not be considered to start jobs.

Typically, machine load average, keyboard activity, time intervals, and job class are used within these various expressions to dynamically control job execution.

For additional information about:

- Time-related variables that you may use for this keyword, see "Variables to use for setting times" on page 320.
- Coding these control expressions in the configuration file, see Chapter 12, "Configuration file reference," on page 263.

How control expressions affect jobs

After LoadLeveler selects a job for execution, the job can be in any of several states.

Figure 10 on page 70 shows how the control expressions can affect the state a job is in. The rectangles represent job or daemon states (Idle, Completed, Running, Suspended, and Vacating) and the diamonds represent the control expressions (Start, Suspend, Continue, Vacate, and Kill).

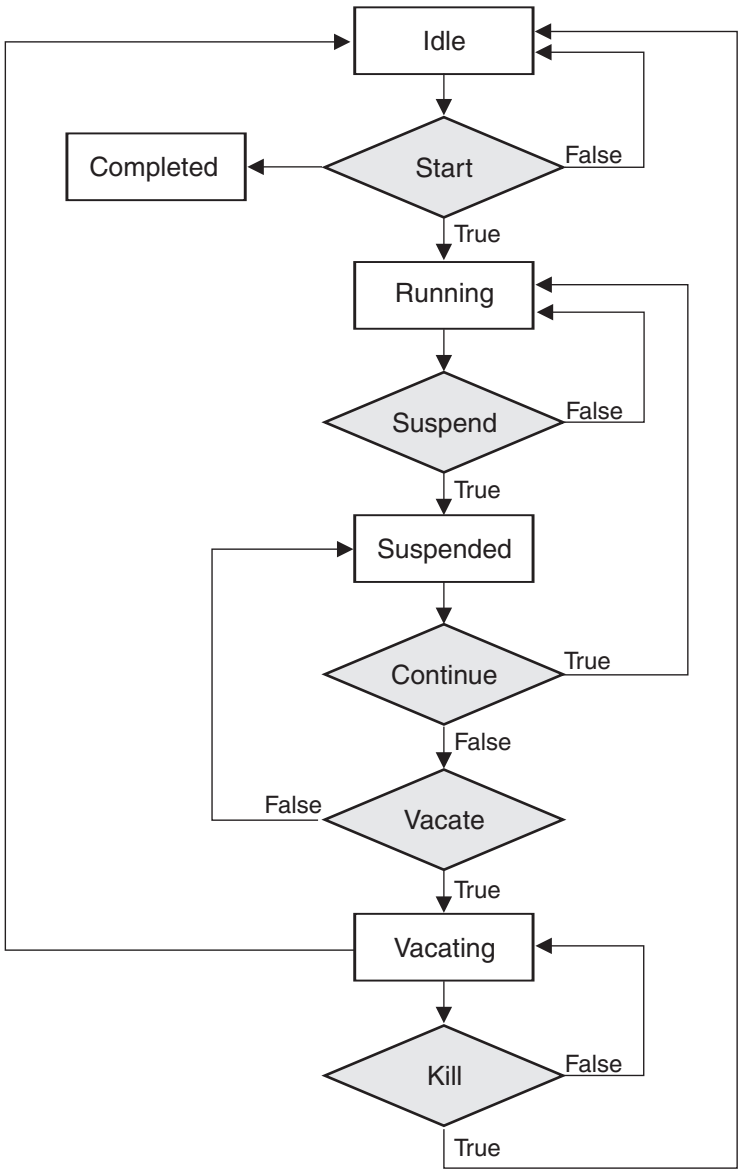

Figure 10. How control expressions affect jobs

Criteria used to determine when a LoadLeveler job will enter Start, Suspend, Continue, Vacate, and Kill states are defined in the LoadLeveler configuration files and they can be different for each machine in the cluster. They can be modified to meet local requirements.

Tracking job processes

When a job terminates, its orphaned processes may continue to consume or hold resources, thereby degrading system performance, or causing jobs to hang or fail.

Process tracking allows LoadLeveler to cancel any processes (throughout the entire cluster), left behind when a job terminates. Process tracking is required to do preemption by the suspend method when running either the BACKFILL or API schedulers. Process tracking is optional in all other cases.

When process tracking is enabled, all child processes are terminated when the main process terminates. This will include any background or orphaned processes started in the prolog, epilog, user prolog, and user epilog.

Process tracking on LoadLeveler for Linux is supported only on RHEL 5 and SLES 10 systems.

There are two keywords used in specifying process tracking:

PROCESS_TRACKING
To activate process tracking, set **PROCESS_TRACKING=TRUE** in the LoadLeveler global configuration file. By default, **PROCESS_TRACKING** is set to **FALSE**.

PROCESS_TRACKING_EXTENSION
On AIX, this keyword specifies the path to the loadable kernel module **LoadL_pt_ke** in the local or global configuration file. If the **PROCESS_TRACKING_EXTENSION** keyword is not supplied, then LoadLeveler will search the **$HOME/bin** default directory.

On Linux, this keyword specifies the path to the loadable kernel module **proctrk.ko** in the local or global configuration file. The **proctrk.ko** kernel module is shipped as source code and must be built and installed on all machines where process tracking is required. See the *TWS LoadLeveler: Installation Guide* for additional information about which directory to specify when using the **PROCESS_TRACKING_EXTENSION** configuration keyword.

The process tracking kernel extension is not unloaded when the **startd** daemon terminates. Therefore if a mismatch in the version of the loaded kernel extension and the installed kernel extension is found when the **startd** starts up the daemon will exit. In this case a reboot of the node is needed to unload the currently loaded kernel extension. If you install a new version of LoadLeveler which contains a new version of the kernel extension you may need to reboot the node.

For information about configuration file keyword syntax and other details, see Chapter 12, “Configuration file reference,” on page 263.

Querying multiple LoadLeveler clusters

This topic applies only to those installations having more than one LoadLeveler cluster, where the separate clusters have not been organized into a multicluster environment.

To organize separate LoadLeveler clusters into a multicluster environment, see “LoadLeveler multicluster support” on page 148.

You can query, submit, or cancel jobs in multiple LoadLeveler clusters by setting up a master configuration file for each cluster and using the **LOADL_CONFIG** environment variable to specify the name of the master configuration file that the LoadLeveler commands must use. The master configuration file must be located in the **/etc** directory and the file name must have a format of *base_name***.cfg** where *base_name* is a user defined identifier for the cluster.

The default name for the master configuration file is **/etc/LoadL.cfg**. The format for the **LOADL_CONFIG** environment variable is **LOADL_CONFIG=/etc/**

base_name.**cfg** or **LOADL_CONFIG=***base_name*. When you use the form **LOADL_CONFIG=***base_name*, the prefix **/etc** and suffix **.cfg** are appended to the *base_name*.

The following example explains how you can set up a machine to query multiple clusters:

You can configure **/etc/LoadL.cfg** to point to the configuration files for the ″default″ cluster, and you can configure **/etc/othercluster.cfg** to point to the configuration files of another cluster which the user can select.

For example, you can enter the following query command:

```
$ llq
```

The **llq** command uses the configuration from **/etc/LoadL.cfg** and queries job information from the ″default″ cluster.

To send a query to the cluster defined in the configuration file of **/etc/othercluster.cfg**, enter:

```
$ env LOADL_CONFIG=othercluster llq
```

Note that the machine from which you issue the **llq** command is considered as a submit-only machine by the other cluster.

Handling switch-table errors

Configuration file keywords can be used to control how LoadLeveler responds to switch-table errors.

You may use the following configuration file keywords to control how LoadLeveler responds to switch-table errors:

- ACTION_ON_SWITCH_TABLE_ERROR
- DRAIN_ON_SWITCH_TABLE_ERROR
- RESUME_ON_SWITCH_TABLE_ERROR_CLEAR

For information about configuration file keyword syntax and other details, see Chapter 12, “Configuration file reference,” on page 263.

Providing additional job-processing controls through installation exits

LoadLeveler allows administrators to further configure the environment through installation exits.

Table 17 lists these additional job-processing controls.

Table 17. Roadmap of administrator tasks accomplished through installation exits

To learn about:	Read the following:
Writing a program to control when jobs are scheduled to run	“Controlling the central manager scheduling cycle” on page 73
Writing a pair of programs to override the default LoadLeveler DCE authentication method	“Handling DCE security credentials” on page 74
Writing a program to refresh an AFS token when a job starts	“Handling an AFS token” on page 75

Table 17. Roadmap of administrator tasks accomplished through installation exits (continued)

To learn about:	Read the following:
Writing a program to check or modify job requests when they are submitted	"Filtering a job script" on page 76
Writing programs to run before and after job requests	"Writing prolog and epilog programs" on page 77
Overriding the LoadLeveler default mail notification method	"Using your own mail program" on page 81
Defining a cluster metric to determine where a remote job is distributed	See the **CLUSTER_METRIC** configuration keyword description in Chapter 12, "Configuration file reference," on page 263.
Defining cluster user mapper for multicluster environment	See the **CLUSTER_USER_MAPPER** configuration keyword description in Chapter 12, "Configuration file reference," on page 263.
Correctly specifying configuration file keywords	Chapter 12, "Configuration file reference," on page 263

Controlling the central manager scheduling cycle

To determine when to run the LoadLeveler scheduling algorithm, the central manager uses the values set in the configuration file for the **NEGOTIATOR_INTERVAL** and the **NEGOTIATOR_CYCLE_DELAY** keywords.

The central manager will run the scheduling algorithm every **NEGOTIATOR_INTERVAL** seconds, unless some event takes place such as the completion of a job or the addition of a machine to the cluster. In such cases, the scheduling algorithm is run immediately. When **NEGOTIATOR_CYCLE_DELAY** is set, a minimum of **NEGOTIATOR_CYCLE_DELAY** seconds will pass between the central manager's scheduling attempts, regardless of what other events might take place. When the **NEGOTIATOR_INTERVAL** is set to zero, the central manager will not run the scheduling algorithm until instructed to do so by an authorized process. This setting enables your program to control the central manager's scheduling activity through one of the following:

- The **llrunscheduler** command.
- The **ll_run_scheduler** subroutine.

Both the command and the subroutine instruct the central manager to run the scheduling algorithm.

You might choose to use this setting if, for example, you want to write a program that directly controls the assignment of the system priority for all LoadLeveler jobs. In this particular case, you would complete the following steps to control system priority assignment and the scheduling cycle:

1. Decide the following:
   - Which system priority value to assign to jobs from specific sources or with specific resource requirements.
   - How often the central manager should run the scheduling algorithm. Your program has to be designed to issue the **ll_run_scheduler** subroutine at regular intervals; otherwise, LoadLeveler will not attempt to schedule any job steps.

   You also need to understand how changing the system priority affects the job queue. After you successfully use the **ll_modify** subroutine or the **llmodify** command to change system priority values, LoadLeveler will not readjust the values for those job steps when the negotiator recalculates priorities at regular

intervals set through the **NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL** keyword. Also, you can change the system priority for jobs only when those jobs are in the Idle state or a state similar to it. To determine which job states are similar to the Idle state or to the Running state, see the table in "LoadLeveler job states" on page 19.

2. Code a program to use LoadLeveler APIs to perform the following functions:
   a. Use the Data Access APIs to obtain data about all jobs.
   b. Determine whether jobs have been added or removed.
   c. Use the **ll_modify** subroutine to set the system priority for the LoadLeveler jobs. The values you set through this subroutine will not be readjusted when the negotiator recalculates job step priorities.
   d. Use the **ll_run_scheduler** subroutine to instruct the central manager to run the scheduling algorithm.
   e. Set a timer for the scheduling interval, to repeat the scheduling instruction at regular intervals. This step is required to replace the effect of setting the configuration keyword **NEGOTIATOR_CYCLE_DELAY**, which LoadLeveler ignores when **NEGOTIATOR_INTERVAL** is set to zero.
3. In the configuration file, set values for the following keywords:
   - Set the **NEGOTIATOR_INTERVAL** keyword to zero to stop the central manager from automatically recalculating system priorities for jobs.
   - (Optional) Set the **SYSPRIO_THRESHOLD_TO_IGNORE_STEP** keyword to specify a threshold value. If the system priority assigned to a job step is less than this threshold value, the job will remain idle.
4. Issue the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the configuration file.
5. (Optional) To make sure that the central manager's automatic scheduling activity has been disabled (by setting the **NEGOTIATOR_INTERVAL** keyword to zero), use the **llstatus** command.
6. Run your program under a user ID with administrator authority.

Once this procedure is complete, you might want to use one or more of the following commands to make sure that jobs are scheduled according to the correct system priority. The value of *q_sysprio* in command output indicates the system priority for the job step.

- Use the command **llq -s** to detect whether a job step is idle because its system priority is below the value set for the **SYSPRIO_THRESHOLD_TO_IGNORE_STEP** keyword.
- Use the command **llq -l** to display the previous system priority for a job step.
- When unusual circumstances require you to change system priorities manually:
  1. Use the command **llmodify -s** to set the system priority for LoadLeveler jobs. The values you set through this command will not be readjusted when the negotiator recalculates job step priorities.
  2. Use the **llrunscheduler** command to instruct the central manager to run the scheduling algorithm.

Handling DCE security credentials

You can write a pair of programs to override the default LoadLeveler DCE authentication method.

To enable the programs, use the **DCE_AUTHENTICATION_PAIR** keyword in your configuration file:

- As an alternative, you can also specify the program pair:
  ```
  DCE_AUTHENTICATION_PAIR = $(BIN)/llgetdce, $(BIN)/llsetdce
  ```

Specifying the **DCE_AUTHENTICATION_PAIR** keyword enables LoadLeveler support for forwarding DCE credentials to LoadLeveler jobs. You may override the default function provided by LoadLeveler to establish DCE credentials by substituting your own programs.

Using the alternative program pair: llgetdce and llsetdce

The program pair, **llgetdce** and **llsetdce**, forwards DCE credentials by copying credential cache files from the submitting machine to the executing machines.

While this technique may require less overhead, it has been known to produce credentials on the executing machines which are not fully capable of being forwarded by rsh commands. This is the only pair of programs offered in earlier releases of LoadLeveler.

Forwarding DCE credentials

An example of a credentials object is a character string containing the DCE principle name and a password.

program1 writes the following to standard output:

- The length of the handle to follow
- The handle

If *program1* encounters errors, it writes error messages to standard error.

program2 receives the following as standard input:

- The length of the handle to follow
- The same handle written by *program1*

program2 writes the following to standard output:

- The length of the login context to follow
- An exportable DCE login context, which is the idl_byte array produced from the sec_login_export_context DCE API call. For more information, see the DCE Security Services API chapter in the *Distributed Computing Environment for AIX: Application Development Reference*.
- A character string suitable for assigning to the KRB5CCNAME environment variable This string represents the location of the credentials cache established in order for *program2* to export the DCE login context.

If *program2* encounters errors, it writes error messages to standard error. The parent process, the LoadLeveler starter process, writes those messages to the starter log.

For examples of programs that enable DCE security credentials, see the **samples/lldce** subdirectory in the release directory.

Handling an AFS token

You can write a program, run by the scheduler, to refresh an AFS token when a job is started.

To invoke the program, use the **AFS_GETNEWTOKEN** keyword in your configuration file.

Before running the program, LoadLeveler sets up standard input and standard output as pipes between the program and LoadLeveler. LoadLeveler also sets up the following environment variables:

LOADL_STEP_OWNER
The owner (UNIX user name) of the job

LOADL_STEP_COMMAND
The name of the command the user's job step invokes.

LOADL_STEP_CLASS
The class this job step will run.

LOADL_STEP_ID
The step identifier, generated by LoadLeveler.

LOADL_JOB_CPU_LIMIT
The number of CPU seconds the job is limited to.

LOADL_WALL_LIMIT
The number of wall clock seconds the job is limited to.

LoadLeveler writes the following current AFS credentials, in order, over the standard input pipe:

- The **ktc_principal** structure indicating the service.
- The **ktc_principal** structure indicating the client.
- The **ktc_token** structure containing the credentials.

The ktc_principal structure is defined in the AFS header file **afs_rxkad.h**. The ktc_token structure is defined in the AFS header file **afs_auth.h**.

LoadLeveler expects to read these same structures in the same order from the standard output pipe, except these should be refreshed credentials produced by the installation exit.

The installation exit can modify the passed credentials (to extend their lifetime) and pass them back, or it can obtain new credentials. LoadLeveler takes whatever is returned and uses it to authenticate the user prior to starting the user's job.

Filtering a job script

You can write a program to filter a job script when the job is submitted to the local cluster and when the job is submitted from a remote cluster.

This program can, for example, modify defaults or perform site specific verification of parameters. To invoke the local job filter, specify the **SUBMIT_FILTER** keyword in your configuration file. To invoke the remote job filter, specify the **CLUSTER_REMOTE_JOB_FILTER** keyword in your configuration file. For more information on these keywords, see the **SUBMIT_FILTER** or **CLUSTER_REMOTE_JOB_FILTER** keyword in Chapter 12, "Configuration file reference," on page 263.

LoadLeveler sets the following environment variables when the program is invoked:

LOADL_ACTIVE
LoadLeveler version

LOADL_STEP_COMMAND
Job command file name

LOADL_STEP_ID
The job identifier, generated by LoadLeveler

LOADL_STEP_OWNER
The owner (UNIX user name) of the job

For details about specific keyword syntax and use in the configuration file, see Chapter 12, "Configuration file reference," on page 263.

Writing prolog and epilog programs

An administrator can write *prolog* and *epilog* installation exits that can run before and after a LoadLeveler job runs, respectively.

Prolog and epilog programs fall into two types:

- Those that run as the LoadLeveler user ID.
- Those that run in a user's environment.

Depending on the type of processing you want to perform before or after a job runs, specify one or more of the following configuration file keywords, in any combination:

- To run a prolog or epilog program under the LoadLeveler user ID, specify `JOB_PROLOG` or `JOB_EPILOG`, respectively.
- To run a prolog or epilog program under the user's environment, specify `JOB_USER_PROLOG` or `JOB_USER_EPILOG`, respectively.

You do not have to provide a prolog/epilog pair of programs. You may, for example, use only a prolog program that runs under the LoadLeveler user ID.

For details about specific keyword syntax and use in the configuration file, see Chapter 12, "Configuration file reference," on page 263.

Note: If process tracking is enabled and your prolog or epilog program invokes the **mailx** command, set the **sendwait** variable to prevent the background mail process from being killed by process tracking.

A user environment prolog or epilog runs with AFS authentication if installed and enabled. For security reasons, you must code these programs on the machines where the job runs *and* on the machine that schedules the job. If you do not define a value for these keywords, the user environment prolog and epilog settings on the executing machine are ignored.

The user environment prolog and epilog can set environment variables for the job by sending information to standard output in the following format:

```
env id = value
```

Where:

id Is the name of the environment variable
value Is the value (setting) of the environment variable

For example, the user environment prolog sets the environment variable **STAGE_HOST** for the job:

```
#!/bin/sh
echo env STAGE_HOST=shd22
```

Coding conventions for prolog programs

The prolog program is invoked by the starter process.

Once the starter process invokes the prolog program, the program obtains information about the job from environment variables.

Syntax:

prolog_program

Where *prolog_program* is the name of the prolog program as defined in the JOB_PROLOG keyword.

No arguments are passed to the program, but several environment variables are set. For more information on these environment variables, see "Run-time environment variables" on page 400.

The real and effective user ID of the prolog process is the LoadLeveler user ID. If the prolog program requires root authority, the administrator must write a secure C or Perl program to perform the desired actions. You should *not* use shell scripts with set uid permissions, since these scripts may make your system susceptible to security problems.

Return code values:

0 The job will begin.

If the prolog program is ended with a signal, the job does not begin and a message is written to the starter log.

Sample prolog programs:

- **Sample of a prolog program for korn shell:**

```
#!/bin/ksh
#
# Set up environment
set -a
. /etc/environment
. /.profile
export PATH="$PATH:/loctools/lladmin/bin"
export LOG="/tmp/$LOADL_STEP_OWNER.$LOADL_STEP_ID.prolog"
#
# Do set up based upon job step class
#
case $LOADL_STEP_CLASS in
    # A OSL job is about to run, make sure the osl filesystem is
    # mounted. If status is negative then filesystem cannot be
    # mounted and the job step should not run.
    "OSL")
      mount_osl_files >> $LOG
    if [ status = 0 ]
        then EXIT_CODE=1
      else
        EXIT_CODE=0
      fi
      ;;
# A simulation job is about to run, simulation data has to
# be made available to the job. The status from copy script must
# be zero or job step cannot run.
"sim")

      copy_sim_data >> $LOG
if [ status = 0 ]
        then EXIT_CODE=0
      else
        EXIT_CODE=1
      fi
      ;;
# All other job will require free space in /tmp, make sure
# enough space is available.
*)
      check_tmp >> $LOG
```

```
      EXIT_CODE=$?
      ;;
esac
# The job step will run only if EXIT_CODE == 0
exit $EXIT_CODE
```

- **Sample of a prolog program for C shell:**

```
#!/bin/csh
#
# Set up environment
source /u/loadl/.login
#
setenv PATH  "${PATH}:/loctools/lladmin/bin"
setenv LOG "/tmp/${LOADL_STEP_OWNER}.${LOADL_STEP_ID}.prolog"
#
# Do set up based upon job step class
#
switch ($LOADL_STEP_CLASS)
    # A OSL job is about to run, make sure the osl filesystem is
    # mounted. If status is negative then filesystem cannot be
    # mounted and the job step should not run.
    case "OSL":
      mount_osl_files >> $LOG
      if ($status < 0 ) then
        set EXIT_CODE = 1
      else
        set EXIT_CODE = 0
      endif
      breaksw
# A simulation job is about to run, simulation data has to
# be made available to the job. The status from copy script must
# be zero or job step cannot run.
case "sim":
    copy_sim_data >> $LOG
    if ($status == 0 ) then
      set EXIT_CODE = 0
    else
      set EXIT_CODE = 1
    endif
    breaksw
# All other job will require free space in /tmp, make sure
# enough space is available.
default:
    check_tmp >> $LOG
    set EXIT_CODE = $status
    breaksw
endsw

# The job step will run only if EXIT_CODE == 0
exit $EXIT_CODE
```

Coding conventions for epilog programs

The installation defined epilog program is invoked after a job step has completed.

The purpose of the epilog program is to perform any required clean up such as unmounting file systems, removing files, and copying results. The exit status of both the prolog program and the job step is set in environment variables.

Syntax:

epilog_program

Where *epilog_program* is the name of the epilog program as defined in the **JOB_EPILOG** keyword.

No arguments are passed to the program but several environment variables are set. These environment variables are described in “Run-time environment variables” on page 400. In addition, the following environment variables are set for the epilog programs:

LOADL_PROLOG_EXIT_CODE
The exit code from the prolog program. This environment variable is set only if a prolog program is configured to run.

LOADL_USER_PROLOG_EXIT_CODE
The exit code from the user prolog program. This environment variable is set only if a user prolog program is configured to run.

LOADL_JOB_STEP_EXIT_CODE
The exit code from the job step.

Note: To interpret the exit status of the prolog program and the job step, convert the string to an integer and use the macros found in the **sys/wait.h** file. These macros include:
- WEXITSTATUS: gives you the exit code
- WTERMSIG: gives you the signal that terminated the program
- WIFEXITED: tells you if the program exited
- WIFSIGNALED: tells you if the program was terminated by a signal

The exit codes returned by the WEXITSTATUS macro are the valid codes. However, if you look at the raw numbers in **sys/wait.h**, the exit code may appear to be 256 times the expected return code. The numbers in **sys/wait.h** are the wait3 system calls.

Sample epilog programs:

- **Sample of an epilog program for korn shell:**

```
#!/bin/ksh
#
# Set up environment
set -a
. /etc/environment
. /.profile
export PATH="$PATH:/loctools/lladmin/bin"
export LOG="/tmp/$LOADL_STEP_OWNER.$LOADL_STEP_ID.epilog"
#
if [ [ -z $LOADL_PROLOG_EXIT_CODE ] ]
then
echo "Prolog did not run" >> $LOG
else
echo "Prolog exit code = $LOADL_PROLOG_EXIT_CODE" >> $LOG
fi
#
if [ [ -z $LOADL_USER_PROLOG_EXIT_CODE ] ]
  then
   echo "User environment prolog did not run" >> $LOG
  else
   echo "User environment exit code = $LOADL_USER_PROLOG_EXIT_CODE" >> $LOG
fi
#
if [ [ -z $LOADL_JOB_STEP_EXIT_CODE ] ]
  then
   echo "Job step did not run" >> $LOG
  else
   echo "Job step exit code = $LOADL_JOB_STEP_EXIT_CODE" >> $LOG
fi
#
#
# Do clean up based upon job step class
#
case $LOADL_STEP_CLASS in
  # A OSL job just ran, unmount the filesystem.
  "OSL")
    umount_osl_files >> $LOG
```

```
    ;;
  # A simulation job just ran, remove input files.
  # Copy results if simulation was successful (second argument
  # contains exit status from job step).
  "sim")
    rm_sim_data >> $LOG
    if [ $2 = 0 ]
      then copy_sim_results >> $LOG
    fi
    ;;
# Clean up /tmp
*)
  clean_tmp >> $LOG
  ;;
esac
```

- **Sample of an epilog program for C shell:**

```
#!/bin/csh
#
# Set up environment
source /u/loadl/.login
#
setenv PATH  "${PATH}:/loctools/lladmin/bin"
setenv LOG "/tmp/${LOADL_STEP_OWNER}.${LOADL_STEP_ID}.prolog"
#
if ( ${?LOADL_PROLOG_EXIT_CODE} ) then
echo "Prolog exit code = $LOADL_PROLOG_EXIT_CODE" >> $LOG
else
echo "Prolog did not run" >> $LOG
endif
#
if ( ${?LOADL_USER_PROLOG_EXIT_CODE} ) then
    echo "User environment exit code = $LOADL_USER_PROLOG_EXIT_CODE" >> $LOG
  else
    echo "User environment prolog did not run" >> $LOG
endif
#
if ( ${?LOADL_JOB_STEP_EXIT_CODE} ) then
    echo "Job step exit code = $LOADL_JOB_STEP_EXIT_CODE" >> $LOG
  else
    echo "Job step did not run" >> $LOG
endif
#
# Do clean up based upon job step class
#
switch ($LOADL_STEP_CLASS)
  # A OSL job just ran, unmount the filesystem.
  case "OSL":
    umount_osl_files >> $LOG
    breaksw
# A simulation job just ran, remove input files.
# Copy results if simulation was successful (second argument
# contains exit status from job step).
case "sim":
  rm_sim_data >> $LOG
  if ($argv{2} == 0 ) then
    copy_sim_results >> $LOG
  endif
  breaksw
# Clean up /tmp
default:
  clean_tmp >> $LOG
  breaksw
endsw
```

Using your own mail program

You can write a program to override the LoadLeveler default mail notification method.

You can use this program, for example, to display your own messages to users when a job completes, or to automate tasks such as sending error messages to a network manager.

The syntax for the program is the same as it is for standard UNIX mail programs; the command is called with the following arguments:

- **-s** to indicate a subject.
- A pointer to a string containing the subject.
- A pointer to a string containing a list of mail recipients.

The mail message is taken from standard input.

To enable this program to replace the default mail notification method, use the **MAIL** keyword in the configuration file. For details about specific keyword syntax and use in the configuration file, see Chapter 12, "Configuration file reference," on page 263.

Chapter 5. Defining LoadLeveler resources to administer

After installing LoadLeveler, you may customize it by modifying the **administration** file.

The administration file optionally lists and defines the machines in the LoadLeveler cluster and the characteristics of classes, users, and groups.

LoadLeveler does not prevent you from having multiple copies of administration files, but you need to be sure to update all the copies whenever you make a change to one. Having only one administration file prevents any confusion.

Table 18 lists the LoadLeveler resources you may define by modifying the administration file.

Table 18. Roadmap of tasks for modifying the LoadLeveler administration file

To learn about:	Read the following:
Modifying the administration file	"Steps for modifying an administration file"
Defining LoadLeveler resources to administer	• "Defining machines" on page 84 • "Defining adapters" on page 86 • "Defining classes" on page 89 • "Defining users" on page 97 • "Defining groups" on page 99 • "Defining clusters" on page 100
Correctly specifying administration file keywords	Chapter 13, "Administration file reference," on page 321

Steps for modifying an administration file

All LoadLeveler commands, daemons, and processes read the administration and configuration files at start up time.

If you change the administration or configuration files after LoadLeveler has already started, any LoadLeveler command or process, such as the **LoadL_starter** process, will read the newer version of the files while the running daemons will continue to use the data from the older version. To ensure that all LoadLeveler commands, daemons, and processes use the same configuration data, run the reconfiguration command on all machines in the cluster each time the administration or configuration files are changed.

Before you begin: You need to:

- Ensure that the installation procedure has completed successfully and that the administration file, **LoadL_admin**, exists in LoadLeveler's home directory. For additional details about installation, see *TWS LoadLeveler: Installation Guide*.
- Know how to correctly specify keywords in the administration file. For information about administration file keyword syntax and other details, see Chapter 13, "Administration file reference," on page 321.

- (Optional) Know how to correctly issue the **llextRPD** command, if you choose to use it (see "llextRPD - Extract data from an RSCT peer domain" on page 443).

Perform the following steps to modify the administration file, **LoadL_admin**:

1. Identify yourself as a LoadLeveler administrator using the **LOADL_ADMIN** keyword.
2. Provide the following stanza types in the administration file:
   - One machine stanza to define the central manager for the LoadLeveler cluster. You also may create machine stanzas for other machines in the LoadLeveler cluster.

     You can use the **llextRPD** command to automatically create machine stanzas.
   - (Optional) An adapter stanza for each type of network adapter that you want LoadLeveler jobs to be able to request.

     You can use the **llextRPD** command to automatically create adapter stanzas.
3. (Optional) Specify one or more of the following stanza types:
   - A class stanza for each set of LoadLeveler jobs that have similar characteristics or resource requirements.
   - A user stanza for specific users, if their requirements do not match those characteristics defined in the default user stanza.
   - A group stanza for each set of LoadLeveler users that have similar characteristics or resource requirements.
4. (Optional) You may specify values for additional administration file keywords, which are listed and described in "Administration file keyword descriptions" on page 327.
5. Notify LoadLeveler daemons by issuing the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the administration file.

Defining machines

The information in a machine stanza defines the characteristics of that machine.

You do not have to specify a machine stanza for every machine in the LoadLeveler cluster, but you must have one machine stanza for the machine that will serve as the central manager.

If you do not specify a machine stanza for a machine in the cluster, the machine and the central manager still communicate and jobs are scheduled on the machine but the machine is assigned the default values specified in the default machine stanza. If there is no default stanza, the machine is assigned default values set by LoadLeveler.

Any machine name used in the stanza must be a name which can be resolved to an IP address. This name is referred to as an interface name because the name can be used for a program to interface with the machine. Generally, interface names match the machine name, but they do not have to.

By default, LoadLeveler will append the DNS domain name to the end of any machine name without a domain name appended before resolving its address. If you specify a machine name without a domain name appended to it and you do not want LoadLeveler to append the DNS domain name to it, specify the name using a trailing period. You may have a need to specify machine names in this way if you are running a cluster with more than one nameserving technique. For

example, if you are using a DNS nameserver and running NIS, you may have some machine names which are resolved by NIS which you do not want LoadLeveler to append DNS names to. In situations such as this, you also want to specify **name_server** keyword in your machine stanzas.

Under the following conditions, you must have a machine stanza for the machine in question:

- If you set the **MACHINE_AUTHENTICATE** keyword to **true** in the configuration file, then you must create a machine stanza for each node that LoadLeveler includes in the cluster.
- If the machine's hostname (the name of the machine returned by the UNIX hostname command) does not match an interface name. In this case, you must specify the interface name as the machine stanza name and specify the machine's hostname using the **alias** keyword.
- If the machine's hostname does match an interface name but not the correct interface name.

For information about automatically creating machine stanzas, see "llextRPD - Extract data from an RSCT peer domain" on page 443.

Planning considerations for defining machines

There are several matters to consider before customizing the administration file.

Before customizing the administration file, consider the following:

- **Node availability**

  Some workstation owners might agree to accept LoadLeveler jobs only when they are not using the workstation themselves. Using LoadLeveler keywords, these workstations can be configured to be available at designated times only.

- **Common name space**

  To run jobs on any machine in the LoadLeveler cluster, a user needs the same uid (the user ID number for a user) and gid (the group ID number for a group) on every machine in the cluster.

  For example, if there are two machines in your LoadLeveler cluster, *machine_1* and *machine_2*, user `john` must have the same user ID and login group ID in the **/etc/passwd** file on both machines. If user `john` has user ID 1234 and login group ID 100 on *machine_1*, then user `john` must have the same user ID and login group ID in **/etc/passwd** on *machine_2*. (LoadLeveler requires a job to run with the same group ID and user ID of the person who submitted the job.)

  If you do not have a user ID on one machine, your jobs will not run on that machine. Also, many commands, such as **llq**, will not work correctly if a user does not have a user ID on the central manager machine.

  However, there are cases where you may choose to not give a user a login ID on a particular machine. For example, a user does not need an ID on every submit-only machine; the user only needs to be able to submit jobs from at least one such machine. Also, you may choose to restrict a user's access to a Schedd machine that is not a public scheduler; again, the user only needs access to at least one Schedd machine.

- **Resource handling**

  Some nodes in the LoadLeveler cluster might have special software installed that users might need to run their jobs successfully. You should configure LoadLeveler to distinguish those nodes from other nodes using, for example, machine features.

Machine stanza format and keyword summary

Machine stanzas take the following format.

Default values for keywords appear in bold:

```
label: type = machine
adapter_stanzas = stanza_list
alias = machine_name
central_manager = true | false | alt
cpu_speed_scale = true | false
machine_mode = batch | interactive | general
master_node_exclusive = true | false
max_jobs_scheduled = number
name_server = list
pool_list = pool_numbers
reservation_permitted = true | false
resources = name(count) name(count) ... name(count)
schedd_fenced = true | false
schedd_host = true | false
speed = number
submit_only = true | false
```

Figure 11. Format of a machine stanza

Examples: Machine stanzas

These machine stanza examples may apply to your situation.

- **Example 1**

  In this example, the machine is being defined as the central manager.

  ```
  #
  machine_a: type = machine
  central_manager = true    # central manager runs here
  ```

- **Example 2**

  This example sets up a submit-only node. Note that the **submit-only** keyword in the example is set to **true**, while the **schedd_host** keyword is set to **false**. You must also ensure that you set the **schedd_host** to **true** on at least one other node in the cluster.

  ```
  #
  machine_b: type = machine
  central_manager = false   # not the central manager
  schedd_host = false       # not a scheduling machine
  submit_only = true        # submit only machine
  alias = machineb          # interface name
  ```

- **Example 3**

  In the following example, machine_c is the central manager and has an alias associated with it:

  ```
  #
  machine_c: type = machine
  central_manager = true    # central manager runs here
  schedd_host = true        # defines a public scheduler
  alias = brianne
  ```

Defining adapters

An adapter stanza identifies network adapters that are available on the machines in the LoadLeveler cluster.

If you want LoadLeveler jobs to be able to request specific adapters, you must either specify adapter stanzas or configure dynamic adapters in the administration file.

Note the following when using an adapter stanza:

- An adapter stanza is required for each adapter stanza name you specify on the **adapter_stanzas** keyword of the machine stanza.
- The **adapter_name**, **interface_address** and **interface_name** keywords are required.

For information about creating adapter stanzas, see "llextRPD - Extract data from an RSCT peer domain" on page 443 for peer domains.

Configuring dynamic adapters

LoadLeveler can dynamically determine the adapters in any operating system instance (OSI) that has RSCT installed.

LoadLeveler must be told on an OSI basis if it is to handle dynamic adapter configuration changes for that OSI. The specification of whether to use dynamic or static adapter configuration for an OSI is done through the presence or absence of the machine stanza's **adapter_stanzas** keyword.

If a machine stanza in the administration file contains an **adapter_stanzas** statement then this is taken as a directive by the LoadLeveler administrator to use only those specified adapters. For this OSI, LoadLeveler will not perform any dynamic adapter configuration or processing. If an adapter change occurs in this OSI then the administrator will have to make the corresponding change in the administration file and then stop and restart or reconfigure the LoadLeveler startd daemon to pick up the adapter changes. If an OSI (machine stanza) in the administration file does not contain the **adapter_stanzas** keyword then this is taken as a directive by the LoadLeveler administrator for LoadLeveler to dynamically configure the adapters for that OSI. For that OSI, LoadLeveler will determine what adapters are present at startup via calls to the RMCAPI. If an adapter change occurs during execution in the OSI then LoadLeveler will automatically detect and handle the change without requiring a restart or reconfiguration.

Configuring InfiniBand adapters

InfiniBand adapters, known as host channel adapters (HCAs) can be multiported.

Tasks can use ports of an HCA independently, which allows them to be allocated by the scheduling algorithm independently.

Note: InfiniBand adapters are supported on the AIX operating system and in SUSE Linux Enterprise Server (SLES) 9 and SLES 10 on TWS LoadLeveler for POWER clusters.

An InfiniBand adapter can have multiple adapter ports. Each port on the InfiniBand adapter can be connected to one network and will be managed by TWS LoadLeveler as a switch adapter. InfiniBand adapter ports derive their resources and usage state from the InfiniBand adapter with which they are associated, but are allocated to jobs separately.

If you want LoadLeveler jobs to be able to request InfiniBand adapters, you must either specify adapter stanzas or configure dynamic adapters in the administration

file. The InfiniBand ports are identified to TWS LoadLeveler in the same way other adapters are. Stanzas are specified in the administration file if static adapters are used and the ports are discovered by RSCT if dynamic adapters are used.

The **port_number** administration keyword has been added to support an InfiniBand port. The **port_number** keyword specifies the port number of the InfiniBand adapter port. Only InfiniBand ports are managed and displayed by TWS LoadLeveler; the InfiniBand adapter itself is not. The adapter stanza for InfiniBand support only contains the adapter port information. There is no InfiniBand adapter information in the adapter stanza (see example 2 in "Examples: Adapter stanzas" on page 89).

Note:

1. TWS LoadLeveler distributes the switch adapter windows of the InfiniBand adapter equally among its ports and the allocation is not adjusted should all of the resources on one port be consumed.
2. The InfiniBand ports determine their usage state and availability from their InfiniBand adapter. If one port is in use exclusively, no other ports on the adapter can be used for any other job.
3. If you have a mixed cluster where some nodes use the InfiniBand adapter and some nodes use the HPS adapter, you have to organize the nodes into pools so that the job is only dispatched to nodes with the same kind of switch adapter.
4. There is no change to the way the InfiniBand adapters are requested on the job command file network statement; that is, InfiniBand adapters are requested the same way as any other adapter would be.
5. Because InfiniBand adapters do not support rCxt blocks, jobs that would otherwise use InfiniBand adapters, but which also request rCxt blocks with the rcxtblks keyword on the network statement will remain in the idle state. This behavior is consistent with how other adapters (for example, the HPS) behave in the same situation. You can use the **llstatus -a** command to see rCxt blocks on adapters (see "llstatus - Query machine status" on page 512 for more information).

Adapter stanza format and keyword summary

Consider this format of an adapter stanza.

An adapter stanza has the following format:

```
label: type = adapter
adapter_name = name
adapter_type = type
device_driver_name = name
interface_address = IP_address
interface_name = name
logical_id = id
multilink_address = ip_address
multilink_list = adapter_name <, adapter_name>*
network_id = id
network_type = type
port_number = number
switch_node_number = integer
```

Figure 12. Format of an adapter stanza

Examples: Adapter stanzas

These adapter stanza examples may apply to your situation.

- **Example 1: Specifying an HPS adapter**

  In the following example, the adapter stanza called "c121s0n10.ppd.pok.ibm.com" specifies an HPS adapter. Note that c121s0n10.ppd.pok.ibm.com is also specified on the **adapter_stanzas** keyword of the machine stanza for the "yugo" machine.

```
          yugo:  type=machine
                 adapter_stanzas = c121s0n10.ppd.pok.ibm.com
                 ...

c121s0n10.ppd.pok.ibm.com: type = adapter
               adapter_name = sn0
               network_type = switch
               interface_address = 192.168.0.10
               interface_name = c121s0n10.ppd.pok.ibm.com
               multilink_address = 10.10.10.10
               logical_id = 2
               adapter_type = Switch_Network_Interface_For_HPS
               device_driver_name = sni0
               network_id = 1

c121f2rp02.ppd.pok.ibm.com: type = adapter
               adapter_name = en0
               network_type = ethernet
               interface_address = 9.114.66.74
               interface_name = c121f2rp02.ppd.pok.ibm.com
               device_driver_name = ent0
```

- **Example 2: Specifying an InfiniBand adapter**

  In the following example, the **port_number** specifies the port number of the InfiniBand adapter port:

```
192.168.9.58: type = adapter
        adapter_name = ib1
        network_type = InfiniBand
        interface_address = 192.168.9.58
        interface_name = 192.168.9.58
        logical_id = 23
        adapter_type = InfiniBand
        device_driver_name = ehca0
        network_id = 18338657682652659714
        port_number = 2
```

Defining classes

The information in a class stanza defines characteristics for that class.

These characteristics can include the quantities of consumable resources that may be used by a class per machine or cluster.

Within a class stanza, you can have optional user substanzas that define policies that apply to a user's job steps that need to use this class. For more information about user substanzas, see "Defining user substanzas in class stanzas" on page 94. For information about user stanzas, see "Defining users" on page 97.

Using limit keywords

A limit is the amount of a resource that a job step or a process is allowed to use. (A process is a dispatchable unit of work.) A job step may be made up of several processes.

Limits include both a **hard limit** and a **soft limit**. When a hard limit is exceeded, the job is usually terminated. When a soft limit is exceeded, the job is usually given a chance to perform some recovery actions. Limits are enforced either per process or per job step, depending on the type of limit. For parallel jobs steps, which consist of multiple tasks running on multiple machines, limits are enforced on a per task basis.

The class stanza includes the **limit** keywords shown in Table 19, which allow you to control the amount of resources used by a job step or a job process.

Table 19. Types of limit keywords

Limit	How the limit is enforced
as_limit	Per process
ckpt_time_limit	Per job step
core_limit	Per process
cpu_limit	Per process
data_limit	Per process
default_wall_clock_limit	Per job step
file_limit	Per process
job_cpu_limit	Per job step
locks_limit	Per process
memlock_limit	Per process
nofile_limit	Per process
nproc_limit	Per user
rss_limit	Per process
stack_limit	Per process
wall_clock_limit	Per job step

For example, a common limit is the **cpu_limit**, which limits the amount of CPU time a single process can use. If you set **cpu_limit** to five hours and you have a job step that forks five processes, each process can use up to five hours of CPU time, for a total of 25 CPU hours. Another limit that controls the amount of CPU used is **job_cpu_limit**. For a serial job step, if you impose a **job_cpu_limit** of five hours, the entire job step (made up of all five processes) cannot consume more than five CPU hours. For information on using this keyword with parallel jobs, see job_cpu_limit keyword.

You can specify limits in either the class stanza of the administration file or in the job command file. The lower of these two limits will be used to run the job even if the system limit for the user is lower. For more information, see:

- "Enforcing limits"
- "Administration file keyword descriptions" on page 327 or "Job command file keyword descriptions" on page 359

Enforcing limits

LoadLeveler depends on the underlying operating system to enforce process limits.

Users should verify that a process limit such as **rss_limit** is enforced by the operating system, otherwise setting it in LoadLeveler will have no effect.

Exceeding job step limits:

When a hard limit is exceeded LoadLeveler sends a *non-trappable* signal (except in the case of a parallel job) to the process group that LoadLeveler created for the job step.

When a soft limit is exceeded, LoadLeveler sends a *trappable* signal to the process group. Any job application that intends to trap a signal sent by LoadLeveler must ensure that all processes in the process group set up the appropriate signal handler.

All processes in the job step normally receive the signal. The exception to this rule is when a child process creates its own process group. That action isolates the child's process, and its children, from any signals that LoadLeveler sends. Any child process creating its own process group is still known to process tracking. So, if process tracking is enabled, all the child processes are terminated when the main process terminates.

Table 20 summarizes the actions that the **LoadL_starter** daemon takes when a job step limit is exceeded.

Table 20. Enforcing job step limits

Type of Job	When a Soft Limit is Exceeded	When a Hard Limit is Exceeded
Serial	SIGXCPU or SIGKILL issued	SIGKILL issued
Parallel	SIGXCPU issued to both the user program and to the parallel daemon	SIGTERM issued

On systems that do not support SIGXCPU, LoadLeveler does not distinguish between hard and soft limits. When a soft limit is reached on these platforms, LoadLeveler issues a SIGKILL.

Enforcing per process limits:

For per process limits, what happens when your job reaches and exceeds either the soft limit or the hard limit depends on the operating system you are using.

When a job forks a process that exceeds a per process limit, such as the CPU limit, the operating system (not LoadLeveler) terminates the process by issuing a SIGXCPU. As a result, you will not see an entry in the LoadLeveler logs indicating that the process exceeded the limit. The job will complete with a 0 return code. LoadLeveler can only report the status of any processes it has started.

If you need more specific information, refer to your operating system documentation.

How LoadLeveler uses hard limits:

Consider these details on how LoadLeveler uses hard limits.

See Table 21 for more information on specifying limits.

Table 21. Setting limits

If the hard limit is:	Then LoadLeveler does the following:
Set in both the class stanza and the job command file	Smaller of the two limits is taken into consideration. If the smaller limit is the job limit, the job limit is then compared with the user limit set on the machine that runs the job. The smaller of these two values is used. If the limit used is the class limit, the class limit is used without being compared to the machine limit.
Not set in either the class stanza or the job command file	User per process limit set on the machine that runs the job is used.
Set in the job command file and is less than its respective job soft limit	The job is not submitted.
Set in the class stanza and is less than its respective class stanza soft limit	Soft limit is adjusted downward to equal the hard limit.
Specified in the job command file	Hard limit must be greater than or equal to the specified soft limit and less than or equal to the limit set by the administrator in the class stanza of the administration file. Note: If the per process limit is not defined in the administration file and the hard limit defined by the user in the job command file is greater than the limit on the executing machine, then the hard limit is set to the machine limit.

Allowing users to use a class

In a class stanza, you may define a list of users or a list of groups to identify those who may use the class.

To do so, use the **include_users** or **include_groups** keyword, respectively, or you may use both keywords. If you specify both keywords, a particular user must satisfy both the **include_users** and the **include_groups** restrictions for the class. This requirement means that a particular user must be defined not only in a User stanza in the administration file, but also in one of the following ways:

- The user's name must appear in the **include_users** keyword in a Group stanza whose name corresponds to a name in the **include_groups** keyword of the Class stanza.
- The user's name must appear in the **include_groups** keyword of the Class stanza. For information about specifying a user name in a group list, see the **include_groups** keyword description in "Administration file keyword descriptions" on page 327.

Class stanza format and keyword summary

Class stanzas are optional.

Class stanzas take the following format. Default values for keywords appear in bold.

```
label: type = class
admin= list
allow_scale_across_jobs = true | false
as_limit= hardlimit,softlimit
ckpt_dir = directory
ckpt_time_limit = hardlimit,softlimit
class_comment = "string"
core_limit = hardlimit,softlimit
cpu_limit = hardlimit,softlimit
data_limit = hardlimit,softlimit
default_resources = name(count) name(count)...name(count)
default_node_resources = name(count) name(count)...name(count)
env_copy = all | master
exclude_bg = list
exclude_groups = list
exclude_users = list
file_limit = hardlimit,softlimit
include_bg = list
include_groups = list
include_users = list
job_cpu_limit = hardlimit,softlimit
locks_limit = hardlimit,softlimit
master_node_requirement = true | false
max_node = number
max_protocol_instances = number
max_top_dogs = number
max_total_tasks = number
maxjobs = number
memlock_limit = hardlimit,softlimit
nice = value
nofile_limit = hardlimit,softlimit
nproc_limit = hardlimit,softlimit
priority = number
rss_limit = hardlimit,softlimit
smt = yes | no | as_is
stack_limit = hardlimit,softlimit
striping_with_minimum_networks = true | false
total_tasks = number
wall_clock_limit = hardlimit,softlimit
default_wall_clock_limit = hardlimit,softlimit
```

Figure 13. Format of a class stanza

Examples: Class stanzas

Any of the following class stanza examples may apply to your situation.

- **Example 1: Creating a class that excludes certain users**

```
class_a: type=class                # class that excludes users
priority=10                        # ClassSysprio
exclude_users=green judy           # Excluded users
```

- **Example 2: Creating a class for small-size jobs**

```
small:  type=class                                  # class for small jobs
priority=80                                         # ClassSysprio (max=100)
cpu_limit=00:02:00                                  # 2 minute limit
data_limit=30mb                                     # max 30 MB data segment
default_resources=ConsumbableVirtualMemory(10mb) # resources consumed by each
ConsumableCpus(1) resA(3) floatinglicenseX(1)       # task of a small job step if
                                                    # resources are not explicitly
                                                    # specified in the job command file
ckpt_time_limit=3:00,2:00                           # 3 minute hardlimit,
                                                    # 2 minute softlimit
core_limit=10mb                                     # max 10 MB core file
file_limit=50mb                                     # max file size 50 MB
```

```
stack_limit=10mb                              # max stack size 10 MB
rss_limit=35mb                                # max resident set size 35 MB
include_users = bob sally                     # authorized users
```

- **Example 3: Creating a class for medium-size jobs**

```
medium: type=class            # class for medium jobs
priority=70                   # ClassSysprio
cpu_limit=00:10:00            # 10 minute run time limit
data_limit=80mb,60mb          # max 80 MB data segment
                              # soft limit 60 MB data segment
ckpt_time_limit=5:00,4:30     # 5 minute hardlimit,
                              # 4 minute 30 second softlimit to checkpoint
core_limit=30mb               # max 30 MB core file
file_limit=80mb               # max file size 80 MB
stack_limit=30mb              # max stack size 30 MB
rss_limit=100mb               # max resident set size 100 MB
job_cpu_limit=1800,1200       # hard limit is 30 minutes,
                              # soft limit is 20 minutes
```

- **Example 4: Creating a class for large-size jobs**

```
large:  type=class             # class for large jobs
priority=60                    # ClassSysprio
cpu_limit=00:10:00             # 10 minute run time limit
data_limit=120mb               # max 120 MB data segment
default_resources=ConsumableVirtualMemory(40mb)         # resources consumed
ConsumableCpus(2) resA(8) floatinglicenseX(1) resB(1)   # by each task of
                               # a large job step if resources are not
                               # explicitly specified in the job command file
ckpt_time_limit=7:00,5:00      # 7 minute hardlimit,
                               # 5 minute softlimit to checkpoint
core_limit=30mb                # max 30 MB core file
file_limit=120mb               # max file size 120 MB
stack_limit=unlimited          # unlimited stack size
rss_limit=150mb                # max resident set size 150 MB
job_cpu_limit = 3600,2700      # hard limit 60 minutes
                               # soft limit 45 minutes
wall_clock_limit=12:00:00,11:59:55 # hard limit is 12 hours
```

- **Example 5: Creating a class for master node machines**

```
sp-6hr-sp:  type=class         # class for master node machines
priority=50                    # ClassSysprio (max=100)
ckpt_time_limit=25:00,20:00    # 25 minute hardlimit,
                               # 20 minute softlimit to checkpoint
cpu_limit = 06:00:00           # 6 hour limit
job_cpu_limit = 06:00:00       # hard limit is 6 hours
core_limit = lmb               # max 1MB core file
master_node_requirement = true # master node definition
```

- **Example 6: Creating a class for MPICH-GM jobs**

```
MPICHGM: type=class             # class for MPICH-GM jobs
default_resources = gmports(1)  # one gmports resource is consumed by each
                                # task, if resources are not explicitly
                                # specified in the job command file
```

Defining user substanzas in class stanzas

In a class stanza, you might define user substanzas using the same syntax as you would for any stanza in the LoadLeveler administration file.

A user substanza within a class stanza defines policies that apply to job steps submitted by that user and belonging to that class. User substanzas are optional and are independent of user stanzas (for information about user stanzas, see "Defining users" on page 97).

Class stanzas that contain user substanzas have the following format:

```
label: {
       type = class
       label: {
              type = user
              maxidle = number
              maxjobs = number
              maxqueued = number
              max_total_tasks = number
        }
}
```

Figure 14. Format of a user substanza

When defining substanzas within other stanzas, you must use opening and closing braces ({ and }) to mark the beginning and the end of the stanza and substanza. The only keywords that are supported in a user substanza are **type** (required), **maxidle**, **maxjobs**, **maxqueued**, and **max_total_tasks**. For detailed descriptions of these keywords, see "Administration file keyword descriptions" on page 327.

Examples: Substanzas

Any of these substanza examples may apply to your situation.

In the following example, the default machine and class stanzas do not require braces, but the parallel class stanza does require them. Without braces to open and close the parallel stanza, it would not be clear that the default user and **dept_head** user stanza belong to the parallel class:

```
default:
      type = machine
      central_manager = false
      schedd_host = true

default:
      type = class
      wall_clock_limit = 60:00,30:00

parallel: {
      type = class

      # Allow at most 50 running jobs for class parallel
      maxjobs = 50

      # Allow at most 10 running jobs for any single
      # user of class parallel
      default: {
            type = user
            maxjobs = 10

      }

      # Allow user dept_head to run as many as 20 jobs
      # of class parallel
      dept_head: {type = user
            maxjobs = 20

      }
}

dept_head: type = user
      maxjobs = 30
```

When user substanzas are used in class stanzas, a default user substanza can be defined. Each class stanza can have its own default user substanza, and even the default class stanza can have a default user substanza. In this example, the default user substanza in the default class indicates that for any combination of class and user, the limits **maxidle=20** and **maxqueued=30** apply, and that **maxjobs** and **max_total_tasks** are unlimited. Some of these values are overridden in the physics class stanza. Here is an example of how class stanzas can be configured:

```
default: {
      type = class
      default: {
            type = user
            maxidle = 20
            maxqueued = 30
            maxjobs = -1
            max_total_tasks = -1
      }
}
physics: {
      type = class
      default: {
            type = user
            maxjobs = 10
            max_total_tasks = 128
      }
      john: {
            type = user
            maxidle = 10
            maxjobs = 14
      }
      jane: {
            type = user
            max_total_tasks = 192
      }
}
```

In the following example, the physics stanza shows which values are inherited from which stanzas:

```
physics: {
         type = class
         default: {
               type = user
               # inherited from default class, default user
               # maxidle = 20

               # inherited from default class, default user
               # maxqueued = 30

               # overrides value of -1 in default class, default user
               maxjobs = 10

               # overrides value of -1 in default class, default user
               max_total_tasks = 128
         }
         john: {
               type = user
               # overrides value of 10 in default user
               maxidle = 10

               # inherited from default user, which was inherited
               # from default class, default user
               # maxqueued = 30

               # overrides value of 10 in default user
               maxjobs = 14
```

```
                # inherited from default user
                # max_total_tasks = 128
        }

        jane: {
              type = user
              # inherited from default user, which was inherited
              # from default class, default user
              # maxidle = 20

              # inherited from default user, which was inherited
              # from default class, default user
              # maxqueued = 30

              # inherited from default user
              # maxjobs = 10

              # overrides value of 128 in default user
              max_total_tasks = 192
        }
}
```

Any user other than john and jane who submits jobs of class physics is subject to the constraints in the default user substanza in the physics class stanza. Should john or jane submit jobs of any class other than physics, they are subject to the constraints in the default user substanza in the default class stanza.

In addition to specifying a default user substanza within the default class stanza, an administrator can specify other user substanzas in the default class stanza. It is important to note that all class stanzas will inherit all user substanzas from the default class stanza.

Note: An important rule to understand is that a user substanza within a class stanza will inherit its values from the user substanza in the default class stanza first, if a substanza for that user is present. The next location a user substanza inherits values from is the default user substanza within the same class stanza.

When no default stanzas or substanzas are provided, the LoadLeveler default for all four keywords is -1 or unlimited.

If a user substanza is provided for a user on the class **exclude_users** list, **exclude_users** takes precedence and the user substanza will be effectively ignored because that user cannot use the class at all. On the other hand, when **include_users** is used in a class, the presence of a user substanza implies that the user is permitted to use the class (it is as if the user were present on the **include_users** list).

Defining users

The information specified in a user stanza defines the characteristics of that user. You can have one user stanza for each user but this is not necessary. If an individual user does not have their own user stanza, that user uses the defaults defined in the default user stanza.

User stanza format and keyword summary

User stanzas take a particular format.

User stanzas take the following format:

```
label: type = user
account = list
default_class = list
default_group = group name
default_interactive_class = class name
env_copy = all | master
fair_shares = number
max_node = number
max_reservation_duration = number
max_reservation_expiration = number
max_reservations = number
max_total_tasks = number
maxidle = number
maxjobs = number
maxqueued = number
priority = number
total_tasks = number
```

Figure 15. Format of a user stanza

For more information about the keywords listed in the user stanza format, see Chapter 13, "Administration file reference," on page 321.

Examples: User stanzas

Any of the following user stanzas may apply to your situation.

- **Example 1**

  In this example, user `fred` is being provided with a user stanza. User `fred`'s jobs will have a user priority of 100. If user `fred` does not specify a job class in the job command file, the default job class **class_a** will be used. In addition, he can have a maximum of 15 jobs running at the same time.

  ```
  # Define user stanzas
  fred:  type = user
  priority = 100
  default_class = class_a
  maxjobs = 15
  ```

- **Example 2**

  This example explains how a default interactive class for a parallel job is set by presenting a series of user stanzas and class stanzas. This example assumes that users do not specify the LOADL_INTERACTIVE_CLASS environment variable.

  ```
  default: type =user
           default_interactive_class = red
           default_class = blue

  carol:   type = user
           default_class = single double
           default_interactive_class = ijobs

  steve:   type = user
           default_class = single double

  ijobs:   type = class
           wall_clock_limit = 08:00:00

  red:     type = class
           wall_clock_limit = 30:00
  ```

  If the user Carol submits an interactive job, the job is assigned to the default interactive class called **ijobs**. The job is assigned a wall clock limit of 8 hours. If

the user Steve submits an interactive job, the job is assigned to the **red** class from the default user stanza. The job is assigned a wall clock limit of 30 minutes.

- **Example 3**

  In this example, Jane's jobs have a user priority of 50, and if she does not specify a job class in her job command file the default job class **small_jobs** is used. This user stanza does not specify the maximum number of jobs that Jane can run at the same time so this value defaults to the value defined in the default stanza. Also, suppose Jane is a member of the primary UNIX group "staff." Jobs submitted by Jane will use the default LoadLeveler group "staff." Lastly, Jane can use three different account numbers.

```
# Define user stanzas
jane:  type = user
priority = 50
default_class = small_jobs
default_group = Unix_Group
account = dept10 user3 user4
```

Defining groups

LoadLeveler groups are another way of granting control to the system administrator.

Although a LoadLeveler group is independent from a UNIX group, you can configure a LoadLeveler group to have the same users as a UNIX group by using the **include_users** keyword.

Group stanza format and keyword summary

The information specified in a group stanza defines the characteristics of that group.

Group stanzas are optional and take the following format:

```
label: type = group
admin = list
env_copy = all | master
fair_shares = number
exclude_users = list
include_users = list
max_node = number
max_reservation_duration = number
max_reservation_expiration = number
max_reservations = number
max_total_tasks = number
maxidle = number
maxjobs = number
maxqueued = number
priority = number
total_tasks = number
```

Figure 16. Format of a group stanza

For more information about the keywords listed in the group stanza format, see Chapter 13, "Administration file reference," on page 321.

Examples: Group stanzas

Any of the following group stanzas may apply to your situation.

- **Example 1**

In this example, the group name is **department_a**. The jobs issued by users belonging to this group will have a priority of 80. There are three members in this group.

```
# Define group stanzas
department_a:  type = group
priority = 80
include_users = susann holly fran
```

- **Example 2**

  In this example, the group called **great_lakes** has five members and these user's jobs have a priority of 100:

```
# Define group stanzas
great_lakes:  type = group
priority = 100
include_users = huron ontario michigan erie superior
```

Defining clusters

The cluster stanza defines the LoadLeveler multicluster environment.

Any cluster that wants to participate in the multicluster must have cluster stanzas defined for all clusters with which the local cluster interacts. If you have a cluster stanza defined, LoadLeveler is configured to be in the multicluster environment.

Cluster stanza format and keyword summary

Cluster stanzas are optional.

Cluster stanzas take the following format. Default values for keywords appear in bold.

The cluster stanza label must define a unique cluster name within the multicluster environment.

```
label: type = cluster
allow_scale_across_jobs = true | false
exclude_classes = class_name[(cluster_name)] ...
exclude_groups = group_name[(cluster_name)] ...
exclude_users = user_name[(cluster_name)] ...
inbound_hosts = hostname[(cluster_name)] ...
inbound_schedd_port = port_number
include_classes = class_name[(cluster_name)] ...
include_groups = group_name[(cluster_name)] ...
include_users = user_name[(clustername)] ...
local = true | false
main_scale_across_cluster = true | false
multicluster_security = SSL
outbound_hosts = hostname[(cluster_name)] ...
secure_schedd_port = port_number
ssl_cipher_list = cipher_list
```

Figure 17. Format of a cluster stanza

Examples: Cluster stanzas

Any of the following cluster stanzas may apply to your situation.

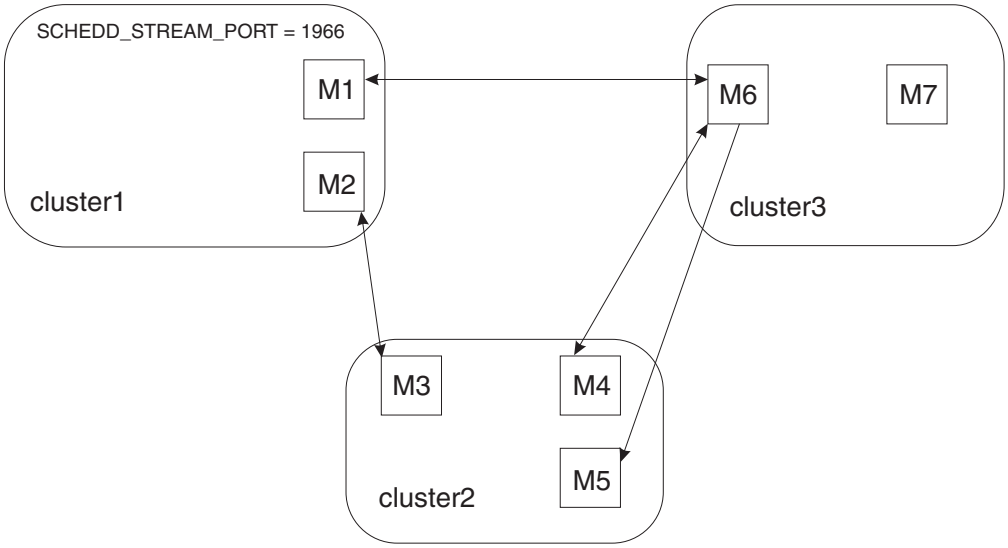

Figure 18. Multicluster Example

Figure 18 shows a simple multicluster with three clusters defined as members. Cluster1 has defined an alternate port number for the Schedds running in its cluster by setting the **SCHEDD_STREAM_PORT = 1966**. All of the other clusters need to define what port to use when connecting to the inbound Schedds of cluster1 by specifying the **inbound_schedd_port = 1966** keyword in the cluster1 stanza. Cluster2 has a single machine connected to cluster1 and 2 machines connected to cluster3. Cluster3 has a single machine connected to both cluster2 and cluster1. Each cluster would set the **local** keyword to **true** for their cluster stanza in the cluster's administration file.

Multicluster with 3 clusters defined as members

```
cluster1: type=cluster
          outbound_hosts = M2(cluster2) M1(cluster3)
          inbound_hosts = M2(cluster2) M1(cluster3)
          inbound_schedd_port = 1966

cluster2: type=cluster
          outbound_hosts = M3(cluster1) M4(cluster3)
          inbound_hosts = M3(cluster1) M4(cluster3) M5(cluster3)


cluster3: type=cluster
          outbound_hosts = M6
          inbound_hosts = M6
```

Chapter 6. Performing additional administrator tasks

There are additional ways to modify the LoadLeveler environment that either require an administrator.

Table 22 lists additional ways to modify the LoadLeveler environment that either require an administrator to customize both the configuration and administration files, or require the use of the LoadLeveler commands or APIs.

Table 22. Roadmap of additional administrator tasks

To learn about:	Read the following:
Setting up the environment for parallel jobs	"Setting up the environment for parallel jobs" on page 104
Configuring and using an alternative scheduler	• "Using the BACKFILL scheduler" on page 110 • "Using an external scheduler" on page 115 • "Example: Changing scheduler types" on page 126
Using additional features available with the BACKFILL scheduler	• "Preempting and resuming jobs" on page 126 • "Configuring LoadLeveler to support reservations" on page 131 • "Working with reservations" on page 213 • "Data staging" on page 113
Working with AIX's workload balancing component	"Steps for integrating LoadLeveler with the AIX Workload Manager" on page 137
Enabling LoadLeveler's checkpoint/restart function	"LoadLeveler support for checkpointing jobs" on page 139
Enabling LoadLeveler's affinity support	• LoadLeveler scheduling affinity (see "LoadLeveler scheduling affinity support" on page 146)
Enabling LoadLeveler's multicluster support	• "LoadLeveler multicluster support" on page 148 • "Configuring a LoadLeveler multicluster" on page 150 • "Scale-across scheduling with multiclusters" on page 153
Enabling LoadLeveler's Blue Gene support	• "LoadLeveler Blue Gene support" on page 155 • "Configuring LoadLeveler Blue Gene support" on page 157
Enabling LoadLeveler's fair share scheduling support	• "Fair share scheduling overview" on page 27 • "Using fair share scheduling" on page 160
Moving job records from a down Schedd to another Schedd within the local cluster	• "Procedure for recovering a job spool" on page 167 • "llmovespool - Move job records" on page 472
Correctly specifying configuration and administration file keywords	• Chapter 12, "Configuration file reference," on page 263 • Chapter 13, "Administration file reference," on page 321
Managing LoadLeveler operations	

Table 22. Roadmap of additional administrator tasks (continued)

To learn about:	Read the following:
• Querying status	• "llclass - Query class information" on page 433 • "llq - Query job status" on page 479 • "llqres - Query a reservation" on page 500 • "llstatus - Query machine status" on page 512
• Changing attributes of submitted jobs	• "llfavorjob - Reorder system queue by job" on page 447 • "llfavoruser - Reorder system queue by user" on page 449 • "llmodify - Change attributes of a submitted job step" on page 464 • "llprio - Change the user priority of submitted job steps" on page 477
• Changing the state of submitted jobs	• "llcancel - Cancel a submitted job" on page 421 • "llhold - Hold or release a submitted job" on page 454

Setting up the environment for parallel jobs

Additional administration tasks apply to parallel jobs.

This topic describes the following administration tasks that apply to parallel jobs:

- Scheduling support
- Reducing job launch overhead
- Submitting interactive POE jobs
- Setting up a class
- Setting up a parallel master node
- Configuring MPICH jobs
- Configuring MVAPICH jobs
- Configuring MPICH-GM jobs

For information on submitting parallel jobs, see "Working with parallel jobs" on page 194.

Scheduling considerations for parallel jobs

For parallel jobs, LoadLeveler supports BACKFILL scheduling for efficient use of system resources.

This scheduler runs both serial and parallel jobs.

BACKFILL scheduling also supports:

- Multiple tasks per node
- Multiple user space tasks per adapter
- Preemption

Specify the LoadLeveler scheduler using the **SCHEDULER_TYPE** keyword. For more information on this keyword and supported scheduler types, see "Choosing a scheduler" on page 44.

Steps for reducing job launch overhead for parallel jobs

Administrators may define a number of LoadLeveler starter processes to be ready and waiting to handle job requests.

Having this pool of ready processes reduces the amount of time LoadLeveler needs to prepare jobs to run. You also may control how environment variables are copied for a job. Reducing the number of environment variables that LoadLeveler has to copy reduces the amount of time LoadLeveler needs to prepare jobs to run.

Before you begin: You need to know:

- How many jobs might be starting at the same time. This estimate determines how many starter processes to have LoadLeveler start in advance, to be ready and waiting for job requests.
- The type of parallel jobs that typically are used. If IBM Parallel Environment (PE) is used for parallel jobs, PE copies the user's environment to all executing nodes. In this case, you may configure LoadLeveler to avoid redundantly copying the same environment variables.
- How to correctly specify configuration keywords. For details about specific keyword syntax and use:
  - In the administration file, see Chapter 13, "Administration file reference," on page 321.
  - In the configuration file, see Chapter 12, "Configuration file reference," on page 263.

Perform the following steps to configure LoadLeveler to reduce job launch overhead for parallel jobs.

1. In the local or global configuration file, specify the number of starter processes for LoadLeveler to automatically start before job requests are submitted. Use the PRESTARTED_STARTERS keyword to set this value.

   Tip: The default value of 1 should be sufficient for most installations.
2. If typical parallel jobs use a facility such as Parallel Environment, which copies user environment variables to all executing nodes, set the **env_copy** keyword in the class, user, or group stanzas to specify that LoadLeveler only copy user environment variables to the master node by default.

   Rules:

   - Users also may set this keyword in the job command file. If the **env_copy** keyword is set in the job command file, that setting overrides any setting in the administration file. For more information, see "Step for controlling whether LoadLeveler copies environment variables to all executing nodes" on page 195.
   - If the **env_copy** keyword is set in more than one stanza in the administration file, LoadLeveler determines the setting to use by examining all values set in the applicable stanzas. See the table in theenv_copy administration file keyword to determine what value LoadLeveler will use.
3. Notify LoadLeveler daemons by issuing the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the configuration and administration files.

When you are done with this procedure, you can use the POE stderr and LoadLeveler logs to trace actions during job launch.

Steps for allowing users to submit interactive POE jobs

You can set up your system so that users can submit interactive POE jobs to LoadLeveler.

Perform the following steps to set up your system so that users can submit interactive POE jobs to LoadLeveler.

1. Make sure that you have installed LoadLeveler and defined LoadLeveler administrators. See "Defining LoadLeveler administrators" on page 43 for information on defining LoadLeveler administrators.
2. If running user space jobs, LoadLeveler must be configured to use switch adapters. A way to do this is to run the **llextRPD** command to extract node and adapter information from the RSCT peer domain. See "llextRPD - Extract data from an RSCT peer domain" on page 443 for additional information.
3. In the configuration file, define your scheduler to be the LoadLeveler BACKFILL scheduler by specifying **SCHEDULER_TYPE = BACKFILL**. See "Choosing a scheduler" on page 44 for more information.
4. In the administration file, specify batch, interactive, or general use for nodes. You can use the **machine_mode** keyword in the machine stanza to specify the type of jobs that can run on a node; you must specify either **interactive** or **general** if you are going to run interactive jobs.
5. In the administration file, configure optional functions, including:
   - Setting up pools: you can organize nodes into pools by using the **pool_list** keyword in the machine stanza. See "Defining machines" on page 84 for more information.
   - Enabling SP™ exclusive use accounting: you can specify that the accounting function on an SP system be informed that a job step has exclusive use of a machine by specifying **spacct_exclusive_enable = true** in the machine stanza (as shown in the previous example).

     See "Defining machines" on page 84 for more information on these keywords.
6. Consider setting up a class stanza for your interactive POE jobs. See "Setting up a class for parallel jobs" for more information. Define this class to be your default class for interactive jobs by specifying this class name on the **default_interactive_class** keyword. See "Defining users" on page 97 for more information.

Setting up a class for parallel jobs

To define the characteristics of parallel jobs run by your installation you should set up a class stanza in the administration file and define a class (in the **Class** statement in the configuration file) for each task you want to run on a node.

Suppose your installation plans to submit long-running parallel jobs, and you want to define the following characteristics:

- Only certain users can submit these jobs
- Jobs have a 30 hour run time limit
- A job can request a maximum of 60 nodes and 120 total tasks
- Jobs will have a relatively low run priority

The following is a sample class stanza for long-running parallel jobs which takes into account these characteristics:

```
long_parallel: type=class
wall_clock_limit = 1800
include_users = jack queen king ace
priority = 50
total_tasks = 120
max_node = 60
maxjobs = 2
```

Note the following about this class stanza:

- The **wall_clock_limit** keyword sets a wall clock limit of 1800 seconds (30 hours) for jobs in this class
- The **include_users** keyword allows four users to submit jobs in this class
- The **priority** keyword sets a relative priority of 50 for jobs in this class
- The **total_tasks** keyword specifies that a user can request up to 120 total tasks for a job in this class
- The **max_node** keyword specifies that a user can request up to 60 nodes for a job in this class
- The **maxjobs** keyword specifies that a maximum of two jobs in this class can run simultaneously

Suppose users need to submit job command files containing the following statements:

```
node = 30
tasks_per_node = 4
```

In your **LoadL_config** file, you must code the **Class** statement such that at least 30 nodes have four or more long_parallel classes defined. That is, the configuration file for each of these nodes must include the following statement:

```
Class = { "long_parallel" "long_parallel" "long_parallel" "long_parallel" }
```

or

```
Class = long_parallel(4)
```

For more information, see "Defining LoadLeveler machine characteristics" on page 54.

Striping when some networks fail

When multiple networks are configured in a cluster, a job can request striping over the networks by setting **sn_all** in the network statement in the job command file. The **striping_with_minimum_networks** administration file keyword in the class stanza is used to tell LoadLeveler how to select nodes for **sn_all** jobs of a specific class when one or more networks are unavailable. When **striping_with_minimum_networks** is set to **false** for a class, LoadLeveler will only select nodes for **sn_all** jobs of that class where all the networks are up and in the READY state. When **striping_with_minimum_networks** is set to **true**, LoadLeveler will select a set of nodes where at least more than half of the networks on the nodes are up and in the READY state.

For example, if there are 8 networks connected to a node and **striping_with_minimum_networks** is set to **false**, all 8 networks would have to be up and in the READY state to consider that node for **sn_all** jobs. If **striping_with_minimum_networks** is set to **true**, nodes with at least 5 networks up and in the READY state would be considered for **sn_all** jobs

Setting up a parallel master node

LoadLeveler allows you to define a parallel master node that LoadLeveler will use as the first node for a job submitted to a particular class.

To set up a parallel master node, code the following keywords in the node's class and machine stanzas in the administration file:

```
# MACHINE STANZA: (optional)
mach1:     type = machine
master_node_exclusive = true


# CLASS STANZA: (optional)
pmv3:      type = class
master_node_requirement = true
```

Specifying **master_node_requirement = true** forces all parallel jobs in this class to use–as their first node–a machine with the **master_node_exclusive = true** setting. For more information on these keywords, see "Defining machines" on page 84 and "Defining classes" on page 89.

Configuring LoadLeveler to support MPICH jobs

The MPICH package can be configured so that LoadLeveler will be used to spawn all tasks in a MPICH application.

Using LoadLeveler to spawn MPICH tasks allows LoadLeveler to accumulate accounting data for the tasks and also allows LoadLeveler to ensure that all tasks are terminated when the job completes.

For LoadLeveler to spawn the tasks of a MPICH job, the MPICH package must be configured to use the LoadLeveler **llspawn.stdio** command when starting tasks. To configure MPICH to use **llspawn.stdio**, set the environment variable **RSHCOMMAND** to the location of the **llspawn.stdio** command and run the configure command for the MPICH package.

On Linux systems, enter the following:

```
# export RSHCOMMAND=/opt/ibmll/LoadL/full/bin/llspawn.stdio
# ./configure
```

Note: This configuration works on MPICH-1.2.7. Additional documentation for MPICH is available from the Argonne National Laboratory web site at http://www-unix.mcs.anl.gov/mpi/mpich1/.

Configuring LoadLeveler to support MVAPICH jobs

To run MVAPICH jobs under LoadLeveler control, you must specify the **llspawn** command to replace the default **RSHCOMMAND** value during software configuration.

The compiled MVAPICH implementation code uses the **llspawn** command to start tasks under LoadLeveler control. This allows LoadLeveler to have total control over the remote tasks for accounting and cleanup.

To configure the MVAPICH code to use the **llspawn** command as **RSHCOMMAND**, change the **mpirun_rsh.c** program source code by following these steps before compiling MVAPICH:

1. Replace:

```
Void child_handler(int);
```

with:

```
Void child_handler(int);
Void term_handler(int);
```

2. For Linux, replace:

```
#define RSH_CMD "/usr/bin/rsh"
#define RSH_CMD "/usr/bin/ssh"
```

with:

```
#define RSH_CMD "/opt/ibmll/LoadL/full/bin/llspawn"
#define SSH_CMD "/opt/ibmll/LoadL/full/bin/llpsawn"
```

3. Replace:

```
signal(SIGCHLD, child_handler);
```

with:

```
signal(SIGCHLD, SIG_IGN);
signal(SIGTERM, term_handler);
```

4. Add the definition for **term_handler** function at the end:

```
Void term_handler(int signal)
{
 exit(0);
}
```

Configuring LoadLeveler to support MPICH-GM jobs

To run MPICH-GM jobs under LoadLeveler control, you need to configure the MPICH-GM implementation you are using by specifying the **llspawn** command as **RSHCOMMAND**.

The compiled MPICH-GM implementation code uses the **llspawn** command to start tasks under LoadLeveler control. This allows LoadLeveler to have total control over the remote tasks for accounting and cleanup.

To configure the MPICH-GM code to use the **llspawn** command as **RSHCOMMAND**, change the **mpich.make.gcc** script before compiling the MPICH-GM:

Replace:

```
Setenv RSHCOMMAND /usr/bin/rsh
```

with:

```
Setenv RSHCOMMAND /opt/ibmll/LoadL/full/bin/llspawn
```

LoadLeveler does not manage the GM ports on the Myrinet switch. For LoadLeveler to keep track of the GM ports they must be identified as LoadLeveler consumable resources.

Perform the following steps to use consumable resources to manage GM ports:

1. Pick a name for the GM port resource.

   Example: As an example, this procedure assumes the name is **gmports**, but you may use another name.

   Tip: Users who submit MPICH-GM jobs need to know the name that you define for the GM port resource.

2. In the LoadLeveler configuration file, specify the GM port resource name on the **SCHEDULE_BY_RESOURCES** keyword.

   Example:

```
SCHEDULE_BY_RESOURCES = gmports
```

Tip: If the **SCHEDULE_BY_RESOURCES** keyword already is specified in the configuration file, you can just add the GM port resource name to other values already listed.

3. In the administration file, specify how many GM ports are available on each machine. Use the **resources** keyword to specify the GM port resource name and the number of GM ports.

   Example:

   ```
   resources=gmports(n)
   ```

   Tips:

   - The **resources** keyword also must appear in the job command file for an MPICH-GM job.

     Example:

     ```
     resources=gmports(1)
     ```

   - To determine the value of *n* use either the number specified in the GM documentation or the number of GM ports you have successfully used. Certain system configurations may not support all available GM ports, so you might need to specify a lower value for the **gmports** resource than what is actually available.

4. Issue the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the configuration and administration files.

For information about submitting MPICH-GM jobs, see "Running MPICH, MVAPICH, and MPICH-GM jobs" on page 204.

Using the BACKFILL scheduler

The BACKFILL scheduling algorithm in LoadLeveler is designed to maximize the use of resources to achieve the highest system efficiency, while preventing potentially excessive delays in starting jobs with large resource requirements.

These large jobs can run because the BACKFILL scheduler does not allow jobs with smaller resource requirements to continuously use up resources before the larger jobs can accumulate enough resources to run. While BACKFILL can be used for both serial and parallel jobs, the potential advantage is greater with parallel jobs.

Job steps are arranged in a queue based on their **SYSPRIO** order as they arrive from the Schedd nodes in the cluster. The queue can be periodically reordered depending on the value of the **RECALCULATE_SYSPRIO_INTERVAL** keyword. In each dispatching cycle, as determined by the **NEGOTIATOR_INTERVAL** and **NEGOTIATOR_CYCLE_DELAY** configuration keywords, the BACKFILL algorithm examines these job steps sequentially in an attempt to find available resources to run each job step, then dispatches those steps to run.

Once the BACKFILL algorithm encounters a job step for which it cannot immediately find enough resources, that job step becomes known as a "top dog". The BACKFILL algorithm can allocate multiple top dogs in the same dispatch cycle. By using the **MAX_TOP_DOGS** configuration keyword (for more information, see Chapter 12, "Configuration file reference," on page 263), you can define the maximum number of top dogs that the central manager will allocate. For each top dog, the BACKFILL algorithm will attempt to calculate the earliest time at which enough resources will become free to run the corresponding top

dog. This is based on the assumption that each currently running job step will run until its hard wall clock limit is reached and that when a job step terminates, the resources which that step has been using will become available.

The time at which enough currently running job steps will have terminated, meaning enough resources have become available to run a top dog, is called top dog's future start time. The future start time of each top dog is effectively guaranteed for the remainder of the execution of the BACKFILL algorithm. The resources that each top dog will use at its corresponding start time and for its duration, as specified by its hard wall clock limit, are reserved (not to be confused with the reservation feature available in LoadLeveler).

Note: A job that is bound to a reservation is not considered for top-dog scheduling, so there is no top-dog scheduling performed inside reservations.

In some cases, it may not be possible to calculate the future start time of a job step. Consider, for example, a case where there are 20 nodes in the cluster and a job step requires 24 nodes to run. Even when all nodes in the cluster are idle, it will not be possible for this job step to run. Only the addition of nodes to the cluster would allow the job step to run, and there is no way the BACKFILL algorithm can make any assumptions about when that could take place. In situations like this, the job step is not considered a "top dog", no resources are "reserved", and the BACKFILL algorithm goes on to the next job step in the queue.

The BACKFILL scheduling algorithm classifies job steps into distinct types: REGULAR, TOP DOG, and BACKFILL:

- The REGULAR job step is a job step for which enough resources are currently available and no top dogs have yet been allocated.
- The TOP DOG job step is a job step for which not enough resources are currently available, but enough resources are available at a future time and one of the following conditions is met:
  - The TOP DOG job step is not expected to run at a time when any other top dog is expected to run.
  - If the TOP DOG is expected to run at a time when some other top dogs are expected to run, then it cannot be using resources reserved by such top dogs.
- The BACKFILL job step is a job step for which enough resources are currently available and one of the following conditions is met:
  - The BACKFILL job step is expected to complete before the future start times of all top dogs, based on the hard wall clock limit of the BACKFILL job step.
  - If the BACKFILL job step is not expected to complete before the future start time of at least one top dog, then it cannot be using resources reserved by the top dogs that are expected to start before BACKFILL job step is expected to complete.

Table 23 provides a roadmap of BACKFILL scheduler tasks.

Table 23. Roadmap of BACKFILL scheduler tasks

Subtask	Associated instructions (see . . .)
Configuring the BACKFILL scheduler	• "Choosing a scheduler" on page 44 • "Tips for using the BACKFILL scheduler" on page 112 • "Example: BACKFILL scheduling" on page 113

Table 23. Roadmap of BACKFILL scheduler tasks (continued)

Subtask	Associated instructions (see . . .)
Using additional LoadLeveler features available under the BACKFILL scheduler	• "Preempting and resuming jobs" on page 126 • "Configuring LoadLeveler to support reservations" on page 131 • "Working with reservations" on page 213 • "Data staging" on page 113 • "Scale-across scheduling with multiclusters" on page 153
Use the BACKFILL scheduler to dispatch and manage jobs	• "llclass - Query class information" on page 433 • "llmodify - Change attributes of a submitted job step" on page 464 • "llpreempt - Preempt a submitted job step" on page 474 • "llq - Query job status" on page 479 • "llsubmit - Submit a job" on page 531 • "Data access API" on page 560 • "Error handling API" on page 639 • "ll_modify subroutine" on page 677 • "ll_preempt subroutine" on page 686

Tips for using the BACKFILL scheduler

There are a number of essential considerations to make when using the BACKFILL scheduler.

Note the following when using the BACKFILL scheduler:

- To use this scheduler, either users must set a wall-clock limit in their job command file or the administrator must define a wall-clock limit value for the class to which a job is assigned. Jobs with the **wall_clock_limit** of **unlimited** cannot be used to backfill because they may not finish in time.
- Using wall clock limits that accurately reflect the actual running time of the job steps will result in a more efficient utilization of resources. When a job step's wall clock limit is substantially longer than the amount of time the job step actually needs, it results in two inefficiencies in the BACKFILL algorithm:
  - The future start time of a "top dog" will be calculated to be much later due to the long wall clock limits of the running job steps, leaving a larger window for BACKFILL job steps to run. This causes the "top dog" to start later than it would have if more accurate wall clock limits had been given.
  - A job step is less likely to be backfilled if its wall clock limit is longer because it is more likely to run past the future start time of a "top dog".
- You should use only the default settings for the **START** expression and the other job control functions described in "Managing job status through control expressions" on page 68. If you do not use these default settings, jobs will still run but the scheduler will not be as efficient. For example, the scheduler will not be able to guarantee a time at which the highest priority job will run.
- You should configure any multiprocessor (SMP) nodes such that the number of jobs that can run on a node (determined by the **MAX_STARTERS** keyword) is always less than or equal to the number of processors on the node.
- Due to the characteristics of the BACKFILL algorithm, in some cases this scheduler may not honor the **MACHPRIO** statement. For more information on **MACHPRIO**, see "Setting negotiator characteristics and policies" on page 45.

- When using **PREEMPT_CLASS** rules it is helpful to create a **SYSPRIO** expression which is consistent with the preemption rules. This can be done by using the **ClassSysprio** built-in variable with a multiplier, such as `SYSPRIO: (ClassSysprio * 10000) - QDate`. If classes which appear on the left-hand side of **PREEMPT_CLASS** rules are given a higher priority than those which appear on the right, preemption won't be required as often because the job steps which can preempt will be higher in the queue than the job steps which can be preempted.
- Entering **llq -s** against a top-dog step will display that this step is a top-dog.

Example: BACKFILL scheduling

On a rack with 10 nodes, 8 of the nodes are being used by Job A.

Job B has the highest priority in the queue, and requires 10 nodes. Job C has the next highest priority in the queue, and requires only two nodes. Job B has to wait for Job A to finish so that it can use the freed nodes. Because Job A is only using 8 of the 10 nodes, the BACKFILL scheduler can schedule Job C (which only needs the two available nodes) to run as long as it finishes before Job A finishes (and Job B starts). To determine whether or not Job C has time to run, the BACKFILL scheduler uses Job C's **wall_clock_limit** value to determine whether or not it will finish before Job A ends. If Job C has a **wall_clock_limit** of **unlimited**, it may not finish before Job B's start time, and it won't be dispatched.

Data staging

Data staging allows you to stage data needed by a job before the job begins execution and to move data back to archives when a job has finished execution. A job can use one inbound data staging step and one outbound data staging step. The inbound step will be the first to be executed and the outbound step, the last.

LoadLeveler provides data staging for two scenarios:

1. A single replica of the data files needed by a job have to be created on a common file system.
2. A replica of the data files has to be created on every machine on which the job will run.

LoadLeveler allows you to request the time at which data staging operations should be scheduled.

1. A single replica must be created as soon as a job is submitted, regardless of when the job will be executed. This is the **AT_SUBMIT** configuration option.
2. A single replica of the data files must be created as close as possible to execution time of the job. This is the **JUST_IN_TIME** configuration option.
3. A replica must be created on each machine that the job runs on, as close as possible to execution time of the job. This is also the **JUST_IN_TIME** configuration option.

The basic steps involved in data staging include:

1. A job is submitted that contains data staging keywords.
2. LoadLeveler generates inbound and outbound data staging steps in accordance with these keywords. All other steps of the job have an implicit dependency on the completion of the inbound data staging step.
3. Scheduling methods:

a. With the **AT_SUBMIT** configuration option, the data staging step is started first and the application steps are scheduled when its data staging dependency is satisfied (that is, when the inbound data staging step is completed).
b. With the **JUST_IN_TIME** configuration option, the first application step of the job is scheduled in the future based on the wall clock time specified for the inbound data staging step. The inbound data staging step is started on the machines that will be used by the first application step.

4. When the inbound data staging step completes, all of the application job steps become eligible for scheduling. The exit code from the inbound data staging program is made available to all application job steps in the LL_DSTG_IN_EXIT_CODE environment variable.
5. When all the application job steps are completed, the outbound data staging step is started by LoadLeveler. Typically, the outbound data staging step would be used to move data files back to their archives.

Note: You cannot preempt data staging steps using the **llpreempt** command or by specifying the **data_stage** class in system preemption rules. Similarly, a step belonging to the **data_stage** class cannot preempt any other job step.

Configuring LoadLeveler to support data staging

LoadLeveler allows you to specify the execution time for data staging job steps using the **DSTG_TIME** keyword. It defaults to the **AT_SUBMIT** value. To schedule data staging operation as close to the application as possible, the **JUST_IN_TIME** value can be used. **DSTG_MIN_SCHEDULING_INTERVAL** is a keyword used to optimize scheduler performance by allowing data staging jobs to be scheduled only at specific intervals.

A special set of data staging step initiators, called **DSTG_MAX_STARTERS**, can be set up for data staging job steps. These initiators will be a distinct set of resources on the compute node, not included in the **MAX_STARTERS** set up for compute jobs. You cannot specify the built-in **data_stage** class in:

- The **CLASS** keyword of a job command file
- The **default_class** keyword in the administration file

For more information about the data staging keywords, see "Configuration file keyword descriptions" on page 265.

The LoadLeveler administration class stanza keywords can be used to specify defaults, limits, and restrictions for the built-in **data_stage** class. The **data_stage** class cannot be specified as the default class for a user. You cannot specify the **data_stage** class in your job command file. Steps of this class will be automatically generated by LoadLeveler based on the data staging keywords used in job command files.

LoadLeveler provides a built-in class called **data_stage** that can be configured in the administration file using a class stanza, just as you would do for any other class. Some examples of how you might use a stanza for the **data_stage** class are:

- Include and exclude users and groups from this class to control which users are permitted to use data staging.
- Specifying defaults for resource limits such as **cpu_limit** or **nofile_limit** for data staging steps.

- Specifying defaults and maximum allowed values for the **dstg_resources** job command file keyword using **default_resources** and **max_resources**.
- Limiting the total number of data staging jobs or tasks in the cluster at any one time using **maxjobs** or **max_total_tasks**.

For more information about the data staging keywords, see "Administration file keyword descriptions" on page 327.

If an inbound data staging job step is soft-bound to a reservation and keyword **dstg_node=any**, it can be started ahead of the reservation start time, if data staging resources are available. In all other cases, data staging steps will run within the reservation itself.

Using an external scheduler

The LoadLeveler API provides interfaces that allow an external scheduler to manage the assignment of resources to jobs and dispatching those jobs.

The primary interfaces for the tasks of an external scheduler are:

- **ll_query** to obtain information about the LoadLeveler cluster, the machines of the cluster, jobs and AIX Workload Manager.
- **ll_get_data** to obtain information about specific objects such as jobs, machines and adapters.
- **ll_start_job_ext** to start a LoadLeveler job.
  - The **ll_start_job_ext** subroutine supports both serial and parallel jobs. For parallel jobs, **ll_start_job_ext** provides the ability to specify which adapters are used by the communication protocols of each job task. This assures that each task uses the same network for communication over a given protocol.

The steps for dispatching jobs with an external scheduler are:

1. Gather information about the LoadLeveler cluster **(ll_query(CLUSTER)).**
2. Gather information about the machines in the LoadLeveler cluster **(ll_query(MACHINES)).**
3. Gather information about the jobs in the cluster **(ll_query(JOBS)).**
4. Determine the resources that are currently free. (See the note that follows.)
5. Determine which jobs to start. Assign resources to jobs to be started and dispatch **(ll_start_job_ext(LL_start_job_info_ext*))**.
6. Repeat steps 1 through 5.

When an external scheduler is used, the LoadLeveler Negotiator does not keep track of the resources used by jobs started by the external scheduler. There are two ways that an external scheduler can keep track of the free resources available for starting new jobs. The method that should be used depends on whether the external scheduler runs continuously while all scheduling is occurring or is executed to start a finite number of jobs and then terminates:

- If the external scheduler runs continuously, it should query the total resources available in the LoadLeveler system with **ll_query** and **ll_get_data**. Then it can keep track of the resource assigned to jobs it starts while they are running and return the resources to the available pool when the jobs complete.
- If the external scheduler is executed to start a finite number of jobs and then terminates, it must determine the pool of available resources when it first starts. It can do this by first querying the total resources in the LoadLeveler system using **ll_query** and **ll_get_data**. Then it would query the jobs in the system

(again using **ll_query**), looking for jobs that are running. For each running job, it would remove the resources used by the job from the available pool. After all the running jobs are processed, the available pool would indicate the amount of free resource for starting new jobs.

To find out more about dispatching jobs with an external scheduler, use the information in Table 24.

Table 24. Roadmap of tasks for using an external scheduler

Subtask	Associated instructions (see . . .)
Learn about the LoadLeveler functions that are limited or not available when you use an external scheduler	"Replacing the default LoadLeveler scheduling algorithm with an external scheduler"
Prepare the LoadLeveler environment for using an external scheduler	"Customizing the configuration file to define an external scheduler" on page 118
Use an external scheduler to dispatch jobs	• "Steps for getting information about the LoadLeveler cluster, its machines, and jobs" on page 118 • "Assigning resources and dispatching jobs" on page 122

Replacing the default LoadLeveler scheduling algorithm with an external scheduler

It is important to know how LoadLeveler keywords and commands behave when you replace the default LoadLeveler scheduling algorithm with an external scheduler.

LoadLeveler scheduling keywords and commands fall into the following categories:

- Keywords not involved in scheduling decisions are unchanged.
- Keywords kept in the job object or in the machine which are used by the LoadLeveler default scheduler have their values maintained as before and passed to the data access API.
- Keywords used only by the LoadLeveler default scheduler have no effect.

Table 25 discusses specific keywords and commands and how they behave when you disable the default LoadLeveler scheduling algorithm.

Table 25. Effect of LoadLeveler keywords under an external scheduler

Keyword type / name	Notes
Job command file keywords	
class	This value is provided by the data access API. Machines chosen by **ll_start_job_ext** *must* have the class of the job available or the request will be rejected.
dependency	Supported as before. Job objects for which dependency cannot be evaluated (because a previous step has not run) are maintained in the NotQueued state, and attempts to start them using **ll_start_job_ext** will result in an error. If the dependency is met, **ll_start_job_ext** can start the proc.

Table 25. Effect of LoadLeveler keywords under an external scheduler (continued)

Keyword type / name	Notes
hold	**ll_start_job_ext** cannot start a job that is in Hold status.
preferences	Passed to the data access API.
requirements	**ll_start_job_ext** returns an error if the specified machines do not match the requirements of the job. This includes Disk and Virtual Memory requirements.
startdate	The job remains in the Deferred state until the **startdate** specified in the job is reached. **ll_start_job_ext** cannot start a job in the Deferred state.
user_priority	Used in calculating the system priority (as described in "Setting and changing the priority of a job" on page 230). The system priority assigned to the job is available through the data access API. No other control of the order in which jobs are run is enforced.
Administration file keywords	
master_node_exclusive	Ignored
master_node_requirement	Ignored
max_jobs_scheduled	Ignored
max_reservations	Ignored
max_reservation_duration	Ignored
max_total_tasks	Ignored
maxidle	Supported
maxjobs	Ignored
maxqueued	Supported
priority	Used to calculate the system priority (where appropriate).
speed	Available through the data access API.
Configuration file keywords	
MACHPRIO	Calculated but is not used.
MAX_STARTERS	Calculated, and if starting the job causes this value to be exceeded, **ll_start_job_ext** returns an error.
SYSPRIO	Calculated and available to the data access API.
NEGOTIATOR_PARALLEL_DEFER	Ignored
NEGOTIATOR_PARALLEL_HOLD	Ignored
NEGOTIATOR_RESCAN_QUEUE	Ignored
NEGOTIATOR_RECALCULATE_ SYSPRIO_INTERVAL	Works as before. Set this value to 0 if you do not want the system priorities of job objects recalculated.

Customizing the configuration file to define an external scheduler

To use an external scheduler, one of the tasks you must perform is setting the configuration file keyword **SCHEDULER_TYPE** to the value **API**.

This keyword option provides a time-based (rather than an event-based) interface. That is, your application must use the data access API to poll LoadLeveler at specific times for machine and job information.

When you enable a scheduler type of API, you must specify **AGGREGATE_ADAPTERS=NO** to make the individual switch adapters available to the external scheduler. This means the external scheduler receives each individual adapter connected to the network, instead of collectively grouping them together. You'll see each adapter listed individually in the **llstatus -l** command output. When this keyword is set to **YES**, the **llstatus -l** command will show an aggregate adapter which contains information on all switch adapters on the same network. For detailed information about individual switch adapters, issue the **llstatus -a** command.

You also may use the **PREEMPTION_SUPPORT** keyword, which specifies the level of preemption support for a cluster. Preemption allows for a running job step to be suspended so that another job step can run.

Steps for getting information about the LoadLeveler cluster, its machines, and jobs

There are steps to retrieve and use information about the LoadLeveler cluster, machines, jobs and AIX Workload Manager.

Perform the following steps to retrieve and use information about the LoadLeveler cluster, machines, jobs and AIX Workload Manager:

1. Create a query object for the kind of information you want.

   Example: To query machine information, code the following instruction:

   ```
   LL_element * query_element = ll_query(MACHINES);
   ```

2. Customize the query to filter the specific information you want. You can filter the list of objects for which you want information. For some queries, you can also filter how much information you want.

   Example: The following lines customize the query for just hosts node01.ibm.com and node02.ibm.com and to return the information contained in the **llstatus -f** command:

   ```
   char * hostlist[] = { "node01.ibm.com","node02.ibm.com",NULL };
   ll_set_request(query_element,QUERY_HOST,hostlist,STATUS_LINE);
   ```

3. Once the query has been customized:

   a. Submit it using **ll_get_objs**, which returns the first object that matches the query.

   b. Interrogate the returned object using the **ll_get_data** command to retrieve specific attributes. Depending on the information being queried for, the query may be directed to a specific node and a specific daemon on that node.

   Example: A **JOBS** query for all data may be directed to the negotiator, Schedd or the history file. If it is directed to the Schedd, you must specify the host of

the Schedd you are interested in. The following demonstrates retrieving the name of the first machine returned by the query constructed previously:

```
int machine_count;
int rc;
LL_element * element =ll_get_objs(query_element,LL_CM,NULL,&machine_count,&rc)
char * mname;
ll_get_data(element,LL_MachineName,&mname);
```

Because there is only one negotiator in a LoadLeveler cluster, the host does not have to be specified. The third parameter is the address of an integer that will receive the count of objects returned and the fourth parameter is the address of an integer that will receive the completion code of the call. If the call fails, NULL is returned and the location pointed to by the fourth parameter is set to a reason code. If the call succeeds, the value returned is used as the first parameter to a call to **ll_get_data**. The second parameter to **ll_get_data** is a specification that indicates what attribute of the object is being interrogated. The third parameter to **ll_get_data** is the address of the location into which to store the result. **ll_get_data** returns zero if it is successful and nonzero if an error occurs. It is important that the specification (the second parameter to **ll_get_data**) be valid for the object passed in (the first parameter) and that the address passed in as the third parameter point to the correct type for the specification. Undefined, potentially dangerous behavior will occur if either of these conditions is not met.

Example: Retrieving specific information about machines

The following example demonstrates printing out the name and adapter list of all machines in the LoadLeveler cluster.

The example could be extended to retrieve all of the information available about the machines in the cluster such as memory, disk space, pool list, features, supported classes, and architecture, among other things. A similar process would be used to retrieve information about the cluster overall.

```
int  i, w, rc;
int machine_count;
LL_element * query_elem;
LL_element * machine;
LL_element * adapter;
char * machine_name;
char * adapter_name;
int * window_list;
int window_count;

/* First we need to obtain a query element which is used to pass     */
/* parameters in to the machine query                                */
if ((query_elem = ll_query(MACHINES)) == NULL)
  {
    fprintf(stderr,"Unable to obtain query element\n");
    /* without the query object we will not be able to do anything */
    exit(-1);
  }

/* Get information relating to machines in the LoadLeveler cluster. */

/* QUERY_ALL: we are querying all machines                           */
/* NULL: since we are querying all machines we do not need to        */
/*       specify a filter to indicate which machines                 */
/* ALL_DATA: we want all the information available about the machine */
rc=ll_set_request(query_elem,QUERY_ALL,NULL,ALL_DATA);
if(rc<0)
  {
    /* A real application would map the return code to a message  */
```

```
    printf("
    /* Without customizing the query we cannot proceed */
    exit(rc);
  }

/* If successful, ll_get_objs() returns the first object that    */
/* satisfies the criteria that are set in the query element and  */
/* the parameters.  In this case those criteris are:             */
/* A machine (from the type of query object)                     */
/* LL_CM: that the negotiator knows about                        */
/* NULL: since there is only one negotiator we don't have to     */
/*       specify which host it is on                             */
/* The number of machines is returned in machine_count and the   */
/* return code is returned in rc                                 */
machine = ll_get_objs(query_elem,LL_CM,NULL,&machine_count,&rc);
if(rc<0)
  {
    /* A real application would map the return code to a message  */
    printf("

    /* query was not successful -- we cannot proceed but we need to */
    /* release the query element                                     */
    if(ll_deallocate(query_elem) == -1)
      {
        fprintf(stderr,"Attempt to deallocate invalid query element\n");
      }
    exit(rc);
  }

printf("Number of Machines =
i = 0;
while(machine!=NULL)
  {
    printf("-----------------------------------------------------\n");
    printf("Machine

    int rc = ll_get_data(machine,LL_MachineName,&machine_name);
    if(0==rc)
      {
 printf("Machine name =
}
    else
      {
 printf("Error
      }

    printf("Adapters\n");
    ll_get_data(machine,LL_MachineGetFirstAdapter,&adapter);
    while(adapter != NULL)
      {
 rc = ll_get_data(adapter,LL_AdapterName,&adapter_name);
        if(0!=rc)
   {
     printf("Error
         }
 else
   {
           /* Because the list of windows on an adapter is returned */
     /* as an array of integers, we also need to know how big */
     /* the list is.  First we query the window count,        */
     /* storing the result in an integer, then we query for   */
     /* the list itself, storing the result in a pointer to   */
     /* an integer.  The window list is allocated for us so   */
     /* we need to free it when we are done                   */

           printf("
           ll_get_data(adapter,LL_AdapterTotalWindowCount,&window_count);
```

```
     ll_get_data(adapter,LL_AdapterWindowList,&window_list);
     for (w = 0;w<iBuffer;w++)
               {
                printf("
}
            printf("\n");
          }
        free(window_list);
 /* After the first object has been gotten, GetNext returns   */
 /* the next until the list is exhausted                      */
        ll_get_data(machine,LL_MachineGetNextAdapter,&adapter);
      }

    printf("\n");
    i++;
    machine = ll_next_obj(query_elem);
  }

/* First we need to release the individual objects that were         */
/* obtained by the query                                             */
if(ll_free_objs(query_elem) == -1)
  {
    fprintf(stderr,"Attempt to free invalid query element\n");
  }

/* Then we need to release the query itself                          */
if(ll_deallocate(query_elem) == -1)
  {
    fprintf(stderr,"Attempt to deallocate invalid query element\n");
  }
```

Example: Retrieving information about jobs

The following example may apply to your situation.

The following example demonstrates retrieving information about jobs up to the point of starting a job:

```
int  i, rc;
int job_count;
LL_element * query_elem;
LL_element * job;
LL_element * step;
int step_state;

/* First we need to obtain a query element which is used to pass     */
/* parameters in to the jobs query                                   */
if ((query_elem = ll_query(JOBS)) == NULL)
  {
    fprintf(stderr,"Unable to obtain query element\n");
    /* without the query object we will not be able to do anything */
    exit(-1);
  }

/* Get information relating to Jobs in the LoadLeveler cluster. */
printf("Jobs Information ======================================\n\n");
/* QUERY_ALL: we are querying all jobs                               */
/* NULL: since we are querying all jobs we do not need to            */
/*       specify a filter to indicate which jobs                     */
/* ALL_DATA: we want all the information available about the job     */
rc=ll_set_request(query_elem,QUERY_ALL,NULL,ALL_DATA);
if(rc<0)
  {
    /* A real application would map the return code to a message  */
    printf("
    /* Without customizing the query we cannot proceed */
    exit(rc);
  }
```

```
/* If successful, ll_get_objs() returns the first object that    */
/* satisfies the criteria that are set in the query element and  */
/* the parameters.  In this case those criteris are:             */
/* A job (from the type of query object)                         */
/* LL_CM: that the negotiator knows about                        */
/* NULL: since there is only one negotiator we don't have to     */
/*       specify which host it is on                             */
/* The number of jobs is returned in job_count and the           */
/* return code is returned in rc                                 */
job = ll_get_objs(query_elem,LL_CM,NULL,&job_count,&rc);
if(rc<0)
  {
    /* A real application would map the return code to a message  */
    printf("

    /* query was not successful -- we cannot proceed but we need to */
    /* release the query element                                    */
    if(ll_deallocate(query_elem) == -1)
      {
        fprintf(stderr,"Attempt to deallocate invalid query element\n");
      }
    exit(rc);
  }

printf("Number of Jobs =
step = NULL;
while(job!=NULL)
  {
    /* Each job is composed of one or more steps which are started   */
    /* individually.  We need to check the state of the job's steps  */
    ll_get_data(job,LL_JobGetFirstStep,&step);
    while(step!=NULL)
      {
 ll_get_data(step,LL_StepState,&step_state);
 /* We are looking for steps that are in idle state.  The     */
 /* state is returned as an int so we cast it to              */
 /* enum StepState as declared in llapi.h                     */
        if((enum StepState)step_state == STATE_IDLE)
   break;
}
    /* If we exit the loop with a valid step, it is the one to start */
    /* otherwise we need to keep looking                             */
    if(step != NULL)
      break;

    ll_next_obj(query_elem);
  }

if(step==NULL)
  {
    printf("No step to start\n");
    exit(0);
  }
```

Assigning resources and dispatching jobs

After an external scheduler selects a job step to start and identifies the machines that the job step will run on, the LoadLeveler job start API is used to tell LoadLeveler the job step to start and the resources that are to be assigned to the job step.

In "Example: Retrieving information about jobs" on page 121, we reached the point where a step to start was identified. In a real external scheduler, the decision would be reached after consideration of all the idle jobs and constructing a priority

value based on attributes such as class and submit time, all of which are accessible through **ll_get_data**. Next, the list of available machines would be examined to determine whether a set exists with sufficient resources to run the job. This process also involves determining the size of that set of machines using attributes of the step such as number of nodes, instances of each node and tasks per node. The LoadLeveler data query API allows access to that information about each job but the interface for starting the job does not require that the machine and adapter resource match the specifications when the job was submitted. For example, a job could be submitted specifying **node=4** but could be started by an external scheduler on a single node only. Similarly, the job could specify the LAPI protocol with **network.lapi=...** but be started and told to use the MPI protocol. This is not considered an error since it is up to the scheduler to interpret (and enforce, if necessary), the specifications in the job command file.

In allocating adapter resources for a step, it is important that the order of the adapter usages be consistent with the structure of the step. In some environments a task can use multiple instances of adapter windows for a protocol. If the protocol requests striping (**sn_all**), an adapter window (or set of windows if instances are used) is allocated on each available network. If multiple protocols are used by the task (for example, MPI and LAPI), each protocol defines its own set of windows. The array of adapter usages passed in to **ll_start_job_ext** must group the windows for all of the instances on one network for the same protocol together. If the protocol requests striping, that grouping must be immediately followed by the grouping for the next network. If the task uses multiple protocols, the set of adapter usages for the first protocol must be immediately followed by the set for the next protocol. Each task will have exactly the same pattern of adapter usage entries. Corresponding entries across all the tasks represent a communication path and must be able to communicate with each other. If the usages are for User Space communication, a network table will be loaded for each set of corresponding entries.

All of the job command file keywords for specifying job structure such as **total_tasks**, **tasks_per_node**, **node=min,max** and **blocking** are supported by the **ll_start_job_ext** interface but users should ensure that they understand the LoadLeveler model that is created for each combination when constructing the adapter usage list for **ll_start_job_ext**. Jobs that are submitted with **node=number** and **tasks_per_node** result in more regular LoadLeveler models and are easier to create adapter usage lists for.

In the following example, it is assumed that the step found to be dispatched will run on one machine with two tasks, each task using one switch adapter window for MPI communication. The name of the machine to run on is contained in the variable **use_machine (char*)**, the names of the switch adapters are contained in **use_adapter_1 (char *)** and **use_adpater_2 (char *)** and the adapter windows on those adapters in **use_window_1 int)** and **use_window_2 (int)**, respectively. Further more, each adapter will be allocated 1M of memory.

If the network adapters that the external scheduler assigns to the job allocate communication buffers in rCxt blocks instead of bytes (the Switch Network Interface for HPS is an example of such a network adapter), the **api_rcxtblocks** field of **adapterUsage** should be used to specify the number of rCxt blocks to assign instead of the **mem** field.

```
LL_start_job_info_ext *start_info;
char * pChar;
LL_element * step;
LL_element * job;
```

```
int rc;
char * submit_host;
char * step_id;

start_info = (LL_start_job_info_ext *)(malloc(sizeof(LL_start_job_info_ext)));
if(start_info == NULL)
  {
    fprintf(stderr, "Out of memory.\n");
    return;
  }

/* Create a NULL terminated list of target machines.  Each task      */
/* must have an entry in this list and the entries for tasks on the  */
/* same machine must be sequential.  For example, if a job is to run */
/* on two machines, A and B, and three tasks are to run on each      */
/* machine, the list would be: AAABBB                                */
/* Any specifications on the job when it was submitted such as       */
/* nodes, total_tasks or tasks_per_node must be explicitly queried   */
/* and honored by the external scheduler in order to take effect.    */
/* They are not automatically enforced by LoadLeveler when an        */
/* external scheduler is used.                                       */
/*                                                                   */
/* In this example, the job will only be run on one machine          */
/* with only one task so the machine list consists of only 1 machine */
/* (plus the terminating NULL entry)                                 */
start_info->nodeList = (char **)malloc(2*sizeof(char *));
if (!start_info->nodeList)
  {
    fprintf(stderr, "Out of memory.\n");
    return;
  }

start_info->nodeList[0] = strdup(use_machine);
start_info->nodeList[1] = NULL;

/* Retrieve information from the job to populate the start_info      */
/* structure                                                         */
/* In the interest of brevity, the success of the ll_get_data()      */
/* is not tested.  In a real application it shuld be                 */

/* The version number is set from the header that is included when   */
/* the application using the API is compiled.  This allows for       */
/* checking that the application was compiled with a version of the  */
/* API that is compatible with the version in the library when the   */
/* application is run.                                               */
start_info->version_num = LL_PROC_VERSION;

/* Get the first step of the job to start                            */
ll_get_data(job,LL_JobGetFirstStep,&step);
if(step==NULL)
  {
    printf("No step to start\n");
    return;
  }

/* In order to set the submitting host, cluster number and proc      */
/* number in the start_info structure, we need to parse it out of    */
/* the step id                                                       */

/* First get the submitting host and save it                         */
ll_get_data(job,LL_JobSubmitHost,&submit_host);
start_info->StepId.from_host = strdup(submit_host);
free(submit_host);

rc = ll_get_data(step, LL_StepID, &step_id);

/* The step id format is submit_host.jobno.stepno .  Because the     */
```

```
/* submit host is a dotted string of indeterminant length, the       */
/* simplest way to detect where the job number starts is to retrieve */
/* the submit host from the job and skip forward its length in the   */
/* step id.                                                          */

pChar = step_id+strlen(start_info->StepId.from_host)+1;
/* The next segment is the cluster or job number                     */
pChar = strtok(pChar,".");
start_info->StepId.cluster=atoi(pChar);
/* The last token is the proc or step number                         */
pChar = strtok(NULL,".");
start_info->StepId.proc = atoi(pChar);
free(step_id);

/* For each protocol (eg. MPI or LAPI) on each task, we need to      */
/* specify which adapter to use, whether a window is being used      */
/* (subsystem = "US") or not (subsytem="IP").  If a window is used,  */
/* the window ID and window buffer size must be specified.           */
/*                                                                   */
/* The adapter usage entries for the protocols of a task must be     */
/* sequential and the set of entries for tasks on the same node must */
/* be sequential.  For example the twelve entries for a job where    */
/* each task uses one window for MPI and one for LAPI with three     */
/* tasks per node and running on two nodes would be laid out as:     */
/*  1: MPI window for 1st task running on 1st node                   */
/*  2: LAPI window for 1st task running on 1st node                  */
/*  3: MPI window for 2nd task running on 1st node                   */
/*  4: LAPI window for 2nd task running on 1st node                  */
/*  5: MPI window for 3rd task running on 1st node                   */
/*  6: LAPI window for 3rd task running on 1st node                  */
/*  7: MPI window for 1st task running on 2nd node                   */
/*  8: LAPI window for 1st task running on 2nd node                  */
/*  9: MPI window for 2nd task running on 2nd node                   */
/* 10: LAPI window for 2nd task running on 2nd node                  */
/* 11: MPI window for 3rd task running on 2nd node                   */
/* 12: LAPI window for 3rd task running on 2nd node                  */
/* An improperly ordered adapter usage list may cause the job not to */
/* be started or, if started, incorrect execution of the job         */
/*                                                                   */
/* This example starts the job with two tasks on one machine, using  */
/* one switch adapter window on each task.  The protocol is forced   */
/* to MPI and a fixed window size of 1M is used.  An actual external */
/* scheduler application would check the steps requirements and its  */
/* adapter requirements of the step with ll_get_data                 */
/*                                                                   */
start_info->adapterUsageCount = 2;
start_info->adapterUsage =
  (LL_ADAPTER_USAGE *)malloc((start_info->adapterUsageCount)
                             * sizeof(LL_ADAPTER_USAGE));

start_info->adapterUsage[0].dev_name = use_adapter_1;
start_info->adapterUsage[0].protocol = "MPI";
start_info->adapterUsage[0].subsystem = "US";
start_info->adapterUsage[0].wid = use_window_1;
start_info->adapterUsage[0].mem = 1048577;

start_info->adapterUsage[1].dev_name = use_adapter_2;
start_info->adapterUsage[1].protocol = "MPI";
start_info->adapterUsage[1].subsystem = "US";
start_info->adapterUsage[1].wid = use_window_2;
start_info->adapterUsage[1].mem = 1048577;

if ((rc = ll_start_job_ext(start_info)) != API_OK)
  {
    printf("Error %d returned attempting to start Job Step %s.%d.%d on %s\n",
           rc,
    start_info->StepId.from_host,
```

```
    start_info->StepId.cluster,
    start_info->StepId.proc,
    start_info->nodeList[0]
    );
  }
else
  {
    printf("ll_start_job_ext() invoked to start job step: "
           "%s.%d.%d on machine: %s.\n\n",
           start_info->StepId.from_host, start_info->StepId.cluster,
           start_info->StepId.proc,  start_info->nodeList[0]);
  }
free(start_info->nodeList[0]);
free(start_info);
```

Finally, when the step and job element are no longer in use, **ll_free_objs()** and **ll_deallocate()** should be called on the query element.

Example: Changing scheduler types

You can toggle between the default LoadLeveler scheduler and other types of schedulers by using the **SCHEDULER_TYPE** keyword.

Changes to **SCHEDULER_TYPE** will not take effect at reconfiguration. The administrator must stop and restart or recycle LoadLeveler when changing **SCHEDULER_TYPE**. A combination of changes to **SCHEDULER_TYPE** and some other keywords may terminate LoadLeveler.

The following example illustrates how you can toggle between the default LoadLeveler scheduler and an external scheduler, such as the Extensible Argonne Scheduling sYstem (EASY), developed by Argonne National Laboratory and available as public domain code.

If you are running the default LoadLeveler scheduler, perform the following steps to switch to an external scheduler:

1. In the configuration file, set **SCHEDULER_TYPE = API**
2. On the central manager machine:
   - Issue **llctl -g stop** and **llctl -g start**, or
   - Issue **llctl -g recycle**

If you are running an external scheduler, this is how you can re-enable the LoadLeveler scheduling algorithm:

1. In the configuration file, set **SCHEDULER_TYPE = LL_DEFAULT**
2. On the central manager machine:
   - Issue **llctl -g stop** and **llctl -g start**, or
   - Issue **llctl -g recycle**

Preempting and resuming jobs

The BACKFILL scheduler allows LoadLeveler jobs to be preempted so that a higher priority job step can run.

Administrators may specify not only preemption rules for job classes, but also the method that LoadLeveler uses to preempt jobs. The BACKFILL scheduler supports various methods of preemption.

Use Table 26 to find more information about preemption.

Table 26. Roadmap of tasks for using preemption

Subtask	Associated instructions (see . . .)
Learn about types of preemption and what it means for preempted jobs	"Overview of preemption"
Prepare the LoadLeveler environment and jobs for preemption	"Planning to preempt jobs" on page 128
Configure LoadLeveler to use preemption	"Steps for configuring a scheduler to preempt jobs" on page 130

Overview of preemption

LoadLeveler supports two types of preemption.

The types of preemption thatLoadLeveler supports are of the following two types:

- System-initiated preemption
  - Automatically enforced by LoadLeveler, except for job steps running under a reservation.
  - Governed by the PREEMPT_CLASS rules defined in the global configuration file.
  - When resources required by an incoming job are in use by other job steps, all or some of those job steps in certain classes may be preempted according to the PREEMPT_CLASS rules.
  - An automatically preempted job step will be resumed by LoadLeveler when resources become available and conditions such as START_CLASS rules are satisfied.
  - An automatically preempted job step cannot be resumed using **llpreempt** command or **ll_preempt** subroutine.
- User-initiated preemption
  - Manually initiated by LoadLeveler administrators using **llpreempt** command or **ll_preempt** subroutine.
  - A manually preempted job step cannot be resumed automatically by LoadLeveler.
  - A manually preempted job step can be resumed using **llpreempt** command or **ll_preempt** subroutine. Issuing this command or subroutine, however, does not guarantee that the job step will successfully be resumed. A manually preempted job step that was resumed through these interfaces competes for resources with system-preempted job steps, and will be resumed only when resources become available.
  - All steps in a set of coscheduled job steps will be preempted if one or more steps in the step is preempted.
  - A coscheduled step will not be resumed until all steps in the set of coscheduled job steps can be resumed.

For the BACKFILL scheduler only, administrators may select which method LoadLeveler uses to preempt and resume jobs. The suspend method is the default behavior, and is the preemption method LoadLeveler uses for any external schedulers that support preemption. For more information about preemption methods, see "Planning to preempt jobs" on page 128.

For a preempted job to be resumed after system- or user-initiated preemption occurs through a method other than suspend, the **restart** keyword in the job command file must be set to **yes**. Otherwise, LoadLeveler vacates the job step and removes it from the cluster.

In order to determine the preempt type and preempt method to use when a coscheduled step preempts another step, an order of precedence for preempt types and preempt methods has been defined. All steps in the preempting coscheduled step will be examined and the preempt type and preempt method having the highest precedence will be used. The order of precedence for preempt type will be ALL, ENOUGH. The precedence order for preempt method will be remove, vacate, system hold, user hold, suspend.

When coscheduled steps are running, if one step is preempted as a result of a system initiated preemption, then all coscheduled steps will be preempted. This implies that more resource than necessary might be preempted when one of the steps being preempted is a coscheduled step.

Planning to preempt jobs

There are points to consider when planning to use preemption.

Consider the following points when planning to use preemption:

- **Avoiding circular preemption under the BACKFILL scheduler**

  BACKFILL scheduling enables job preemption using rules specified with the **PREEMPT_CLASS** keyword. When you are setting up the preemption rules, make sure that you do not create a circular preemption path. Circular preemption causes a job class to preempt itself after applying the preemption rules recursively. For example, the following keyword definitions set up circular preemption rules on Class_A:

  ```
  PREEMPT_CLASS[Class_A] = ALL { Class_B }
  PREEMPT_CLASS[Class_B] = ALL { Class_C }
  PREEMPT_CLASS[Class_C] = ENOUGH { Class_A }
  ```

  Another example of circular preemption involves **allclasses**:

  ```
  PREEMPT_CLASS[Class_A] = ENOUGH {allclasses}
  PREEMPT_CLASS[Class_B] = ALL {Class_A}
  ```

  In this instance, **allclasses** means all classes except Class_A, any additional preemption rule preempting Class_A causes circular preemption.

- **Understanding implied START_CLASS values**

  Using the "ALL" value in the **PREEMPT_CLASS** keyword places implied restrictions on when a job can start. For example,

  ```
  PREEMPT_CLASS[Class_A] = ALL {Class_B Class_C}
  ```

  tells LoadLeveler two things:

  1. If a new Class_A job is about to run on a node set, then preempt all Class_B and Class_C jobs on those nodes
  2. If a Class_A job is running on a node set, then do not start any Class_B or Class_C jobs on those nodes

  This **PREEMPT_CLASS** statement also implies the following **START_CLASS** expressions:

  1. START_CLASS[Class_B] = (Class_A < 1)
  2. START_CLASS[Class_C] = (Class_A < 1)

LoadLeveler adds all implied **START_CLASS** expressions to the **START_CLASS** expressions specified in the configuration file. This overrides any existing values for **START_CLASS**.

For example, if the configuration file contains the following statements:

```
PREEMPT_CLASS[Class_A] = ALL {Class_B Class_C}
START_CLASS[Class_B] = (Class_A < 5)
START_CLASS[Class_C] = (Class_C < 3)
```

When LoadLeveler runs through the configuration process, the **PREEMPT_CLASS** statement on the first line generates the two implied **START_CLASS** statements. When the implied **START_CLASS** statements get added in, the user specified **START_CLASS** statements are overridden and the resulting **START_CLASS** statements are effectively equivalent to:

```
START_CLASS[Class_B] = (Class_A < 1)
START_CLASS[Class_C] = (Class_C < 3) && (Class_A < 1)
```

Note: LoadLeveler's central manager (CM) uses these effective expressions instead of the original statements specified in the configuration file. The output from **llclass -l** displays the original customer specified **START_CLASS** expressions.

- **Selecting the preemption method under the BACKFILL scheduler**

  Use Table 27 and Table 28 on page 130 to determine which preemption you want to use for jobs running under the BACKFILL scheduler. You may define one or more of the following:
  - A default preemption method to be used for all job classes, by setting the **DEFAULT_PREEMPT_METHOD** keyword in the configuration file.
  - A specific preemption method for one or more classes or job steps, by using an option on:
    - The **PREEMPT_CLASS** statement in the configuration file.
    - The **llpreempt** command, **ll_preempt** subroutine or **ll_preempt_jobs** subroutine.

  Note:

  1. Process tracking must be enabled in order to use the suspend method to preempt a job. To configure LoadLeveler for process tracking, see "Tracking job processes" on page 70.
  2. For a preempted job to be resumed after system- or user-initiated preemption occurs through a method other than suspend and remove, the **restart** keyword in the job command file must be **set** to yes. Otherwise, LoadLeveler vacates the job step and removes it from the cluster.

Table 27. Preemption methods for which LoadLeveler automatically resumes preempted jobs

Preemption method (abbreviation)	**LoadLeveler resumes preempted job:**		
	At this time	**At this location**	**At this processing point**
Suspend (su)	When preempting job completes	On the same nodes	At the point of suspension
Vacate (vc)	When nodes are available	Any nodes that meet job requirements	At the beginning or at the last successful checkpoint

Table 28. Preemption methods for which administrator or user intervention is required

Preemption method (abbreviation)	Required intervention	LoadLeveler resumes preempted job:	
		At this location	At this processing point
Remove (rm)	Administrator or user must resubmit the preempted job	Any nodes that meet job requirements, when they are available	At the beginning or at the last successful checkpoint
System Hold (sh)	Administrator must release the preempted job		
User Hold (uh)	User must release the preempted job		

- **Understanding how LoadLeveler treats resources held by jobs to be preempted**

  When a job step is running, it may be holding the following resources:
  - Processors
  - Scheduling slots
  - Real memory
  - ConsumableCpus, ConsumableMemory, ConsumableVirtualMemory, and ConsumableLargePageMemory
  - Communication switches, if the **PREEMPTION_TYPE** keyword is set to `FULL` in the configuration file.

  When LoadLeveler suspends preemptable jobs running under the BACKFILL scheduler, certain resources held by those jobs do not become available for the preempting jobs. These resources include ConsumableVirtualMemory, ConsumableLargePageMemory, and floating resources. Under the BACKFILL scheduler only, LoadLeveler releases these resources when you select a preemption method other than suspend. For all preemption methods other than suspend, LoadLeveler treats all job-step resources as available when it preempts the job step.
- **Understanding how LoadLeveler processes multiple entries for the same keywords**

  If there are multiple entries for the same keyword in either a configuration file or an administration file, the last entry wins. For example, the following statements are all valid specifications for the same keyword **START_CLASS**:

  ```
  START_CLASS [Class_B] = (Class_A < 1)
  START_CLASS [Class_B] = (Class_B < 1)
  START_CLASS [Class_B] = (Class_C < 1)
  ```

  However, all three statements identify Class_B as the incoming class. LoadLeveler resolves these statements according to the ″last one wins″ rule. Because of that, the actual value used for the keyword is (Class_C < 1).

Steps for configuring a scheduler to preempt jobs

You need to know certain details about the job characteristics and workload at your installation before you begin to define rules for starting and preempting jobs.

Before you begin:

- To define rules for starting and preempting jobs, you need to know certain details about the job characteristics and workload at your installation, including:
  - Which jobs require the same resources, or must be run on the same machines, and so on. This knowledge allows you to group specific jobs into a class.
  - Which jobs or classes have higher priority than others. This knowledge allows you to define which job classes can preempt other classes.

- To correctly configure LoadLeveler to preempt jobs, you might need to refer to the following information:
  - "Choosing a scheduler" on page 44.
  - "Planning to preempt jobs" on page 128.
  - Chapter 12, "Configuration file reference," on page 263.
  - Chapter 13, "Administration file reference," on page 321.
  - "llctl - Control LoadLeveler daemons" on page 439.

Perform the following steps to configure a scheduler to preempt jobs:

1. In the configuration file, use the **SCHEDULER_TYPE** keyword to define the type of LoadLeveler or external scheduler you want to use. Of the LoadLeveler schedulers, only the BACKFILL scheduler supports preemption.

   Rule: If you select the BACKFILL or API scheduler, you must set the **PREEMPTION_SUPPORT** configuration keyword to either **full** or **no_adapter**.
2. (Optional) In the configuration file, use the **DEFAULT_PREEMPT_METHOD** to define the default method that the BACKFILL scheduler should use for preempting jobs.

   Alternative: You also may set the preemption method through the **PREEMPT_CLASS** keyword or on the LoadLeveler preemption command or APIs, which override the setting for the **DEFAULT_PREEMPT_METHOD** keyword.
3. For either the BACKFILL or API scheduler, to preempt by the suspend method requires that you set the **PROCESS_TRACKING** configuration keyword to **true**.
4. In the configuration file, use the **PREEMPT_CLASS** and **START_CLASS** to define the preemption and start policies for job classes.
5. In the administration file, use the max_total_tasks keyword to define the maximum number of tasks that may be run per user, group, or class.
6. On the central manager machine:
   - Issue **llctl -g stop** and **llctl -g start**, or
   - Issue **llctl -g recycle**

When you are done with this procedure, you can use the **llq** command to determine whether jobs are being preempted and resumed correctly. If not, use the LoadLeveler logs to trace the actions of each daemon involved in preemption to determine the problem.

Configuring LoadLeveler to support reservations

Under the BACKFILL scheduler only, LoadLeveler allows authorized users to make reservations or recurring reservations, which specify one or more time periods during which specific node resources are reserved for use by particular users or groups.

Normally, jobs wait to be dispatched until the resources they require become available. Through the use of reservations, wait time can be reduced because only jobs that are bound to the reservation may use the node resources as soon as the reservation period begins.

Reservation tasks for administrators

Use Table 29 to find additional information about reservations.

Table 29. Roadmap of reservation tasks for administrators

Subtask	Associated instructions (see . . .)
Learn how reservations work in the LoadLeveler environment	• "Overview of reservations" on page 25 • "Understanding the reservation life cycle" on page 214
Configuring a LoadLeveler cluster to support reservations	• "Steps for configuring reservations in a LoadLeveler cluster" • "Examples: Reservation keyword combinations in the administration file" on page 134 • "Collecting accounting data for reservations" on page 63
Working with reservations: • Creating reservations • Submitting jobs under a reservation • Managing reservations	"Working with reservations" on page 213
Correctly coding and using administration and configuration keywords	• Chapter 13, "Administration file reference," on page 321 • Chapter 12, "Configuration file reference," on page 263

Steps for configuring reservations in a LoadLeveler cluster

Only the BACKFILL scheduler supports the use of reservations.

Before you begin:

- For information about configuring the BACKFILL scheduler, see "Choosing a scheduler" on page 44.
- You need to decide:
  - Which users will be allowed to create reservations.
  - How many reservations users may own, and how long a duration for their reservations will be allowed.
  - Which nodes will be used for reservations.
  - How much setup time is required before the reservation period starts.
  - Whether accounting data for reservations is to be saved.
  - The maximum lifetime for a recurring reservation before you require the user to request a new reservation for that job.
  - Additional system-wide limitations that you may want to implement such as maintenance time blocks for specific node sets.
- For examples of possible reservation keyword combinations, see "Examples: Reservation keyword combinations in the administration file" on page 134.
- For details about specific keyword syntax and use:
  - In the administration file, see Chapter 13, "Administration file reference," on page 321.
  - In the configuration file, see Chapter 12, "Configuration file reference," on page 263.

Perform the following steps to configure reservations:

1. In the administration file, modify the user or group stanzas to authorize users to create reservations. You may grant the ability to create reservations to an individual user, a group of users, or a combination of users and groups. To do so, define the following keywords in the appropriate user or group stanzas:
   - **max_reservations**, to set the maximum number of reservations that a user or group may have.
   - (Optional) **max_reservation_duration**, to set the maximum amount of time for the reservation period.

   Tip: To quickly set up and use reservations, use one of the following examples:
   - To allow every user to create a reservation, add `max_reservations=1` to the default user stanza. Then every administrator or user may create a reservation, as long as the number of reservations has not reached the limit for a LoadLeveler cluster.
   - To allow a specific group of users to make 10 reservations, add `max_reservations=10` to the group stanza for that LoadLeveler group. Then every user in that group may create a reservation, as long as the number of reservations has not reached the limit for that group or for a LoadLeveler cluster.

   See the **max_reservations** description in Chapter 13, "Administration file reference," on page 321 for more information about setting this keyword in the user or group stanza.
2. In the administration file, modify the machine stanza of each machine that may be reserved. To do so, set the **reservation_permitted** keyword to **true**.

   Tip: If you want to allow every machine to be reserved, you do not have to set this keyword; by default, any LoadLeveler machine may be reserved. If you want to prevent particular machines from being reserved, however, you must define a machine stanza for that machine and set the **reservation_permitted** keyword to **false**.
3. In the global configuration file, set reservation policy by specifying values for the following keywords:
   - **MAX_RESERVATIONS** to specify the maximum number of reservations per cluster.

     Note: A recurring reservation only counts as one reservation towards the **MAX_RESERVATIONS** limit regardless of the number of times that the reservation recurs.
   - **RESERVATION_CAN_BE_EXCEEDED** to specify whether LoadLeveler will be permitted to schedule job steps bound to a reservation when their expected end times exceed the reservation end time.

     The default for this keyword is `TRUE`, which means that LoadLeveler will schedule these bound job steps even when they are expected to continue running beyond the time at which the reservation ends. Whether these job steps run and successfully complete depends on resource availability, which is not guaranteed after the reservation ends. In addition, these job steps become subject to preemption rules after the reservation ends.

     Tip: You might want to set this keyword value to `FALSE` to prevent users from binding long-running jobs to run under reservations of short duration.
   - **RESERVATION_MIN_ADVANCE_TIME** to define the minimum time between the time at which a reservation is created and the time at which the reservation is to start.

     Tip: To reduce the impact to the currently running workload, consider changing the default for this keyword, which allows reservations to begin as soon as they are created. You may, for example, require reservations to be

made at least one day (1440 minutes) in advance, by specifying `RESERVATION_MIN_ADVANCE_TIME=1440` in the global configuration file.

- **RESERVATION_PRIORITY** to define whether LoadLeveler administrators may reserve nodes on which running jobs are expected to end after the start time for the reservation.

  Tip: The default for this keyword is `NONE`, which means that LoadLeveler will not reserve a node on which running jobs are expected to end after the start time for the reservation. If you want to allow LoadLeveler administrators to reserve specific nodes regardless of the expected end times of job steps currently running on the node, set this keyword value to `HIGH`. Note, however, that setting this keyword value to `HIGH` might increase the number of job steps that must be preempted when LoadLeveler sets up the reservation, and many jobs might remain in Preempted state. This also applies to Blue Gene job steps.

  This keyword value applies only for LoadLeveler administrators; other reservation owners do not have this capability.
- **RESERVATION_SETUP_TIME** to define the amount of time LoadLeveler uses to prepare for a reservation before it is to start.

4. (Optional) In the global configuration file, set controls for the collection of accounting data for reservations:
   - To turn on accounting for reservations, add the **A_RES** flag to the **ACCT** keyword.
   - To specify a file other than the default history file to contain the data, use the **RESERVATION_HISTORY** keyword.

   To learn how to collect accounting data for reservations, see "Collecting accounting data for reservations" on page 63.
5. If LoadLeveler is already started, to process the changes you made in the preceding steps, issue the command **llctl -g reconfig**.

   Tip: If you have changed the value of only the **RESERVATION_PRIORITY** keyword, issue the command **llctl reconfig** only on the central manager node.

   Result: The new keyword values take effect immediately, but they do not change the attributes of existing reservations.

When you are done with this procedure, you may perform additional tasks described in "Working with reservations" on page 213.

Examples: Reservation keyword combinations in the administration file

The following examples demonstrate LoadLeveler behavior when the **max_reservations** and **max_reservation_duration** keywords are set.

The examples assume that only the user and group stanzas listed exist in the LoadLeveler administration file.

- **Example 1:** Assume the administration file contains the following stanzas:

```
default: type = user
         maxjobs = 10

group2: type = group
        include_users = rich dave steve

rich: type = user
      default_group = group2
```

This example shows that, by default, no one is allowed to make any reservations. No one, including LoadLeveler administrators, is permitted to make any reservations unless the **max_reservations** keyword is used.

- **Example 2:** Assume the administration file contains the following stanzas:

```
default: type = user
         maxjobs = 10

group2: type = group
        include_users = rich dave steve

rich: type = user
      default_group = group2
      max_reservations = 5
```

This example shows how permission to make reservations can be granted to a specific user through the user stanza only. Because the **max_reservations** keyword is not used in any group stanza, by default, the group stanzas neither grant permissions nor put any restrictions on reservation permissions. User Rich can make reservations in any group (group2, No_Group, Group_A, and so on), whether or not the group stanzas exist in the LoadLeveler administration file. The total number of reservations user Rich can own at any given time is limited to five.

- **Example 3:** Assume the administration file contains the following stanzas:

```
default: type = user
         maxjobs = 10

group2: type = group
        include_users = rich dave steve
        max_reservations = 5

rich: type = user
      default_group = group2
```

This example shows how permission to make reservations can be granted to a group of users through the group stanza only. Because the **max_reservations** keyword is not used in any user stanza, by default, the user stanzas neither grant nor deny permission to make reservations. All users in group2 (Rich, Dave and Steve) can make reservations, but they must make reservations in group2 because other groups do not grant the permission to make reservations. The total number of reservations the users in group2 can own at any given time is limited to five.

- **Example 4:** Assume the administration file contains the following stanzas:

```
default: type = user
         maxjobs = 10

group2: type = group
        include_users = rich dave steve
        max_reservations = 5

rich: type = user
      default_group = group2
      max_reservations = 0
```

This example shows how permission to make reservations can be granted to a group of users except one specific user. Because the **max_reservations** keyword is set to zero in the user stanza for Rich, he does not have permission to make any reservation, even though all other users in group2 (Dave and Steve) can make reservations.

- **Example 5:** Assume the administration file contains the following stanzas:

```
default: type = group
         max_reservations = 0

default: type = user
         max_reservations = 0

group2: type = group
        include_users = rich dave steve
        max_reservations = 5

rich: type = user
      default_group = group2
      max_reservations = 5

dave: type = user
      max_reservations = 2
```

This example shows how permission to make reservations can be granted to specific user and group pairs. Because the **max_reservations** keyword is set to zero in both the default user and group stanza, no one has permission to make any reservation unless they are specifically granted permission through both the user and group stanza. In this example:
– User Rich can own at any time up to five reservations in group2 only.
– User Dave can own at any time up to two reservations in group2 only.

The total number of reservations they can own at any given time is limited to five. No other combination of user or group pairs can make any reservations.

- **Example 6:** Assume the administration file contains the following stanzas:

```
default: type = user
         max_reservations = 1
```

This example permits any user to make one reservation in any group, until the number of reservations reaches the maximum number allowed in the LoadLeveler cluster.

- **Example 7:** Assume the administration file contains the following stanzas:

```
default: type = group
         max_reservations = 0

default: type = user
         max_reservations = 0

group1: type = group
        max_reservations = 6
        max_reservation_duration = 1440

carol: type = user
       default_group = group1
       max_reservations = 4
       max_reservation_duration = 720

dave: type = user
      default_group = group1
      max_reservations = 4
      max_reservation_duration = 2880
```

In this example, two users, Carol and Dave, are members of group1. Neither Carol nor Dave belong to any other group with a group stanza in the LoadLeveler administration file, although they may use any string as the name of a LoadLeveler group and belong to it by default.

Because the **max_reservations** keyword is set to zero in the default group stanza, reservations can be made only in group1, which has an allotment of six reservations. Each reservation can have a maximum duration of 1440 minutes (24 hours).

Considering only the user-stanza attributes for reservations:
- User Carol can make up to four reservations with each having a maximum duration of 720 minutes (12 hours).
- User Dave can make up to four reservations with each having a maximum duration of 2880 minutes (48 hours).

If there are no reservations in the system and user Carol wants to make four reservations, she may do so. Each reservation can have a maximum duration of no more than 720 minutes. If Carol attempts to make a reservation with a duration greater than 720 minutes, LoadLeveler will not make the reservation because it exceeds the duration allowed for Carol.

Assume that Carol has created four reservations, and user Dave now wants to create four reservations:

- The number of reservations Dave may make is limited by the state of Carol's reservations and the maximum limit on reservations for group1. If the four reservations Carol made are still being set up, or are active, active shared or waiting, LoadLeveler will restrict Dave to making only two reservations at this time.
- Because the value of **max_reservation_duration** for the group is more restrictive than **max_reservation_duration** for user Dave, LoadLeveler enforces the group value, 1440 minutes.

If Dave belonged to another group that still had reservations available, then he could make reservations under that group, assuming the maximum number of reservations for the cluster had not been met. However, in this example, Dave cannot make any further reservations because they are allowed in group1 only.

Steps for integrating LoadLeveler with the AIX Workload Manager

Another administrative setup task you must consider is whether you want to enforce resource usage of **ConsumableCpus**, **ConsumableMemory**, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory**.

If you want to control these resources, AIX Workload Manager (WLM) can be integrated with LoadLeveler to balance workloads at the machine level. When you are using WLM, workload balancing is done by assigning relative priorities to job processes. These job priorities prevent one job from monopolizing system resources when that resource is under contention.

Note: WLM is not supported in LoadLeveler for Linux.

To integrate LoadLeveler and WLM, perform the following steps:

1. As required for your use, define the applicable options for **ConsumableCpus**, **ConsumableMemory**, **ConsumableVirtualMemory**, or **ConsumableLargePageMemory** as consumable resources in the **SCHEDULE_BY_RESOURCES** global configuration keyword. This enables the LoadLeveler scheduler to consider these consumable resources.
2. As required for your use, define the applicable options for **ConsumableCpus**, **ConsumableMemory**, **ConsumableVirtualMemory**, or **ConsumableLargePageMemory** in the **ENFORCE_RESOURCE_USAGE** global configuration keyword. This enables enforcement of these consumable resources by AIX WLM.
3. Define **hard**, **soft** or **shares** in the **ENFORCE_RESOURCE_POLICY** configuration keyword. This defines what policy is used by LoadLeveler for CPUs and real memory when setting WLM class resource entitlements.

4. (Optional) Set the **ENFORCE_RESOURCE_MEMORY** configuration keyword to **true**. This setting allows AIX WLM to limit the real memory usage of a WLM class as precisely as possible. When a class exceeds its limit, all processes in the class are killed.

   Rule: ConsumableMemory must be defined in the **ENFORCE_RESOURCE_USAGE** keyword in the global configuration file, or LoadLeveler does not consider the **ENFORCE_RESOURCE_MEMORY** keyword to be valid.

   Tips:

   - When set to true, the **ENFORCE_RESOURCE_MEMORY** keyword overrides the policy set through the **ENFORCE_RESOURCE_POLICY** keyword for **ConsumableMemory** only. The **ENFORCE_RESOURCE_POLICY** keyword value still applies for **ConsumableCpus**.
   - **ENFORCE_RESOURCE_MEMORY** may be set in either the global or the local configuration file. In the global configuration file, this keyword sets the default value for all the machines in the LoadLeveler cluster. If the keyword also is defined in a local file, the local setting overrides the global setting.

5. Using the **resources** keyword in a machine stanza in the administration file, define the CPU, real memory, virtual memory, and large page machine resources available for user jobs.
   - The **ConsumableCpus** reserved word accepts a count value of ″all.″ This indicates that the initial resource count will be obtained from the Startd machine update value for CPUs.
   - If no resources are defined for a machine, then no enforcement will be done on that machine.
   - If the count specified by the administrator is greater than what the Startd update indicates, the initial count value will be reduced to match what the Startd reports.
   - For CPUs and real memory, if the count specified by the administrator is less than what the Startd update indicates, the WLM resource shares assigned to a job will be adjusted to represent that difference. In addition, a WLM softlimit will be defined for each WLM class. For example, if the administrator defines 8 CPUs on a 16 CPU machine, then a job requesting 4 CPUs will get a share of 4 and a softlimit of 50%.
   - Use caution when determining the amount of real memory available for user jobs. A certain percentage of a machine's real memory will be dedicated to the Default and System WLM classes and will not be included in the calculation of real memory available for users jobs. Start LoadLeveler with the **ENFORCE_RESOURCE_USAGE** keyword enabled and issue **wlmstat -v -m**. Look at the npg column to determine how much memory is being used by these classes.
   - **ConsumableVirtualMemory** and **ConsumableLargePageMemory** are hard max limit values.
     - AIX WLM considers the **ConsumableVirtualMemory** value to be real memory plus large page plus swap space.
     - The **ConsumableLargePageMemory** value should be a value equal to the multiple of the pagesize. For example, 16MB (page size) * 4 pages = 64MB.

6. Decide if all jobs should have their CPU, real memory, virtual memory, or large page resources enforced and then define the **ENFORCE_RESOURCE_SUBMISSION** global configuration keyword.
   - If the value specified is **true**, LoadLeveler will check all jobs at submission time for the **resources** and **node_resources** keywords. To be submitted, either the job's **resources** or **node_resources** keyword must have the same resources specified as the **ENFORCE_RESOURCE_USAGE** keyword.

- If the value specified is **false**, no checking is performed and jobs submitted without the **resources** or **node_resources** keyword will not have resources enforced and it might interfere with other jobs whose resources are enforced.
- To support existing job command files without the **resources** or **node_resources** keyword, the **default_resources** and **default_node_resources** keywords in the class stanza can be defined.

For more information on the **ENFORCE_RESOURCE_USAGE** and the **ENFORCE_RESOURCE_SUBMISSION** keywords, see "Defining usage policies for consumable resources" on page 60.

LoadLeveler support for checkpointing jobs

Checkpointing is a method of periodically saving the state of a job step so that if the step does not complete it can be restarted from the saved state.

When checkpointing is enabled, checkpoints can be initiated from within the application at major milestones, or by the user, administrator or LoadLeveler external to the application. Both serial and parallel job steps can be checkpointed.

Once a job step has been successfully checkpointed, if that step terminates before completion, the checkpoint file can be used to resume the job step from its saved state rather than from the beginning. When a job step terminates and is removed from the LoadLeveler job queue, it can be restarted from the checkpoint file by submitting a new job and setting the **restart_from_ckpt** = yes job command file keyword. When a job is terminated and remains on the LoadLeveler job queue, such as when a job step is vacated, the job step will automatically be restarted from the latest valid checkpoint file. A job can be vacated as a result of flushing a node, issuing checkpoint and hold, stopping or recycling LoadLeveler or as the result of a node crash.

To find out more about checkpointing jobs, use the information in Table 30.

Table 30. Roadmap of tasks for checkpointing jobs

Subtask	Associated instructions (see . . .)
Preparing the LoadLeveler environment for checkpointing and restarting jobs	• "Checkpoint keyword summary" • "Planning considerations for checkpointing jobs" on page 140 • "AIX checkpoint and restart limitations" on page 141 • "Naming checkpoint files and directories" on page 145
Checkpointing and restarting jobs	• "Checkpointing a job" on page 232 • "Removing old checkpoint files" on page 146
Correctly specifying configuration and administration file keywords	• Chapter 12, "Configuration file reference," on page 263 • Chapter 13, "Administration file reference," on page 321

Checkpoint keyword summary

There are keywords associated with the checkpoint and restart function.

The following is a summary of keywords associated with the checkpoint and restart function.

- **Configuration file keywords**

  - **CKPT_CLEANUP_INTERVAL**
  - **CKPT_CLEANUP_PROGRAM**
  - **CKPT_EXECUTE_DIR**
  - **MAX_CKPT_INTERVAL**
  - **MIN_CKPT_INTERVAL**

  For more information about these keywords, see Chapter 12, "Configuration file reference," on page 263.
- **Administration file keywords**
  - **ckpt_dir**
  - **ckpt_time_limit**

  For more information about these keywords, see Chapter 13, "Administration file reference," on page 321.
- **Job command file keywords**
  - **checkpoint**
  - **ckpt_dir**
  - **ckpt_execute_dir**
  - **ckpt_file**
  - **ckpt_time_limit**
  - **restart_from_ckpt**

  For more information about these keywords, see "Job command file keyword descriptions" on page 359.

Planning considerations for checkpointing jobs

There are guidelines to review before you submit a checkpointing job.

Review the following guidelines before you submit a checkpointing job:

- **Plan for jobs that you will restart on different nodes**

  If you plan to migrate jobs (restart jobs on a different node or set of nodes), you should understand the difference between writing checkpoint files to a local file system versus a global file system (such as AFS or GPFS™). The **ckpt_file** and **ckpt_dir** keywords in the job command and configuration files allow you to write to either type of file system. If you are using a local file system, before restarting the job from checkpoint, make certain that the checkpoint files are accessible from the machine on which the job will be restarted.
- **Reserve adequate disk space**

  A checkpoint file requires a significant amount of disk space. The checkpoint will fail if the directory where the checkpoint file is written does not have adequate space. For serial jobs, one checkpoint file will be created. For parallel jobs, one checkpoint file will be created for each task. Since the old set of checkpoint files are not deleted until the new set of files are successfully created, the checkpoint directory should be large enough to contain two sets of checkpoint files. You can make an accurate size estimate only after you have run your job and noticed the size of the checkpoint file that is created.
- **Plan for staging executables**

  If you want to stage the executable for a job step, use the **ckpt_execute_dir** keyword to define the directory where LoadLeveler will save the executable. This directory cannot be the same as the current location of the executable file, or LoadLeveler will not stage the executable.

  You may define the **ckpt_execute_dir** keyword in either the configuration file or the job command file. To decide where to define the keyword, use the information in Table 31 on page 141.

Table 31. Deciding where to define the directory for staging executables

If the ckpt_execute_dir keyword is defined in:	Then the following information applies:
The configuration file only	• LoadLeveler stages the executable file in a new subdirectory of the specified directory. The name of the subdirectory is the job step ID. • The user is the owner of the subdirectory and has permission 700. • If the user issues the **llckpt** command with the **-k** option, LoadLeveler deletes the staged executable. • LoadLeveler will delete the subdirectory and the staged executable when the job step ends.
The job command file only	• LoadLeveler stages the executable file in the directory specified in the job command file. • The user is the owner of the file and has execute permission for it. • The user is responsible for deleting the staged file after the job step ends.
Both the configuration and job command files	
Neither file (the keyword is not defined)	LoadLeveler does not stage the executable file for the job step.

- **Set your checkpoint file size to the maximum**

  To make sure that your job can write a large checkpoint file, assign your job to a job class that has its file size limit set to the maximum (unlimited). In the administration file, set up a class stanza for checkpointing jobs with the following entry:

  ```
  file_limit = unlimited,unlimited
  ```

  This statement specifies that there is no limit on the maximum size of a file that your program can create.

- **Choose a unique checkpoint file name**

  To prevent another job step from writing over your checkpoint file with another checkpoint file, make certain that your checkpoint file name is unique. The **ckpt_dir** and **ckpt_file** keywords give you control over the location and name of these files.

  For mode information, see "Naming checkpoint files and directories" on page 145.

AIX checkpoint and restart limitations

There are limitations associated with checkpoint and restart.

- The following items cannot be checkpointed:
  - Programs that are being run under:
    - The dynamic probe class library (DPCL).
    - Any debugger.
  - MPI programs that are *not* compiled with **mpcc_r**, **mpCC_r**, **mpxlf_r**, **mpxlf90_r**, or **mpxlf95_r**.
  - Processes that use:
    - Extended **shmat** support
    - Pinned shared memory segments
    - The debug malloc tool (**MALLOCTYPE=debug**)
  - Sets of processes in which any process is running a **setuid** program when a checkpoint occurs.
  - Sets of processes if any process is running a **setgid** program when a checkpoint occurs.

  - Interactive parallel jobs for which POE input or output is a pipe.
  - Interactive parallel jobs for which POE input or output is redirected, unless the job is submitted from a shell that had the CHECKPOINT environment variable set to **yes** before the shell was started. If POE is run from inside a shell script and is run in the background, the script must be started from a shell started in the same manner for the job to be checkpointable.
  - Interactive POE jobs for which the **su** command was used prior to checkpointing or restarting the job.
- The node on which a process is restarted must have:
  - The same operating system level (including PTFs). In addition, a restarted process may not load a module that requires a system call from a kernel extension that was not present at checkpoint time.
  - The same switch type as the node where the checkpoint occurred.

  If any threads in a process were bound to a specific processor ID at checkpoint time, that processor ID must exist on the node where that process is restarted.
- If the LoadLeveler cluster contains nodes running a mix of 32-bit and 64-bit kernels then applications must be checkpointed and restarted on the same set of nodes. For more information, see "llckpt - Checkpoint a running job step" on page 430 and the restart_on_same_nodes keyword description.
- For a parallel job, the number of tasks and the task geometry (the tasks that are common within a node) must be the same on a restart as it was when the job was checkpointed.
- Any regular file open in a process when it is checkpointed must be present on the node where that process is restarted, including the executable and any dynamically loaded libraries or objects.
- If any process uses sockets or pipes, user callbacks should be registered to save data that may be "in flight" when a checkpoint occurs, and to restore the data when the process is resumed after a checkpoint or restart. Similarly, any user shared memory in a parallel task should be saved and restored.
- A checkpoint operation will not begin on a process until each user thread in that process has released all pthread locks, if held. This can potentially cause a significant delay from the time a checkpoint is issued until the checkpoint actually occurs. Also, any thread of a process that is being checkpointed that does not hold any pthread locks and tries to acquire one will be stopped immediately. There are no similar actions performed for atomic locks (**_check_lock** and **_clear_lock**, for example).
- Atomic locks must be used in such a way that they do not prevent the releasing of pthread locks during a checkpoint. For example, if a checkpoint occurs and thread 1 holds a pthread lock and is waiting for an atomic lock, and thread 2 tries to acquire a different pthread lock (and does not hold any other pthread locks) before releasing the atomic lock that is being waited for in thread 1, the checkpoint will hang.
- A process must not hold a pthread lock when creating a new process (either implicitly using **popen**, for example, or explicitly using **fork**) if releasing the lock is contingent on some action of the new process. Otherwise, a checkpoint could occur which would cause the child process to be stopped before the parent could release the pthread lock causing the checkpoint operation to hang.
- The checkpoint operation will hang if any user pthread locks are held across:
  - Any collective communication calls in MPI or LAPI
  - Calls to mpc_init_ckpt or mp_init_ckpt
- Processes cannot be profiled at the time a checkpoint is taken.
- There can be no devices other than TTYs or **/dev/null** open at the time a checkpoint is taken.

- Open files must either have an absolute path name that is less than or equal to PATHMAX in length, or must have a relative path name that is less than or equal to PATHMAX in length from the current directory at the time they were opened. The current directory must have an absolute path name that is less than or equal to PATHMAX in length.
- Semaphores or message queues that are used within the set of processes being checkpointed must only be used by processes within the set of processes being checkpointed. This condition is not verified when a set of processes is checkpointed. The checkpoint and restart operations will succeed, but inconsistent results can occur after the restart.
- The processes that create shared memory must be checkpointed with the processes using the shared memory if the shared memory is ever detached from all processes being checkpointed. Otherwise, the shared memory may not be available after a restart operation.
- The ability to checkpoint and restart a process is not supported for B1 and C2 security configurations.
- A process can only checkpoint another process if it can send a signal to the process. In other words, the privilege checking for checkpointing processes is identical to the privilege checking for sending a signal to the process. A privileged process (the effective user ID is **0**) can checkpoint any process. A set of processes can only be checkpointed if each process in the set can be checkpointed.
- A process can only restart another process if it can change its entire privilege state (real, saved, and effective versions of user ID, group ID, and group list) to match that of the restarted process. A set of processes can only be restarted if each process in the set can be restarted.
- The only DCE function supported is DCE credential forwarding by LoadLeveler using the DCE_AUTHENTICATION_PAIR configuration keyword. DCE credential forwarding is for the sole purpose of DFS™ access by the application.
- If a process invokes any Network Information Service (NIS) functions, from then on, AIX will delay the start of a checkpoint of a process until the process returns from any system calls.
- Jobs in which the message passing application is not a direct child of the Partition Manager Daemon (pmd) cannot be checkpointed.
- Scale-across jobs cannot be checkpointed.
- The following functions will return ENOTSUP if called in a job that has enabled checkpointing:
  - clock_getcpuclockid()
  - clock_getres()
  - clock_gettime()
  - clock_nanosleep()
  - clock_settime()
  - mlock()
  - mlockall()
  - mq_close()
  - mq_getattr()
  - mq_notify()
  - mq_open()
  - mq_receive()
  - mq_send()
  - mq_setattr()
  - mq_timedreceive()
  - mq_timedsend()

- mq_unlink()
- munlock()
- munlockall()
- nanosleep()
- pthread_barrier_destroy()
- pthread_barrier_init()
- pthread_barrier_wait()
- pthread_barrierattr_destroy()
- pthread_barrierattr_getpshared()
- pthread_barrierattr_init()
- pthread_barrierattr_setpshared()
- pthread_condattr_getclock()
- pthread_condattr_setclock()
- pthread_getcpuclockid()
- pthread_mutex_getprioceiling()
- pthread_mutex_setprioceiling()
- pthread_mutex_timedlock()
- pthread_mutexattr_getprioceiling()
- pthread_mutexattr_getprotocol()
- pthread_mutexattr_setprioceiling()
- pthread_mutexattr_setprotocol()
- pthread_rwlock_timedrdlock()
- pthread_rwlock_timedwrlock()
- pthread_setschedprio()
- pthread_spin_destroy()
- pthread_spin_init()
- pthread_spin_lock()
- pthread_spin_trylock()
- pthread_spin_unlock()
- sched_get_priority_max()
- sched_get_priority_min()
- sched_getparam()
- sched_getscheduler()
- sched_rr_get_interval()
- sched_setparam()
- sched_setscheduler()
- sem_close()
- sem_destroy()
- sem_getvalue()
- sem_init()
- sem_open()
- sem_post()
- sem_timedwait()
- sem_trywait()
- sem_unlink()
- sem_wait()
- shm_open()
- shm_unlink()
- timer_create()
- timer_delete()
- timer_getoverrun()
- timer_gettime()
- timer_settime()

Naming checkpoint files and directories

At checkpoint time, a checkpoint file and potentially an error file will be created.

For jobs which are enabled for checkpoint, a control file may be generated at the time of job submission. The directory which will contain these files must pre-exist and have sufficient space and permissions for these files to be written. The name and location of these files will be controlled through keywords in the job command file or the LoadLeveler configuration. The file name specified is used as a base name from which the actual checkpoint file name is constructed. To prevent another job step from writing over your checkpoint file, make certain that your checkpoint file name is unique. For serial jobs and the master task (POE) of parallel jobs, the checkpoint file name will be *<basename>.Tag*. For a parallel job, a checkpoint file is created for each task. The checkpoint file name will be *<basename>.Taskid.Tag*.

The tag is used to differentiate between a current and previous checkpoint file. A control file may be created in the checkpoint directory. This control file contains information LoadLeveler uses for restarting certain jobs. An error file may also be created in the checkpoint directory. The data in this file is in a machine readable format. The information contained in the error file is available in mail, LoadLeveler logs or is output of the checkpoint command. Both of these files are named with the same base name as the checkpoint file with the extensions *.cntl* and *.err*, respectively.

Naming checkpoint files for serial and batch parallel jobs

There is an order in which keywords are checked to construct the full path name for a serial or batch checkpoint file.

The following describes the order in which keywords are checked to construct the full path name for a serial or batch checkpoint file:

- Base name for the checkpoint file name
  1. The **ckpt_file** keyword in the job command file
  2. The default file name [< *jobname*.>]<*job_step_id*>.ckpt

     Where:

     jobname
     : The job_name specified in the Job Command File. If job_name is not specified, it is omitted from the default file name

     job_step_id
     : Identifies the job step that is being checkpointed
- Checkpoint Directory Name
  1. The **ckpt_file** keyword in the job command file, if it contains a "/" as the first character
  2. The **ckpt_dir** keyword in the job command file
  3. The **ckpt_dir** keyword specified in the class stanza of the LoadLeveler admin file
  4. The default directory is the initial working directory

Note that two or more job steps running at the same time cannot both write to the same checkpoint file, since the file will be corrupted.

Naming checkpointing files for interactive parallel jobs

There is an order in which keywords and variables are checked to construct the full path name for the checkpoint file for an interactive parallel job.

The following describes the order in which keywords and variables are checked to construct the full path name for the checkpoint file for an interactive parallel job.

- Checkpoint File Name
  1. The value of the MP_CKPTFILE environment variable within the POE process
  2. The default file name, poe.ckpt.<pid>
- Checkpoint Directory Name
  1. The value of the MP_CKPTFILE environment variable within the POE process, if it contains a full path name.
  2. The value of the MP_CKPTDIR environment variable within the POE process.
  3. The initial working directory.

Note: The keywords **ckpt_dir** and **ckpt_file** are not allowed in the command file for an interactive session. If they are present, they will be ignored and the job will be submitted.

Removing old checkpoint files

LoadLeveler provides two keywords to help automate the process of removing checkpoint files that are no longer necessary.

To keep your system free of checkpoint files that are no longer necessary, LoadLeveler provides two keywords to help automate the process of removing these files:

- **CKPT_CLEANUP_PROGRAM**
- **CKPT_CLEANUP_INTERVAL**

Both keywords must contain valid values to automate this process. For information about configuration file keyword syntax and other details, see Chapter 12, “Configuration file reference,” on page 263.

LoadLeveler scheduling affinity support

LoadLeveler offers a number of scheduling affinity options.

LoadLeveler offers the following scheduling affinity options:

- Memory and adapter affinity
- Processor affinity

Enabling scheduling affinity allows LoadLeveler jobs to utilize performance improvement from multiple chip modules (MCMs) (memory and adapter) and processor affinities. If enabled, LoadLeveler will schedule and attach the appropriate CPUs in the cluster to the job tasks in order to maximize performance improvement based on the type of affinity requested by the job.

Memory and adapter affinity

Memory affinity is a special purpose option for improving performance on IBM POWER6™, POWER5™, and POWER4™ processor-based systems. These machines contain MCMs, each containing multiple processors. System memory is attached to these MCMs. While any processor can access all of the memory in the system, a processor has faster access and higher bandwidth when addressing memory that is attached to its own MCM rather than memory attached to the other MCMs in the system. The concept of affinity also applies to the I/O subsystem. The processes running on CPUs from an MCM have faster access to the adapters attached to the

I/O slots of that MCM. I/O affinity will be referred to as adapter affinity in this topic. For more information about memory and adapter affinity, see *AIX Performance Management Guide*.

Processor affinity

LoadLeveler provides processor affinity options to improve job performance on the following platforms:

- IBM POWER6 and POWER5 processor-based systems running in simultaneous multithreading (SMT) mode with AIX or Linux
- IBM POWER6 and POWER5 processor-based systems running in Single Threaded (ST) mode with AIX or Linux
- IBM POWER4 processor-based systems with AIX or Linux
- x86 and x86_64 processor-based systems with Linux

On AIX, affinity support is implemented by using a Resource Set (RSet), which contains bit maps for CPU and memory pool resources. The RSet APIs available in AIX can be used to attach RSets to processes. Attaching an RSet to a process limits the process to only using the resources contained in the RSet. One of the main uses of RSets is to limit the application processes to run only on the processors contained in a single MCM and hence to benefit from memory affinity. For more details on RSets, refer to *AIX System Management Guide: Operating System and Devices*.

On Linux on Power systems, affinity support is implemented by using ″cpusets,″ which provide a mechanism for assigning a set of CPUs and memory nodes (MCMs) to a set of tasks. The cpusets constrain the CPU and memory placement of tasks to only the resources within a task's current cpuset. The cpusets are managed by the virtual file system type cpuset. Before configuring LoadLeveler to support affinity, the cpuset virtual file system must be created on every machine in the cluster to enable affinity support.

On Linux on x86 and x86_64 systems, affinity support is implemented by using the **sched_setaffinity** Linux-specific system call to assign a set of physical or logical CPUs to the job processes.

Configuring LoadLeveler to use scheduling affinity

On AIX and Linux on Power systems, scheduling affinity can be enabled by using the **RSET_SUPPORT** configuration file keyword. Machines that are configured with this keyword indicate the ability to service jobs requesting or requiring scheduling affinity.

Enable **RSET_SUPPORT** with one of these values:

- Choose **RSET_MCM_AFFINITY** to allow jobs specifying **rset = RSET_MCM_AFFINITY** or the **task_affinity** keyword to run on a node. When **rset = RSET_MCM_AFFINITY**, LoadLeveler will select and attach sets of CPUs to task processes such that a set of CPUs will be from the same MCM. When the **task_affinity** keyword is used, LoadLeveler will select CPUs regardless of their location with respect to an MCM.
- Choose **RSET_USER_DEFINED** to allow jobs specifying a user-defined RSet name for **rset** to run on a node. The **RSET_USER_DEFINED** option enables scheduling affinity, allowing users more control over scheduling affinity parameters by allowing the use of user-defined RSets. Through the use of user-defined RSets, users can utilize new RSet features before a LoadLeveler

implementation is released. This option also allows users to specify a different number of CPUs in their RSets depending on the needs of each task. This value is supported only on AIX machines.

Note:

1. Because LoadLeveler creates a cpuset for each task requesting affinity under the **/dev/cpuset** directory on Linux on POWER machines, the cpuset virtual file system must be created and mounted on the **/dev/cpuset** directory by issuing the following commands on each node:

   ```
   # mkdir /dev/cpuset
   # mount -t cpuset none /dev/cpuset
   ```

2. A virtual file system of type cpuset mounted at **/dev/cpuset** will be deleted when the node is rebooted. To create the **/dev/cpuset** directory and have the virtual cpuset file system mounted on it automatically when the node is rebooted, add the following commands to your start-up script (for example, **/etc/init.d/boot.local**), which is run when the node is rebooted or started:

   ```
   if test -e /dev/cpuset || mkdir -p /dev/cpuset ; then
    mount -t cpuset none /dev/cpuset
   fi
   ```

See "Configuration file keyword descriptions" on page 265 for more information on the **RSET_SUPPORT** keyword.

On AIX and Linux on Power systems, jobs requesting processor affinity with the **task_affinity** keyword in the job command file will only run on machines where the resource statement in the machine stanza in the LoadLeveler administration file contains the **ConsumableCpus** keyword. For more information on specifying **ConsumableCpus**, see the **resource** keyword description in "Administration file keyword descriptions" on page 327.

On Linux on x86 and x86_64 systems, exclusive allocation of CPUs to job steps is enabled by using the **ALLOC_EXCLUSIVE_CPU_PER_JOB** configuration file keyword. Enable **ALLOC_EXCLUSIVE_CPU_PER_JOB** with one of these values:

- Choose the **PHYSICAL** option to allow LoadLeveler to assign tasks to physical processor packages. The **PHYSICAL** option allows LoadLeveler to treat hyperthreaded processors and multicore processors as a single unit so that a job has dedicated computing resources. For example, a node with two Intel x86 processors with hyperthreading turned **ON**, will be treated as a node with two physical processors. Similarly, a node with two dual-core AMD Opteron processors will be treated as a node with two physical processors.
- Choose the **LOGICAL** option to allow LoadLeveler to assign tasks to processor units. For example, a node with two Intel x86 processors with hyperthreading turned **ON** will be treated as a node with four processors. A node with two dual-core AMD Opteron processors will be treated as a node with four processors.

See "Configuration file keyword descriptions" on page 265 for more information on the **ALLOC_EXCLUSIVE_CPU_PER_JOB** keyword.

LoadLeveler multicluster support

To provide a more scalable runtime environment and more efficient workload balancing, you may configure a LoadLeveler multicluster environment.

A LoadLeveler multicluster environment consists of two or more LoadLeveler clusters, grouped together through network connections that allow the clusters to share resources. These clusters may be AIX, Linux, or mixed clusters.

Within a LoadLeveler multicluster environment:
- The **local cluster** is the cluster from which the user submits jobs or issues commands.
- A **remote cluster** is a cluster that accepts job submissions and commands from the local cluster.
- A **local gateway Schedd** is a Schedd within the local cluster serving as an inbound point from some remote cluster, an outbound point to some remote cluster, or both.
- A **remote gateway Schedd** is a Schedd within a remote cluster serving as an inbound point from the local cluster, an outbound point to the local cluster, or both.
- A **local central manager** is the central manager in the same cluster as the local gateway Schedd.
- A **remote central manager** is the central manager in the same cluster as a remote gateway Schedd.

A LoadLeveler multicluster environment addresses scalability and workload balancing issues by providing the ability to:
- Distribute workload among LoadLeveler clusters when jobs are submitted.
- Easily access multiple LoadLeveler cluster resources.
- Display information about the multicluster.
- Monitor and control operations in a multicluster.
- Transfer idle jobs from one cluster to another.
- Transfer user input and output files between clusters.
- Enable LoadLeveler to operate in a secure environment where clusters are separated by a firewall.

Table 32 shows the multicluster support subtasks with a pointer to the associated instructions:

Table 32. Multicluster support subtasks and associated instructions

Subtask	Associated instructions (see . . .)
Configure a LoadLeveler multicluster	"Configuring a LoadLeveler multicluster" on page 150
Submit and monitor jobs in a LoadLeveler multicluster	"Submitting and monitoring jobs in a LoadLeveler multicluster" on page 223
Scale-across scheduling	"Scale-across scheduling with multiclusters" on page 153

Table 33. Multicluster support related topics

Related topics	Additional information (see . . .)
Administration file: Cluster stanzas	"Defining clusters" on page 100
Administration file: Cluster keywords	"Administration file keyword descriptions" on page 327
Configuration file: Cluster keywords	"Configuration file keyword descriptions" on page 265
Job command file: Cluster keywords	"Job command file keyword descriptions" on page 359

Table 33. Multicluster support related topics (continued)

Related topics	Additional information (see . . .)
Commands and APIs	Chapter 16, "Commands," on page 411 or Chapter 17, "Application programming interfaces (APIs)," on page 541
Diagnosis and messages	*TWS LoadLeveler: Diagnosis and Messages Guide*

Configuring a LoadLeveler multicluster

These are the subtasks for configuring a LoadLeveler multicluster.

Table 34 lists the subtasks for configuring a LoadLeveler multicluster.

Table 34. Subtasks for configuring a LoadLeveler multicluster

Subtask	Associated instructions (see . . .)
Configure the LoadLeveler multicluster environment	• "Steps for configuring a LoadLeveler multicluster" on page 151 • "Steps for securing communications within a LoadLeveler multicluster" on page 153
Display information about the LoadLeveler multicluster environment	• Use the **llstatus** command: – With the **-X** option to display information about machines in the multicluster. – With the **-C** option to display information defined in cluster stanzas in the administration file. • Use the **llclass** command with the **-X** option to display information about classes on any cluster (local or remote). • Use the **llq** command with the **-X** option to display information about jobs on any cluster (local or remote).

Table 34. Subtasks for configuring a LoadLeveler multicluster (continued)

Subtask	Associated instructions (see . . .)
Monitor and control operations in the LoadLeveler multicluster environment	Existing LoadLeveler user commands accept the **-X** option for a multicluster environment. **Rules:** • Administrator only commands are not applicable in a multicluster environment. • The options **-x**, **-W**, **-s**, and **-p** cannot be specified together with the **-X** option on the **llmodify** command. • The options **-x** and **-w** cannot be specified together with the **-X** option on the **llq** command. • The **-X** option on the following commands is restricted to a single cluster: – **llcancel** – **llckpt** – **llhold** – **llmodify** – **llprio** • The following commands are not applicable in a multicluster environment: – **llacctmrg** – **llchres** – **llextRPD** – **llinit** – **llmkres** – **llqres** – **llrmres** – **llrunscheduler** – **llsummary**

Steps for configuring a LoadLeveler multicluster

The primary task for configuring a LoadLeveler multicluster environment is to enable communication between gateway Schedd daemons on all of the clusters in the multicluster.

To do so requires defining each Schedd daemon as either local or remote, and defining the inbound and outbound hosts with which the daemon will communicate.

Before you begin: You need to know that:
- A single machine may be defined as an inbound or outbound host, or as both.
- A single cluster must belong to only one multicluster.
- A single multicluster must consist of 10 or fewer clusters.
- Clusters must have unique host names within the multicluster network domain space.
- The inbound Schedd becomes the **schedd_host** of all remote jobs it receives.

Perform the following steps to configure a LoadLeveler multicluster:

1. In the administration file, define one cluster stanza for each cluster in the LoadLeveler multicluster environment.

   Rules:
   - You must define one cluster as the local cluster.
   - You must code the following required cluster-stanza keywords and variable values:

```
cluster_name: type=cluster
outbound_hosts = hostname[(cluster_name)]
inbound_hosts = hostname[(cluster_name)]
```

- If you want to allow users to submit remote jobs to the local cluster, the list of inbound hosts must include the name of the inbound Schedd and the cluster you are defining as remote or you must specify the name of an inbound Schedd without any cluster specification so that it defaults to being an inbound Schedd for all clusters.
- If the configuration file keyword **SCHEDD_STREAM_PORT** for any cluster is set to use a port other than the default value of 9605, you must set the **inbound_schedd_port** keyword in the cluster stanza for that cluster.

2. (Optional) If the local cluster wants to provide job distribution where users allow LoadLeveler to select the appropriate cluster for job submission based on administration defined objectives, then define an installation exit to be executed at submit time using the **CLUSTER_METRIC** configuration keyword. You can use the LoadLeveler data access APIs in this exit to query other clusters for information about possible metrics, such as the number of jobs in a specified job class, the number of jobs in the idle queue, or the number of free nodes in the cluster. For more detailed information, see CLUSTER_METRIC.

   Tip: LoadLeveler provides a set of sample exits for you to use as models. These samples are in the `${RELEASEDIR}/samples/llcluster` directory.
3. (Optional) If the local cluster wants to perform user mapping on jobs arriving from remote clusters, define the **CLUSTER_USER_MAPPER** configuration keyword. For more information, see CLUSTER_USER_MAPPER.
4. (Optional) If the local cluster wants to perform job filtering on jobs received from remote clusters, define the **CLUSTER_REMOTE_JOB_FILTER** configuration keyword. For more information, see CLUSTER_REMOTE_JOB_FILTER.
5. Notify LoadLeveler daemons by issuing the **llctl** command with either the **reconfig** or **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the administration file.

Additional considerations:

- Remote jobs are subjected to the same configuration checks as locally submitted jobs. Examples include account validation, class limits, include lists, and exclude lists.
- Remote jobs will be processed by the local **submit_filter** prior to submission to a remote cluster.
- Any tracker program specified in the API parameters will be invoked upon the scheduling cluster nodes.
- If a step is enabled for checkpoint and the **ckpt_execute_dir** is not specified, LoadLeveler will not copy the executable to the remote cluster, the user must ensure that executable exists on the remote cluster. If the executable is not in a shared file system, the executable can be copied to the remote cluster using the **cluster_input_file** job command file keyword.
- If the job command file is also the executable and the job is submitted or moved to a remote cluster, the **$(executable)** variable will contain the full path name of the executable on the local cluster from which it came. This differs from the behavior on the local cluster, where the **$(executable)** variable will be the command line argument passed to the **llsubmit** command. If you only want the file name, use the **$(base_executable)** variable.

Steps for securing communications within a LoadLeveler multicluster

Configuring LoadLeveler to use the OpenSSL library enables it to operate in a secure environment where clusters are separated by a firewall.

Perform the following steps to configure LoadLeveler to use OpenSSL in a multicluster environment:

1. Install SSL using the standard platform installation process.
2. Ensure a link exists from the installed SSL library to:
   a. **/usr/lib/libssl.so** for 32-bit Linux platforms.
   b. **/usr/lib64/libssl.so** for 64-bit Linux platforms.
   c. **/usr/lib/libssl.a** for AIX platforms.
3. Create the SSL authorization keys by invoking the **llclusterauth** command with the **-k** option on all local gateway schedds.

   Result: LoadLeveler creates a public key, a private key, and a security certificate for each gateway node.
4. Distribute the public keys to remote gateway schedds on other secure clusters. This is done by exchanging the public keys with the other clusters you wish to communicate with.
   - for AIX, public keys can be found in the **/var/LoadL/ssl/id_rsa.pub** file.
   - for Linux, public keys can be found in the **/var/opt/LoadL/ssl/id_rsa.pub** file.
5. Copy the public keys of the clusters you wish to communicate with into the **authorized_keys** directory on your inbound Schedd nodes.
   - for AIX, **/var/LoadL/ssl/authorized_keys**
   - for Linux, **/var/opt/LoadL/ssl/authorized_keys**
   - The authorization key files can be named anything within the **authorized_keys** directory.
6. Define the cluster stanzas within the LoadLeveler administration file, using the **multicluster_security = SSL** keyword. Define the keyword **ssl_cipher_list** if a specific OpenSSL cipher encryption method is desired. Use **secure_schedd_port** to define the port number to be used for secure inbound transactions to the cluster.
7. Notify LoadLeveler daemons by issuing the **llctl -g** command with the **recycle** keyword. Otherwise, LoadLeveler will not process the modifications you made to the administration file.
8. Configure firewalls to accept connections to the **secure_schedd_port** numbers you defined in the administration file.

Scale-across scheduling with multiclusters

In the multicluster environment, scale-across scheduling allows you to schedule jobs across more than one cluster. This feature allows large jobs that request more resources than a single cluster can provide to combine resources from more than one cluster and run large jobs on the combined resources. effectively spanning resources across more than one cluster.

By effectively spanning resources across more than one cluster, scale-across scheduling also allows utilization of fragmented resources from more than one cluster. Fragmented resources occur when the resources available on a single cluster cannot satisfy any single job on that cluster. This feature allows any size job to take advantage of these resources by combining them from multiple clusters.

The following are not supported with scale-across scheduling:

- Checkpointing jobs
- Coscheduled jobs
- Data staging jobs
- Hostlist jobs
- IBM Blue Gene Systems resources jobs
- Interactive Parallel Operating Environment (POE)
- Multistep jobs
- Preemption of scale-across jobs
- Reservations
- Secure Sockets Layer (SSL)
- Task-geometry jobs
- User space jobs

Requirements for scale-across scheduling

Main Cluster

In a multicluster environment that supports scale-across scheduling, one of the clusters in the multicluster environment must be designated as the ″main cluster.″ The main cluster will only schedule scale-across jobs; it will not run any jobs. Scale-across jobs will run on non-main clusters.

Network Connectivity

A requirement for any cluster that will participate in scale-across scheduling is that any node in one cluster must be able to communicate with any other node in any other cluster that is part of the scale-across configuration. There are two reasons for this requirement:

- Since the main cluster initiates the scale-across job, one node in the main cluster must have connectivity to any node in any of the other clusters where the job will run.
- Tasks of parallel applications must communicate with other tasks running on different nodes.

Configuring LoadLeveler for scale-across scheduling

After you choose a set of clusters to participate in scale-across scheduling, you must designate one cluster as the main cluster. Do so by specifying a value of **true** in the **main_scale_across_cluster** keyword for that cluster's stanza in the administration files of all scale-across clusters. The cluster that specifies this keyword as **true** for its own cluster stanza becomes the main cluster. Any cluster that specifies this keyword as **true** for another cluster stanza becomes a non-main cluster.

Table 35 lists scale-across scheduling keywords:

Table 35. Keywords for configuring scale-across scheduling

Keyword type	Keyword reference
Administration file keywords	allow_scale_across_jobs cluster stanza keyword main_scale_across_cluster cluster stanza keyword allow_scale_across_jobs class stanza keyword
Configuration file keyword	SCALE_ACROSS_SCHEDULING_TIMEOUT keyword

Tuning considerations for scale-across scheduling

NEGOTIATOR_CYCLE_DELAY
The value on both the main and the non-main clusters should be set to similar values to minimize the wait delays on both the main and the non-main clusters that occur when the main cluster is requesting a negotiator cycle on the non-main clusters. It is reasonable to set **NEGOTIATOR_CYCLE_DELAY=1** on all clusters.

MAX_TOP_DOGS
The maximum number of top-dog scale-across jobs allowed on the main cluster should be smaller than the maximum number of top-dog jobs allowed on the non-main clusters to allow the non-main clusters to schedule both the scale-across and regular jobs as top dogs.

SCALE_ACROSS_SCHEDULING_TIMEOUT
The default value should be overridden only if there are non-main clusters that have extremely long dispatch cycles or that have very long **NEGOTIATOR_CYCLE_DELAY** values. In these cases, the **SCALE_ACROSS_SCHEDULING_TIMEOUT** needs to be set to a value greater than those intervals.

LoadLeveler Blue Gene support

Blue Gene is a massively parallel system based on a scalable cellular architecture which exploits a very large number of tightly interconnected compute nodes (C-nodes).

To take advantage of Blue Gene support, you must be using the LoadLeveler BACKFILL scheduler. With the BACKFILL scheduler, LoadLeveler enables the Blue Gene system to take advantage of reservations that allow you to schedule when, and with which resources a job will run.

While LoadLeveler Blue Gene support is available on all platforms, Blue Gene®/L™ software is only supported on IBM POWER servers running SLES 9. This limitation currently restricts LoadLeveler Blue Gene/L support to SLES 9 on IBM POWER servers. LoadLeveler Blue Gene®/P™ software is only supported on IBM POWER servers running SLES 10. Mixed clusters of Blue Gene/L and Blue Gene/P systems are not supported.

Terms you should know:
- **Compute nodes**, also called C-nodes, are system-on-a-chip nodes that execute at most a single job at a time. All the C-nodes are interconnected in a three-dimensional toroidal pattern. Each C-node has a unique address and location in the three-dimensional toroidal space. Compute nodes execute the jobs' tasks. Compute nodes run a minimal custom operating system called BLRTS.
- **Front End Nodes** (FEN) are machines from which users and administrators interact with Blue Gene. Applications are compiled on and submitted for execution in the Blue Gene core from FENs. User interactions with applications, including debugging, are also performed from the FENs.
- The **Service Node** is dedicated hardware that runs software to control and manage the Blue Gene system.
- **I/O nodes** are special nodes that connect the compute nodes to the outside world. I/O nodes allow processes that are executing in the compute nodes to perform I/O operations, such as accessing files, and to communicate with the

job management system. Each I/O node serves anywhere from 8 to 64 C-nodes, depending on the physical configuration.

- **mpirun** is a program that is executed partly on the Front End Node, and partly on the Service Node. mpirun controls and monitors the parallel Blue Gene job. The mpirun program is executed by the user program that is run on the FEN by LoadLeveler.
- A **base partition** (BP) is a group of compute nodes connected in a 3D rectangular pattern and their controlled I/O nodes. A base partition is one of the basic allocation units for jobs. For example, an allocation for the job will require at least one base partition, unless an allocation requests a small partition, in which case sub base partition allocation is possible.
- A **small partition** is a group of C-nodes which are part of one base partition. Valid small partitions have size of 32 or 128 C-nodes.
- A **partition** is a group of base partitions, switches, and switch states allocated to a job. A partition is predefined or is created on demand to execute a job. Partitions are physically (electronically) isolated from each other (for example, messages cannot flow outside an allocated partition). A partition can have the topology of a mesh or a torus.
- The **Control System** is a component that serves as the interface to the Blue Gene system. It contains persistent storage with configuration and status information on the entire system. It also provides various services to perform actions on the Blue Gene system, such as launching a job.
- A **node card** is a group of 32 compute nodes within a base partition. This is the minimal allocation size for a partition.
- A **quarter** is a group of 4 node cards. This is a logical grouping of node cards within a base partition. A quarter, which is 128 compute nodes, is the next smallest allowed allocation size for a partition after a node card.
- A **switch state** is a set of internal switch connections which physically ″wire″ the partition. A switch has a number of incoming and outgoing wires. An internal switch connection physically connects one incoming wire with one outgoing wire, setting up a communication path between base partitions.

For more information about the Blue Gene system and Blue Gene terminology, refer to IBM System Blue Gene Solution documentation. Table 36 lists the IBM System Blue Gene Solution publications that are available from the IBM Redbooks® Web site at the following URLs:

Table 36. IBM System Blue Gene Solution documentation

Blue Gene System	Publication Name	URL
Blue Gene/P	*IBM System Blue Gene Solution: Blue Gene/P System Administration*	http://www.redbooks.ibm.com/abstracts/sg247417.html
	IBM System Blue Gene Solution: Blue Gene/P Safety Considerations	http://www.redbooks.ibm.com/abstracts/redp4257.html
	IBM System Blue Gene Solution: Blue Gene/P Application Development	http://www.redbooks.ibm.com/abstracts/sg247287.html
	Evolution of the IBM System Blue Gene Solution	http://www.redbooks.ibm.com/abstracts/redp4247.html

Table 36. IBM System Blue Gene Solution documentation (continued)

Blue Gene System	Publication Name	URL
Blue Gene/L	*IBM System Blue Gene Solution: System Administration*	http://www.redbooks.ibm.com/abstracts/sg247178.html
	Blue Gene/L: Hardware Overview and Planning	http://www.redbooks.ibm.com/abstracts/sg246796.html
	IBM System Blue Gene Solution: Application Development	http://www.redbooks.ibm.com/abstracts/sg247179.html
	Unfolding the IBM eServer™ Blue Gene Solution	http://www.redbooks.ibm.com/abstracts/sg246686.html

Table 37 lists the Blue Gene subtasks with a pointer to the associated instructions:

Table 37. Blue Gene subtasks and associated instructions

Subtask	Associated instructions (see . . .)
Configure LoadLeveler Blue Gene support	"Configuring LoadLeveler Blue Gene support"
Submit and monitor Blue Gene jobs	"Submitting and monitoring Blue Gene jobs" on page 226

Table 38 lists the Blue Gene related topics and associated information:

Table 38. Blue Gene related topics and associated information

Related topic	Associated information (see . . .)
Configuration file: Blue Gene keywords	"Configuration file keyword descriptions" on page 265
Job command file: Blue Gene keywords	"Job command file keyword descriptions" on page 359
Commands and APIs	Chapter 16, "Commands," on page 411 or Chapter 17, "Application programming interfaces (APIs)," on page 541
Diagnosis and messages	*TWS LoadLeveler: Diagnosis and Messages Guide*

Configuring LoadLeveler Blue Gene support

This is a list of the subtasks for configuring LoadLeveler Blue Gene support along with a pointer to the associated instructions.

Table 39 lists the subtasks for configuring LoadLeveler Blue Gene support along with a pointer to the associated instructions:

Table 39. Blue Gene configuring subtasks and associated instructions

Subtask	Associated instructions (see . . .)
Configuring LoadLeveler Blue Gene support	"Steps for configuring LoadLeveler Blue Gene support" on page 158

Table 39. Blue Gene configuring subtasks and associated instructions (continued)

Subtask	Associated instructions (see . . .)
Display information about the Blue Gene system	• Use the **llstatus** command with the **-b** option to display information about the Blue Gene system. The **llstatus** command can also be used with the **-B** option to display information about Blue Gene base partitions. Using **llstatus** with the **-P** option can be used to display information about Blue Gene partitions.
Display information about Blue gene jobs	• Use the **llsummary** command with the **-l** option to display job resource information. • Use the **llq** command with the **-b** option to display information about all Blue Gene jobs.

Steps for configuring LoadLeveler Blue Gene support

The primary task for configuring LoadLeveler Blue Gene support consists of setting up the environment of the **LoadL_negotiator** daemon, the environment of any process that will run Blue Gene jobs, and the LoadLeveler configuration file.

Perform the following steps to configure LoadLeveler Blue Gene support:

1. Configure the **LoadL_negotiator** daemon to run on a node which has access to the Blue Gene Control System.
2. Enable Blue Gene support by setting the **BG_ENABLED** configuration file keyword to **true.**
3. (Optional) Set any of the following additional Blue Gene related configuration file keywords which your setup requires:
   - **BG_ALLOW_LL_JOBS_ONLY**
   - **BG_CACHE_PARTITIONS**
   - **BG_MIN_PARTITION_SIZE**
   - **CM_CHECK_USERID**

   See "Configuration file keyword descriptions" on page 265 for more information on these keywords.
4. Set the required environment variables for the **LoadL_negotiator** daemon and any process that will run Blue Gene jobs. You can use global profiles to set the necessary environment variables for all users. Follow these steps to set environment variables for a LoadLeveler daemon:
   a. Add required environment variable settings to global profile.
   b. Set the environment as the administrator before invoking **llctl start** on the central manager node.
   c. Build a shell script which sets the required environments and starts LoadLeveler, which can be invoked using **rsh** remotely.

   Note: Using the **llctl -h** or **llctl -g** command to start the central manager remotely will not carry the environment variables from the login session to the LoadLeveler daemons on the remote nodes.

   - Specify the full path name of the bridge configuration file by setting the **BRIDGE_CONFIG_FILE** environment variable. For details on the contents of the bridge configuration file, see the *Blue Gene/L: System Administration* or *Blue Gene/P: System Administration* book.

     Example:

     For ksh:

     ```
     export BRIDGE_CONFIG_FILE=/var/bluegene/config/bridge.cfg
     ```

For csh:

```
setenv BRIDGE_CONFIG_FILE=/var/bluegene/config/bridge.cfg
```

- Specify the full path name of the file containing the data required to access the Blue Gene Control System database by setting the **DB_PROPERTY** environment variable. For details on the contents of the database property file, see the *Blue Gene/L: System Administration* or *Blue Gene/P: System Administration* book.

  Example:

  For ksh:

  ```
  export DB_PROPERTY=/var/bluegene/config/db.cfg
  ```

  For csh:

  ```
  setenv DB_PROPERTY=/var/bluegene/config/db.cfg
  ```

- Specify the host name of the machine running the Blue Gene control system by setting the **MMCS_SERVER_IP** environment variable. For details on the use of this environment variable, see the *Blue Gene/L: System Administration* or *Blue Gene/P: System Administration* book.

  Example:

  For ksh:

  ```
  export MMCS_SERVER_IP=bluegene.ibm.com
  ```

  For csh:

  ```
  setenv MMCS_SERVER_IP=bluegene.ibm.com
  ```

Blue Gene reservation support

Reservation supports Blue Gene resources including the Blue Gene compute nodes. It is important to note that when the reservation includes Blue Gene nodes, it cannot include conventional nodes. A front end node (FEN), which is used to start a Blue Gene job, is not part of the Blue Gene resources. A Blue Gene reservation only reserves Blue Gene resources and a Blue Gene job step bound to a reservation uses the reserved Blue Gene resources and shares a FEN outside the reservation.

Jobs using Blue Gene resources can be submitted to a Blue Gene reservation to run. A Blue Gene job step can also be used to select what Blue Gene resources to reserve to make sure the reservation will have enough Blue Gene resources to run the Blue Gene job step.

For more information about reservations, see "Overview of reservations" on page 25.

Blue Gene fair share scheduling support

Fair share scheduling has been extended to Blue Gene resources as well.

The **FAIR_SHARE_TOTAL_SHARES** keyword in **LoadL_config** and the **fair_shares** keyword for the user and group stanza in **LoadL_admin** apply to both the CPU resources and the Blue Gene resources. When a Blue Gene job step ends, both the CPU utilization and the Blue Gene resource utilization data will be collected. The elapsed job running time multiplied by the number of C-nodes allocated to the job step (the **Size Allocated field** in the **llq -l** output) will be counted as the amount of Blue Gene resource used. The used shares of the Blue Gene resources are independent of the used shares of the CPU resources and are made available through the LoadLeveler variables **UserUsedBgShares** and **GroupUsedBgShares**. LoadLeveler variable **JobIsBlueGene** will indicate whether a job step is a Blue Gene job step or not. LoadLeveler administrators have flexibility

in specifying the behavior of fair share scheduling by using these variables in the SYSPRIO expression. The **llfs** command and the related APIs can also handle requests related to the Blue Gene resources.

For more information about fair share scheduling, see "Using fair share scheduling."

Blue Gene heterogeneous memory support

The LoadLeveler job command file has a **bg_requirements** keyword that can be used to specify the requirements that a Blue Gene base partition must meet to execute the job step.

The Blue Gene compute nodes (C-nodes) in the same base partition have the same amount of physical memory. The C-nodes in different base partitions might have different amounts of physical memory. The **bg_requirements** job command file keyword allows users to specify the memory requirement on the Blue Gene C-nodes.

The **bg_requirements** keyword works like the **requirements** keyword, but it can only support memory requirements and applies only to Blue Gene base partitions. For a Blue Gene job step, the **requirements** keyword value applies to the front end node needed by the job step and the **bg_requirements** keyword value applies to the Blue Gene base partitions needed by the job step.

Blue Gene preemption support

Preemption support for Blue Gene jobs has been enabled.

Blue Gene jobs have the same preemption support as non-Blue Gene jobs. In a typical Blue Gene system, many Blue Gene jobs share the same front end node while dedicated Blue Gene resources are used for each job. To avoid preempting Blue Gene jobs that use different Blue Gene resources as requested by a preempting job, **ENOUGH** instead of **ALL** must be used in the **PREEMPT_CLASS** rules for Blue Gene job preemption.

For more information about preemption, see "Preempting and resuming jobs" on page 126

Blue Gene/L HTC partition support

The allocation of High Throughput Computing (HTC) partitions on Blue Gene/L is supported when the LoadLeveler **BG_CACHE_PARTITIONS** configuration keyword is set to **false**.

See the following IBM System Blue Gene Solution Redbooks (dated April 27, 2007) for more information about Blue Gene/L HTC support:

- *IBM Blue Gene/L: System Administration*, SG24-7178
- *IBM Blue Gene/L: Application Development*, SG24-7179

Using fair share scheduling

Fair share scheduling in LoadLeveler provides a way to divide resources in a LoadLeveler cluster among users or groups of users.

To fairly share cluster resources, LoadLeveler can be configured to allocate a proportion of the resources to each user or group and to let job priorities be

adjusted based on how much of the resources have been used and when they were used. Generally speaking, LoadLeveler should be configured so that job priorities decrease for a user or group that has recently used more resources than the allocated proportion and job priorities should increase for a user or group that has not run any jobs recently.

Administrators can configure the behavior of fair share scheduling through a set of configuration keywords. They can also query fair share information, save a snapshot of historic data, reset and restore fair share scheduling, and perform other functions by using the LoadLeveler **llfs** command, the GUI, and the corresponding APIs.

Fair share scheduling also includes Blue Gene resources (see "Blue Gene fair share scheduling support" on page 159 for more information).

Note: The time of day clocks on all of the nodes in the cluster *must* be synchronized in order for fair share scheduling to work properly.

For more information, see the following:

- "llfs - Fair share scheduling queries and operations" on page 450
- Corresponding APIs:
  - "ll_fair_share subroutine" on page 642
  - "Data access API" on page 560
- Keywords:
  - fair_shares
  - FAIR_SHARE_INTERVAL
  - FAIR_SHARE_INTERVAL
- SYSPRIO expression

Fair share scheduling keywords

The **FAIR_SHARE_TOTAL_SHARES** global configuration file keyword is used to specify the total number of shares that each type of resource is divided into.

The **fair_shares** keyword in a user or group stanza in the administration file specifies how many shares the user or group is allocated. The ratio of the **fair_shares** keyword value in a user or group stanza over the **FAIR_SHARE_TOTAL_SHARES** keyword value defines the resource usage proportion for the user or group. For example, if a user is allocated one third of the cluster resources, then the ratio of the user's **fair_share** value over the **FAIR_SHARE_TOTAL_SHARES** keyword value should be one third.

The LoadLeveler SYSPRIO expression can be configured to let job priorities change to achieve the specified resource usage proportions. Besides changing job priorities, fair share scheduling does not change in any way how LoadLeveler schedules jobs. If a job can be scheduled to run, it will be run regardless of whether the owner and the LoadLeveler group of the job has any shares allocated or not. No matter how many shares are allocated to a user, if the user does not submit any jobs to run, then the resource usage proportion for that user cannot be achieved and other users might be able to use more than their allocated proportions.

Note: The sum of all allocated shares for users or groups does not have to equal the value of the **FAIR_SHARE_TOTAL_SHARES** keyword. The share

allocation can be used as a way to prevent a single user from consuming too much of the cluster resources and as a way to share the resources as fairly as possible.

When the value of the **FAIR_SHARE_TOTAL_SHARES** keyword is greater than 0, fair share scheduling is on, which means that resource usage data is collected when every job ends, regardless of the **fair_shares** values for any user or group. The collected usage data is converted to used shares for each user and group. The **llfs** command can be used to display the allocated and used shares. Turning fair share scheduling on does not mean that job priorities are affected by fair share scheduling. You have to configure the SYSPRIO expression to let fair share scheduling affect job priorities in a way that suits your needs. By default, the value of the **FAIR_SHARE_TOTAL_SHARES** keyword is 0 and fair share scheduling is disabled.

There is a built-in decay mechanism for the historic resource usage data that is collected when jobs end, that is, the initial resource usage value becomes smaller and smaller as times goes by. This decay mechanism allows the most recent resource usage to have more impact on fair share scheduling. The **FAIR_SHARE_INTERVAL** global configuration file keyword is used to specify how fast the decay is. The shorter the interval, the faster the historic data decays. A resource usage value decays to 5% of its initial value after an elapsed time period of the same length as the **FAIR_SHARE_INTERVAL** value. Generally, the interval should be at least several times larger than the typical job running time in the cluster to get stable results. A value should be chosen corresponding to how long the historic resource usage data should have an impact on the current job priorities.

The LoadLeveler SYSPRIO expression is used to calculate job priorities. A set of LoadLeveler variables including some related to fair share scheduling can be used in the SYSPRIO expression in the global configuration file. You can define the SYSPRIO expression to let fair share scheduling influence the job priorities in a way that is suitable to your needs. For more information, see the SYSPRIO expression in Chapter 12, “Configuration file reference,” on page 263.

When the **GroupTotalShares**, **GroupUsedShares**, **UserTotalShares**, **UserUsedShares**, **UserUsedBgShares**, **GroupUsedBgShares**, and **JobIsBlueGene** and their corresponding user-defined variables are used, you must use the **NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL** global configuration keyword to specify a time interval at which the job priorities will be recalculated using the most recent share usage information.

You can add the following user-defined variables to the **LoadL_config** global configuration file to make it easier to specify fair share scheduling in the SYSPRIO expressions:

- **GroupRemainingShares** = (GroupTotalShares - GroupUsedShares)
- **GroupHasShares** = ($(GroupRemainingShares) > 0)
- **GroupSharesExceeded** = ($(GroupRemainingShares) <= 0)
- **UserRemainingShares** = (UserTotalShares - UserUsedShares)
- **UserHasShares** = ($(UserRemainingShares) > 0)
- **UserSharesExceeded** = ($(UserRemainingShares) <= 0)
- **UserRemainingBgShares** = (UserTotalShares - UserUsedBgShares)
- **UserHasBgShares** = ($(UserRemainingBgShares) > 0)
- **UserBgSharesExceeded** = ($(UserRemainingBgShares) <= 0)
- **GroupRemainingBgShares** = (GroupTotalShares - GroupUsedBgShares)
- **GroupHasBgShares** = ($(GroupRemainingBgShares) > 0)

- **GroupBgSharesExceeded** = ($(GroupRemainingBgShares) <= 0)
- **JobIsNotBlueGene** = ! JobIsBlueGene

If fair share scheduling is not turned on, either because the **FAIR_SHARE_INTERVAL** keyword value is not positive or because the scheduler type is not **BACKFILL**, then the variables will have the following values:

```
GroupTotalShares: 0
GroupUsedShares: 0
$(GroupRemainingShares): 0
$(GroupHasShares): 0
$(GroupSharesExceeded): 1
UserUsedBgShares: 0
$(UserRemainingBgShares): 0
$(UserHasBgShares): 0
$(UserBgSharesExceeded): 1
```

If a user has the **fair_shares** keyword set to 10 in its user stanza and the user has used up 8 CPU shares and 3 Blue Gene shares, then the variables will have the following values:

```
UserTotalShares: 10
UserUsedShares: 8
$(UserRemainingShares): 2
$(UserHasShares): 1
$(UserSharesExceeded): 0
UserUsedBgShares: 3
$(UserRemainingBgShares): 7
$(UserHasBgShares): 1
$(UserBgSharesExceeded): 0
```

If a group has the **fair_shares** keyword set to 10 in its group stanza and the group has used up 15 CPU shares and 0 Blue Gene shares, then the variables will have the following values:

```
GroupTotalShares: 10
GroupUsedShares: 15
$(GroupRemainingShares): -5
$(GroupHasShares): 0
$(GroupSharesExceeded): 1
GroupUsedBgShares: 0
$(GroupRemainingBgShares): 10
$(GroupHasBgShares): 1
$(GroupBgSharesExceeded): 0
```

The values of the following variables for a Blue Gene job step:

```
JobIsBlueGene: 1
$(JobIsNotBlueGene): 0
```

The values of the following variables for a non-Blue Gene job step:

```
JobIsBlueGene: 0
$(JobIsNotBlueGene): 1
```

Reconfiguring fair share scheduling keywords

LoadLeveler configuration and administration files can be modified to assign new values to various keywords.

After files have been modified, issue the **llctl -g reconfig** command to read in the new keyword values. All new keywords introduced for fair share scheduling become effective right after reconfiguration.

Reconfiguring when the Schedd daemons are up

To avoid any inconsistency, change the value of the **FAIR_SHARE_INTERVAL** keyword while the central manager and all **Schedd** daemons are up, then do the reconfiguration.

After the reconfiguration, the following will happen:

- All historic fair share scheduling data will be decayed to the current time using the old value.
- The old value is replaced with the new value
- The new value will be used from here on

Note:

1. You must have the same value for the **FAIR_SHARE_INTERVAL** keyword in the central manager and the **Schedd** daemons because the **FAIR_SHARE_INTERVAL** keyword determines the rate of decay for the historic fair share data and the same value on the daemons maintains the data consistency.
2. There are some LoadLeveler configuration parameters that require restarting LoadLeveler with **llctl recycle** for changes to take effect. You can use **llctl recycle** when changing fair share parameters also. The effect will be the same as using **llctl reconfig** because when the Schedd machine shuts down normally, the fair share scheduling data will be decayed to the time of the shutdown and it will be saved.

Reconfiguring when the Schedd daemons are down

The value for the **FAIR_SHARE_INTERVAL** keyword may need to be changed while a **Schedd** daemon is down.

If the value for the **FAIR_SHARE_INTERVAL** keyword has to be changed while a **Schedd** daemon is down, the following will happen when the **Schedd** daemon is restarted:

- All historic fair share scheduling data will be read in from the disk files in the $(SPOOL) directory with no change.
- When a new job ends, the historic fair share scheduling data for the owner and the LoadLeveler group of the job will be updated using the new value and then sent to the central manager. The new value is used effectively from the time the data was last updated before the **Schedd** went down, not from the time of the reconfiguration as it would normally be.

Example: three groups share a LoadLeveler cluster

This example in which three groups share a LoadLeveler cluster may apply to your situation.

For purposes of this example, we will assume the following:

- Three groups of users share a LoadLeveler cluster and each group is to have one third of the resources
- Historic data will have significant impact for about 10 days
- Groups with unused shares will have much higher job priorities than the groups which have used up their shares

To setup for fair share scheduling with these assumptions, an administrator could update the **LoadL_config** global configuration file as follows:

```
FAIR_SHARE_TOTAL_SHARES = 99

FAIR_SHARE_INTERVAL = 240

NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL = 300

GroupRemainingShares = ( GroupTotalShares - GroupUsedShares )

GroupHasShares = ( $(GroupRemainingShares) > 0 )

SYSPRIO : 10000000 * $(GroupHasShares) - QDate
```

In the admin file **LoadL_admin**, add:

```
chemistry: type = group

   include_users = harold mark kim enci george charlie

   fair_shares = 33

physics: type = group

   include_users = cnyang gchen newton roy

   fair_shares = 33

math: type = group

   include_users = rich dave chris popco
   fair_shares = 33
```

When user rich in the math group wants to submit a job, the following keyword can be put into the job command file so that the job will have high priority through the math group:

```
#@group=math
```

If user rich has a job that does not need to be run right away or as soon as possible (can be run at any time), then he should run the job in a LoadLeveler group with no shares allocated (for example, the **No_Group** group). Because the group **No_Group** has no shares allocated to it in this example, $(GroupHasShares) has a value of 0 and the job priority will be lower than those jobs whose group has unused shares. The job will be run when all higher priority jobs are done or when it is used to backfill a higher priority job (will be run whenever it can be scheduled).

Example: two thousand students share a LoadLeveler cluster

This example in which two thousand students share a LoadLeveler cluster may apply to your situation.

For purposes of this example, we will assume the following:

- A university has 2000 students who share a LoadLeveler cluster and every student is to have the same number of shares of the resources.
- Historic data will have significant impact for about 7 days (because **FAIR_SHARE_INTERVAL** is not specified and the default value is 7 days).
- A student with unused shares is to have somewhat higher job priorities and let the priorities decrease as the number of used shares increase.

The **LoadL_config** global configuration file should contain the following:

```
FAIR_SHARE_TOTAL_SHARES = 10000

NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL = 600

UserRemainingShares = ( UserTotalShares - UserUsedShares )

SYSPRIO : 100000 * $(UserRemainingShares) - QDate
```

In the **LoadL_admin** admin file, add

```
default: type = user

  fair_shares = 5
```

Note: The value **fair_shares = 5** is the result of dividing the total shares into the number of students (10000 ÷ 2000). The number of students can be more or less than 2000, but the same configuration parameters still prevent a single user from using too much cluster resources in a short time period.

We can see from the SYSPRIO expression that the larger the number of unused shares for a student and the earlier the job is submitted, the higher the priority is for the student's job.

Querying information about fair share scheduling

The **llfs** command, the GUI, and the data access API can be used to query information about fair share scheduling.

The **llfs** command without any options displays the allocated and used shares for all users and LoadLeveler groups having run one or more jobs in the cluster to completion. The **-u** and **-g** options can show the allocated and used shares for any user or LoadLeveler group regardless of whether they have run any jobs in the cluster. In either case, the user or group need not have any **fair_shares** allocated in the **LoadL_admin** administration file for the usage to be reported by the **llfs** command.

Resetting fair share scheduling

The **llfs -r** command option (or the GUI option **Reset historic data**), by default, will start fair share scheduling from the beginning, which means that all the previous historic data will be lost.

This command will not be run unless all **Schedd** daemons are up and running.

In case a **Schedd** daemon is down when this command option is being run, the request will not be processed. To manually reset fair share scheduling, bring down the LoadLeveler cluster, remove all fair share data files (**fair_share_queue.dir** and **fair_share_queue.pag**) in the $(SPOOL) directory and then restart the LoadLeveler cluster.

Saving historic data

The LoadLeveler central manager holds the complete historic fair share data when it is up.

Every Schedd holds a portion of the historic fair share data and the data is stored on disk in the $(SPOOL) directory. When the central manager is restarted, it receives the historic fair share data from every Schedd. If a Schedd machine is down temporarily and the central manager remains up, the data in the central manager is not affected. In case a Schedd machine is permanently damaged and

the central manager restarts, the central manager will not be able to get all of the historic fair share data because the data stored on the damaged Schedd is lost. If the value of **FAIR_SHARE_INTERVAL** is very large, many days of data on the damaged Schedd could be lost. To reduce the loss of data, the historic fair share data in the central manager can be saved to disk periodically. Recovery can be done using the latest saved data when a Schedd machine is permanently out of service. The **llfs -s** command, the GUI, or the **ll_fair_share** API can be used to save a snapshot of the historic data in the central manager to a file.

Restoring saved historic data

You can use the **llfs -r** command option, the GUI, or the **ll_fair_share** API to restore fair share scheduling to a previously saved state.

For the file name, specify a file you saved previously using **llfs -s**.

If the central manager goes down and restarts again, the historic data stored in an out of service Schedd machine is not reported to the central manager. If the Schedd machine will not be brought back to service at all, then the administrator can consider restoring fair share scheduling to a state corresponding to the latest saved file.

Procedure for recovering a job spool

The **llmovespool** command is intended for recovery purposes only.

Jobs being managed by a down Schedd are unable to clean up resources or move to completion. These jobs need their job records transferred to another Schedd. The **llmovespool** command moves the job records from the spool of one managing Schedd to another managing Schedd in the local cluster. All moved jobs retain their original job identifiers.

It is very important that the Schedd that created the job records to be moved is not running during the move operation. Jobs within the job queue database will be unrecoverable if the job queue is updated during the move by any process other than the **llmovespool** command.

The **llmovespool** command operates on a set of job records, these records are updated as the command executes. When a job is successfully moved, the records for that job are deleted. Job records that are not moved because of a recoverable failure, like the original Schedd not being fenced, may have the **llmovespool** command executed against them again. It is very important that a Schedd never reads the job records from the spool being moved. Jobs will be unrecoverable if more than one Schedd is considered to be the managing Schedd.

The procedure for recovering a job spool is:

1. Move the files located in the spool directory to be transferred to another directory before entering the **llmovespool** command in order to guarantee that no other Schedd process is updating the job records.
2. Add the statement **schedd_fenced=true** to the machine stanza of the original Schedd node in order to guarantee that the central manager ignores connections from the original managing Schedd, and to prevent conflicts from arising if the original Schedd is restarted after the **llmovespool** command has been run. See the **schedd_fenced=true** keyword in Chapter 13, "Administration file reference," on page 321 for more information.

3. Reconfigure the central manager node so that it recognizes that the original Schedd is ″fenced″.
4. Issue the **llmovespool** command providing the spool directory where the job records are stored. The command displays a message that the transfer has started and reports status for each job as it is processed. For more information about the **llmovespool** command, see “llmovespool - Move job records” on page 472. For more information about the **ll_move_spool** API, see “ll_move_spool subroutine” on page 683.

Chapter 7. Using LoadLeveler's GUI to perform administrator tasks

Note: This is the last release that will provide the Motif-based graphical user interface **xloadl**. The function available in **xloadl** has been frozen since TWS LoadLeveler 3.3.2.

The end user can perform many tasks more efficiently and faster using the graphical user interface (GUI), but there are certain tasks that end users cannot perform unless they have the proper authority.

If you are defined as a LoadLeveler administrator in the LoadLeveler configuration file then you are immediately granted administrative authority and can perform the administrative tasks discussed in this topic. To find out how to grant someone administrative authority, see "Defining LoadLeveler administrators" on page 43.

You can access LoadLeveler administrative commands using the **Admin** pull-down menu on both the Jobs window and the Machines window of the GUI. The **Admin** pull-down menu on the Jobs window corresponds to the command options available in the **llhold**, **llfavoruser**, and **llfavorjob** commands. The **Admin** pull-down menu on the Machines window corresponds to the command options available in the **llctl** command.

The main window of the GUI has three sub-windows: one for job status with pull-down menus for job-related commands, one for machine status with pull-down menus for machine-related commands, and one for messages and logs (see "The LoadLeveler main window" on page 404 in the Chapter 15, "Graphical user interface (GUI) reference," on page 403). There are a variety of facilities available that allow you to sort and select the items displayed.

Job-related administrative actions

You access the administrative commands that act on jobs through the **Admin** pull-down menu in the Jobs window of the GUI.

You can perform the following tasks with this menu:

Favor Users
Allows you to favor users. This means that you can select one or more users whose jobs you want to move up in the job queue. This corresponds to the **llfavoruser** command.

Select **Admin** from the Jobs window

Select **Favor User**

▲The **Order by User** window appears.

Type in
The name of the user whose jobs you want to favor.

Press OK

Unfavor Users
Allows you to unfavor users. This means that you want to unfavor the user's jobs which you previously favored. This corresponds to the **llfavoruser** command.

Select **Admin** from the Jobs window

Select **Unfavor User**

▲The **Order by User** window appears.

Type in
The name of the user for whom you want to unfavor their jobs.

Press OK

Favor Jobs
Allows you to select a job that you want to favor. This corresponds to the **llfavorjob** command.

Select One or more jobs from the Jobs window

Select **Admin** from the Jobs window

Select **Favor Job**

▲The selected jobs are favored.

Press OK

Unfavor Jobs
Allows you select a job that you want to unfavor. This corresponds to the **llfavorjob** command.

Select One or more jobs from the Jobs window

Select **Admin** from the Jobs window

Select **Unfavor Job**

▲Unfavors the jobs that you previously selected.

Syshold
Allows you to place a system hold on a job. This corresponds to the **llhold** command.

Select A job from the Jobs window

Select **Admin** pull-down menu from the Jobs window

Select **Syshold** to place a system hold on the job.

Release From Hold
Allows you to release the system hold on a job. This corresponds to the **llhold** command.

Select A job from the Jobs window

Select **Admin** pull-down menu from the Jobs window

Select **Release From Hold** to release the system hold on the job.

Preempt
Available when using the BACKFILL or external schedulers. Preempt allows you to place the selected jobs in preempted state. This action corresponds to the **llpreempt** command.

Select One or more jobs from the Jobs window

Select **Admin** pull-down menu from the Jobs window

Select **Preempt**

Resume Preempted Job
Available only when using the BACKFILL or external schedulers. Resume Preempted Job allows you to remove user-initiated preemption (initiated using the Preempt menu option or the **llpreempt** command) from the selected jobs. This action corresponds to the **llpreempt -r** command.

Select One or more jobs from the Jobs window

Select **Admin** pull-down menu from the Jobs window

Select **Resume Preempted Job**

Prevent Preempt
Available only when using the BACKFILL or API scheduler. Prevent Preempt allows you to place the selected running job into a non-preemptable state. When the BACKFILL or API scheduler is in use, this is equivalent to the **llmodify -p nopreempt** command.

Select One job from the Jobs window

Select **Admin** pull-down menu from the Jobs window

Select **Prevent Preempt**

Allow Preempt
Available only when using the BACKFILL or API scheduler, Allow Preempt makes the unpreemptable job preemptable again. When the BACKFILL or API scheduler is in use, this is equivalent to the **llmodify -p preempt** command.

Select One or more jobs from the Jobs window

Select **Admin** pull-down menu from the Jobs window

Select **Allow Preempt**

Extend Wallclock Limits
Allows you to extend the wallclock limits by the number of minutes specified. This corresponds to the **llmodify -W** command.

Select **Admin** pull-down window from the Jobs window

Select **Extend Wallclock Limit**

▲The Extend Wallclock Limits window appears.

Type in
The number of minutes to extend the wallclock limit.

Press OK

Modify Job Priority
Allows you to modify the system priority of a job step. This corresponds to the **llmodify -s** command.

Select **Admin** pull-down window from the Jobs window

Select **Modify Job Priority**

▲The Modify Job Priority window appears.

Type in
An integer value for system priority.

Press OK

Move to another cluster
Allows you to move an idle job from the local cluster to another. This menu items appears only when a mulitcluster environment is configured. It corresponds to the **llmovejob** command.

Select **Admin** pull-down window from the Jobs window

Select **Modify Job Priority**

▲The Move Job to Another Cluster window appears.

Select The name of the target cluster.

Press OK

Machine-related administrative actions

You access the administrative commands that act on machines using the **Admin** pull-down menu in the Machines window of the GUI.

Using the GUI pull-down menu, you can perform the tasks described in this topic.

Start All
Starts LoadLeveler on all machines listed in machine stanzas beginning with the central manager. Submit-only machines are skipped. Use this option when specifying alternate central managers in order to ensure the primary central manager starts before any alternate central manager attempts to serve as central manager.

Select **Admin** from the Machines window.

Select **Start All**

Start LoadLeveler
Allows you to start LoadLeveler on selected machines.

Select One or more machines on which you want to start LoadLeveler.

Select **Admin** from the Machines window.

Select **Start LoadLeveler**

Start Drained
Allows you to start LoadLeveler with **startd** drained on selected machines.

Select One or more machines on which you want **startd** drained.

Select **Admin** from the Machines window.

Select **Start Drained**

Stop LoadLeveler
Allows you to stop LoadLeveler on selected machines.

Select One or more machines on which you want to stop LoadLeveler.

Select **Admin** from the Machines window.

Select **Stop LoadLeveler**.

Stop All
Stops LoadLeveler on all machines listed in machine stanzas. Submit-only machines are skipped.

Select **Admin** from the Machines window.

Select **Stop All**

Reconfig
Forces all daemons to reread the configuration files

Select The machine on which you want to operate. To reconfigure this **xloadl** session, choose **reconfig** but do not select a machine.

Select **Admin** from the Machines window.

Select **reconfig**

Recycle
Stops all LoadLeveler daemons and restarts them.

Select The machine on which you want to operate.

Select **Admin** from the Machines window.

Select **recycle**

Configuration Tasks
Starts Configuration Tasks wizard

Select **Admin** from the Machines window.

Select Config Tasks

Note: Use the invoking script **lltg** to start the wizard outside of **xloadl**. This option will appear on the pull-down only if the LoadL.tguides fileset is installed.

Drain
Allows no more LoadLeveler jobs to begin running on this machine but it does allow running jobs to complete.

Select The machine on which you want to operate.

Select **Admin** from the Machines window.

Select **drain**.

A cascading menu allows you to select either **daemons**, **Schedd**, **startd**, or **startd by class**. If you select **daemons**, both the **startd** and the Schedd on the selected machine will be drained. If you select **Schedd**, only the Schedd on the selected machine will be drained. If you select **startd**, only the startd on the selected machine will be drained. If you select **startd by class**, a window appears which allows you to select classes to be drained.

Flush
Terminates running jobs on this host and sends them back to the system queue to await redispatch. No new jobs are redispatched to this machine until **resume** is issued. Forces a checkpoint if jobs are enabled for checkpointing.

Select The machine on which you want to operate.

Select **Admin** from the Machines window.

Select **flush**

Suspend
Suspends all jobs on this host.

Select The machine on which you want to operate.

Select **Admin** from the Machines window.

Select **suspend**

Resume
Resumes all jobs on this machine.

Select The machine on which you want to operate.

Select **Admin** from the Machines window

Select **resume**

A cascading menu allows you to select either **daemons**, **Schedd**, **startd**, or **startd by class**. If you select **daemons**, both machines will be resumed. If you select **Schedd**, only the Schedd on the selected machine will be resumed. If you select **startd**, only the startd on the selected machine will be resumed. If you select **startd by class**, a window appears which allows you to select classes to be resumed.

Capture Data
Collects information on the machines selected.

Select The machine on which you want to operate.

Select **Admin** from the Machines window.

Select **Capture Data**.

Collect Account Data
Collects accounting data on the machines selected.

Select The machine on which you want to operate.

Select **Admin** from the Machines window.

Select **Collect Account Data**.

A window appears prompting you to enter the name of the directory in which you want the collected data stored.

Collect Reservation Data
Collects reservation data on the machines selected.

Select The machine on which you want to operate.

Select **Admin** from the Machines window.

Select **Collect Reservation Data**.

A window appears prompting you to enter the name of the directory in which you want the collected data stored.

Create Account Report
Creates an accounting report for you.

Select **Admin → Create Account Report...**

Note: If you want to receive an extended accounting report, select the **extended** cascading button.

A window appears prompting you to enter the following information:
- A short, long, or extended version of the output. The short version is the default.
- The user ID
- The class name
- The LoadL (LoadLeveler) group name
- The UNIX group name
- The Allocated host
- The job ID
- The report Type

- The section
- A start and end date for the report. If no date is specified, the default is to report all of the data in the report.
- The name of the input data file.
- The name of the output data file. This is the same as stdout.

Press OK

The window closes and you return to the main window. The report appears in the Messages window if no output data file was specified.

Move Spool

Moves the job records from the spool of one managing Schedd to another managing Schedd in the local cluster. This is intended for recovery purposes only.

Select One Schedd machine from the Machines window.

Select **Admin** from the Machines window.

Select **Move Spool**

A window is displayed prompting you to enter the directory containing the job records to be moved.

Press OK

Version

Displays version and release data for LoadLeveler on the machines selected in an information window.

Select The machine on which you want to operate.

Select **Admin** from the Machines window.

Select **version**

Fair Share Scheduling

Provides fair share scheduling functions (see "llfs - Fair share scheduling queries and operations" on page 450).

Select **Admin** from the Machines window.

Select **Fair Share Scheduling**

A cascading menu allows you to select one of the following:

- **Show**

  Displays fair share scheduling information for all users or for specified users and groups.
- **Save historic data**

  Saves fair share scheduling information into the directory specified.
- **Restore historic data**

  Restores fair share scheduling data to a state corresponding to a file previously saved by Save historic data or the **llfs -s** command.
- **Reset historic data**

  Erases all historic CPU data to reset fair share scheduling.

Part 3. Submitting and managing TWS LoadLeveler jobs

After an administrator installs IBM Tivoli Workload Scheduler (TWS) LoadLeveler and customizes the environment, general users can build and submit jobs to exploit the many features of the TWS LoadLeveler runtime environment.

Chapter 8. Building and submitting jobs

Learn more about building and submitting jobs.

The topics listed Table 40 will help you learn about building and submitting jobs:

Table 40. Learning about building and submitting jobs

To learn about:	Read the following:
Creating and submitting serial and parallel jobs	Chapter 8, "Building and submitting jobs"
Controlling and monitoring TWS LoadLeveler jobs	Chapter 9, "Managing submitted jobs," on page 229
Ways to control or monitor TWS LoadLeveler operations by using the TWS LoadLeveler commands, GUI, and APIs	• Chapter 16, "Commands," on page 411 • Chapter 10, "Example: Using commands to build, submit, and manage jobs," on page 235 • Chapter 11, "Using LoadLeveler's GUI to build, submit, and manage jobs," on page 237 • Chapter 17, "Application programming interfaces (APIs)," on page 541

Table 41 lists the tasks that general users perform to run LoadLeveler jobs.

Table 41. Roadmap of user tasks for building and submitting jobs

To learn about:	Read the following:
Building jobs	• "Building a job command file" • "Editing job command files" on page 185 • "Defining resources for a job step" on page 185 • "Working with coscheduled job steps" on page 187 • "Using bulk data transfer" on page 188 • "Preparing a job for checkpoint/restart" on page 190 • "Preparing a job for preemption" on page 193
Submitting jobs	• "Submitting a job command file" on page 193 • "llsubmit - Submit a job" on page 531
Working with parallel jobs	"Working with parallel jobs" on page 194
Working with reserved node resources and the jobs that use them	"Working with reservations" on page 213
Correctly specifying job command file keywords	Chapter 14, "Job command file reference," on page 357

Building a job command file

Before you can submit a job or perform any other job related tasks, you need to build a job command file.

A job command file describes the job you want to submit, and can include LoadLeveler keyword statements. For example, to specify a binary to be executed,

you can use the **executable** keyword, which is described later in this topic. To specify a shell script to be executed, the **executable** keyword can be used; if it is not used, LoadLeveler assumes that the job command file itself is the executable.

The job command file can include the following:

- LoadLeveler keyword statements: A *keyword* is a word that can appear in job command files. A *keyword statement* is a statement that begins with a LoadLeveler keyword. These keywords are described in "Job command file keyword descriptions" on page 359.
- Comment statements: You can use comments to document your job command files. You can add comment lines to the file as you would in a shell script.
- Shell command statements: If you use a shell script as the executable, the job command file can include shell commands.
- LoadLeveler variables: See "Job command file variables" on page 399 for more information.

You can build a job command file either by using the Build a Job window on the GUI or by using a text editor.

Using multiple steps in a job command file

To specify a stream of job steps, you need to list each job step in the job command file.

You must specify one **queue** statement for each job step. Also, the executables for all job steps in the job command file must exist when you submit the job. For most keywords, if you specify the keyword in a job step of a multi-step job, its value is inherited by all proceeding job steps. Exceptions to this are noted in the keyword description.

LoadLeveler treats all job steps as independent job steps unless you use the **dependency** keyword. If you use the **dependency** keyword, LoadLeveler determines whether a job step should run based upon the exit status of the previously run job step.

For example, Figure 19 on page 181 contains two separate job steps. Notice that `step1` is the first job step to run and that `step2` is a job step that runs only if `step1` exits with the correct exit status.

```
# This job command file lists two job steps called "step1"
# and "step2".  "step2" only runs if "step1" completes
# with exit status = 0.  Each job step requires a new
# queue statement.
#
# @ step_name = step1
# @ executable = executable1
# @ input = step1.in1
# @ output = step1.out1
# @ error = step2.err1
# @ queue
# @ dependency = (step1 == 0)
# @ step_name = step2
# @ executable = executable2
# @ input = step2.in1
# @ output = step2.out1
# @ error = step2.err1
# @ queue
```

Figure 19. Job command file with multiple steps

In Figure 19, `step1` is called the *sustaining* job step. `step2` is called the *dependent* job step because whether or not it begins to run is dependent upon the exit status of `step1`. A single sustaining job step can have more than one dependent job steps and a dependent job step can also have job steps dependent upon it.

In Figure 19, each job step has its own **executable**, **input**, **output**, and **error** statements. Your job steps can have their own separate statements, or they can use those statements defined in a previous job step. For example, in Figure 20, `step2` uses the **executable** statement defined in `step1`:

```
# This job command file uses only one executable for
# both job steps.
#
# @ step_name = step1
# @ executable = executable1
# @ input = step1.in1
# @ output = step1.out1
# @ error = step1.err1
# @ queue
# @ dependency = (step1 == 0)
# @ step_name = step2
# @ input = step2.in1
# @ output = step2.out1
# @ error = step2.err1
# @ queue
```

Figure 20. Job command file with multiple steps and one executable

Examples: Job command files

These examples of job command files may apply to your situation.

- **Example 1: Generating multiple jobs with varying outputs**

  To run a program several times, varying the initial conditions each time, you could can multiple LoadLeveler scripts, each specifying a different input and output file as described in Figure 22 on page 183. It would probably be more convenient to prepare different input files and submit the job only once, letting LoadLeveler generate the output files and do the multiple submissions for you.

  Figure 21 on page 182 illustrates the following:

  – You can refer to the LoadLeveler name of your job symbolically, using **$(jobid)** and **$(stepid)** in the LoadLeveler script file.

  – **$(jobid)** refers to the job identifier.

– **$(stepid)** refers to the job step identifier and increases after each **queue** command. Therefore, you only need to specify input, output, and error statements once to have LoadLeveler name these files correctly.

Assume that you created five input files and each input file has different initial conditions for the program. The names of the input files are in the form **longjob.in.***x*, where *x* is 0–4.

Submitting the LoadLeveler script shown in Figure 21 results in your program running five times, each time with a different input file. LoadLeveler generates the output file from the LoadLeveler job step IDs. This ensures that the results from the different submissions are not merged.

```
# @ executable = longjob
# @ input = longjob.in.$(stepid)
# @ output = longjob.out.$(jobid).$(stepid)
# @ error = longjob.err.$(jobid).$(stepid)
# @ queue
# @ queue
# @ queue
# @ queue
# @ queue
```

Figure 21. Job command file with varying input statements

To submit the job, type the command:

```
llsubmit longjob.cmd
```

LoadLeveler responds by issuing the following:

```
submit: The job "ll6.23" with 5 job steps has been submitted.
```

Table 42 lists the standard input files, standard output files, and standard error files for the five job steps:

Table 42. Standard files for the five job steps

Job Step	Standard Input	Standard Output	Standard Error
ll6.23.0	longjob.in.0	longjob.out.23.0	longjob.err.23.0
ll6.23.1	longjob.in.1	longjob.out.23.1	longjob.err.23.1
ll6.23.2	longjob.in.2	longjob.out.23.2	longjob.err.23.2
ll6.23.3	longjob.in.3	longjob.out.23.3	longjob.err.23.3
ll6.23.4	longjob.in.4	longjob.out.23.4	longjob.err.23.4

- **Example 2: Using LoadLeveler variables in a job command file**

  Figure 22 on page 183 shows how you can use LoadLeveler variables in a job command file to assign different names to input and output files. This example assumes the following:

  – The name of the machine from which the job is submitted is `lltest1`
  – The user's home directory is **/u/rhclark** and the current working directory is **/u/rhclark/OSL**
  – LoadLeveler assigns a value of 122 to **$(jobid)**.

  In Job Step 0:

  – LoadLeveler creates the subdirectories **oslsslv_out** and **oslsslv_err** if they do not exist at the time the job step is started.

  In Job Step 1:

– The character string **rhclark** denotes the home directory of user **rhclark** in **input**, **output**, **error**, and **executable** statements.
– The **$(base_executable)** variable is set to be the "base" portion of the **executable**, which is **oslsslv**.
– The **$(host)** variable is equivalent to **$(hostname)**. Similarly, **$(jobid)** and **$(stepid)** are equivalent to **$(cluster)** and **$(process)**, respectively.

In Job Step 2:

– This job step is executed only if the return codes from Step 0 and Step 1 are both equal to zero.
– The initial working directory for Step 2 is explicitly specified.

```
# Job step 0 ============================================================
#   The names of the output and error files created by this job step are:
#
#     output: /u/rhclark/OSL/oslsslv_out/lltest1.122.0.out
#     error : /u/rhclark/OSL/oslsslv_err/lltest1_122_0_err
#
# @ job_name = OSL
# @ step_name = step_0
# @ executable = oslsslv
# @ arguments = -maxmin=min -scale=yes -alg=dual
# @ environment = OSL_ENV1=20000; OSL_ENV2=500000
# @ requirements = (Arch == "R6000") && (OpSys == "AIX53")
# @ input  = test01.mps.$(stepid)
# @ output = $(executable)_out/$(host).$(jobid).$(stepid).out
# @ error  = $(executable)_err/$(host)_$(jobid)_$(stepid)_err
# @ queue
#
# Job step 1 ============================================================
#   The names of the output and error files created by this job step are:
#
#     output: /u/rhclark/OSL/oslsslv_out/lltest1.122.1.out
#     error : /u/rhclark/OSL/oslsslv_err/lltest1_122_1_err
#
# @ step_name = step_1
# @ executable = rhclark/$(job_name)/oslsslv
# @ arguments = -maxmin=max -scale=no -alg=primal
# @ environment = OSL_ENV1=60000; OSL_ENV2=500000; \
                  OSL_ENV3=70000; OSL_ENV4=800000;
# @ input  = rhclark/$(job_name)/test01.mps.$(stepid)
# @ output = rhclark/$(job_name)/$(base_executable)_out/$(hostname).$(cluster).$(process).out
# @ error  = rhclark/$(job_name)/$(base_executable)_err/$(hostname)_$(cluster)_$(process)_err
# @ queue
#
# Job step 2 ============================================================
#   The names of the output and error files created by this job step are:
#
#     output: /u/rhclark/OSL/oslsslv_out/lltest1.122.2.out
#     error : /u/rhclark/OSL/oslsslv_err/lltest1_122_2_err
#
# @ step_name = OSL
# @ dependency = (step_0 == 0) && (step_1 == 0)
# @ comment = oslsslv
# @ initialdir = /u/rhclark/$(step_name)
# @ arguments = -maxmin=min -scale=yes -alg=dual
# @ environment = OSL_ENV1=300000; OSL_ENV2=500000
# @ input  = test01.mps.$(stepid)
# @ output = $(comment)_out/$(host).$(jobid).$(stepid).out
# @ error  = $(comment)_err/$(host)_$(jobid)_$(stepid)_err
# @ queue
```

Figure 22. Using LoadLeveler variables in a job command file

- **Example 3: Using the job command file as the executable**

  The name of the sample script shown in Figure 23 on page 185 is **run_spice_job**. This script illustrates the following:

  – The script does not contain the **executable** keyword. When you do not use this keyword, LoadLeveler assumes that the script is the executable. (Since the

name of the script is **run_spice_job**, you can add the **executable = run_spice_job** statement to the script, but it is not necessary.)

– The job consists of four job steps (there are 4 **queue** statements). The **spice3f5** and **spice2g6** programs are invoked at each job step using different input data files:

  - **spice3f5:** Input for this program is from the file **spice3f5_input**_*x* where *x* has a value of 0, 1, and 2 for job steps 0, 1, and 2, respectively. The name of this file is passed as the first argument to the script. Standard output and standard error data generated by **spice3f5** are directed to the file **spice3f5_output**_*x*. The name of this file is passed as second argument to the script. In job step 3, the names of the input and output files are **spice3f5_input_benchmark1** and **spice3f5_output_benchmark1**, respectively.
  - **spice2g6:** Input for this program is from the file **spice2g6_input**_*x*. Standard output and standard error data generated by **spice2g6** together with all other standard output and standard error data generated by this script are directed to the files **spice_test_output**_*x* and **spice_test_error**_*x*, respectively. In job step 3, the name of the input file is **spice2g6_input_benchmark1**. The standard output and standard error files are **spice_test_output_benchmark1** and **spice_test_error_benchmark1**.

  All file names that are not fully qualified are relative to the initial working directory **/home/loadl/spice**. LoadLeveler will send the job steps 0 and 1 of this job to a machine for that has a real memory of 64 MB or more for execution. Job step 2 most likely will be sent to a machine that has more that 128 MB of real memory and has the ESSL library installed since these preferences have been stated using the LoadLeveler **preferences** keyword. LoadLeveler will send job step 3 to the machine `l15.pok.ibm.com` for execution because of the explicit requirement for this machine in the **requirements** statement.

```
#!/bin/ksh
# @ job_name = spice_test
# @ account_no = 99999
# @ class = small
# @ arguments = spice3f5_input_$(stepid) spice3f5_output_$(stepid)
# @ input  = spice2g6_input_$(stepid)
# @ output = $(job_name)_output_$(stepid)
# @ error  = $(job_name)_error_$(stepid)
# @ initialdir = /home/loadl/spice
# @ requirements = ((Arch == "R6000") && \
#           (OpSys == "AIX53") && (Memory > 64))
# @ queue
# @ queue
# @ preferences  = ((Memory > 128)  && (Feature == "ESSL"))
# @ queue
# @ class = large
# @ arguments = spice3f5_input_benchmark1 spice3f5_output_benchmark1
# @ requirements = (Machine == "ll5.pok.ibm.com")
# @ input  = spice2g6_input_benchmark1
# @ output = $(job_name)_output_benchmark1
# @ error  = $(job_name)_error_benchmark1
# @ queue
OS_NAME=`uname`

case $OS_NAME in
   AIX)
      echo "Running $OS_NAME version of spice3f5" > $2
      AIX_bin/spice3f5 < $1  >> $2  2>&1
      echo "Running $OS_NAME version of spice2g6"
      AIX_bin/spice2g6
      ;;
   *)
      echo "spice3f5 for $OS_NAME is not available" > $2
      echo "spice2g6 for $OS_NAME is not available"
      ;;
esac
```

Figure 23. Job command file used as the executable

Editing job command files

After you build a job command file, you can edit it using the editor of your choice.

You may want to change the name of the executable or add or delete some statements.

When you create a job command file, it is considered the job executable unless you specify otherwise by using the **executable** keyword in the job command file. LoadLeveler copies the executable to the spool directory unless the **checkpoint** keyword was set to **yes** or **interval**. Jobs that are to be checkpointed cannot be moved to the spool directory. Do not make any changes to the executable while the job is still in the queue–it could affect the way that job runs.

Defining resources for a job step

The LoadLeveler user may use the **resources** keyword in the job command file to specify the resources to be consumed by each task of a job step.

If the **resources** keyword is specified in the job command file, it overrides any **default_resources** specified by the administrator for the job step's class.

For example, the following job requests one CPU and one FRM license for each of its tasks:

```
resources = ConsumableCpus(1) FRMlicense(1)
```

If this were specified in a serial job step, one CPU and one FRM license would be consumed while the job step runs. If this were a parallel job step, then the number of CPUs and FRM licenses consumed while the job step runs would depend upon how many tasks were running on each machine. For more information on assigning tasks to nodes, see "Task-assignment considerations" on page 196.

Alternatively, you can use the **node_resources** keyword in the job command file to specify the resources to be consumed by the job step on each machine it runs on, regardless of the number of tasks assigned to each machine. If the **node_resources** keyword is specified in the job command file, it overrides the **default_node_resources** specified by the administrator for the job step's class.

For example, the following job requests 240 MB of **ConsumableMemory** on each machine:

```
node_resources = ConsumableMemory(240 mb)
```

Even if one machine only runs one task of the job step, while other machines run multiple tasks, 240 MB will be consumed on every machine.

Submitting jobs requesting data staging

The **dstg_in_script** keyword causes LoadLeveler to generate an inbound data staging step, without requiring the #@queue specification. The value assigned to this keyword is the executable that will be started for data staging and any arguments needed by this script or executable as well.

The **dstg_in_wall_clock_limit** keyword specifies a wall clock time for the inbound data staging step. Specifying the estimated wall clock limit is mandatory when a data staging script is specified. Similarly, **dstg_out_script** and **dstg_out_wall_clock_limit** will be used for generation and execution of the outbound data staging step for the job. All data staging job steps are assigned to the predefined class called **data_stage**.

Resources required for data staging can be specified using the **dstg_resources** keyword.

The **dstg_node** keyword allows you to specify how data replicas must be created:

- If the value specified is **any**, one data staging task is executed on any available node in the cluster with data staging resources. This value can be used with either the **at_submit** or the **just_in_time** configuration options.
- If the value specified is **master**, one data staging task is executed on the master node. The master node is the machine that will be used to run the inbound and outbound data staging steps as well as the first application step of the job.
- If the value is **all**, a data staging task is executed on each of the nodes that will be or were used by the first application step.

Any environment variables needed by the data staging scripts can be specified using the **dstg_environment** keyword. The **copy_all** value can be assigned to this keyword to get all of the user's environment variables.

For detailed information about the data staging job command file keywords, see "Job command file keyword descriptions" on page 359.

Working with coscheduled job steps

LoadLeveler allows you to specify that a group of two or more steps within a job are to be coscheduled. Coscheduled steps are dispatched at the same time.

Submitting coscheduled job steps

The **coschedule = yes** keyword in the job command file is used to specify which steps within a job are to be coscheduled.

All steps within a job with the **coschedule** keyword set to **yes** will be coscheduled. The coscheduled steps will continue to be stored as individual steps in both memory and in the job queue, but when performing certain operations, such as scheduling, the steps will be managed as a single entity. An operation initiated on one of the coscheduled steps will cause the operation to be performed on all other steps (unless the coscheduling dependency between steps is broken).

Determining priority for coscheduled job steps

Coscheduled steps are supported only with the BACKFILL scheduler. The LoadLeveler BACKFILL scheduler will only dispatch the set of coscheduled steps when enough resource is available for all steps in the set to start.

If the set of coscheduled steps cannot be started immediately, but enough resource will be available in the future, then the resource for all the steps will be reserved. In this case, only one of the coscheduled steps will be designated as a top dog, but enough resources will be reserved for all coscheduled steps and all the steps will be dispatched when the top dog step is started. The coscheduled step with the highest priority in the current job queue will be designated as the primary coscheduled step and all other steps will be secondary coscheduled steps. The primary coscheduled step will determine when the set of coscheduled steps will be scheduled. The priority for all other coscheduled steps is ignored.

Supporting preemption of coscheduled job steps

Preemption of coscheduled steps is supported.

Preemption of coscheduled steps is supported with the following restrictions:

- In order for a step S to be preemptable by a coscheduled step, all steps in the set of coscheduled steps must be able to preempt step S.
- In order for a step S to preempt a coscheduled step, all steps in the set of coscheduled steps must be preemptable by step S.
- The set of job steps available for preemption will be the same for all coscheduled steps. Any resource made available by preemption for one coscheduled step will be available to all other coscheduled steps.

To determine the preempt type and preempt method to use when a coscheduled step preempts another step, an order of precedence for preempt types and preempt methods has been defined. All steps in the preempting coscheduled step are examined and the preempt type and preempt method having the highest precedence are used. The order of precedence for preempt type will be **ALL** and **ENOUGH**. The precedence order for preempt method is:

- Remove

- Vacate
- System Hold
- User hold
- Suspend

For more information about preempt types and methods, see "Planning to preempt jobs" on page 128.

When coscheduled steps are running, if one step is preempted as a result of a system-initiated preemption, then all coscheduled steps are preempted. When determining an optimal preempt set, the BACKFILL scheduler does not consider coscheduled steps as a single entity. All coscheduled steps are in the initial preempt set, but the final preempt set might not include all coscheduled steps, if the scheduler determines the resources of some coscheduled steps are not necessary to start the preempting job step. This implies that more resource than necessary might be preempted when a coscheduled step is in the set of steps to be preempted because regardless of whether or not all coscheduled steps are in the preempt set, if one coscheduled step is preempted, then all coscheduled steps will be preempted.

Coscheduled job steps and commands and APIs

Commands and APIs that operate on job steps are impacted by coscheduled steps.

For the **llbind**, **llcancel**, **llhold**, and **llpreempt** commands, even if all coscheduled steps are not in the list of targeted steps, the requested operation is performed on all coscheduled steps.

For the **llmkres** and **llchres** commands, a coscheduled job step cannot be specified when using the **-j** or **-f** flags. For the **llckpt** command, you cannot specify a coscheduled job step using the **-u** flag.

Termination of coscheduled steps

If a coscheduled step is dispatched but cannot be started and is rejected by the **startd** daemon or the starter process, then all coscheduled steps are rejected.

If a running step is removed or vacated by LoadLeveler as a result of a system related failure, then all coscheduled steps are removed or vacated. If a running step is vacated as a result of the VACATE expression evaluating to true for the step, then all coscheduled steps are vacated.

Using bulk data transfer

On systems with device drivers and network adapters that support remote direct-memory access (RDMA), LoadLeveler supports bulk data transfer for jobs that use either the Internet or user space communication protocol mode.

For jobs using the Internet protocol (IP jobs), LoadLeveler does not monitor or control the use of bulk transfer. For user space jobs that request bulk transfer, however, LoadLeveler creates a consumable RDMA resource requirement. Machines with Switch Network Interface for HPS network adapters are automatically given an RDMA consumable resource with an available amount of four. Machines with InfiniBand switch adapters are given unlimited RDMA consumable resources. Each step that requests bulk transfer consumes one RDMA resource on each machine on which that step runs.

The RDMA resource is similar to user-defined consumable resources except in one important way: A user-specified resource requirement is consumed by every task of the job assigned to a machine, whereas the RDMA resource is consumed once on a machine no matter how many tasks of the job are running on the machine. Other than that exception, LoadLeveler handles the RDMA resource as it does all other consumable resources. LoadLeveler displays RDMA resources in the output of the following commands:

- **llq -l**
- **llsummary -l**

LoadLeveler also displays RDMA resources in the output of the following commands for machines with Switch Network Interface for HPS network adapters:

- **llstatus -l**
- **llstatus -R**

Bulk transfer is supported only on systems where the device driver of the network adapters supports RDMA. To determine which systems will support bulk transfer, use the **llstatus** command with the **-l**, **-R**, or **-a** flag to display machines with adapters that support RDMA. Machines with Switch Network Interface for HPS network adapters will have an RDMA resource listed in the command output of **llstatus -l** and **llstatus -R**. The **llstatus -a** command displays the adapters list, which can be used to verify whether InfiniBand adapters are connected to the machines.

Under certain conditions, LoadLeveler displays a total count of RDMA resources as less than four for machines with Switch Network Interface for HPS network adapters:

- If jobs that LoadLeveler does not manage use RDMA, the amount of available RDMA resource reported to the Negotiator is reduced by the amount consumed by the unmanaged jobs.
- In rare situations, LoadLeveler jobs can fail to release their adapter resources before reporting to the Negotiator that they have completed. When this occurs, the amount of available RDMA reported to the Negotiator is reduced by the amount consumed by the unreleased adapter resources. When the adapter resources are eventually released, the RDMA resource they consumed becomes available again.

These conditions do not require corrective action.

You do not need to perform specific job-definition tasks to enable bulk transfer for LoadLeveler jobs that use the IP network protocol. LoadLeveler cannot affect whether IP communication uses bulk transfer; the implementation of IP where the job runs determines whether bulk transfer is supported.

To enable user space jobs to use bulk data transfer, however, **all** of the following tasks must be completed. If you omit one or more of these steps, the job will run but will not be able to use bulk transfer.

- A LoadLeveler administrator must update the LoadLeveler configuration file to include the value **RDMA** in the **SCHEDULE_BY_RESOURCES** list for machines with Switch Network Interfaces for HPS network adapters. It is not required to include **RDMA** in the **SCHEDULE_BY_RESOURCES** list for machines with InfiniBand network adapters.

  Example:

  ```
  SCHEDULE_BY_RESOURCES = RDMA others
  ```

- Users must request bulk transfer for their LoadLeveler jobs, using one of the following methods:
  - Specifying the **bulkxfer** keyword in the LoadLeveler job command file.

    Example:

    ```
    #@ bulkxfer=yes
    ```

    If users specify this keyword for jobs that use the IP communication protocol, LoadLeveler ignores the **bulkxfer** keyword.
  - Specifying a POE line command parameter on interactive jobs.

    Example:

    ```
    poe_job -use_bulk_xfer=yes
    ```
  - Specifying an environment variable on interactive jobs.

    Example:

    ```
    export MP_USE_BULK_XFER=yes
        poe_job
    ```
- Because LoadLeveler honors the bulk transfer request only for LAPI or MPI jobs, users must ensure that the **network** keyword in the job command file specifies the **MPI**, **LAPI**, or **MPI_LAPI** protocol for user space communication.

  Examples:

  ```
  network.MPI =sn_single,not_shared,US,HIGH
  network.MPI_LAPI =sn_single,not_shared,US,HIGH
  ```

Preparing a job for checkpoint/restart

You can checkpoint your entire job step, and allow a job step to restart from the last checkpoint.

LoadLeveler has the ability to checkpoint your entire job step, and to allow a job step to restart from the last checkpoint. When a job step is checkpointed, the entire state of each process of that job step is saved by the operating system. On AIX, this checkpoint capability is built in to the base operating system.

Use the information in Table 43 on page 191 to correctly configure your job for checkpointing.

Table 43. Checkpoint configurations

To specify that:	Do this:
Your job is checkpointable	• Add either one of the following two options to your job command file: 1. **checkpoint = yes** This enables your job to checkpoint in any of the following ways: – The application can initiate the checkpoint. This is only available on AIX. – Checkpoint from a program which invokes the **ll_ckpt** API. – Checkpoint using the **llckpt** command. – As the result of a flush command. OR 2. **checkpoint = interval** This enables your job to checkpoint in any of the following ways: – The application can initiate the checkpoint. This is only available on AIX. – Checkpoint from a program which invokes the **ll_ckpt** API. – Checkpoint using the **llckpt** command. – Checkpoint automatically taken by LoadLeveler. – As the result of a flush command. • If you would like your job to checkpoint itself, use the API **ll_init_ckpt** in your serial application, or **mpc_init_ckpt** for parallel jobs to cause the checkpoint to occur. This is only available on AIX.
Your job step's executable is to be copied to the execute node	Add the **ckpt_execute_dir** keyword to the job command file.

Table 43. Checkpoint configurations (continued)

To specify that:	Do this:
LoadLeveler automatically checkpoints your job at preset intervals	1. Add the following option to your job command file: **checkpoint = interval** This enables your job to checkpoint in any of the following ways: • Checkpoint automatically at preset intervals • Checkpoint initiated from user application. This is only available on AIX. • Checkpoint from a program which invokes the **ll_ckpt** API • Checkpoint using the **llckpt** command • As the result of a flush command 2. The system administrators must set the following two keywords in the configuration file to specify how often LoadLeveler should take a checkpoint of the job. These two keywords are: **MIN_CKPT_INTERVAL =** *number* Where *number* specifies the initial period, in seconds, between checkpoints taken for running jobs. **MAX_CKPT_INTERVAL =** *number* Where *number* specifies the maximum period, in seconds, between checkpoints taken for running jobs. The time between checkpoints will be increased after each checkpoint within these limits as follows: • The first checkpoint is taken after a period of time equal to the **MIN_CKPT_INTERVAL** has passed. • The second checkpoint is taken after LoadLeveler waits *twice as long* (**MIN_CKPT_INTERVAL** X 2) • The third checkpoint is taken after LoadLeveler waits twice as long again (**MIN_CKPT_INTERVAL** X 4) before taking the third checkpoint. LoadLeveler continues to double this period until the value of **MAX_CKPT_INTERVAL** has been reached, where it stays for the remainder of the job. A minimum value of 900 (15 minutes) and a maximum value of 7200 (2 hours) are the defaults. You can set these keyword values globally in the global configuration file so that all machines in the cluster have the same value, or you can specify a different value for each machine by modifying the local configuration files.
Your job will not be checkpointed	Add the following option to your job command file: • **checkpoint = no** This will disable checkpoint.

Table 43. Checkpoint configurations (continued)

To specify that:	Do this:
Your job has successfully checkpointed and terminated. The job has left the LoadLeveler job queue and you want LoadLeveler to restart your executable from an existing checkpoint file.	1. Add the following option to your job command file: • **restart_from_ckpt = yes** 2. On AIX, specify the name of the checkpoint file by setting the following job command file keywords to specify the directory and file name of the checkpoint file to be used: • **ckpt_dir** • **ckpt_file** When the job command file is submitted, a new job will be started that uses the specified checkpoint file to restart the previously checkpointed job. The job command file which was used to submit the original job should be used to restart from checkpoint. The only modifications to this file should be the addition of **restart_from_ckpt = yes** and ensuring **ckpt_dir** and **ckpt_file** point to the appropriate checkpoint file.
Your job has successfully checkpointed. The job has been vacated and remains on the LoadLeveler job queue.	When the job restarts, if a checkpoint file is available, the job will be restarted from that file. If a checkpoint file is not available upon restart, the job will be started from the beginning.

Preparing a job for preemption

Depending on various configuration options, LoadLeveler may preempt your job so that a higher priority job step can run.

Administrators may:
- Configure LoadLeveler or external schedulers to preempt jobs through various methods.
- Specify preemption rules for job classes.
- Manually preempt your job using LoadLeveler interfaces.

To ensure that your job can be resumed after preemption, set the **restart** keyword in the job command file to **yes**.

Submitting a job command file

After building a job command file, you can submit it for processing either to a machine in the LoadLeveler cluster or one outside of the cluster.

See “Querying multiple LoadLeveler clusters” on page 71 for information on submitting a job to a machine outside the cluster. You can submit a job command file either by using the GUI or the **llsubmit** command.

When you submit a job, LoadLeveler assigns a job identifier and one or more step identifiers.

The LoadLeveler job identifier consists of the following:

machine name
The name of the machine which assigned the job identifier.

jobid A number given to a group of job steps that were initiated from the same job command file.

The LoadLeveler step identifier consists of the following:

job identifier
The job identifier.

stepid A number that is unique for every job step in the job you submit.

If a job command file contains multiple job steps, every job step will have the same jobid and a unique stepid.

For an example of submitting a job, see Chapter 10, "Example: Using commands to build, submit, and manage jobs," on page 235.

In a multicluster environment, job and step identifiers are assigned by the local cluster and are retained by the job regardless of what cluster the job runs in.

Submitting a job using a submit-only machine

You can submit jobs from submit-only machines.

Submit-only machines allow machines that do not run LoadLeveler daemons to submit jobs to the cluster. You can submit a job using either the submit-only version of the GUI or the **llsubmit** command.

To install submit-only LoadLeveler, follow the procedure in the *TWS LoadLeveler: Installation Guide*.

In addition to allowing you to submit jobs, the submit-only feature allows you to cancel and query jobs from a submit-only machine.

Working with parallel jobs

LoadLeveler allows you to schedule parallel batch jobs.

LoadLeveler allows you to schedule parallel batch jobs that have been written using the following:

- On AIX and Linux:
  - IBM Parallel Environment (PE)
  - MPICH, which is an open-source, portable implementation of the Message-Passing Interface Standard developed by Argonne National Laboratory
  - MPICH-GM, which is a port of MPICH on top of Myrinet GM code
- On Linux:
  - MVAPICH, which is a high performance implementation of MPI-1 over InfiniBand based on MPICH support for PE is available in this release of LoadLeveler for Linux

Step for controlling whether LoadLeveler copies environment variables to all executing nodes

You may specify that LoadLeveler is to copy, either to all executing nodes or to only the master executing node, the environment variables that are specified in the environment job command file statement for a parallel job.

Before you begin: You need to know:

- Whether Parallel Environment (PE) will be used to run the parallel job; if so, then LoadLeveler does not have to copy the application environment to the executing nodes.
- How to correctly specify the **env_copy** keyword. For information about keyword syntax and other details, see the env_copy keyword description.
- To specify whether LoadLeveler is to copy environment variables to only the master node, or to all executing nodes, use the **#@ env_copy** keyword in the job command file.

Ensuring that parallel jobs in a cluster run on the correct levels of PE and LoadLeveler software

If support for parallel POE jobs is required, users must be aware that when LoadLeveler uses Parallel Environment for parallel job submission, that the PE software requires the same level of PE to be used throughout the parallel job.

Different levels of PE cannot be mixed. For example, PE 5.1 supports only LoadLeveler 3.5, and PE 4.3 only supports LoadLeveler 3.4.3. Therefore, a POE parallel job cannot run some of its tasks on LoadLeveler 3.4.3 machines and the remaining tasks on LoadLeveler 3.5 machines.

The **requirements** keyword of the job command file can be used to ensure that all the tasks of a POE job run on compatible levels of PE and LoadLeveler software in a cluster. Here are three examples showing different ways this can be done:

1. If the following requirements statement is included in the job command file, LoadLeveler's central manager will select only 3.5 or higher machines with the appropriate OpSys level for this job step.

   ```
   # @ requirements = (LL_Version >= "3.5") && (OpSys == "AIX53")
   ```

2. If a requirements statement such as the following is specified, the tasks of a POE job will see a consistent environment when ″hostname1″ and ″hostname2″ run the same levels of PE and LoadLeveler software.

   ```
   # @ requirements = (Machine == { "hostname1" "hostname2" }) && (OpSys == "AIX53")
   ```

3. If the mixed cluster has been partitioned into 3.4.3 and 3.5 LoadLeveler pools, then you may use a requirements statement similar to one of the two following statements to select machines running the same levels of software.

   - `# @ requirements = (Pool == 35) && (OpSys == "AIX53")`
   - `# @ requirements = (Pool == 343) && (OpSys == "AIX53")`

   Here, it is assumed that all the 3.4.3 machines in this mixed cluster are assigned to pool 343 and all 3.5 machines are assigned to pool 35. A LoadLeveler administrator can use the **pool_list** keyword of the machine stanza of the LoadLeveler administration file to assign machines to pools.

If a statement such as `# @ executable = /bin/poe` is specified in a job command file, and if the job is intended to be run on 3.5 machines, then it is important that the job be submitted from a 3.5 machine. When the ″executable″ keyword is used, LoadLeveler will copy the associated binary on the submitting machine and send it

to a running machine for execution. In this example, the POE program will fail if the submitting and the running machines are at different software levels. In a mixed cluster, this problem can be circumvented by not using the **executable** keyword in the job command file. By omitting this keyword, the job command file itself is the shell script that will be executed. If this script invokes a local version of the POE binary then there is no compatibility problem at run time.

Task-assignment considerations

You can use the keywords to specify how LoadLeveler assigns tasks to nodes.

You can use the keywords listed in Table 44 to specify how LoadLeveler assigns tasks to nodes. With the exception of unlimited blocking, each of these methods prioritizes machines in an order based on their **MACHPRIO** expressions. Various task assignment keywords can be used in combination, and others are mutually exclusive.

Table 44. Valid combinations of task assignment keywords are listed in each column

Keyword	Valid Combinations				
total_tasks	X	X			
tasks_per_node			X	X	
node = <min, max>			X		
node = <number>	X			X	
task_geometry					X
blocking		X			

The following examples show how each allocation method works. For each example, consider a 3-node SP with machines named ″N1,″ ″N2,″ and ″N3″. The machines' order of priority, according to the values of their MACHPRIO expressions, is: N1, N2, N3. N1 has 4 initiators available, N2 has 6, and N3 has 8.

node and total_tasks

When you specify the **node** keyword with the **total_tasks** keyword, the assignment function will allocate all of the tasks in the job step evenly among however many nodes you have specified.

If the number of **total_tasks** is not evenly divisible by the number of nodes, then the assignment function will assign any larger groups to the first nodes on the list that can accept them. In this example, 14 tasks must be allocated among 3 nodes:

```
# @ node=3
# @ total_tasks=14
```

Table 45 shows the machine, available initiators, and assigned tasks:

Table 45. node and total_tasks

Machine	Available Initiators	Assigned Tasks
N1	4	4
N2	6	5
N3	8	5

The assignment function divides the 14 tasks into groups of 5, 5, and 4, and begins at the top of the list, to assign the first group of 5. The assignment function starts

at N1, but because there are only 4 available initiators, cannot assign a block of 5 tasks. Instead, the function moves down the list and assigns the two groups of 5 to N2 and N3, the assignment function then goes back and assigns the group of 4 tasks to N1.

node and tasks_per_node

When you specify the node keyword with the **tasks_per_node** keyword, the assignment function will assign tasks in groups of the specified value among the specified number of nodes.

```
# @ node = 3
# @ tasks_per_node = 4
```

blocking

When you specify blocking, tasks are allocated to machines in groups (blocks) of the specified number (blocking factor).

The assignment function will assign one block at a time to the machine which is next in the order of priority until all of the tasks have been assigned. If the total number of tasks are not evenly divisible by the blocking factor, the remainder of tasks are allocated to a single node. The blocking keyword must be specified with the total_tasks keyword. For example:

```
# @ blocking = 4
# @ total_tasks = 17
```

Where **blocking** specifies that a job's tasks will be assigned in blocks, and **4** designates the size of the blocks. Table 46 shows how a blocking factor of 4 would work with 17 tasks:

Table 46. Blocking

Machine	Available Initiators	Assigned Tasks
N1	4	4
N2	6	5
N3	8	8

The assignment function first determines that there will be 4 blocks of 4 tasks, with a remainder of one task. Therefore, the function will allocate the remainder with the first block that it can. N1 gets a block of four tasks, N2 gets a block, plus the remainder, then N3 gets a block. The assignment function begins again at the top of the priority list, and N3 is the only node with enough initiators available, so N3 ends up with the last block.

unlimited blocking

When you specify unlimited blocking, the assignment function will allocate as many jobs as possible to each node; the function prioritizes nodes primarily by how many initiators each node has available, and secondarily on their MACHPRIO expressions.

This method allows you to allocate tasks among as few nodes as possible. To specify unlimited blocking, specify ″unlimited″ as the value for the blocking keyword. The **total_tasks** keyword must also be specified with unlimited blocking. For example:

```
# @ blocking = unlimited
# @ total_tasks = 17
```

Table 47 on page 198 lists the machine, available initiators, and assigned tasks for unlimited blocking:

Table 47. Unlimited blocking

Machine	Available Initiators	Assigned Tasks
N3	8	8
N2	6	6
N1	4	3

The assignment function begins with N3 (because N3 has the most initiators available), and assigns 8 tasks, N2 takes six, and N1 takes the remaining 3.

task_geometry

The **task_geometry** keyword allows you to specify which tasks run together on the same machines, although you cannot specify which machines.

In this example, the **task_geometry** keyword groups 7 tasks to run on 3 nodes:

```
# @ task_geometry = {(5,2)(1,3)(4,6,0)}
```

The entire **task_geometry** expression must be enclosed within braces. The task IDs for each node must be enclosed within parenthesis, and must be separated by commas. The entire range of task IDs that you specify must begin with zero, and must end with the task ID which is one less than the total number of tasks. You can specify the task IDs in any order, but you cannot skip numbers (the range of task IDs must be complete). Commas may only appear between task IDs, and spaces may only appear between nodes and task IDs.

Submitting jobs that use striping

When communication between parallel tasks occurs only over a single device such as en0, the application and the device are gated by each other.

The device must wait for the application to fill a communication buffer before it transmits the buffer and the application must wait for the device to transmit and empty the buffer before it can refill the buffer. Thus the application and the device must wait for each other and this wastes time.

The technique of striping refers to using two or more communication paths to implement a single communication path as perceived by the application. As the application sends data, it fills up a buffer on one device. As that buffer is transmitted over the first device, the application's data begins filling up a second buffer and the application perceives no delay in being able to write. When the second buffer is full, it begins transmission over the second device and the application moves on to the next device. When all devices have been used, the application returns to the first device. Much, if not all of the buffer on the first device has been transmitted while the application wrote to the buffers on the other devices so the application waits for a minimal amount of time or possibly does not wait at all.

LoadLeveler supports striping in two ways. When multiple switch planes or networks are present, striping over them is indicated by requesting **sn_all** (multiple networks).

If multiple adapters are present on the same network and the communication subsystem, such as LAPI, supports striping over multiple adapters on the same network, specifying the **instances** keyword on the network statement requests striping over adapters on the same network. The **instances** keyword specifies the number of adapters on a single network to stripe on. It is possible to stripe over

multiple networks and over multiple adapters on each network by specifying both **sn_all** and a value for **instances** greater than one. For HPS adapters, only machines that are connected to both networks are considered for **sn_all** jobs.

- **User space striping:** When **sn_all** is specified on a network statement with **US** mode, LoadLeveler commits an equivalent set of adapter resources (adapter windows and memory) on each of the networks present in the system to the job on each node where the job runs. The communication subsystem is initialized to indicate that it should use the user space communication protocol on all the available switch adapters to service communication requests on behalf of the application.
- **IP striping:** When the **sn_all** device is specified on a network statement with the **IP** mode, LoadLeveler attempts to locate the striped IP address associated with the switch adapters, known as the multi-link address. If it is successful, it passes the multi-link address to POE for use. If multi-link addresses are not available, LoadLeveler instructs POE to use the IP address of one of the switch adapters. The IP address that is used is different each time a choice has to be made in an attempt to balance the adapter use. Multi-link addresses must be configured on the system prior to running LoadLeveler and they are specified with the **multilink_address** keyword on the switch adapter stanza in the administration file. If a multi-link address is specified for a node, LoadLeveler assigns the multi-link address and multi-link IP name to the striping adapter on that node. If a multi-link address is not present on a node, the **sn_all** adapter associated with the node will not have an IP address or IP name. If not all of the nodes of a system have multi-link addresses but some do, LoadLeveler will only dispatch jobs that request IP striping to nodes that have multi-link addresses.

  Jobs that request striping (both user space and IP) can be submitted to nodes with only one switch adapter. In that situation, the result is the same as if the job requested no striping.

  Note: When configured, a multi-link address is associated with the virtual **ml0** device. The IP address of this device is the multi-link address. The **llextRPD** program will create a stanza for the **ml0** device that will appear similar to Ethernet or token ring adapter stanzas except that it will include the **multilink_list** keyword that lists the adapters it performs striping over. As with any other device with an IP address, the **ml0** device can be requested in IP mode on the network statement. Doing so would yield a comparable effect to requesting **sn_all** IP except that no checking would be performed by LoadLeveler to ensure the associated adapters are actually working. Thus it would be possible to dispatch a job that requested communication over **ml0** only to have the job fail because the switch adapters that **ml0** stripes over were down.
- **Striping over one network:** If the **instances** keyword is specified on a network statement with a value greater than one, LoadLeveler allocates multiple sets of resources for the protocol using as many sets as the **instances** keyword specified. For User Space jobs, these sets are adapter windows and memory. For IP jobs, these sets are IP addresses. If multiple adapters exist on each node on the same network, then these sets of adapter resources will be distributed among all the available adapters on the same network. Even though LoadLeveler will allocate resources to support striping over a single network, the communication subsystem must be capable of exploiting these resources in order for them to be used.

Understanding striping over multiple networks

Striping over multiple networks involves establishing a communication path using one or more of the available communication networks or switch fabrics.

How those paths are established depends on the network adapter that is present. For the SP Switch2 family of adapters, it is not necessary to acquire communication paths among all tasks on all fabrics as long as there is at least one fabric over which all tasks can communicate. However, each adapter on a machine, if it is available, must use exactly the same adapter resources (window and memory amount) as the other adapters on that machine. Switch Network Interface for HPS adapters are not required to use exactly the same resources on each network, but in order for a machine to be selected, there must be an available communication path on all networks.

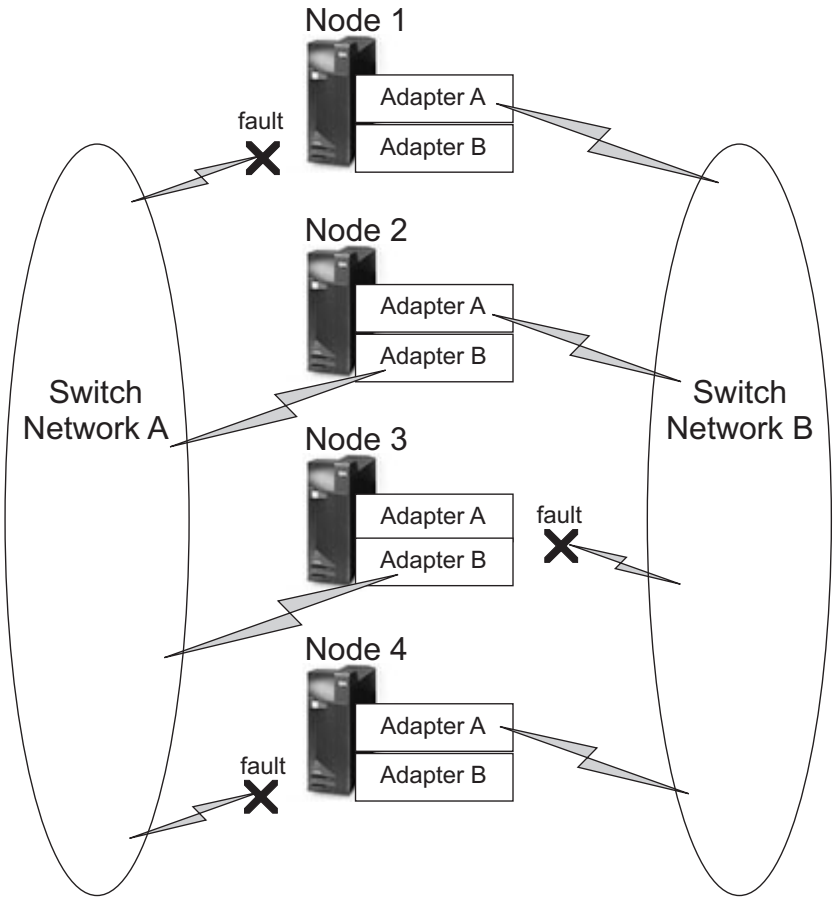

Figure 24. Striping over multiple networks

Consider these sample scenarios using the network configuration as shown in Figure 24 where the adapters are from the SP Switch2 family:

- If a three node job requests striping over networks, it will be dispatched to Node 1, Node 2 and Node 4 where it can communicate on Network B as long as the adapters on each machine have a common window free and sufficient memory available. It cannot run on Node 3 because that node only has a common communication path with Node 2, namely Network A.
- If a three node job does not request striping, it will not be run because there are not enough adapters connected to Network A to run the job. Notice both the adapter connected to Network A on Node 1 and the adapter connected to Network A on Node 4 are both at fault. SP Switch2 family adapters can only use the adapter connected to Network A for non-striped communication.

- If a three node job requests striped IP and some but not all of the nodes have multi-linked addresses, the job will only be dispatched to the nodes that have the multi-link addresses.

Consider these sample scenarios using the network configuration as shown in Figure 24 on page 200 where the adapters are Switch Network Interface for HPS adapters:

- If a three node job requests striping over networks, it will not be dispatched because there are not three nodes that have active connections to both networks.
- If a three node job does not request striping, it can be run on Node 1, Node 2, and Node 4 because they have an active connection to network B.
- If a three node job requests striped IP and some but not all of the nodes have multi-linked addresses, the job will only be dispatched to the nodes that have the multi-link addresses.

Note that for all adapter types, adapters are allocated to a step that requests striping based on what the node knows is the available set of networks or fabrics. LoadLeveler expects each node to have the same knowledge about available networks. If this is not true, it is possible for tasks of a step to be assigned adapters which cannot communicate with tasks on other nodes.

Similarly, LoadLeveler expects all adapters that are identified as being on the same Network ID or fabric ID to be able to communicate with each other. If this is not true, such as when LoadLeveler operates with multiple, independent sets of networks, other attributes of the Step, such as the requirements expression, must be used to ensure that only nodes from a single network set are considered for the step.

As you can see from these scenarios, LoadLeveler will find enough nodes on the same communication path to run the job. If enough nodes connected to a common communication path cannot be found, no communication can take place and the job will not run.

Understanding striping over a single network

Striping over a single network is only supported by Switch Network Interface for HPS adapters.

Figure 25 on page 202 shows a network configuration where the adapters support striping over a single network.

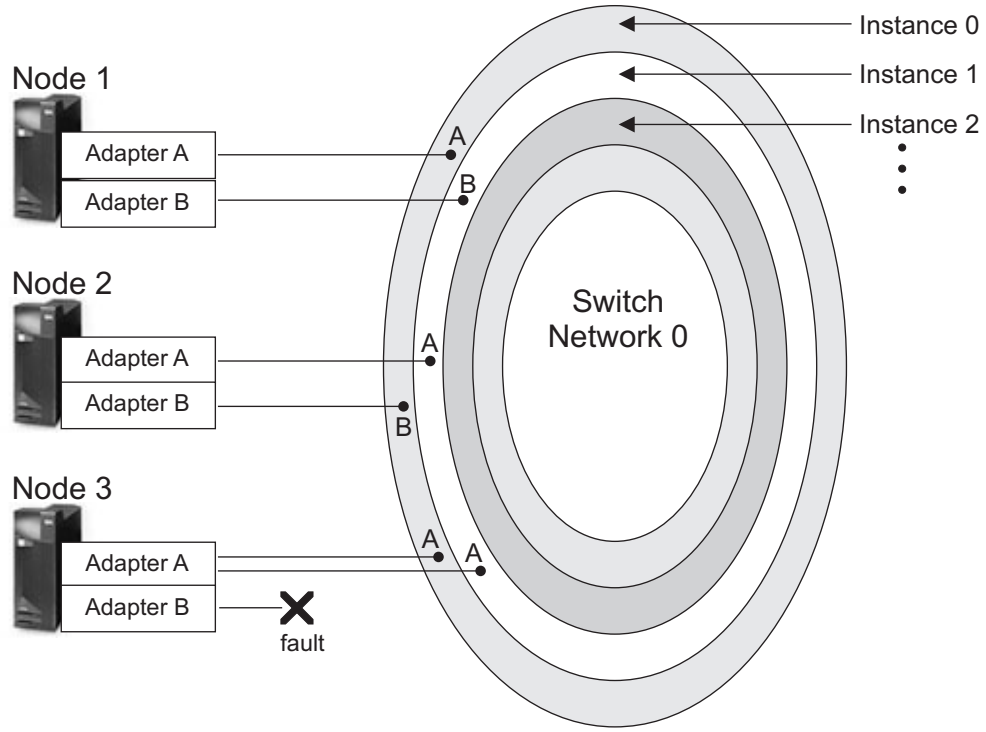

Figure 25. Striping over a single network

Both Adapter A and Adapter B on a node are connected to Network 0. The entire oval represents the physical network and the concentric ovals (shaded differently) represent the separate communication paths created for a job by the **instances** keyword on the network statement. In this case a three node job requests two instances for communication. On Node 1, adapter A is used for instance 0 and adapter B is used for instance 1. There is no requirement to use the same adapter for the same instance so on Node 2, adapter B was used for instance 0 and adapter A for instance 1.

On Node 3, where a fault is keeping adapter B from connecting to the network, adapter A is used for both instance 0 and instance 1 and Node 3 is available for the job to use.

The network itself does not impose any limitation on the total number of communication paths that can be active at a given time for either a single job or all the jobs using the network. As long as nodes with adapter resources are available, additional communication paths can be created.

Examples: Requesting striping in network statements

You request that a job be run using striping with the **network** statement in your job command file.

The default when instances is not specified for a job in the **network** statement is controlled by the class stanza keyword for **sn_all**. For more information on the **network** and **max_protocol_instances** statements, see the keyword descriptions in "Job command file keyword descriptions" on page 359.

Shown here are examples of IP and user space network modes:

- **Example 1: Requesting striping using IP mode**

  To submit a job using IP striping, your network statement would look like this:

```
network.MPI = sn_all,,IP
```

- **Example 2: Requesting striping using user space mode**

  To submit a job using user space striping, your network statement would look like this:

  ```
  network.MPI = sn_all,,US
  ```

- **Example 3: Requesting striping over a single network**

  To request IP striping over multiple adapter on a single network, the network statement would look like this:

  ```
  network.MPI = sn_single,,IP,,instances=2
  ```

  If the nodes on which the job runs have two or more adapters on the same network, two different IP addresses will be allocated to each task for MPI communication. If only one adapter exists per network, the same IP address will be used twice for each task for MPI communication.

- **Example 4: Requesting striping over multiple networks and multiple adapters on the same network**

  To submit a user space job that will stripe MPI communication over multiple adapters on all networks present in the system the network statement would look like this:

  ```
  network.MPI = sn_all,,US,,instances=2
  ```

  If, on a node where the job runs, there are two adapters on each of the two networks, one adapter window would be allocated from each adapter for MPI communication by the job. If only one network were present with two adapters, one adapter window from each of the two adapters would be used. If two networks were present but each only had one adapter on it, two adapter windows from each adapter would be used to satisfy the request for two instances.

Running interactive POE jobs

POE will accept LoadLeveler job command files

However, you can still set the following environment variables to define specific LoadLeveler job attributes before running an interactive POE job:

LOADL_ACCOUNT_NO
: The account number associated with the job.

LOADL_INTERACTIVE_CLASS
: The class to which the job is assigned.

MP_TASK_AFFINITY
: The affinity preferences requested for the job.

For information on other POE environment variables, see *IBM Parallel Environment for AIX and Linux: Operation and Use, Volume 1*.

For an interactive POE job, LoadLeveler does not start the POE process therefore LoadLeveler has no control over the process environment or resource limits.

You also may run interactive POE jobs under a reservation. For additional details about reservations and submitting jobs to run under them, see “Working with reservations” on page 213.

Interactive POE jobs cannot be submitted to a remote cluster.

Running MPICH, MVAPICH, and MPICH-GM jobs

LoadLeveler for AIX andLoadLeveler for Linux support three open-source implementations of the Message-Passing Interface (MPI).

MPICH is an open-source, portable implementation of the MPI Standard developed by Argonne National Laboratory. It contains a complete implementation of version 1.2 of the MPI Standard and also significant parts of MPI-2, particularly in the area of parallel I/O. MPICH, MVAPICH, and MPICH-GM are the three MPI implementations supported by LoadLeveler for AIX and LoadLeveler for Linux:

- Additional documentation for MPICH is available from the Argonne National Laboratory web site at:

  http://www-unix.mcs.anl.gov/mpi/mpich1/
- MVAPICH is a high performance implementation of MPI-1 over InfiniBand based on MPICH. Additional documentation for MVAPICH is available at the Ohio State University Web site at:

  http://mvapich.cse.ohio-state.edu/
- MPICH-GM is a port of MPICH on top of GM (ch_gm). GM is a low-level message-passing system for Myrinet Networks. Additional documentation for MPICH-GM is available from the Myrinet web site at:

  http://www.myri.com/scs/

For either MPICH, MVAPICH, or MPICH-GM, LoadLeveler allocates the machines to run the parallel job and starts the implementation specific script as master task. Some of the options of implementation specific scripts might not be required or are not supported when used with LoadLeveler.

The following standard **mpirun** script options are not supported:

-map <*list*>
: The **mpirun** script can either take a **machinefile** or a mapping of the machines in which to run the **mpirun** job. If both the **machinefile** and **map** are specified, then the map list overrides the **machinefile**. Because we want LoadLeveler to decide which nodes to run on, use the **machinefile** specified by the environment variable **LOADL_HOSTFILE**. Specifying a mapping of the host name is not supported.

-allcpus
: This option is *only* supported when the **-machinefile** option is used. The **mpirun** script will run the job using all machines specified in the machine file, without the need to specify the **-np** option. Without specifying **machinefile**, the **mpirun** script will look in the default machines <arch> file to find the machines on which to run the job. The machines defined in the default file might not match what LoadLeveler has selected, which will cause the job to be removed.

-exclude <*list*>
: This option is not supported because if you specified a machine in the exclude list that has already been scheduled by LoadLeveler to run the job, the job will be removed.

-dbg
: This option might be used to select a debugger. This option is used to select a debugger to be used with the **mpirun** script. LoadLeveler currently does not support running interactive MPICH jobs, so starting **mpirun** jobs under a debugger is not supported.

-ksq
This option keeps the send queue. This is useful if you expect later to attach totalview to the running (or deadlocked) job, and want to see the send queues. This option is used for debugging purposes when attaching the **mpirun** job to totalview. Since we do not support running debuggers under LoadLeveler MPICH job management, this option is not supported.

-machinedir <*directory***>**
This option looks for the machine files in the indicated directory. LoadLeveler will create a **machinefile** that contains the host name for each task in the **mpirun** job. The environment variable **LOADL_HOSTFILE** contains the full path to the **machinefile**. A different **machinefile** is created per job and stored in the LoadLeveler execute directory. Because there might be multiple jobs running at one time, we do not want the **mpirun** script to choose any file in the execute directory because it might not be the correct file that the central manager has assigned to the job step. This option is therefore not supported, use the **-machinefile** option instead.

- When using MPICH, the **mpirun** script is run on the first machine allocated to the job. The **mpirun** script starts the actual execution of the parallel tasks on the other nodes included in the LoadLeveler cluster using **llspawn.stdio** as **RSHCOMMAND**.

  The following option of MPICHs **mpirun** script is not supported.

  -nolocal
  This option specifies not to run on the local machine. The default behavior of MPICH (p4) is that the first MPI process is always spawned on the machine which **mpirun** has invoked. The **-nolocal** option disables the default behavior and does not run the MPI process on the local node. Under LoadLeveler's MPICH Job management, it is required that at least one task is run on the local node, so the **-nolocal** option should *not* be used.

- When using MVAPICH, the **mpirun_rsh** command is run on the first machine allocated to the job as master task. The **mpirun_rsh** command starts the actual execution of parallel tasks on the other nodes included in the LoadLeveler cluster using **llspawn** as **RSHCOMMAND**.

  The following options of MVAPICHs **mpirun_rsh** command are not supported when used with LoadLeveler.

  -rsh
  Specifies to use **rsh** for connecting.

  -ssh
  Specifies to use **ssh** for connecting. The **-rsh** and **-ssh** options are supported, but the behavior has been changed to run **mpirun_rsh** jobs under LoadLeveler MPICH job manager. Replace the **-rsh** and **-ssh** commands with **llspawn** before compiling **mpirun_rsh**. Even if you select **-rsh** and **-ssh**, the **llspawn** command is actually used in place of **-rsh** and **-ssh** at runtime.

  -xterm
  Runs remote processes under **xterm**. This option starts an xterm window for each task in the **mpirun** job and runs the remote shell with the application inside the xterm window. This will not work under LoadLeveler because the **llspawn** command replaces the remote shell (**rsh** or **ssh**) and **llspawn** is not kept alive to the end of the application process.

  -debug
  Runs each process under the control of gdb. This option is used to select a debugger to be used with **mpirun** jobs. LoadLeveler currently does not support running interactive MPICH jobs so starting **mpirun** jobs under a

debugger is not supported. This option also requires xterm to be working properly as it opens gdb under an xterm window. Since we do not support the **-xterm** option, the **-debug** option is also not supported.

h*1* **h***2***....**
Specifies the names of hosts where processes should run. The **mpirun_rsh** script can either take a host file or read in the names of the hosts, *h1 h2* and so on, in which to run the **mpirun** job. If both host file and list of machines are specified in the **mpirun_rsh** arguments, **mpirun_rsh** will have an error parsing the arguments. Because we want LoadLeveler to decide which nodes to run on, you should use the host list specified by the environment variable **LOADL_HOSTFILE**. Specifying the names of the hosts is not supported.

- When using MPICH-GM, the **mpirun.ch_gm** script is run on the first machine allocated to the job as master task. The **mpirun.ch_gm** script starts the actual execution of the parallel tasks on the other nodes included in the LoadLeveler cluster using the **llspawn** command as **RSHCOMMAND**.

  The following options of MPICH-GMs **mpirun** script are not supported when used with LoadLeveler.

  --gm-kill <*n***>**
  This is an option that allows you to kill all remaining processes <*n*> seconds after the first one dies or exits. Do not specify this option when running the application under LoadLeveler, because LoadLeveler will handle the cleanup of the tasks.

  --gm-tree-spawn
  This is an option that uses a two-level spawn tree to launch the processes in an effort to reduce the load on any particular host. Because LoadLeveler is providing its own scalable method for spawning the application tasks from the master host, using the **llspawn** command, spawning processes in a tree-like fashion is not supported.

  -totalview
  This option is used to select a totalview debugging session to be used with the **mpirun** script. LoadLeveler currently does not support running interactive MPICH jobs, so starting **mpirun** jobs under a debugger is not supported.

  -r This is an optional option for MPICH-GM, which forces the removal of the shared memory files. Because this option is not required, it is not supported. If you specify this option, it will be ignored.

  -ddt
  This option is used to select a DDT debugging session to be used with the **mpirun** script. LoadLeveler currently does not support running interactive MPICH jobs, so starting **mpirun** jobs under a debugger is not supported.

Sample programs are available:

- See “MPICH sample job command file” on page 208 for a sample MPICH job command file.
- See “MPICH-GM sample job command file” on page 209 for a sample MPICH-GM job command file.
- See “MVAPICH sample job command file” on page 211 for a sample MVAPICH job command file.
- The LoadLeveler samples directory also contains sample files:
  - On AIX, use directory `/usr/lpp/LoadL/full/samples/llmpich`
  - On Linux, use directory `/opt/ibmll/LoadL/full/samples/llmpich`

These sample files include:
– `ivp.c`: A simple MPI application that you may run as an MPICH, MVAPICH, or MPICH-GM job.
– Job command files to run the `ivp.c` program as a batch job:
  - For MPICH: `mpich_ivp.cmd`
  - For MPICH-GM: `mpich_gm_ivp.cmd`

Examples: Building parallel job command files

This topic contains sample job command files for several parallel environments.

This topic contains sample job command files for the following parallel environments:
- IBM AIX Parallel Operating Environment (POE)
- MPICH
- MPICH-GM
- MVAPICH

POE sample job command file

This is a sample job command file for POE.

Figure 26 is a sample job command file for POE.

```
#
# @ job_type = parallel
# @ environment = COPY_ALL
# @ output = poe.out
# @ error = poe.error
# @ node = 8,10
# @ tasks_per_node = 2
# @ network.LAPI = sn_all,US,,instances=1
# @ network.MPI = sn_all,US,,instances=1
# @ wall_clock_limit = 60
# @ executable = /usr/bin/poe
# @ arguments = /u/richc/My_POE_program -euilib "us"
# @ class = POE
# @ queue
```

Figure 26. POE job command file – multiple tasks per node

Figure 26 shows the following:
- The total number of nodes requested is a minimum of eight and a maximum of 10 (**node=8,10**). Two tasks run on each node (**tasks_per_node=2**). Thus the total number of tasks can range from 16 to 20.
- Each task of the job will run using the LAPI protocol in US mode with a switch adapter (**network.LAPI=sn_all,US,,instances=1**), and using the MPI protocol in US mode with a switch adapter (**network.MPI=sn_all,US,,instances=1**).
- The maximum run time allowed for the job is 60 seconds (**wall_clock_limit=60**).

Figure 27 on page 208 is a second sample job command file for POE

```
#
# @ job_type = parallel
# @ input = poe.in.1
# @ output = poe.out.1
# @ error = poe.err
# @ node = 2,8
# @ network.MPI = sn_single,shared,IP
# @ wall_clock_limit = 60
# @ class = POE
# @ queue
/usr/bin/poe /u/richc/my_POE_setup_program -infolevel 2
/usr/bin/poe /u/richc/my_POE_main_program -infolevel 2
```

Figure 27. POE sample job command file – invoking POE twice

Figure 27 shows the following:

- POE is invoked twice, through **my_POE_setup_program** and **my_POE_main_program**.
- The job requests a minimum of two nodes and a maximum of eight nodes (**node=2,8**).
- The job by default runs one task per node.
- The job uses the MPI protocol with a switch adapter in IP mode (**network.MPI=sn_single,shared,IP**).
- The maximum run time allowed for the job is 60 seconds (**wall_clock_limit=60**).

MPICH sample job command file

This is a sample job command file for MPICH.

Figure 28 is a sample job command file for MPICH.

```
# ! /bin/ksh
# LoadLeveler JCF file for running an MPICH job
# @ job_type = MPICH
# @ node = 4
# @ tasks_per_node = 2
# @ output = mpich_test.$(cluster).$(process).out
# @ error = mpich_test.$(cluster).$(process).err
# @ queue
echo "----------------------------------------------------------"
echo LOADL_STEP_ID=$LOADL_STEP_ID
echo "----------------------------------------------------------"

/opt/mpich/bin/mpirun -np $LOADL_TOTAL_TASKS -machinefile \
 $LOADL_HOSTFILE /common/NFS/ll_bin/mpich_test
```

Figure 28. MPICH job command file - sample 1

Note: You can also specify the **job_type=parallel** keyword and invoke the **mpirun** script to run an MPICH job. In that case, the **mpirun** script would use **rsh** or **ssh** and not the **llspawn** command.

Figure 28 shows that in the following job command file statement:

```
/opt/mpich/bin/mpirun -np $LOADL_TOTAL_TASKS -machinefile \
$LOADL_HOSTFILE /common/NFS/ll_bin/mpich_test
```

-np
Specifies the number of parallel processes.

LOADL_TOTAL_TASKS
Is the environment variable set by LoadLeveler with the number of parallel processes of the job step.

-machinefile
Specifies the machine list file.

LOADL_HOSTFILE
Is the environment variable set by LoadLeveler with the file name that contains host names assigned to the parallel job step.

The following is another example of a MPICH job command file:

```
# ! /bin/ksh
# LoadLeveler JCF file for running an MPICH job
# @ job_type = MPICH
# @ node = 4
# @ tasks_per_node = 2
# @ output = mpich_test.$(cluster).$(process).out
# @ error = mpich_test.$(cluster).$(process).err
# @ executable = /opt/mpich/bin/mpirun
# @ arguments = -np $LOADL_TOTAL_TASKS -machinefile \
 $LOADL_HOSTFILE /common/NFS/ll_bin/mpich_test
# @ queue
```

Figure 29. MPICH job command file - sample 2

Figure 29 shows the following:

- The **mpirun** script is specified as a value of the executable job command file keyword.
- The following **mpirun** script arguments are specified with the arguments job command file keyword:

  -np $LOADL_TOTAL_TASKS -machinefile $LOADL_HOSTFILE /common/NFS/ll_bin/mpich_test

  -np
  Specifies the number of parallel processes.

  LOADL_TOTAL_TASKS
  Is the environment variable set by LoadLeveler with the number of parallel processes of the job step.

  -machinefile
  Specifies the machine list file.

  LOADL_HOSTFILE
  Is the environment variable set by LoadLeveler with file name, which contains host names assigned to the parallel job step.

MPICH-GM sample job command file

This is a sample job command file for MPICH-GM.

Figure 30 on page 210 is a sample job command file for MPICH-GM.

```
#! /bin/ksh
# LoadLeveler JCF file for running an MPICH-GM job
# @ job_type = MPICH
# @ resources = gmports(1)
# @ node = 4
# @ tasks_per_node = 2
# @ output = mpich_gm_test.$(cluster).$(process).out
# @ error = mpich_gm_test.$(cluster).$(process).err
# @ queue
echo "------------------------------------------------------------"
echo LOADL_STEP_ID=$LOADL_STEP_ID
echo "------------------------------------------------------------"
/opt/mpich/bin/mpirun.ch_gm -np $LOADL_TOTAL_TASKS -machinefile \
$LOADL_HOSTFILE /common/NFS/ll_bin/mpich_gm_test
```

Figure 30. MPICH-GM job command file - sample 1

Figure 30 shows the following:

- The statement **# @ resources = gmports(1)** specifies that each task consumes one GM port. This is how LoadLeveler limits the number of GM ports simultaneously in use on any machine. This resource name is the name you specified in **schedule_by_resources** in the configuration file and each machine stanza in the administration file must define GM ports and specify the quantity of GM ports available on each machine. Use the **llstatus -R** command to confirm the names and values of the configured and available consumable resources.
- In the following job command file statement:

  ```
  /opt/mpich/bin/mpirun.ch_gm -np $LOADL_TOTAL_TASKS \
    -machinefile $LOADL_HOSTFILE /common/NFS/ll_bin/mpich_gm_test
  ```

  /opt/mpich/bin/mpirun.ch_gm
  Specifies the location of the **mpirun.ch_gm** script shipped with the MPICH-GM implementation that runs the MPICH-GM application.

  -np
  Specifies the number of parallel processes.

  -machinefile
  Specifies the machine list file.

  LOADL_HOSTFILE
  Is the environment variable set by LoadLeveler with file name, which contains host names assigned to the parallel job step.

Figure 31 is another sample job command file for MPICH-GM.

```
#! /bin/ksh
# LoadLeveler JCF file for running an MPICH-GM job
# @ job_type = MPICH
# @ resources = gmports(1)
# @ node = 4
# @ tasks_per_node = 2
# @ output = mpich_gm_test.$(cluster).$(process).out
# @ error = mpich_gm_test.$(cluster).$(process).err
# @ executable = /opt/mpich/bin/mpirun.ch_gm
# @ arguments = -np $LOADL_TOTAL_TASKS -machinefile \
$LOADL_HOSTFILE /common/NFS/ll_bin/mpich_gm_test
# @ queue
```

Figure 31. MPICH-GM job command file - sample 2

Figure 31 shows the following:

- The **mpirun_gm** script is specified as value of the executable job command file keyword.

- The following **mpirun_gm** script arguments are specified with the arguments job command file keyword:

  -np $LOADL_TOTAL_TASKS -machinefile $LOADL_HOSTFILE /common/NFS/ll_bin/mpich_test

  -np
  Specifies the number of parallel processes.

  LOADL_TOTAL_TASKS
  Is the environment variable set by LoadLeveler with the number of parallel processes of the job step.

  -machinefile
  Specifies the machine list file.

  LOADL_HOSTFILE
  Is the environment variable set by LoadLeveler with file name, which contains host names assigned to the parallel job step.

MVAPICH sample job command file

This is a sample job command file for MVAPICH.

Figure 32 is a sample job command file for MVAPICH:

```
# ! /bin/ksh
# LoadLeveler JCF file for running an MVAPICH job
# @ job_type = MPICH
# @ node = 4
# @ tasks_per_node = 2
# @ output = mvapich_test.$(cluster).$(process).out
# @ error = mvapich_test.$(cluster).$(process).err
# @ queue
echo "------------------------------------------------------------"
echo LOADL_STEP_ID=$LOADL_STEP_ID
echo "------------------------------------------------------------"

/opt/mpich/bin/mpirun_rsh -np $LOADL_TOTAL_TASKS -machinefile \
 $LOADL_HOSTFILE /common/NFS/ll_bin/mpich_test
```

Figure 32. MVAPICH job command file - sample 1

Figure 32 shows that in the following job command file statement:

**/opt/mpich/bin/mpirun_rsh -np $LOADL_TOTAL_TASKS -machinefile \
 $LOADL_HOSTFILE /common/NFS/ll_bin/mpich_test**

-np
Specifies the number of parallel processes.

LOADL_TOTAL_TASKS
Is the environment variable set by LoadLeveler with the number of parallel processes of the job step.

-machinefile
Specifies the machine list file.

LOADL_HOSTFILE
Is the environment variable set by LoadLeveler with file name, which contains host names assigned to the parallel job step.

Figure 32 is another sample job command file for MVAPICH:

```
# ! /bin/ksh
# LoadLeveler JCF file for running an MVAPICH job
# @ job_type = MPICH
# @ node = 4
# @ tasks_per_node = 2
# @ output = mvapich_test.$(cluster).$(process).out
# @ error = mvapich_test.$(cluster).$(process).err
# @ executable = /opt/mpich/bin/mpirun_rsh
# @ arguments = -np $LOADL_TOTAL_TASKS -machinefile \
 $LOADL_HOSTFILE /common/NFS/ll_bin/mpich_test
# @ queue
```

Figure 33. MVAPICH job command file - sample 2

Figure 33 shows the following:

- The **mpirun_rsh** command is specified as value for the executable job command file keyword.
- The following **mpirun_rsh** command arguments are specified with the arguments job command file keyword:

  -np $LOADL_TOTAL_TASKS -machinefile $LOADL_HOSTFILE /common/NFS/ll_bin/mpich_test

  -np
  Specifies the number of parallel processes.

  LOADL_TOTAL_TASKS
  Is the environment variable set by LoadLeveler with the number of parallel processes of the job step.

  -machinefile
  Specifies the machine list file.

  LOADL_HOSTFILE
  Is the environment variable set by LoadLeveler with file name, which contains host names assigned to the parallel job step.

Obtaining status of parallel jobs

Both end users and LoadLeveler administrators can obtain status of parallel jobs in the same way as they obtain status of serial jobs – either by using the **llq** command or by viewing the Jobs window on the graphical user interface (GUI).

By issuing **llq -l**, or by using the Job Actions → Details selection in xloadl, users get a list of machines allocated to the parallel job. If you also need to see task instance information use the -x option in addition to the -l option (**llq -l -x**). See "llq - Query job status" on page 479 for samples of output using the -x and -l options with the **llq** command.

Obtaining allocated host names

llq -l output includes information on allocated host names.

Another way to obtain the allocated host names is with the LOADL_PROCESSOR_LIST environment variable, which you can use from a shell script in your job command file as shown in Figure 34 on page 213.

This example uses LOADL_PROCESSOR_LIST to perform a remote copy of a local file to all of the nodes, and then invokes POE. Note that the processor list contains an entry for each task running on a node. If two tasks are running on a node, LOADL_PROCESSOR_LIST will contain two instances of the host name where the tasks are running. The example in Figure 34 on page 213 removes any duplicate entries.

Note that LOADL_PROCESSOR_LIST is set by LoadLeveler, not by the user. This environment variable is limited to 128 hostnames. If the value is greater than the 128 limit, the environment variable is not set.

```
#!/bin/ksh
# @ output     =  my_POE_program.$(cluster).$(process).out
# @ error      =  my_POE_program.$(cluster).$(process).err
# @ class      =  POE
# @ job_type   =  parallel
# @ node = 8,12
# @ network.MPI = sn_single,shared,US
# @ queue

tmp_file="/tmp/node_list"
rm -f $tmp_file

# Copy each entry in the list to a new line in a file so
# that duplicate entries can be removed.
for node in $LOADL_PROCESSOR_LIST
        do
                echo $node >> $tmp_file
        done

# Sort the file removing duplicate entries and save list in variable
nodelist= sort -u /tmp/node_list

for node in $nodelist
        do
                rcp localfile $node:/home/userid
        done

rm -f $tmp_file


/usr/bin/poe /home/userid/my_POE_program
```

Figure 34. Using LOADL_PROCESSOR_LIST in a shell script

Working with reservations

Under the BACKFILL scheduler only, LoadLeveler allows authorized users to make reservations, which specify a time period during which specific node resources are reserved for use by particular users or groups.

Use Table 48 to find information about working with reservations.

Table 48. Roadmap of tasks for reservation owners and users

Subtask	Associated instructions (see . . .)
Learn how reservations work in the LoadLeveler environment	• "Overview of reservations" on page 25 • "Understanding the reservation life cycle" on page 214
Creating new reservations	"Creating new reservations" on page 216
Managing jobs that run under a reservation	• "Submitting jobs to run under a reservation" on page 218 • "Removing bound jobs from the reservation" on page 220
Managing existing reservations	• "Querying existing reservations" on page 221 • "Modifying existing reservations" on page 221 • "Canceling existing reservations" on page 222

Table 48. Roadmap of tasks for reservation owners and users (continued)

Subtask	Associated instructions (see . . .)
Using the LoadLeveler interfaces for reservations	• Chapter 16, "Commands," on page 411 • "Reservation API" on page 643

Understanding the reservation life cycle

From the time at which LoadLeveler creates a reservation through the time the reservation ends or is canceled, a reservation goes through various states, which are indicated in command listings and other displays or output.

Understanding these states is important because the current state of a reservation dictates what actions you can take; for example, if you want to modify the start time for a reservation, you may do so only while the reservation is in Waiting state. Table 49 lists the possible reservation states, their abbreviations, and usage notes.

Table 49. Reservation states, abbreviations, and usage notes

Reservation state	Abbreviation in displays / output	Usage notes
Waiting	W	Reservations are in the Waiting state: 1. When LoadLeveler first creates a reservation. 2. After one occurrence of a recurring reservation ends and before the next occurrence starts. While the reservation is in the Waiting state: • Only administrators and reservation owners may modify, cancel, and add users or groups to the reservation. • Administrators, reservation owners, and users or groups that are allowed to use the reservation may query it, and submit jobs to run during the reservation period.

Table 49. Reservation states, abbreviations, and usage notes (continued)

Reservation state	Abbreviation in displays / output	Usage notes
Setup	S	LoadLeveler changes the state of a reservation from Waiting to Setup just before the start time of the reservation. The actual time at which LoadLeveler places the reservation in Setup state depends on the value set for the **RESERVATION_SETUP_TIME** keyword in the configuration file. While the reservation is in Setup state: • Only administrators and reservation owners may modify, cancel, and add users or groups to the reservation. • Administrators, reservation owners, and users or groups that are allowed to use the reservation may query it, and submit jobs to run during the reservation period. During this setup period, LoadLeveler: • Stops scheduling unbound job steps to reserved nodes. • Preempts any jobs that are still running on the nodes that are reserved through this reservation. To preempt the running jobs, LoadLeveler uses the preemption method specified through the **DEFAULT_PREEMPT_METHOD** keyword in the configuration file. **Note:** The default value for **DEFAULT_PREEMPT_METHOD** is SU (suspend), which is not supported in all environments, and the default value for **PREEMPTION_SUPPORT** is NONE. If you want preemption to take place at the start of the reservation, make sure the cluster is configured for preemption (see "Steps for configuring a scheduler to preempt jobs" on page 130 for more information).
Active	A	At the reservation start time, LoadLeveler changes the reservation state from Setup to Active. It also dispatches only job steps that are bound to the reservation, until the reservation completes or is canceled. LoadLeveler does not dispatch bound job steps that: • Require certain resources, such as floating consumable resources, that are not available during the reservation period. • Have expected end times that exceed the end time of the reservation. By default, LoadLeveler allows such jobs to run, but their completion is subject to resource availability. (An administrator may configure LoadLeveler to prevent such jobs from running.) These bound job steps remain idle unless the required resources become available. While the reservation is in Active state: • Only administrators and reservation owners may modify, cancel, and add users or groups to the reservation. • Administrators, reservation owners, and users or groups that are allowed to use the reservation may query it, and submit jobs to run during the reservation period.

Table 49. Reservation states, abbreviations, and usage notes (continued)

Reservation state	Abbreviation in displays / output	Usage notes
Active_Shared	AS	At the reservation start time, LoadLeveler changes the reservation state from Setup to Active. It also dispatches only job steps that are bound to the reservation, unless the reservation was created with the SHARED mode. In this case, if reserved resources are still available after LoadLeveler dispatches any bound job steps that are eligible to run, LoadLeveler changes the reservation state to Active_Shared, and begins dispatching job steps that are not bound to the reservation. Once the reservation state changes to Active_Shared, it remains in that state until the reservation completes or is canceled. During this time, LoadLeveler dispatches both bound and unbound job steps, pending resource availability; bound job steps are considered before unbound job steps. The conditions under which LoadLeveler will not dispatch bound job steps are the same as those listed in the notes for the Active state. The actions that administrators, reservation owners, and users may perform are the same as those listed in the notes for the Active state.
Canceled	CA	When a reservation owner, administrator, or LoadLeveler issues a request to cancel the reservation, LoadLeveler changes the state of a reservation to Canceled and unbinds any job steps bound to this reservation. When the reservation is in this state, no one can modify or submit jobs to this reservation.
Complete	C	When a reservation end time is reached, LoadLeveler changes the state of a reservation to Complete. When the reservation is in this state, no one can modify or submit jobs to this reservation.

Creating new reservations

You must be an authorized user or member of an authorized group to successfully create a reservation. LoadLeveler administrators define authorized users by adding the **max_reservations** keyword to the user or group stanza in the administration file.

The **max_reservations** keyword setting also defines how many reservations you are allowed to own. Ask your administrator whether you are authorized to create reservations.

To be authorized to create reservations, LoadLeveler administrators also must have the **max_reservations** keyword set in their user or group stanza.

To create a reservation, use the **llmkres** command. Specify the start time of the reservation using the **-t** command option and the duration of the reservation using the **-d** command option. If you are creating a recurring reservation, you must use the **-t** option to specify the schedule for that reservation.

In addition to the start time and duration (or reservation schedule), you must also use one of the following methods to specify how you want to select nodes for the reservation.

Note: These methods are mutually exclusive.

- The **-n** option on the **llmkres** command instructs LoadLeveler to reserve a number of nodes. LoadLeveler may select any unreserved node to satisfy a reservation. This command option is perhaps the easiest to use, because you need to know only how many nodes you want, not specific node characteristics.

  The minimum number of nodes a reservation must have is 1.
- The **-h** option on the **llmkres** command instructs LoadLeveler to reserve specific nodes.
- The **-f** option on the **llmkres** command instructs LoadLeveler to submit the specified job command file, and reserve appropriate nodes for the first job step in the job command file. Through this action, all job steps for the job are bound to the reservation. If the reservation request fails, LoadLeveler changes the state for all job steps for this job to NotQueued, and will not schedule any of those job steps to run.
- The **-j** option on the **llmkres** command instructs LoadLeveler to reserve appropriate nodes for that job step. Through this action, the job step is bound to the reservation. If the reservation request fails, the job step remains in the same state as it was before.
- The **-c** option on the **llmkres** command instructs LoadLeveler to reserve a number of Blue Gene compute nodes (C-nodes). The **-j** and **-f** option also reserve Blue Gene resources if the job type is bluegene.

You also may define other reservation attributes, including:

- Whether additional users or groups are allowed to use the reservation. Use the **-U** or **-G** command options, respectively.
- Whether the reservation will be in one or both of these optional modes:
  - `SHARED` mode: When you use the **-s** command option, LoadLeveler allows reserved resources to be shared by job steps that are not associated with a reservation. This mode enables the efficient use of reserved resources; if the bound job steps do not use all of the reserved resources, LoadLeveler can schedule unbound job steps as well so the resources do not remain idle. Unless you specify this mode, however, only job steps bound to the reservation may use the reserved resources.
  - `REMOVE_ON_IDLE` mode: When you use the **-i** command option, LoadLeveler automatically cancels the reservation when all bound job steps that can run finish running. Using this mode is efficient because it prevents LoadLeveler from wasting reserved resources when no jobs are available to use them. Selecting this mode is especially useful for workloads that will run unattended.
- The default binding method to use when jobs are bound to the reservation. Use the **-m** option to specify whether the soft or firm binding method should be used when the binding method is not specified by the **llbind** command.
  - Soft binding allows the bound job to use resources outside of the reservation.
  - Firm binding restricts the job to the reserved resources.
- For a recurring reservation, when the reservation will expire. Use the **-e** option to specify the expiration date of the recurring reservation.

Additional rules apply to the use of these options; see "llmkres - Make a reservation" on page 459 for details.

Alternative: Use the **ll_make_reservation** and the **ll_init_reservation_param** subroutines in a program.

Tips:

- If your user ID is not authorized to create any type of reservation but you are member of a group with authority to create reservations, you must use the **-g** option to specify the name of the authorized group on the **llmkres** command.
- Only reservations in waiting and in use are counted toward the limit of allowed reservations set through the **max_reservations** keyword. LoadLeveler does not count reservations or recurring reservations that have already ended or are in the process of being canceled.
- For accounting purposes, although recurring reservations have multiple instances, a recurring reservation counts as one reservation no matter how many times it may recur during its reservation period.
- Although you may create more than one reservation or recurring reservation for a particular node or set of nodes, only one of those reservations may be active at a time. If LoadLeveler determines that the reservation you are requesting will overlap with another reservation, LoadLeveler fails the create request. No reservation periods for the same set of machines can overlap.

If the create request is successful, LoadLeveler assigns and returns to the owner a unique reservation identifier, in the form *host*.*rid*.r, where:

host The name of the machine which assigned the reservation identifier.

rid A number assigned to the reservation by LoadLeveler.

r The letter **r** is used to distinguish a reservation identifier from a job step identifier.

The following are examples of reservation identifiers:

```
c94n16.80.r
c94n06.1.r
```

For details about the LoadLeveler interfaces for creating reservations, see:

- "llmkres - Make a reservation" on page 459.
- "ll_make_reservation subroutine" on page 653 and "ll_init_reservation_param subroutine" on page 652.

Submitting jobs to run under a reservation

LoadLeveler administrators, reservation owners, and authorized users may submit jobs to run under a reservation.

You may bind both batch and interactive POE job steps to a reservation, both before a reservation starts or while it is active.

Before you begin:

- If you are a reservation owner and used the **-f** or **-j** options on the **llmkres** command when you created the reservation, you do not have to perform the steps listed in Table 50 on page 219. Those command options automatically bind the job steps to the reservation. To find out whether a particular job step is bound to a reservation, use the command **llq -l** and check the listing for a reservation ID.
- To find out which reservation IDs you may use, check with your LoadLeveler administrator, or enter the command **llqres -l** and check the names in the Users or Groups fields (under the Modification time field) in the output listing. If your

user name or a group name to which you belong appears in these output fields, you are authorized to use the reservation.

- LoadLeveler cannot guarantee that certain resources will be available during a reservation period. If you submit job steps that require these resources, LoadLeveler will bind the job steps to the reservation, but will not dispatch them unless the resources become available during the reservation. These resources include:
  - Specific nodes that were not reserved under this reservation.
  - Floating consumable resources for a cluster.
  - Resources that are not released through preemption, such as virtual memory and adapters.
- Whether bound job steps are successfully dispatched depends not only on resource availability, but also on administration file keywords that set maximum numbers, including:
  - **max_jobs_scheduled**
  - **maxidle**
  - **maxjobs**
  - **maxqueued**

  If LoadLeveler determines that scheduling a bound job will exceed one or more of these configured limits, your job will remain idle unless conditions permit scheduling at a later time during the reservation period.

Table 50. Instructions for submitting a job to run under a reservation

To bind this type of job:	Use these instructions:
Already submitted jobs	Use the **llbind** command **Alternative:** Use the **ll_bind_reservation** subroutine in a program. **Result:** LoadLeveler either sets the reservation ID for each job step that can be bound to the reservation, or sends a failure notification for the bind request.
A new job that has not been submitted	1. Specify the reservation ID through the LL_RES_ID environment variable or the **ll_res_id** command file keyword. The **ll_res_id** keyword takes precedence over the LL_RES_ID environment variable. **Tip:** You can use the **ll_res_id** keyword to modify the reservation to submit to in a job command file filter. 2. Use the **llsubmit** command to submit the job. **Result:** If the job can be bound to the requested reservation, LoadLeveler sets the reservation ID for each job step that can be bound to the reservation. Otherwise, if the job step cannot be bound to the reservation, LoadLeveler changes the job state to NotQueued. To change the job step's state to Idle, issue the **llbind -r** command.

Use the **llqres** command or **llq** command with the **-l** option to check the success or failure of the binding request for each job step.

Selecting firm or soft binding: There are two methods by which a job step can be bound to a reservation: **firm** and **soft**. When a job step is firm bound to a reservation, the job step can only use the reserved resources. A job step that is soft bound to a reservation can be started before the reservation becomes active and can use nodes that are not part of the reservation. Using soft binding is a way of guaranteeing that resources will be available for the job step at a given time, but allowing the job step to start earlier if there are available resources.

Which method to use is specified by the **-m** option of the **llbind** command. If neither is specified by **llbind**, the default method specified for the reservation is used. Use **llqres -l** and review the **Binding Method** field to determine which method is the default for a reservation.

Binding a job step to a recurring reservation: When a job step is bound to a reservation, the job step can be considered for scheduling as soon as any occurrence of the reservation is active. If you do not want the job step to run right away, but instead you want it to run in a later occurrence of the reservation, you can specify which occurrence the job step will be bound to by adding the occurrence ID to the end of the reservation ID.

The format of the reservation identifier is [*host*.]*rid*[.**r**[.*oid*]].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional if *oid* is not specified).
- *oid* is the occurrence ID of a recurring reservation (*oid* is optional).

When *oid* is specified, the job step will not be considered for scheduling until that occurrence of the reservation becomes active. The step will remain in Idle state during all earlier occurrences.

If a job step is bound to a recurring reservation, and the reservation occurrence's end time is reached before the job step can be scheduled to run, the job step will be automatically bound to the next occurrence of the reservation by LoadLeveler. When the next occurrence becomes active, the job step will again be considered for scheduling.

A job can be submitted with the **recurring** keyword set to **yes** in the job command file to specify that all steps of the job will be run in every occurrence of the reservation to which it is bound. When all steps of the job have completed, the entire job is requeued and all steps are bound to the next occurrence of the reservation.

For details about the LoadLeveler interfaces for submitting jobs under reservations, see:

- "llbind - Bind job steps to a reservation" on page 415.
- "ll_bind subroutine" on page 645.
- "llsubmit - Submit a job" on page 531.

Removing bound jobs from the reservation

LoadLeveler administrators, reservation owners, and authorized users may use the **llbind** command to unbind one or more existing jobs from a reservation.

Alternative: Use the **ll_bind_reservation** subroutine in a program.

Result: LoadLeveler either unbinds the jobs from the reservation, or sends a failure notification for the unbind request. Use the **llqres** or **llq** command to check the success or failure of the remove request.

For details about the LoadLeveler interfaces for removing bound jobs from the reservation, see:
- "llbind - Bind job steps to a reservation" on page 415.
- "ll_bind subroutine" on page 645.

Querying existing reservations

Any LoadLeveler administrator or user can issue the **llqres** and **llq** commands to query the status of an existing reservation or recurring reservation.

Use these commands to request specific information about reservations:
- Various options are available to filter reservations to be displayed.
- To show details of specific reservations, use the **llqres** command with the **-l** option.
- To show job steps that are bound to specific reservations, use the **llq** command with the **-R** option.

For details about:
- Reservation attributes and **llqres** command syntax, see "llqres - Query a reservation" on page 500.
- **llq** command syntax, see "llq - Query job status" on page 479.

Modifying existing reservations

Only administrators and reservation owners can use the **llchres** command to modify one or more attributes of a reservation or a recurring reservation.

Certain attributes cannot be changed after a reservation has become active. Typical uses for the **llchres** command include the following:
- Using the command **llchres -U** ***+newuser1 newuser2*** to allow additional users to submit jobs to the reservation.
- If a reservation was made through the command **llmkres -h free** but LoadLeveler cannot include a particular node because it is down, you can use the command **llchres -h** ***+node*** to add the node to the reserved node list when that node becomes available again.
- If a reserved node is down after the reservation becomes active, a LoadLeveler administrator can use:
  - The command **llchres -h** ***-node*** to remove that node from the reservation.
  - The command **llchres -h +1** to add another node to the reservation.
- Extending the expiration of a recurring reservation which may be about to expire. You can use **llchres -e** to specify a new expiration date for the reservation without having to create a new reservation.
- Making a temporary change to the next occurrence of a recurring reservation without affecting any future occurrences of that reservation. For example, you can use the **-o** option of the **llchres** command to temporarily add a user (**-U**) or additional nodes (**-n**). Once that occurrence ends, the next occurrence will not retain the change.

Alternative: Use the **ll_change_reservation** subroutine in a program.

For details about the LoadLeveler interfaces for modifying reservations, see:
- "llchres - Change attributes of a reservation" on page 424.
- "ll_change_reservation subroutine" on page 648.

Canceling existing reservations

Administrators and reservation owners may use the **llrmres** command to cancel one or more reservations or to cancel some occurrences of a recurring reservation while leaving the remaining occurrences of that reservation unchanged in the system.

The options available when canceling a reservation are:

- Remove the entire reservation. All occurrences are removed and any bound job steps are automatically unbound from the reservation.
- Remove a specific occurrence of the reservation. All other occurrences remain in the system and all bound job steps remain bound to the reservation.
- Remove all occurrences during a specified interval. For example, a reservation may recur every day for one year, but during a one-week holiday period, the reservation is not needed. The reservation owner could cancel all of the occurrences during that one week period and all other occurrences would remain in the system and all bound job steps would remain bound to the reservation.

If some occurrences are canceled and the result is that no occurrences remain, then the entire reservation is removed and all jobs are unbound from the reservation.

Alternative: Use the **ll_remove_reservation** subroutine in a program.

Use the **llqres** command to check the success or failure of the remove request.

Use the **llqres -l** command to see a list of canceled occurrence IDs or to note individual occurrence start times which have been omitted due to cancellation.

For details about the LoadLeveler interfaces for canceling reservations, see:
- "llrmres - Cancel a reservation" on page 508.
- "ll_remove_reservation subroutine" on page 658.

Submitting jobs requesting scheduling affinity

You can request that a job use scheduling affinity by setting the **RSET** and **TASK_AFFINITY** job command file keywords.

Specify **RSET** with a value of:

- **RSET_MCM_AFFINITY** to have LoadLeveler schedule the job to machines where **RSET_SUPPORT** is enabled with a value of **RSET_MCM_AFFINITY**.
- *user_defined_rset* to have LoadLeveler schedule the job to machines where **RSET_SUPPORT** is enabled with a value of **RSET_USER_DEFINED**; *user_defined_rset* is the name of a valid user-defined RSet.

Specifying the **RSET** job command file keyword defaults to requesting memory affinity as a requirement and adapter affinity as a preference. Scheduling affinity options can be customized by using the job command file keyword **MCM_AFFINITY_OPTIONS**. For more information on these keywords, see "Job command file keyword descriptions" on page 359.

Note: If a job specifies memory or adapter affinity scheduling as a requirement, LoadLeveler will only consider machines where **RSET_SUPPORT** is set to **RSET_MCM_AFFINITY**. If there are not enough machines satisfying the memory affinity requirements, the job will stay in the idle state.

Specify **TASK_AFFINITY** with a value of:

- **CORE**(*n*) to have LoadLeveler schedule the job to machines where **RSET_SUPPORT** is enabled with a value of **RSET_MCM_AFFINITY**. On SMT and ST nodes, LoadLeveler will assign *n* physical CPUs to each job task.
- **CPU**(*n*) to have LoadLeveler schedule the job to machines where **RSET_SUPPORT** is enabled with a value of **RSET_MCM_AFFINITY**. On SMT nodes, LoadLeveler will assign *n* logical CPUs to each per job task. On ST nodes, LoadLeveler will assign *n* physical CPUs to each job task.

Specify a requirement of **SMT** with a value of:

- **Enabled** to have LoadLeveler schedule the job to machines where SMT is currently enabled.

  ```
  Example: #@ requirements = (SMT == "Enabled")
  ```

- **Disabled** to have LoadLeveler schedule the job to machines where SMT is currently disabled or is not supported.

  ```
  Example: #@ requirements = (SMT == "Disabled")
  ```

OpenMP multithreaded jobs can be submitted requesting thread-level binding, where each individual thread of an OpenMP application is bound to a separate physical core processor or logical CPU. Use the **parallel_threads** job command file keyword to request OpenMP thread-level binding, optionally, along with the **task_affinity** job command file keyword.

The CPUs to individual OpenMP threads of the tasks are selected based on the number of parallel threads (the **parallel_threads** job command file keyword) in each task and set of CPUs or cores assigned (the **task_affinity** job command file keyword) to the tasks. The CPUs are assigned to the threads only if at least one CPU is available for each thread from the set of CPUs or cores assigned to the task. If the number of CPUs in the set of CPUs or cores assigned to the tasks are not sufficient to bind all of the threads, the job will not run.

This example binds 4 OpenMP parallel threads to 4 separate cores:

```
#@ task_affinity = Core(4)
#@ parallel_threads = 4
```

Note: If you specify **cpus_per_core** along with your affinity request as:

```
#@ task_affinity = core(n)
#@ cpus_per_core = 1
```

Then LoadLeveler allocates the requested number of CPUs to each task on SMT nodes only. The nodes running in ST mode are not assigned for the jobs requesting **cpus_per_core**.

Submitting and monitoring jobs in a LoadLeveler multicluster

There are subtasks and associated instructions for submitting and monitoring jobs in a LoadLeveler multicluster.

Table 51 on page 224 shows the subtasks and associated instructions for submitting and monitoring jobs in a LoadLeveler multicluster:

Table 51. Submitting and monitoring jobs in a LoadLeveler multicluster

Subtask	Associated instructions (see . . .)
Prepare and submit a job in the LoadLeveler multicluster	"Steps for submitting jobs in a LoadLeveler multicluster environment"
Display information about a job in the LoadLeveler multicluster environment	• Use the **llq -X** *cluster_name* command to display information about jobs on remote clusters. • Use **llq -x -d** to display the user's job command file keyword statements. • Use **llq -X** *cluster_name* **-l** to obtain multicluster specific information.
Transfer an idle job from one cluster to another cluster	Use the **llmovejob** command, which is described in "llmovejob - Move a single idle job from the local cluster to another cluster" on page 470.

Steps for submitting jobs in a LoadLeveler multicluster environment

There are steps for submitting jobs in a LoadLeveler multicluster environment.

In a multicluster environment, you can specify one of the following:
- That a job is to run on a particular cluster.
- That LoadLeveler is to decide which cluster is best from the list of clusters, based on an administrator-defined metric. If **any** is specified, the job is submitted to the best cluster, based on an administrator-defined metric.
- That a job is a scale-across job which will run across multiple clusters

The following procedure explains how to prepare your job to be submitted in the multicluster environment.

Before you begin: You need to know that:
- Only batch jobs are supported in the LoadLeveler multicluster environment. LoadLeveler will fail any interactive jobs that you attempt to submit in a multicluster environment.
- LoadLeveler assigns all steps of a multistep job to the same cluster.
- Job identifiers are assigned by the local cluster and are retained by the job regardless of what cluster the job executes in.
- Remote jobs are subjected to the same configuration checks as locally submitted jobs. Examples include account validation, class limits, include lists, and exclude lists.

Perform the following steps to submit jobs to run in one cluster in a LoadLeveler multicluster environment.

1. If files used by your job need to be copied between clusters, you must specify the job files to be copied from the local to the remote cluster in the job command file. Use the **cluster_input_file** and **cluster_output_file** keywords to specify these files.

   Rules:
   - Any local file specified for copy must be accessible from the local gateway Schedd machines. Input files must be readable. Directories and permissions must be in place to write output files.

- Any remote file specified for copy must be accessible from the remote gateway Schedd machines. Directories and permissions must be in place to write input files. Output files must be readable when the job terminates.
- To copy more than one file, these keywords can be specified multiple times.

Tip: Each instance of these keywords allows you to specify a single local file and a single remote file. If your job requires copying multiple files (for example, all files in a directory), you may want to use a procedure to consolidate the multiple files into a single file rather than specify multiple cluster_file statements in the job command file. The following is an example of how you could consolidate input files:

a. Use the **tar** command to produce a single tar file from multiple files.
b. On the **cluster_input_file** keyword, specify the file that resulted from the **tar** command processing.
c. Modify your job command file such that it uses the **tar** command to restore the multiple files from the tar file prior to invoking your application.

2. In the job command file, specify the clusters to which LoadLeveler may submit the job. The **cluster_list** keyword is a blank-delimited list of cluster names or the reserved word **any** where:
   - A single cluster name indicates that the job is to be submitted to that cluster.
   - A list of multiple cluster names indicates that the job is to be submitted to one of the clusters as determined by the installation exit **CLUSTER_METRIC**.
   - The reserved word **any** indicates that the job is to be submitted to any cluster defined by the installation exit **CLUSTER_METRIC**.

   Alternative: You can specify the clusters to which LoadLeveler can submit your job on the **llsubmit** command using the **-X** option.
3. Use the **llsubmit** command to submit the job.

   Tip: You may use the **-X** option on the **llsubmit** command to specify:
   -X {*cluster_list* | **any**}
   Is a blank-delimited list of cluster names or the reserved word **any** where:
   - A single cluster name indicates that the job is to be submitted to that cluster.
   - A list of multiple cluster names indicates that the job is to be submitted to one of the clusters as determined by the installation exit **CLUSTER_METRIC**.
   - The reserved word **any** indicates that the job is to be submitted to any cluster defined by the installation exit **CLUSTER_METRIC**.

   Note: If a remote job is submitted with a list of clusters or the reserved word **any** and the installation exit **CLUSTER_METRIC** is not specified, the remote job is not submitted.

Perform the following steps to submit scale-across jobs to run across multiple clusters in a multicluster environment:

1. In the job command file, specify the **cluster_option** keyword as **scale_across**.

   Alternative: You can submit a scale-across job using the **-S** option of the **llsubmit** command.
2. You can limit which clusters can be used to run the job by using the **cluster_list** keyword to specify the limited set of cluster. For a scale-across job, if the **cluster_list** keyword is not specified or the reserved word **any** is specified in the **cluster_list**, all clusters may be used to run the job.

   Alternative: You can limit which clusters can be used to run the scale-across job using the **-X** option of the **llsubmit** command.

3. Use the **llsubmit** command to submit the job from any cluster in the scale-across multicluster environment.

The **llsubmit** command displays the assigned local outbound Schedd, the assigned remote inbound Schedd, the scheduling cluster and the job identifier when the remote job has been successfully submitted. Use the **-q** flag to stop these additional messages from being displayed.

When you are done, you can use commands to display information about the submitted job; for example:

- Use **llq -l -X** *cluster_name* **-j** *job_id* where *cluster_name* and *job_id* were displayed by the **llsubmit** command to display information about the remote job.
- Use **llq -l -X** *cluster_list* to display the long listing about jobs, including scheduling cluster, submitting cluster, user-requested cluster, cluster input and output files.
- Use **llq -X all** to display information about all jobs in all configured clusters.
- Use **llq** twice to display the job status for a scale-across job on all clusters where the job has been distributed. In the first command, specify the **-l** option to display the set of clusters where the job has been distributed (the value from the Cluster List output line). The second time you run the command, specify the **-X** option with the list of clusters reported from the first command. The result from that command shows the job status on the other clusters.

Submitting and monitoring Blue Gene jobs

The following procedure explains how to prepare your job to be submitted to the Blue Gene system.

The submission of Blue Gene jobs is similar to the submission of other job types.

Before you begin: You need to know that checkpointing Blue Gene jobs is not currently supported.

Tip: Use the **llstatus** command to check if Blue Gene support is enabled and whether Blue Gene is currently present. The **llstatus** command will display:

```
The BACKFILL scheduler with Blue Gene support is in use

Blue Gene is present
```

when Blue Gene is support is enabled and Blue Gene is currently present

Perform the following steps to submit Blue Gene jobs:

1. In the job command file, set the job type to Blue Gene by specifying:
   ```
   #@job_type = bluegene
   ```
2. Specify the size or shape of the Blue Gene job or the Blue Gene partition in which the job will run.
   - The size of the Blue Gene job can be specified by using the job command file keyword **bg_size** to specify the size of the job. For more information, see the detailed description of the bg_size keyword.
   - The shape of the Blue Gene job can be specified by using the job command file keyword **bg_shape** to specify the shape of the job. If you require the specific shape you specified, you may wish to specify the **bg_rotate** keyword to false. For more information on these keywords, see the detailed descriptions of the bg_shape keyword and bg_rotate keyword.

- The partition in which the Blue Gene job is run can be specified using the **bg_partition** job command file keyword. For more information, see the detailed description of the bg_partition keyword.
- The size of a Blue Gene job refers to the number of Blue Gene compute nodes instead of the number of tasks running on Startd machines. The following keywords cannot be used to control the size of a Blue Gene job:
  - **node**
  - **tasks_per_node**
  - **total_tasks**

3. Specify any other job command file keywords you require, including the **bg_connection** and **bg_requirements** Blue Gene job command file keywords. See "Job command file keyword descriptions" on page 359 for more information on job command file keywords.
4. Upon completing your job command file, submit the job using the **llsubmit** command.

If you experience a problem submitting a Blue Gene job, see "Troubleshooting in a Blue Gene environment" on page 717 for common questions and answers pertaining to operations within a Blue Gene environment.

When you are done, you can use the **llq -b** command to display information about Blue Gene jobs in short form. For more information see "llq - Query job status" on page 479.

Example:

The following is a sample job command file for a Blue Gene job:

```
# @ job_name            = bgsample
# @ job_type            = bluegene
# @ comment             = "BGL Job by Size"
# @ error               = $(job_name).err
# @ output              = $(job_name).out
# @ environment         = COPY_ALL;
# @ wall_clock_limit    = 200:00,200:00
# @ notification        = always
# @ notify_user         = sam
# @ bg_size             = 1024
# @ bg_connection       = torus
# @ class               = 2bp
# @ queue
/usr/bin/mpirun -exe /bgscratch/sam/com -verbose 2 -args "-o 100  -b 64 -r"
```

Chapter 9. Managing submitted jobs

This is a list of the tasks and sources of additional information for managing LoadLeveler jobs.

Table 52 lists the tasks and sources of additional information for managing LoadLeveler jobs.

Table 52. Roadmap of user tasks for managing submitted jobs

To learn about:	Read the following:
Displaying information about a submitted job or its environment	• "Querying the status of a job" • "Working with machines" on page 230 • "Displaying currently available resources" on page 230 • "llclass - Query class information" on page 433 • "llq - Query job status" on page 479 • "llstatus - Query machine status" on page 512 • "llsummary - Return job resource information for accounting" on page 535
Changing the priority of a submitted job	• "Setting and changing the priority of a job" on page 230 • "llmodify - Change attributes of a submitted job step" on page 464
Changing the state of a submitted job	• "Placing and releasing a hold on a job" on page 232 • "Canceling a job" on page 232 • "llhold - Hold or release a submitted job" on page 454 • "llcancel - Cancel a submitted job" on page 421
Checkpointing a submitted job	• "Checkpointing a job" on page 232 • "llckpt - Checkpoint a running job step" on page 430

Querying the status of a job

Once you submit a job, you can query the status of the job to determine, for example, if it is still in the queue or if it is running.

You also receive other job status related information such as the job ID and the submitting user ID. You can query the status of a LoadLeveler job either by using the GUI or the **llq** command. For an example of querying the status of a job, see Chapter 10, "Example: Using commands to build, submit, and manage jobs," on page 235.

Querying the status of a job using a submit-only machine: In addition to allowing you to submit and cancel jobs, a submit-only machine allows you to query the status of jobs. You can query a job using either the submit-only version of the GUI or by using the **llq** command. For information on **llq**, see "llq - Query job status" on page 479.

Working with machines

There are types tasks related to machines.

You can perform the following types of tasks related to machines:

- **Display machine status**

  When you submit a job to a machine, the status of the machine automatically appears in the Machines window on the GUI. This window displays machine related information such as the names of the machines running jobs, as well as the machine's architecture and operating system. For detailed information on one or more machines in the cluster, you can use the Details option on the Actions pull-down menu. This will provide you with a detailed report that includes information such as the machine's state and amount of installed memory.

  For an example of displaying machine status, see Chapter 10, "Example: Using commands to build, submit, and manage jobs," on page 235.

- **Display central manager**

  The LoadLeveler administrator designates one of the machines in the LoadLeveler cluster as the central manager. When jobs are submitted to any machine, the central manager is notified and decides where to schedule the jobs. In addition, it keeps track of the status of machines in the cluster and jobs in the system by communicating with each machine. LoadLeveler uses this information to make the scheduling decisions and to respond to queries.

  Usually, the system administrator is more concerned about the location of the central manager than the typical end user but you may also want to determine its location. One reason why you might want to locate the central manager is if you want to browse some configuration files that are stored on the same machine as the central manager.

- **Display public scheduling machines**

  Public scheduling machines are machines that participate in the scheduling of LoadLeveler jobs on behalf of users at submit-only machines and users at other workstations that are not running the Schedd daemon. You can find out the names of all these machines in the cluster.

  Submit-only machines allow machines that are not part of the LoadLeveler cluster to submit jobs to the cluster for processing.

Displaying currently available resources

The LoadLeveler user can get information about currently available resources by using the **llstatus** command with either the **-F**, or **-R** options.

The **-F** option displays a list of all of the floating resources associated with the LoadLeveler cluster. The **-R** option lists all of the consumable resources associated with all of the machines in the LoadLeveler cluster. The user can specify a hostlist with the **llstatus** command to display only the consumable resources associated with specific hosts.

Setting and changing the priority of a job

LoadLeveler uses the priority of a job to determine its position among a list of all jobs waiting to be dispatched.

LoadLeveler schedules jobs based on the *adjusted system priority*, which takes in account both system priority and user priority:

User priority
Every job has a user priority associated with it. A job with a higher priority runs before a job with a lower priority (when both jobs are owned by the same user). You can set this priority through the **user_priority** keyword in the job command file, and modify it through the **llprio** command. See "llprio - Change the user priority of submitted job steps" on page 477 for more information.

System priority
Every job has a system priority associated with it. Administrators can set this priority in the configuration file using the **SYSPRIO** keyword expression. The **SYSPRIO** expression can contain class, group, and user priorities, as shown in the following example:

```
SYSPRIO : (ClassSysprio * 100) + (UserSysprio * 10) + (GroupSysprio * 1) - (QDate)
```

The **SYSPRIO** expression is evaluated by LoadLeveler to determine the overall system priority of a job. To determine which jobs to run first, LoadLeveler does the following:

1. Assigns a system priority value when the negotiator adds the new job to the queue of jobs eligible for dispatch.
2. Orders jobs first by system priority.
3. Assigns jobs belonging to the same user and the same class an adjusted system priority, which takes all the system priorities and orders them by user priority. Jobs with a higher adjusted system priority are scheduled ahead of jobs with a lower adjusted system priority.

Only administrators may modify the system priority through the **llmodify** command with the **-s** option. See "llmodify - Change attributes of a submitted job step" on page 464 for more information.

Example: How does a job's priority affect dispatching order?

To understand how a job's priority affects dispatching order, consider the sample jobs which lists the priorities assigned to jobs submitted by two users, Rich and Joe.

To understand how a job's priority affects dispatching order, consider the sample jobs in Table 53, which lists the priorities assigned to jobs submitted by two users, Rich and Joe.

Two of the jobs belong to Joe, and three belong to Rich. User Joe has two jobs (Joe1 and Joe2) in Class A with SYSPRIOs of 9 and 8 respectively. Since Joe2 has the higher user priority (20), and because both of Joe's jobs are in the same class, Joe2's priority is swapped with that of Joe1 when the adjusted system priority is calculated. This results in Joe2 getting an adjusted system priority of 9, and Joe1 getting an adjusted system priority of 8. Similarly, the Class A jobs belonging to Rich (Rich1 and Rich3) also have their priorities swapped. The priority of the job Rich2 does not change, since this job is in a different class (Class B).

Table 53. How LoadLeveler handles job priorities

Job	User Priority	System Priority (SYSPRIO)	Class	Adjusted System Priority
Rich1	50	10	A	6

Table 53. How LoadLeveler handles job priorities (continued)

Job	User Priority	System Priority (SYSPRIO)	Class	Adjusted System Priority
Joe1	10	9	A	8
Joe2	20	8	A	9
Rich2	100	7	B	7
Rich3	90	6	A	10

Placing and releasing a hold on a job

You may place a hold on a job and thereby cause the job to remain in the queue until you release it.

There are two types of holds: a user hold and a system hold. Both you and your LoadLeveler administrator can place and release a user hold on a job. Only a LoadLeveler administrator, however, can place and release a system hold on a job.

You can place a hold on a job or release the hold either by using the GUI or the **llhold** command. For examples of holding and releasing jobs, see Chapter 10, "Example: Using commands to build, submit, and manage jobs," on page 235.

As a user or an administrator, you can also use the startdate keyword to place a hold on a job. This keyword allows you to specify when you want to run a job.

Canceling a job

You can cancel one of your jobs that is either running or waiting to run by using either the GUI or the **llcancel** command. You can use **llcancel** to cancel LoadLeveler jobs, including jobs from a submit-only machine.

For more information about the **llcancel** command, see "llcancel - Cancel a submitted job" on page 421.

Checkpointing a job

Checkpointing is a method of periodically saving the state of a job so that, if for some reason, the job does not complete, it can be restarted from the saved state. Checkpoints can be taken either under the control of the user application or external to the application.

On AIX only, the LoadLeveler API **ll_init_ckpt** is used to initiate a serial checkpoint from the user application. For initiating checkpoints from within a parallel application, the API **mpc_init_ckpt** should be used. These APIs allow the writer of the application to determine at what points in the application it would be appropriate save the state of the job. To enable parallel applications to initiate checkpointing, you must use the APIs provided with the Parallel Environment (PE) program. For information on parallel checkpointing, see *IBM Parallel Environment for AIX and Linux: Operation and Use, Volume 1*.

It is also possible to checkpoint a program running under LoadLeveler outside the control of the application. There are several ways to do this:

- Use the **llckpt** command to initiate checkpoint for a specific job step. See "llckpt - Checkpoint a running job step" on page 430 for more information.

- Checkpoint from a program which invokes the **ll_ckpt** API to initiate checkpoint of a specific job step. See "ll_ckpt subroutine" on page 550 for more information.
- Have LoadLeveler automatically checkpoint all running jobs that have been enabled for checkpoint.To enable this automatic checkpoint, specify **checkpoint = interval** in the job command file.
- As the result of an **llctl flush** command.

Note: For interactive parallel jobs, the environment variable **CHECKPOINT** must be set to **yes** in the environment prior to starting the parallel application or the job will not be enabled for checkpoint. For more information see, *IBM Parallel Environment for AIX and Linux: MPI Programming Guide*.

Chapter 10. Example: Using commands to build, submit, and manage jobs

The following procedure presents a series of simple tasks that a user might perform using commands.

For additional information about individual commands noted in the procedure, see Chapter 16, “Commands,” on page 411.

1. Build your job command file by using a text editor to create a script file. Into the file enter the name of the executable, other keywords designating such things as output locations for messages, and the necessary LoadLeveler statements, as shown in Figure 35:

```
# This job command file is called longjob.cmd.  The
# executable is called longjob, the input file is longjob.in,
# the output file is longjob.out, and the error file is
# longjob.err.
#
# @ executable = longjob
# @ input      = longjob.in
# @ output     = longjob.out
# @ error      = longjob.err

# @ queue
```

Figure 35. Building a job command file

2. You can optionally edit the job command file you created in step 1.
3. To submit the job command file that you created in step 1, use the **llsubmit** command:

   ```
   llsubmit longjob.cmd
   ```

   LoadLeveler responds by issuing a message similar to:

   ```
   submit: The job "wizard.22" has been submitted.
   ```

   Where `wizard` is the name of the machine to which the job was submitted and `22` is the job identifier (ID). You may want to record the identifier for future use (although you can obtain this information later if necessary).
4. To display the status of the job you just submitted, use the **llq** command. This command returns information about all jobs in the LoadLeveler queue:

   ```
   llq wizard.22
   ```

   Where `wizard` is the machine name to which you submitted the job, and `22` is the job ID. You can also query this job using the command **llq wizard.22.0**, where `0` is the step ID.
5. To change the priority of a job, use the **llprio** command. To increase the priority of the job you submitted by a value of 10, enter:

   ```
   llprio +10 wizard.22.0
   ```

   You can change the user priority of a job that is in the queue or one that is running. This only affects jobs belonging to the same user and the same class. If you change the priority of a job in the queue, the job’s priority increases or decreases in relation to your other jobs in the queue. If you change the priority of a job that is running, it does not affect the job while it is running. It only

affects the job if the job re-enters the queue to be dispatched again. For more information, see “Setting and changing the priority of a job” on page 230.

6. To place a temporary hold on a job in a queue, use the **llhold** command. This command only takes effect if jobs are in the Idle or NotQueued state. To place a hold on `wizard.22.0`, enter:

   ```
   llhold wizard.22.0
   ```

7. To release the hold you placed in step 6, use the **llhold** command:

   ```
   llhold -r wizard.22.0
   ```

8. To display the status of the machine to which you submitted a job, use the **llstatus** command:

   ```
   llstatus -l wizard
   ```

9. To cancel *wizard.22.0*, use the **llcancel** command:

   ```
   llcancel wizard.22.0
   ```

Chapter 11. Using LoadLeveler's GUI to build, submit, and manage jobs

Note: This is the last release that will provide the Motif-based graphical user interface **xloadl**. The function available in **xloadl** has been frozen since TWS LoadLeveler 3.3.2.

You do not have to perform the tasks in the order listed. You may perform certain tasks before others without any difficulty; however, some tasks must be performed prior to others for succeeding tasks to work. For example, you cannot submit a job if you do not have a job command file that you built using either the GUI or an editor.

The tasks included in this topic are listed in Table 54.

Table 54. User tasks available through the GUI

Subtask	Associated information (see...)
Building and submitting jobs	• "Building jobs" • "Editing the job command file" on page 249 • "Submitting a job command file" on page 250
Obtaining job status	• "Displaying and refreshing job status" on page 251 • "Specifying which jobs appear in the Jobs window" on page 258 • "Sorting the Jobs window" on page 252
Managing a submitted job	• "Changing the priority of your jobs" on page 253 • "Placing a job on hold" on page 253 • "Releasing the hold on a job" on page 253 • "Canceling a job" on page 254
Working with machines	• "Displaying and refreshing machine status" on page 255 • "Specifying which machines appear in Machines window" on page 259 • "Sorting the Machines window" on page 257 • "Finding the location of the central manager" on page 257 • "Finding the location of the public scheduling machines" on page 258
Saving LoadLeveler messages in a file	"Saving LoadLeveler messages in a file" on page 259

Building jobs

Use these instructions when building jobs.

From the Jobs window:

SELECT

File → Build a Job

▲ The dialog box shown in Figure 36 on page 238 appears:

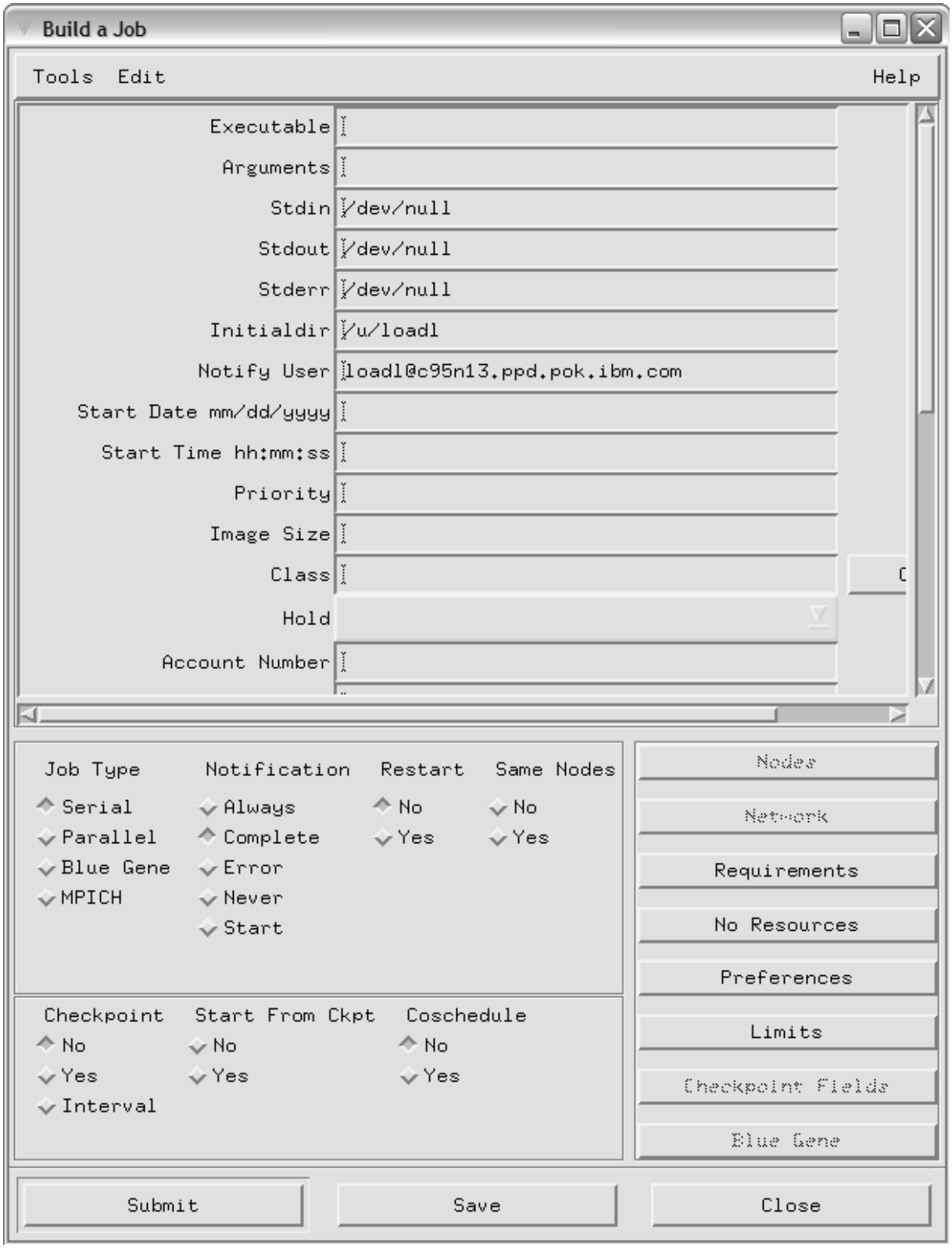

Figure 36. LoadLeveler build a job window

Complete those fields for which you want to override what is currently specified in your **skel.cmd** defaults file. Sample **skel.cmd** and **mcluster_skel.cmd** files are found in the samples subdirectory of the

release directory. You can update this file to define defaults for your site, and then update the ***skelfile** resource in **Xloadl** to point to your new **skel.cmd** file. If you want a personal defaults file, copy **skel.cmd** to one of your directories, edit the file, and update the ***skelfile** resource in **.Xdefaults**. Table 55 shows the fields displayed in the Build a Job window:

Table 55. GUI fields and input

Field	Input
Executable	Name of the program to run. It must be an executable file. Optional. If omitted, the command file is executed as if it were a shell script.
Arguments	Parameters to pass to the program. Required only if the executable requires them.
Stdin	Filename to use as standard input (stdin) by the program. Optional. The default is **/dev/null**.
Stdout	Filename to use as standard output (stdout) by the program. Optional. The default is **/dev/null**.
Stderr	Filename to use as standard error (stderr) by the program. Optional. The default is **/dev/null**.
Cluster Input File	A comma delimited local and remote path name pair, representing the local file to copy to the remote location. If you have more than one pair to enter, the **More** button will display a **Cluster Input Files** input window. Optional. The default is no files are copied.
Cluster Output File	A comma delimited local and remote path name pair, representing the local file destination to copy to the remote file into. If you have more than one pair to enter, the **More** button will display a **Cluster Output Files** input window. Optional. The default is no files are copied.
Initialdir	Initial directory. LoadLeveler changes to this directory before running the job. Optional. The default is your current working directory.
Notify User	User id of person to notify regarding status of submitted job. Optional. The default is your userid.
StartDate	Month, day, and year in the format mm/dd/yyyy. The job will not start before this date. Optional. The default is to run the job as soon as possible.
StartTime	Hour, minute, second in the format hh:mm:ss. The job will not start before this time. Optional. The default is to run the job as soon as possible. If you specify *StartTime* but not *StartDate*, the default *StartDate* is the current day. If you specify *StartDate* but not StartTime, the default *StartTime* is 00:00:00. This means that the job will start as soon as possible on the specified date.

Table 55. GUI fields and input (continued)

Field	Input
Priority	Number between 0 and 100, inclusive. Optional. The default is 50. This is the user priority. For more information on this priority, refer to "Setting and changing the priority of a job" on page 230.
Image size	Number in kilobytes that reflects the maximum size you expect your program to grow to as it runs. Optional.
Class	Class name. The job will only run on machines that support the specified class name. Your system administrator defines the class names. Optional: • Press the Choices button to get a list of available classes. • Press the Details button under the class list to obtain long listing information about classes.
Hold	Hold status of the submitted job. Permitted values are: **user** User hold **system** System hold (only valid for LoadLeveler administrators) **usersys** User and system hold (only valid for LoadLeveler administrators) **Note:** The default is a no-hold state.
Account Number	Number associated with the job. For use with the llacctmrg and llsummary commands for acquiring job accounting data. Optional. Required only if the **ACCT** keyword is set to **A_VALIDATE** in the configuration file.
Environment	Your initial environment variables when your job starts. Separate environment specifications with semicolons. Optional.
Copy Environment	All or Master, to indicate whether the environment variables specified in the keyword Environment are copied to all nodes or just to the master node of a parallel job. Optional.
Shell	The name of the shell to use for the job. Optional. If not specified, the shell used in the owner's password file entry is used. If none is specified, **/bin/sh** is used.
Group	The LoadLeveler group name to which the job belongs. Optional.
Step Name	The name of this job step. Optional.

Table 55. GUI fields and input (continued)

Field	Input
Node Usage	How the node is used. Permitted values are: **shared** The node can be shared with other tasks of other job steps. This is the default. **not shared** The node cannot be shared. **slice not shared** Has the same meaning as **not shared**. It is provided for compatibility.
Dependency	A Boolean expression defining the relationship between the job steps. Optional.
Large Page	Whether or not the job step requires Large Page memory. **yes** Use Large Page memory if available, otherwise use regular memory. **mandatory** Use of Large Page memory is mandatory. **no** Do not use Large Page memory.
Bulk Transfer	Indicates to the communication subsystem whether it should use the bulk transfer mechanism to communicate between tasks. **yes** Use bulk transfer. **no** Do not use bulk transfer. Optional.
Rset	What type of RSet support is requested. Permitted values are: **rset_mcm_affinity** Requests scheduling affinity. Use the **MCM options** button to specify task allocation method, memory affinity preference or requirement, and adapter affinity preference or requirement. *rset_name* Requests a user defined RSet and nodes with **rset_support** set to **rset_user_defined**. Optional.
Comments	Comments associated with the job. These comments help to distinguish one job from another job. Optional.
SMT	Indicates whether a job requires dynamic simultaneous multithreading (SMT) function. **yes** The job requires SMT function. **no** The job does not require SMT function. **as_is** The SMT state will not be changed.

Note: The fields that appear in this table are what you see when viewing the Build a Job window. The text in these fields does not necessarily correspond with the keywords listed in "Job command file keyword descriptions" on page 359.

See "Job command file keyword descriptions" on page 359 for information on the defaults associated with these keywords.

SELECT

A Job Type if you want to change the job type.

Your choices are:

Serial Specifies a serial job. This is the default.

Parallel

Specifies a parallel job.

Blue Gene

Specifies a bluegene job.

MPICH

Specifies a MPICH job.

Note that the job type you select affects the choices that are active on the Build A Job window.

SELECT

a Notification option.

Your choices are:

Always

Notify you when the job starts, completes, and if it incurs errors.

Complete

Notify you when the job completes. This is the default option as initially defined in the skel.cmd file.

Error Notify you if the job cannot run because of an error.

Never Do not notify you.

Start Notify you when the job starts.

SELECT

a Restart option.

Your choices are:

No This job is not restartable. This is the default.

Yes Restart the job.

SELECT

To restart the job on the same nodes from which it was vacated.

Your choices are:

No Restart the job on any available nodes.

Yes Restart the job on the same nodes it ran on previously. This option is valid after a job has been vacated.

Note that there is no default for the selection.

SELECT

a Checkpoint option.

Your choices are:

No Do not checkpoint the job. This is the default.

Yes Yes, checkpoint the job at intervals you determine. See the checkpoint keyword for more information.

Interval

Yes, checkpoint the job at intervals determined by LoadLeveler. See the checkpoint keyword for more information.

SELECT

To start from a checkpoint file

Your choices are:

No Do not start the job from a checkpoint file (start job from beginning).

Yes Yes, restart the job from an existing checkpoint file when you submit the job. The file name must be specified by the job command file. The directory name may be specified by the job command file, configuration file, or default location.

SELECT

Coschedule if you want steps within a job to be scheduled and dispatched at the same time.

Your choices are:

No Disables coscheduling for your job step.

Yes Allows coscheduling to occur for your job step.

Note:

1. This keyword is not inherited by other job steps.
2. The default is No.
3. The coscheduling function is only available with the BACKFILL scheduler.

SELECT

Nodes (available when the job type is parallel)

▲ The Nodes dialog box appears.

Complete the necessary fields to specify node information for a parallel job (see Table 56). Depending upon which model you choose, different fields will be available; any unavailable fields will be desensitized. LoadLeveler will assign defaults for any fields that you leave blank. For more information, see the appropriate job command file keyword (listed in parentheses) in "Job command file keyword descriptions" on page 359.

Table 56. Nodes dialog box

Field	Available in:	Input
Min # of Nodes	Tasks Per Node Model and Tasks with Uniform Blocking Model	Minimum number of nodes required for running the parallel job (**node** keyword). Optional. The default is one.
Max # of Nodes	Tasks Per Node Model	Maximum number of nodes required for running the parallel job (**node** keyword). Optional. The default is the minimum number of nodes.
Tasks per Node	Tasks Per Node Model	The number of tasks of the parallel job you want to run per node (**tasks_per_node** keyword). Optional.
Total Tasks	Tasks with Uniform Blocking Model, and Custom Blocking Model	The total number of tasks of the parallel job you want to run on all available nodes (**total_tasks** keyword). Optional for Uniform, required for Custom Blocking. The default is one.
Blocking	Custom Blocking Model	The number of tasks assigned (as a block) to each consecutive node until all of a job's tasks have been assigned (**blocking** keyword)

Table 56. Nodes dialog box (continued)

Field	Available in:	Input
Task Geometry	Custom Geometry Model	The task ids of each task that you want to run on each node. You can use the ″Set Geometry″ button for step-by-step directions (**task_geometry** keyword).

SELECT

Close to return to the Build a Job dialog box.

SELECT

Network (available when the job type is parallel)

▲ The Network dialog box appears.

The Network dialog box consists of two parts: The top half of the panel is for MPI, and the bottom half is for LAPI. Click on the check box to the left of **MPI** or **LAPI** to activate the part of the panel for which you want to specify network information. If you want to use MPI with LAPI, click on both:

- The MPI check box.
- The check box for **Share windows between MPI and LAPI**.

Complete those fields for which you want to specify network information (see Table 57). For more information, see the **network** keyword description in "Job command file keyword descriptions" on page 359.

Table 57. Network dialog box fields

Field	Input
MPI (MPI/LAPI)	Select: • Only the **MPI** check box to use the Message Passing Interface (MPI) protocol only. • Both the **MPI** check box and the **Share windows between MPI and LAPI** check box to use both MPI and the Low-level Application Programming Interface (LAPI) protocols. This selection corresponds to setting the **network** keyword in the job command file to **MPI_LAPI**. Optional.
LAPI	Select the **LAPI** check box to use Low-level Application Programming Interface (LAPI) protocol only. Optional.
Adapter/Network	Select an adapter name or a network type from the list. Required for each protocol you select.
Adapter Usage	Specifies that the adapter is either shared or not shared. Optional. The default is shared.
Communication Mode	Specifies the communication subsystem mode used by the communication protocol that you specify and can be either IP (Internet Protocol) or US (User Space). Optional. The default is IP.
Communication Level	Implies the amount of memory to be allocated to each window for User Space mode. Allocation can be Low, Average, or High. It is ignored by Switch_Network_Interface_For_HPS adapters.

Table 57. Network dialog box fields (continued)

Field	Input
Instances	Specifies the number of windows or IP addresses the communication subsystem should allocate to this protocol. Optional. The default is 1 unless **sn_all** is specified for network and then the default is max.
rCxt Blocks	The number of user rCxt blocks requested for each window used by the associated protocol. It is recognized only by Switch_Network_Interface_For_HPS adapters. Optional.

SELECT

Close to return to the Build a Job dialog box.

SELECT

Requirements

▲ The Requirements dialog box appears.

Complete those fields for which you want to specify requirements (see Table 58). Defaults are used for those fields that you leave blank. LoadLeveler dispatches your job only to one of those machines with resources that matches the requirements you specify.

Table 58. Build a job dialog box fields

Field	Input
Architecture (see note 2)	Machine type. The job will not run on any other machine type. Optional. The default is the architecture of your current machine.
Operating System (see note 2)	Operating system. The job will not run on any other operating system. Optional. The default is the operating system of your current machine.
Disk	Amount of disk space in the execute directory. The job will only run on a machine with at least this much disk space. Optional. The default is defined in your local configuration file.
Memory	Amount of memory. The job will only run on a machine with at least this much memory. Optional. The default is defined in your local configuration file.
Large Page Memory	Amount of Large Page memory, in megabytes. The job step requires at least this much Large Page memory to run. Optional.
Total Memory	Amount of total (regular and Large Page memory) in megabytes needed to run the job step. Optional.
Machines	Machine names. The job will only run on the specified machines. Optional.
Features	Features. The job will only run on machines with specified features. Optional.

Table 58. Build a job dialog box fields (continued)

Field	Input
Pool	Specifies the number associated with the pool you want to use. All available pools listed in the administration file appear as choices. The default is to select nodes from any pool.
LoadLeveler Version	Specifies the version of LoadLeveler, in dotted decimal format, on the machine where you want the job to run. For example: 3.3.0.0 specifies that your job will run on a machine running LoadLeveler Version 3.3.0.0 or higher. Optional.
Connectivity	A number from 0.0 through 1.0, representing the average connectedness of the node's managed adapters.
Requirement	Requirements. The job will only run if these requirements are met.

Note:

1. If you enter a resource that is not available, you will NOT receive a message. LoadLeveler holds your job in the Idle state until the resource becomes available. Therefore, make certain that the spelling of your entry is correct. You can issue **llq -s** *jobID* to find out if you have a job for which requirements were not met.
2. If you do not specify an architecture or operating system, LoadLeveler assumes that your job can run only on your machine's architecture and operating system. If your job is not a shell script that can be run successfully on any platform, you should specify a required architecture and operating system.

SELECT
Close to return to the Build a Job dialog box.

SELECT
Resources

▲ The Resources dialog box appears.

This dialog box allows you to set the amount of defined consumable resources required for a job step. Resources with an ″*″ appended to their names are not in the SCHEDULE_BY_RESOURCES list. For more information, see the resources keyword.

SELECT
Close to return to the Build a Job dialog box.

SELECT
Preferences

▲ The Preferences dialog box appears.

This dialog box is similar to the Requirements dialog box, with the exception of the Adapter choice, which is not supported as a Preference. Complete the fields for those parameters that you want to specify. These parameters are not binding. For any preferences that you specify, LoadLeveler attempts to find a machine that matches these preferences along with your requirements. If it cannot find the machine, LoadLeveler chooses the first machine that matches the requirements.

SELECT
Close to return to the Build a Job dialog box.

SELECT
Limits

▲ The Limits dialog box appears.

Complete the fields for those limits that you want to impose upon your job (see Table 59). If you type *copy* in any field except **wall_clock_limit** or **job_cpu_limit**, the limits in effect on the submit machine are used. If you leave any field blank, the default limits in effect for your userid on the machine that runs the job are used. For more information, see "Using limit keywords" on page 89.

Table 59. Limits dialog box fields

Field	Input
CPU Limit	Maximum amount of CPU time that the submitted job can use. Express the amount as: `[[hours:]minutes:]seconds[ .fraction]` For example, 12:56:21 is 12 hours, 56 minutes, and 21 seconds. Optional
Data Limit	Maximum amount of the data segment that the submitted job can use. Express the amount as: `integer[.fraction][units]` Optional
Core Limit	Maximum size of a core file. Optional
RSS Limit	Maximum size of the resident set size. It is the largest amount of physical memory a user's process can allocate. Optional
File Limit	Maximum size of a file that is created. Optional
Stack Limit	Maximum size of the stack. Optional
Job CPU Limit	Maximum total CPU time to be used by all processes of a serial job step or if a parallel job, then this is the total CPU time for each **LoadL_starter** process and its descendants for each job step of a parallel job. Optional
Wall Clock Limit	Maximum amount of elapsed time for which a job can run. Optional

SELECT

Close to return to the Build a Job dialog box.

SELECT

Checkpointing to specify checkpoint options (available when the checkpoint option is set to Yes or Interval)

▲ The checkpointing dialog box appears.

Complete those fields for which you want to specify checkpoint information (see Table 60 on page 248). For detailed information on specific keywords, see "Job command file keyword descriptions" on page 359.

Table 60. Checkpointing dialog box fieldsF

Field	Input
Ckpt File	Specifies a checkpoint file. The serial default is : $(job_name).$(host).$(domain).$(jobid).$(stepid).ckpt
Ckpt Directory	Specifies a checkpoint directory name.
Ckpt Execute Directory	Specifies a directory to use for staging the checkpoint executable file.
Ckpt Time Limits	Sets the limits for the elapsed time a job can take checkpointing.

SELECT

Close to return to the Build a Job dialog box.

SELECT

Blue Gene (available when the job type is bluegene)

▲ The Blue Gene window appears.

Complete the necessary fields to specify information for a Blue Gene job (see Table 61). Depending upon which request type you choose, different fields will be available; any unavailable fields will be desensitized. For more information, see the appropriate job command file keyword (listed in parentheses) in "Job command file keyword descriptions" on page 359.

Table 61. Blue Gene job fields

Field	Available when requesting by:	Input
# of Compute Nodes	Size	The requested size in number of compute nodes that describes the size of the partition for this Blue Gene job. (**bg_size**)
Shape	Shape	The requested shape of the requested Blue Gene job. The units of each dimension of the shape are in number of base partitions, *X***x***Y***x***Z**, where *X*, *Y*, and *Z* are the number of base partitions in the X-direction, Y-direction, and Z-direction. (**bg_shape**)
Partition Name	Partition	The name of an existing partition in the Blue Gene system where the requested job should run. (**bg_partition**)
Connection Type	Size and Shape	The kinds of Blue Gene partitions that can be selected for this job. You can select Torus, Mesh, or Prefer Torus. (**bg_connection**) Optional. The default is Mesh.
Rotate Dimensions	Shape	Whether to consider all possible rotations of the specified shape (True) or only the specified shape (False) when assigning a partition for the Blue Gene job. (**bg_rotate**) Optional. The default is True.

Table 61. Blue Gene job fields (continued)

Field	Available when requesting by:	Input
Memory	Megabytes	A number (in megabytes) that represents the minimum available virtual memory that is needed to run the job. LoadLeveler generates a Blue Gene requirement that specifies memory that is greater than or equal to the amount you specify. Optional. If you leave this field blank, this parameter is not used when searching for machines to run your job.
Requirements	Expression	An expression that specifies the Blue Gene requirements that a machine must meet in order to run the job. Memory is the supported keyword.

SELECT
Close to return to the Build a Job dialog box.

Editing the job command file

Use these instructions to edit the job command file that you just built.

There are several ways that you can edit the job command file that you just built:

1. Using the Jobs window:

   SELECT
   File → Submit a Job

   ▲ The Submit a Job dialog box appears.

   SELECT
   The job file you want to edit from the file column.

   SELECT
   Edit

   ▲ Your job command file appears in a window. You can use any editor to edit the job command file. The default editor is specified in your .Xdefaults file.

   If you have an icon manager, an icon may appear. An icon manager is a program that creates a graphic symbol, displayed on a screen, that you can point to with a device such as a mouse in order to select a particular function or application. Select this icon to view your job command file.

2. Using the **Tools Edit** pull-down menus on the Build a Job window:

   Using the Edit pull-down menu, you can modify the job command file. Your choices appear in the Table 62:

Table 62. Modifying the job command file with the Edit pull-down menu

To	Select
Add a step to the job command file	Add a Step or Add a First Step
Delete a step from the job command file	Delete a Step

Table 62. Modifying the job command file with the Edit pull-down menu (continued)

To	Select
Clear the fields in the Build a Job window	Clear Fields
Select defaults to use in the fields	Set Field Defaults
Note: Other options include Go to Next Step, Go to Previous Step, and Go to Last Step that allow you to edit various steps in the job command file.	

Using the **Tools** pull-down menu, you can modify the job command file. Your choices appear in Table 63:

Table 63. Modifying the job command file with the Tools pull-down menu

To	Select
Name the job	Set Job Name
Specify a cluster, cluster list, or any cluster, if a multicluster environment is configured.	Set Cluster
Open a window where you can enter a script file	Append Script
Fill in the fields using another file	Restore from File
View the job command file in a window	View Entire Job
Determine which step you are viewing	What is step #
Start a new job command file	Start a new job

You can save and submit the information you entered by selecting the choices shown in Table 64:

Table 64. Saving and submitting information

To	Do This
Save the information you entered into a file which you can submit later	**SELECT** **Save** ▲ A window appears prompting you to enter a job filename. **ENTER** a job filename in the text entry field. **SELECT** **OK** ▲ The window closes and the information you entered is saved in the file you specified.
Submit the program immediately and discard the information you entered	**SELECT** **Submit**

Submitting a job command file

After building a job command file, you can submit it to one or more machines for processing.

To submit a job, from the Jobs window:

SELECT
File → Submit a Job

▲ The Submit a Job dialog box appears.

SELECT

The job file that you want to submit from the file column.

You can also use the filter field and the directories column to select the file or you can type in the file name in the text entry field.

SELECT

Submit

▲ The job is submitted for processing.

You can now submit another job or you can press Close to exit the window.

Displaying and refreshing job status

When you submit a job, the status of the job is automatically displayed in the Jobs window.

You can update or refresh this status using the Jobs window and selecting one of the following:

- **Refresh → Refresh Jobs**
- **Refresh → Refresh All**.

To change how often the amount of time should pass before the jobs window is automatically refreshed, use the Jobs window.

SELECT

Refresh → Set Auto Refresh

▲ A window appears.

TYPE IN

a value for the number of seconds to pass before the Jobs window is updated.

Automatic refresh can be expensive in terms of network usage and CPU cycles. You should specify a refresh interval of 120 seconds or more for normal use.

SELECT

OK

▲ The window closes and the value you specified takes effect.

To receive detailed information on a job:

SELECT

Actions → Extended Status to receive additional information on the job. Selecting this option is the same as typing **llq -x** command.

You can also get information in the following way:

SELECT

Actions → Extended Details

Selecting this option is the same as typing **llq -x -l** command. You can also double click on the job in the Jobs window to get details on the job.

Note: Obtaining extended status or details on multiple jobs can be expensive in terms of network usage and CPU cycles.

SELECT

Actions → Job Status

You can also use the **llq -s** command to determine why a submitted job remains in the Idle or Deferred state.

SELECT

Actions → Resource Use

Allows you to display resource use for running jobs. Selecting this option is the same as entering the **llq -w** command.

SELECT

Actions → Blue Gene Job Status

Allows you to display Blue Gene job information for jobs. Selecting this option is the same as entering the **llq -b** command.

For more information on requests for job information, see "llq - Query job status" on page 479.

Sorting the Jobs window

You can specify up to two sorting options for the Jobs window.

The options you specify determine the order in which the jobs appear in the Jobs window.

From the Jobs window:

Select **Sort → Set Sort Parameters**

▲ A window appears

Select A **primary and secondary** sort

Table 65 lists the sorting options:

Table 65. Sorting the jobs window

To:	Select Sort
Sort jobs by the machine from which they were submitted	**Sort by Submitting Machine**
Sort by owner	**Sort by Owner**
Sort by the time the jobs were submitted	**Sort by Submission Time**
Sort by the state of the job	**Sort by State**
Sort jobs by their user priority (last job listed runs first)	**Sort by Priority**
Sort by the class of the job	**Sort by Class**
Sort by the group associated with the job	**Sort by Group**
Sort by the machine running the job	**Sort by Running Machine**
Sort by dispatch order	**Sort by Dispatch Order**
Not specify a sort	**No Sort**

You can select a sort type as either a Primary or Secondary sorting option. For example, suppose you select Sort by Owner as the primary sorting option and Sort by Class as the secondary sorting option. The Jobs window is sorted by owner and, within each owner, by class.

Changing the priority of your jobs

If your job has not yet begun to run and is still in the queue, you can change the priority of the job in relation to your other jobs in the queue that belong to the same class.

This only affects the user priority of the job. For more information on this priority, refer to "Setting and changing the priority of a job" on page 230. Only the owner of a job or the LoadLeveler administrator can change the priority of a job.

From the Jobs window:

SELECT
a job by clicking on it with the mouse

SELECT
Actions → Priority

▲ A window appears.

TYPE IN
a number between 0 and 100, inclusive, to indicate a new priority.

SELECT
OK

▲ The window closes and the priority of your job changes.

Placing a job on hold

Only the owner of a job or the LoadLeveler administrator can place a hold on a job.

From the Jobs window:

SELECT
The job you want to hold by clicking on it with the mouse

SELECT
Actions → Hold

▲ The job is put on hold and its status changes in the Jobs window.

Releasing the hold on a job

Only the owner of a job or the LoadLeveler administrator can release a hold on a job.

From the Jobs window:

SELECT
The job you want to release by clicking on it with the mouse

SELECT
Actions → Release from Hold

▲ The job is released from hold and its status is updated in the Jobs window.

Canceling a job

Only the owner of a job or the LoadLeveler administrator can cancel a job.

From the Jobs window:

SELECT
The job you want to cancel by clicking on it with the mouse

SELECT
Actions → Cancel

▲ LoadLeveler cancels the job and the job information disappears from the Jobs window.

Modifying consumable resources and other job attributes

Use these commands to modify the consumable CPUs or memory requirements of a nonrunning job.

SELECT

Modify → Consumable CPUs
or
Modify → Consumable Memory
or
Modify → Class
or
Modify → Account number
or
Modify → Blue Gene → Connection
or
Modify → Blue Gene → Partition
or
Modify → Blue Gene → Rotate
or
Modify → Blue Gene → Shape
or
Modify → Blue Gene → Size
or
Modify → Blue Gene → Requirement

▲ A dialog box appears prompting you to enter a new value for the selected job attribute. Blue Gene attributes are available when Blue Gene is enabled.

TYPE IN
The new value

SELECT
OK

▲ The dialog box closes and the value you specified takes effect.

Taking a checkpoint

Use these commands to checkpoint the selected job.

SELECT

One of the following actions to take when checkpoint has completed:

- Continue the step
- Terminate the step
- Hold the step

▲ A checkpoint monitor for this step appears.

Adding a job to a reservation

Use these commands to bind selected job steps to a reservation so that they will only be scheduled to run on the nodes reserved for the reservation.

SELECT

The job you want to bind by clicking on it with the mouse.

SELECT

Actions → Bind to Reservation

▲ A window appears.

SELECT

A reservation from the list.

SELECT

OK

▲ The window closes and the job is bound to that reservation.

Removing a job from a reservation

Use these commands to unbind selected job steps from reservations to which they currently belong.

SELECT

The job you want to unbind by clicking on it with the mouse.

SELECT

Actions → Unbind from Reservation

If the job is bound to a reservation, it is removed from the reservation.

Displaying and refreshing machine status

The status of the machines is automatically displayed in the Machines window.

You can update or refresh this status using the Machines window and selecting one of the following:

- **Refresh → Refresh Machines**
- **Refresh → Refresh All**.

To specify an amount of time to pass before the Machines window is automatically refreshed, from the Machines window:

SELECT

Refresh → Set Auto Refresh

▲ A window appears.

TYPE IN

a value for the number of seconds to pass before the Machines window is updated.

Automatic refresh can be expensive in terms of network usage and CPU cycles. You should specify a refresh interval of 120 seconds or more for normal use.

SELECT

OK

▲ The window closes and the value you specified takes effect.

To receive detailed information on a machine:

SELECT

Actions → Details

This displays status information about the selected machines. Selecting this option has the same effect as typing the **llstatus -l** command

SELECT

Actions → Adapter Details

This displays virtual and physical adapter information for each selected machine. Selecting this option has the same effect as typing the **llstatus -a** command

SELECT

Actions → Floating Resources

This displays consumable resources for the LoadLeveler cluster. Selecting this option has the same effect as typing the **llstatus -R** command

SELECT

Actions → Machine Resources

This displays consumable resources defined for the selected machines or all machines. Selecting this option has the same effect as typing the **llstatus -R** command

SELECT

Actions → Cluster Status

This displays status of machines in the defined cluster or clusters. It appears only when a multicluster environment is configured and is equivalent to the **llstatus -X all** command.

SELECT

Actions → Cluster Config

This displays cluster information from the **LoadL_admin** file. Only fields with data specified or which have defaults when not specified are displayed. It appears only when a multicluster environment is configured and is equivalent to the **llstatus -C** command.

SELECT

Actions → Blue Gene ...

This displays information about the Blue Gene system. You can select the option for **Status** for a short listing, **Details** for a long listing, **Base Partitions** for Blue Gene base partition status, or **Partitions** for existing

Blue Gene partition status. It is available only when Blue Gene support is enabled in LoadLeveler. This is equivalent to the **llstatus** command with the options **-b**, **-b -l**, **-B**, or **-P**.

Sorting the Machines window

You can specify up to two sorting options for the Machines window.

The options you specify determine the order in which machines appear in the window.

From the Machines window:

Select **Sort → Set Sort Parameters**

▲ A window appears

Select A **primary and secondary** sort

Table 66 lists sorting options for the Machines window:

Table 66. Sorting the machines window

To:	Select Sort →
Sort by machine name	**Sort by Name**
Sort by Schedd state	**Sort by Schedd**
Sort by total number of jobs scheduled	**Sort by InQ**
Sort by number of running jobs scheduled by this machine	**Sort by Act**
Sort by startd state	**Sort by Startd**
Sort by the number of jobs running on this machine	**Sort by Run**
Sort by load average	**Sort by LdAvg**
Sort by keyboard idle time	**Sort by Idle**
Sort by hardware architecture	**Sort by Arch**
Sort by operating system type	**Sort by OpSys**
Not specify a sort	**No Sort**

You can select a sort type as either a Primary or Secondary sorting option. For example, suppose you select Sort by Arch as the primary sorting option and Sort by Name as the secondary sorting option. The Machines window is sorted by hardware architecture, and within each architecture type, by machine name.

Finding the location of the central manager

The LoadLeveler administrator designates one of the nodes in the LoadLeveler cluster as the central manager.

When jobs are submitted at any node, the central manager is notified and decides where to schedule the jobs. In addition, it keeps track of the status of machines in the cluster and the jobs in the system by communicating with each node. LoadLeveler uses this information to make the scheduling decisions and to respond to queries.

To find the location of the central manager, from the Machines window:

SELECT

Actions → Find Central Manager

▲ A message appears in the message window declaring on which machine the central manager is located.

Finding the location of the public scheduling machines

Public scheduling machines are those machines that participate in the scheduling of LoadLeveler jobs on behalf of the submit-only machines.

To get a list of these machines in your cluster, use the Machines window:

SELECT

Actions → Find Public Scheduler

▲ A message appears displaying the names of these machines.

Finding the type of scheduler in use

The LoadLeveler administrator defines the scheduler used by the cluster.

To determine which scheduler is currently in use:

SELECT

Actions → Find Scheduler Type

▲ A message appears displaying the type:
- ll_default
- BACKFILL
- External (API)

Specifying which jobs appear in the Jobs window

Normally, only your jobs appear in the Jobs window.

You can, however, specify which jobs you want to appear by using the Select pull-down menu on the Jobs window (see Table 67).

Table 67. Specifying which jobs appear in the Jobs window

To Display	Select Select →
All jobs in the queue	**All**
All jobs belonging to a specific user (or users)	**By User** ▲ A window appears prompting you to enter the user IDs whose jobs you want to view.
All jobs submitted to a specific machine (or machines)	**By Machine** ▲ A window appears prompting you to enter the machine names on which the jobs you want to view are running.
All jobs belonging to a specific group (or groups)	**By Group** ▲ A window appears prompting you to enter the LoadLeveler group names to which the jobs you want to view belong.

Table 67. Specifying which jobs appear in the Jobs window (continued)

To Display	Select Select →
All jobs having a particular ID	**By Job Id** A dialog box prompts you to enter the id of the job you want to appear. This ID appears in the left column of the Jobs window. Type in the ID and press OK.

Note: When you choose By User, By Machines, or By Group, you can use a UNIX regular expression enclosed in parenthesis. For example, you can enter **(^k10)** to display all machines beginning with the characters "k10".

SELECT

Select → Show Selection to show the selection parameters.

Specifying which machines appear in Machines window

You can specify which machines will appear in the Machines window.

See Table 68. The default is to view all of the machines in the LoadLeveler pool.

From the Machines window:

Table 68. Specifying which machines appear in Machines window

To	Select Select →
View all of the machines	**All**
View machines by operating system	**by OpSys** ▲ A window appears prompting you to enter the operating system of those machines you want to view.
View machines by hardware architecture	**by Arch** ▲ A window appears prompting you to enter the hardware architecture of those machines you want to view.
View machines by state	**by State** ▲ A cascading pull-down menu appears prompting you to select the state of the machines that you want to view.

SELECT

Select → Show Selection to show the selection parameters.

Saving LoadLeveler messages in a file

Normally, all the messages that LoadLeveler generates appear in the Messages window.

If you would also like to have these messages written to a file, use the Messages window.

SELECT

Actions → Start logging to a file

▲ A window appears prompting you to enter a filename in which to log the messages.

TYPE IN

The filename in the text entry field.

SELECT

OK

▲ The window closes.

Part 4. TWS LoadLeveler interfaces reference

The topics in the TWS LoadLeveler interfaces reference provide the details you need to know to correctly use the IBM Tivoli Workload Scheduler (TWS) LoadLeveler interfaces for the following tasks:

- Specifying keywords in the TWS LoadLeveler control files
- Starting and customizing the TWS LoadLeveler GUI
- Correctly coding the TWS LoadLeveler commands and APIs

Chapter 12. Configuration file reference

The configuration file contains many parameters that you can set or modify to control how LoadLeveler operates.

You may control LoadLeveler's operation either:

- Across the cluster, by modifying the global configuration file, **LoadL_config**, or
- Locally, by modifying the **LoadL_config.local** file on individual machines.

Table 69 shows the configuration subtasks:

Table 69. Configuration subtasks

Subtask	Associated information (see . . .)
To find out what administrator tasks you can accomplish by using the configuration file	Chapter 4, "Configuring the LoadLeveler environment," on page 41
To learn how to correctly specify the contents of a configuration file	• "Configuration file syntax" • "Configuration file keyword descriptions" on page 265 • "User-defined keywords" on page 313 • "LoadLeveler variables" on page 314

Configuration file syntax

The information in both the **LoadL_config** and the **LoadL_config.local** files is in the form of a statement. These statements are made up of *keywords* and *values*.

There are three types of configuration file keywords:

- Keywords, described in "Configuration file keyword descriptions" on page 265.
- User-defined variables, described in "User-defined keywords" on page 313.
- LoadLeveler variables, described in "LoadLeveler variables" on page 314.

Configuration file statements take one of the following formats:

```
keyword=value
keyword:value
```

Statements in the form *keyword=value* are used primarily to customize an environment. Statements in the form *keyword:value* are used by LoadLeveler to characterize the machine and are known as part of the machine description. Every machine in LoadLeveler has its own machine description which is read by the central manager when LoadLeveler is started.

Keywords are *not* case sensitive. This means you can enter them in lower case, upper case, or mixed case.

Note: For the *keyword=value* form, if the keyword is of a boolean type and only **true** and **false** are valid input, a value string starting with **t** or **T** is taken as **true**; all other values are taken as **false**.

To continue configuration file statements, use the back-slash character (\).

In the configuration file, comments must be on a separate line from keyword statements.

You can use the following types of constants and operators in the configuration file.

Numerical and alphabetical constants

These are the numerical and alphabetical constants.

Constants may be represented as:
- Boolean expressions
- Signed integers
- Floating point values
- Strings enclosed in double quotes (″ ″).

Mathematical operators

You can use the following C operators.

The operators are listed in order of precedence. All of these operators are evaluated from left to right:
- !
- * /
- - +
- < <= > >=
- == !=
- &&
- ||

64-bit support for configuration file keywords and expressions

Administrators can assign 64-bit integer values to selected keywords in the configuration file.

floating_resources

Consumable resources associated with the **floating_resources** keyword may be assigned 64-bit integer values. Fractional and unit specifications are not allowed. The predefined ConsumableCpus, ConsumableMemory, ConsumableLargePageMemory, and ConsumableVirtualMemory may not be specified as floating resources.

Example:

```
floating_resources = spice2g6(9876543210123) db2_license(1234567890)
```

MACHPRIO expression

The LoadLeveler variables: Disk, ConsumableCpus, ConsumableMemory, ConsumableVirtualMemory, ConsumableLargePageMemory, PagesScanned, Memory, VirtualMemory, FreeRealMemory, and PagesFreed may be used in a MACHPRIO expression. They are 64-bit integers and 64-bit arithmetic is used to evaluate them.

Example:

```
MACHPRIO: (Memory + FreeRealMemory) - (LoadAvg*1000 + PagesScanned)
```

Configuration file keyword descriptions

This topic provides an alphabetical list of the keywords you can use in a LoadLeveler configuration file.

It also provides examples of statements that use these keywords.

ACCT
Turns the accounting function on or off.

Syntax:
```
ACCT = flag ...
```

The available flags are:

A_DETAIL
Enables extended accounting. Using this flag causes LoadLeveler to record detail resource consumption by machine and by events for each job step. This flag also enables the **-x** flag of the **llq** command, permitting users to view resource consumption for active jobs.

A_RES
Turns reservation data recording on.

A_OFF
Turns accounting data recording off.

A_ON Turns accounting data recording on. If specified without the **A_DETAIL** flag, the following is recorded:
- The total amount of CPU time consumed by the entire job
- The maximum memory consumption of all tasks (or nodes).

A_VALIDATE
Turns account validation on.

Default value: A_OFF

Example: This example specifies that accounting should be turned on and that extended accounting data should be collected and that the -x flag of the **llq** command be enabled.
```
ACCT = A_ON A_DETAIL
```

ACCT_VALIDATION
Identifies the executable called to perform account validation.

Syntax:
```
ACCT_VALIDATION = program
```

Where *program* is a validation program.

Default value: $(BIN)/llacctval (the accounting validation program shipped with LoadLeveler.

ACTION_ON_MAX_REJECT
Specifies the state in which jobs are placed when their rejection count has reached the value of the **MAX_JOB_REJECT** keyword. HOLD specifies that jobs are placed in User Hold status; SYSHOLD specifies that jobs are placed in System Hold status; CANCEL specifies that jobs are canceled. When a job is rejected, LoadLeveler sends a mail message stating why the job was rejected.

Syntax:
```
ACTION_ON_MAX_REJECT = HOLD | SYSHOLD | CANCEL
```

Default value: HOLD

ACTION_ON_SWITCH_TABLE_ERROR
Points to an administrator supplied program that will be run when **DRAIN_ON_SWITCH_TABLE_ERROR** is set to **true** and a switch table unload error occurs.

Syntax:

```
ACTION_ON_SWITCH_TABLE_ERROR = program
```

Default value: The default is to not run a program.

ADMIN_FILE
Points to the administration file containing user, class, group, machine, and adapter stanzas.

Syntax:

```
ADMIN_FILE = directory
```

Default value: `$(tilde)/admin_file`

AFS_GETNEWTOKEN
Specifies a filter that, for example, can be used to refresh an AFS token.

Syntax:

```
AFS_GETNEWTOKEN = full_path_to_executable
```

Where *full_path_to_executable* is an administrator-supplied program that receives the AFS authentication information on standard input and writes the new information to standard output. The filter is run when the job is scheduled to run and can be used to refresh a token which expired when the job was queued.

Default value: The default is to not run a program.

AGGREGATE_ADAPTERS
Allows an external scheduler to specify per-window adapter usages.

Syntax:

```
AGGREGATE_ADAPTERS = YES | NO
```

When this keyword is set to **YES**, the resources from multiple switch adapters on the same switch network are treated as one aggregate pool available to each job. When this keyword is set to **NO**, the switch adapters are treated individually and a job cannot use resources from multiple adapters on the same network.

Set this keyword to **NO** when you are using an external scheduler; otherwise, set to **YES** (or accept the default).

Default value: YES

ALLOC_EXCLUSIVE_CPU_PER_JOB
Specifies the way CPU affinity is enforced on Linux platforms. When this keyword is not specified or when an unrecognized value is assigned to it, LoadLeveler will not attempt to set CPU affinity for any application processes spawned by it.

Note: This keyword is valid only on Linux x86 and x86_64 platforms. This keyword is ignored by LoadLeveler on all other platforms.

The **ALLOC_EXCLUSIVE_CPU_PER_JOB** keyword can be specified in the global or local configuration files. It can also be specified in both configuration

files, in which case the setting in the local configuration file will override that of the global configuration file. The keyword cannot be turned off in a local configuration file if it has been set to any value in the global configuration file.

Changes to **ALLOC_EXCLUSIVE_CPU_PER_JOB** will not take effect at reconfiguration. The administrator must stop and restart or recycle LoadLeveler when changing **ALLOC_EXCLUSIVE_CPU_PER_JOB**.

Syntax:

```
ALLOC_EXCLUSIVE_CPU_PER_JOB = LOGICAL|PHYSICAL
```

Default value: By default, when this keyword is not specified, CPU affinity is not set.

Example: When the value of this keyword is set to **LOGICAL**, only one LoadLeveler job step will run on each of the processors available on the machine:

```
ALLOC_EXCLUSIVE_CPU_PER_JOB = LOGICAL
```

Example: When the value of this keyword is set to **PHYSICAL**, *all* logical processors (or physical cores) configured in one physical CPU package will be allocated to one and only one LoadLeveler job step.

```
ALLOC_EXCLUSIVE_CPU_PER_JOB = PHYSICAL
```

ARCH

Indicates the standard architecture of the system. The architecture you specify here must be specified in the same format in the **requirements** and **preferences** statements in job command files. The administrator defines the character string for each architecture.

Syntax:

```
ARCH = string
```

Default value: Use the command **llstatus -l** to view the default.

Example: To define a machine as an RS/6000®, the keyword would look like:

```
ARCH = R6000
```

BG_ALLOW_LL_JOBS_ONLY

Specifies if only jobs submitted through LoadLeveler will be accepted by the Blue Gene job launcher program.

Syntax:

```
BG_ALLOW_LL_JOBS_ONLY = true | false
```

Default value: false

BG_CACHE_PARTITIONS

Specifies whether allocated partitions are to be reused for Blue Gene jobs whenever possible.

Syntax:

```
BG_CACHE_PARTITIONS = true | false
```

Default value: true

BG_ENABLED

Specifies whether Blue Gene support is enabled.

Syntax:

```
BG_ENABLED = true | false
```

If the value of this keyword is **true**, the central manager will load the Blue Gene control system libraries and query the state of the Blue Gene system so that jobs of type **bluegene** can be scheduled.

Default value: false

BG_MIN_PARTITION_SIZE
Specifies the smallest number of compute nodes in a partition.

Syntax:

```
BG_MIN_PARTITION_SIZE = 32 | 128 | 512 (for Blue Gene/L)

BG_MIN_PARTITION_SIZE = 16 | 32 | 64 | 128 | 256 | 512 (for Blue Gene/P)
```

The value for this keyword must not be smaller than the minimum partition size supported by the physical Blue Gene hardware. If the number of compute nodes requested in a job is less than the minimum partition size, LoadLeveler will increase the requested size to the minimum partition size.

If the **max_psets_per_bp** value is set in the **DB_PROPERTY** file, the value for the **BG_MIN_PARTITION_SIZE** must be set as described in Table 70:

Table 70. BG_MIN_PARTITION_SIZE values

max_psets_per_bp value in DB_PROPERTY file	BG_MIN_PARTITION_SIZE for Blue Gene/L	BG_MIN_PARTITION_SIZE for Blue Gene/P
4	>= 128	>= 128
8	>= 128	>= 64
16	>= 32	>= 32
32	>= 32	>= 16

Default value: 32

BIN
Defines the directory where LoadLeveler binaries are kept.

Syntax:

```
BIN = $(RELEASEDIR)/bin
```

Default value: `$(tilde)/bin`

CENTRAL_MANAGER_HEARTBEAT_INTERVAL
Specifies the amount of time, in seconds, that defines how frequently primary and alternate central manager communicate with each other.

Syntax:

```
CENTRAL_MANAGER_HEARTBEAT_INTERVAL = number
```

Default value: The default is 300 seconds or 5 minutes.

CENTRAL_MANAGER_TIMEOUT
Specifies the number of heartbeat intervals that an alternate central manager will wait before declaring that the primary central manager is not operating.

Syntax:

```
CENTRAL_MANAGER_TIMEOUT = number
```

Default value: The default is 6.

CKPT_CLEANUP_INTERVAL
Specifies the interval, in seconds, at which the **Schedd** daemon will run the program specified by the **CKPT_CLEANUP_PROGRAM** keyword.

Syntax:

```
CKPT_CLEANUP_INTERVAL = number
```

number must be a positive integer.

Default value: -1

CKPT_CLEANUP_PROGRAM

Identifies an administrator-provided program which is to be run at the interval specified by the **ckpt_cleanup_interval** keyword. The intent of this program is to delete old checkpoint files created by jobs running under LoadLeveler during the checkpoint process.

Syntax:

```
CKPT_CLEANUP_PROGRAM = program
```

Where *program* is the fully qualified name of the program to be run. The program must be accessible and executable by LoadLeveler.

A sample program to remove checkpoint files is provided in the `/usr/lpp/LoadL/full/samples/llckpt/rmckptfiles.c` file.

Default value: No default value is set.

CKPT_EXECUTE_DIR

Specifies the directory where the job step's executable will be saved for checkpointable jobs. You can specify this keyword in either the configuration file or the job command file; different file permissions are required depending on where this keyword is set. For additional information, see "Planning considerations for checkpointing jobs" on page 140.

Syntax:

```
CKPT_EXECUTE_DIR = directory
```

This directory cannot be the same as the current location of the executable file, or LoadLeveler will not stage the executable. In this case, the user must have execute permission for the current executable file.

Default value: By default, the executable of a checkpointable job step is not staged.

CLASS

Determines whether a machine will accept jobs of a certain job class. For parallel jobs, you must define a class instance for each task you want to run on a node using one of two formats:

- The format, **CLASS** = *class_name (count)*, defines the **CLASS** names using a statement that names the classes and sets the number of tasks for each class in parenthesis.

  With this format, the following rules apply:
  - Each class can have only one entry
  - If a class has more than one entry or there is a syntax error, the entire **CLASS** statement will be ignored
  - If the **CLASS** statement has a blank value or is not specified, it will be defaulted to **No_Class (1)**
  - The number of instances for a class specified inside the parenthesis **( )** must be an unsigned integer. If the number specified is 0, it is correct syntactically, but the class will not be defined in LoadLeveler
  - If the number of instances for all classes in the **CLASS** statement are 0, the default **No_Class(1)** will be used

- The format, **CLASS** = { *"class1" "class2" "class2" "class2"*}, defines the **CLASS** names using a statement that names each class and sets the number of tasks for each class based on the number of times that the class name is used inside the **{}** operands.

Note: With both formats, the class names list is blank delimited.

For a LoadLeveler job to run on a machine, the machine must have a vacancy for the class of that job. If the machine is configured for only one **No_Class** job and a LoadLeveler job is already running there, then no further LoadLeveler jobs are started on that machine until the current job completes.

You can have a maximum of 1024 characters in the class statement. You cannot use **allclasses** or **data_stage** as a class name, since these are reserved LoadLeveler keywords.

You can assign multiple classes to the same machine by specifying the classes in the LoadLeveler configuration file (called **LoadL_config**) or in the local configuration file (called **LoadL_config.local**). The classes, themselves, should be defined in the administration file. See "Setting up a single machine to have multiple job classes" on page 723 and "Defining classes" on page 89 for more information on classes.

Syntax:

```
CLASS = { "class_name" ... } | {"No_Class"} | class_name (count) ...
```

Default value: {"**No_Class**"}

CLIENT_TIMEOUT

Specifies the maximum time, in seconds, that a daemon waits for a response over TCP/IP from a process. If the waiting time exceeds the specified amount, the daemon tries again to communicate with the process. In general, you should use the default setting unless you are experiencing delays due to an excessively loaded network. If so, you should try increasing this value.

Syntax:

```
CLIENT_TIMEOUT = number
```

Default value: The default is 30 seconds.

CLUSTER_METRIC

Indicates the installation exit to be run by the Schedd to determine where a remote job is distributed. If a remote job is submitted with a list of clusters or the reserved word **any** and the installation exit is not specified, the remote job is not submitted.

Syntax:

```
CLUSTER_METRIC = full_pathname_to_executable
```

The installation exit is run with the following parameters passed as input. All parameters are character strings.

- The job ID of the job to be distributed
- The number of clusters in the list of clusters
- A blank-delimited list of clusters to be considered

If the user specifies the reserved word **any** as the **cluster_list** during job submission, the job is sent to the first outbound Schedd defined for the first configured remote cluster. The **CLUSTER_METRIC** is executed on this machine to determine where the job will be distributed. If this machine is not the **outbound_hosts** Schedd for the assigned cluster, the job will be forwarded

to the correct **outbound_hosts** Schedd. If the user specifies a list of clusters as the **cluster_list** during job submission, the job is sent to the first outbound Schedd defined for the first specified remote cluster. The **CLUSTER_METRIC** is executed on this machine to determine where the job will be distributed. If this machine is not the **outbound_hosts** Schedd for the assigned cluster, the job will be forwarded to the correct **outbound_hosts** Schedd.

Note: The list of clusters may contain a single entry of the reserved word **any**, which indicates that the **CLUSTER_METRIC** installation exit must determine its own list of clusters to select from. This can be all of the clusters available using the data access API or a predetermined list set by the administrator. If **any** is specified in place of a cluster list, the metric will receive a count of 1 followed by the keyword **any**.

The installation exit must write the remote cluster name to which the job is submitted as standard output and exit with a value of 0. An exit value of -1 indicates an error in determining the cluster for distribution and the job is not submitted. Returned cluster names that are not valid also cause the job to be not submitted. STDERR from the exit is written to the Schedd log.

LoadLeveler provides a set of sample exits for use in distributing jobs by the following metrics:

- The number of jobs in the idle queue
- The number of jobs in the specified class
- The number of free nodes in the cluster

The installation exit samples are available in the **${RELEASEDIR}/samples/llcluster** directory.

CLUSTER_REMOTE_JOB_FILTER

Indicates the installation exit to be run by the inbound Schedd for each remote job request to filter the user's job command file statements during submission or move job. If the keyword is not specified, no job filtering is done.

Syntax:

```
CLUSTER_REMOTE_JOB_FILTER = full_pathname_to_executable
```

The installation exit is run with the submitting user's ID. All parameters are character strings.

This installation exit is executed on the **inbound_hosts** of the local cluster when receiving a job submission or move job request.

The executable specified is called with the submitting user's unfiltered job command file statements as the standard input. The standard output is submitted to LoadLeveler. If the exit returns with a nonzero exit code, the remote job submission or job move will fail. A submit filter can only make changes to LoadLeveler job command file statements.

The data access API can be used by the remote job filter to query the Schedd for the job object received from the sending cluster.

If the local submission filter on the submitting cluster has added or deleted steps from the original user's job command file, the remote job filter must add or delete the same number of steps. The job command file statements returned by the remote job filter must contain the same number of steps as the job object received from the sending cluster.

Changes to the following job command file keyword statements are ignored:

- **executable**

- **environment**
- **image_size**
- **cluster_input_file**
- **cluster_output_file**
- **cluster_list**

The following job command file keyword will have different behavior:

- **initialdir** – If not set by the remote job filter or the submitting user's unfiltered job command file, the default value will remain the current working directory at the time the job was submitted. Access to the **initialdir** will be verified on the cluster selected to run the job. If access to **initialdir** fails, the submission or move job will fail.

When you distribute a scale-across job to other clusters for scheduling and a remote job filter is configured, the filter will be applied to the distributed job. However, only changes to the following job command file keyword statements will be accepted. Changes to any other statement by the remote job filter will be ignored.

- **#@ class**
- **#@ priority**
- **#@ as_limit**
- **#@ core_limit**
- **#@ cpu_limit**
- **#@ data_limit**
- **#@ file_limit**
- **#@ job_cpu_limit**
- **#@ locks_limit**
- **#@ memlock_limit**
- **#@ nofile_limit**
- **#@ nproc_limit**
- **#@ rss_limit**
- **#@ stack_limit**

To maintain compatibility between the **SUBMIT_FILTER** and **CLUSTER_REMOTE_JOB_FILTER** programs, the following environment variables are set when either exit is invoked:

- **LOADL_ACTIVE** – the LoadLeveler version.
- **LOADL_STEP_COMMAND** – the location of the job command file passed as input to the program. This job command file only contains LoadLeveler keywords.
- **LOADL_STEP_ID** – The job identifier, generated by the submitting LoadLeveler cluster.

  Note: The environment variable name is **LOADL_STEP_ID** although the value it contains is a "job" identifier. This name is used to be compatible with the local job filter interface.
- **LOADL_STEP_OWNER** – The owner (UNIX user name) of the job.

CLUSTER_USER_MAPPER
Indicates the installation exit to be run by the inbound Schedd for each remote

job request to determine the user mapping of the cluster. This keyword implies that user mapping is performed. If the keyword is not specified, no user mapping is done.

Syntax:

```
CLUSTER_USER_MAPPER = full_pathname_to_executable
```

The installation exit is run with the following parameters passed as input. All parameters are character strings.

- The user name to be mapped
- The cluster name where the user originated from

This installation exit is executed on the **inbound_hosts** of the local cluster when receiving a job submission, move job request or remote command.

The installation exit must write the new user name as standard output and exit with a value of 0. An exit value of -1 indicates an error and the job is not submitted. STDERR from the exit is written to the Schedd log. An exit value of 1 indicates that the user name returned for this job was **not** mapped.

CM_CHECK_USERID
Specifies whether the central manager will check the existence of user IDs that sent requests through a command or API on the central manager machine.

Syntax:

```
CM_CHECK_USERID = true | false
```

Default value: true

COLLECTOR_DGRAM_PORT
Specifies the port number used when connecting to a daemon.

Syntax:

```
CM_COLLECTOR_PORT = port number
```

Default value: The default is 9612.

COMM
Specifies a local directory where LoadLeveler keeps special files used for UNIX domain sockets for communicating among LoadLeveler daemons running on the same machine. This keyword allows the administrator to choose a different file system other than /tmp for these files. If you change the COMM option you must stop and then restart LoadLeveler using the **llctl** command.

Syntax:

```
COMM = local directory
```

Default value: The default location for the files is **/tmp**.

CONTINUE
Determines whether suspended jobs should continue execution.

Syntax:

```
CONTINUE: expression that evaluates to T or F (true or false)
```

When **T**, suspended LoadLeveler jobs resume execution on the machine.

Default value: No default value is set.

For information about time-related variables that you may use for this keyword, see "Variables to use for setting times" on page 320.

CUSTOM_METRIC
Specifies a machine's relative priority to run jobs.

Syntax:

```
CUSTOM_METRIC = number
```

This is an arbitrary number which you can use in the MACHPRIO expression. Negative values are not allowed.

Default value: If you specify neither **CUSTOM_METRIC** nor **CUSTOM_METRIC_COMMAND**, **CUSTOM_METRIC = 1** is assumed. For more information, see "Setting negotiator characteristics and policies" on page 45.

For more information related to using this keyword, see "Defining a LoadLeveler cluster" on page 44.

CUSTOM_METRIC_COMMAND
Specifies an executable and any required arguments. The exit code of this command is assigned to **CUSTOM_METRIC**. If this command does not exit normally, **CUSTOM_METRIC** is assigned a value of 1. This command is forked every (**POLLING_FREQUENCY** * **POLLS_PER_UPDATE**) period.

Syntax:

```
CUSTOM_METRIC_COMMAND = command
```

Default value: No default is set; LoadLeveler does not run any command to determine CUSTOM_METRIC.

DCE_AUTHENTICATION_PAIR
Specifies a pair of installation supplied programs that are used to authenticate DCE security credentials.

Restriction: DCE security is not supported by LoadLeveler for Linux.

Syntax:

```
DCE_AUTHENTICATION_PAIR = program1, program2
```

Where *program1* and *program2* are LoadLeveler- or installation-supplied programs that are used to authenticate DCE security credentials. *program1* obtains a handle (an opaque credentials object), at the time the job is submitted, which is used to authenticate to DCE. *program2* uses the handle obtained by *program1* to authenticate to DCE before starting the job on the executing machines.

Default value: See "Handling DCE security credentials" on page 74 for information about defaults.

DEFAULT_PREEMPT_METHOD
Specifies the default preemption method for LoadLeveler to use when a preempt method is not specified in a PREEMPT_CLASS statement or in the **llpreempt** command. LoadLeveler also uses this default preemption method to preempt job steps that are running on reserved machines when a reservation period begins.

Restrictions:

- This keyword is valid only for the BACKFILL scheduler.
- The suspend method of preemption (the default) might not be supported on your level of Linux. If you want to preempt jobs that are running where process tracking is not supported, you must use this keyword to specify a method other than suspend.

Syntax:

```
DEFAULT_PREEMPT_METHOD =  rm | sh | su | vc | uh
```

Valid values are:

rm
LoadLeveler preempts the jobs and removes them from the job queue. To rerun the job, the user must resubmit the job to LoadLeveler.

sh LoadLeveler ends the jobs and puts them into System Hold state. They remain in that state on the job queue until an administrator releases them. After being released, the jobs go into Idle state and will be rescheduled to run as soon as resources for the job are available.

su LoadLeveler suspends the jobs and puts them in Preempted state. They remain in that state on the job queue until the preempting job has terminated, and resources are available to resume the preempted job on the same set of nodes. To use this value, process tracking must be enabled.

vc LoadLeveler ends the jobs and puts them in Vacate state. They remain in that state on the job queue and will be rescheduled to run as soon as resources for the job are available.

uh LoadLeveler ends the jobs and puts them into User Hold state. They remain in that state on the job queue until an administrator releases them. After being released, the jobs go into Idle state and will be rescheduled to run as soon as resources for the job are available.

Default value: su (suspend method)

For more information related to using this keyword, see "Steps for configuring a scheduler to preempt jobs" on page 130.

DRAIN_ON_SWITCH_TABLE_ERROR
Specifies whether the **startd** should be drained when the switch table fails to unload. This will flag the administrator that intervention may be required to unload the switch table. When **DRAIN_ON_SWITCH_TABLE_ERROR** is set to true, the **startd** will be drained when the switch table fails to unload.

Syntax:

```
DRAIN_ON_SWITCH_TABLE_ERROR = true | false
```

Default value: false

DSTG_MAX_STARTERS
Specifies a machine-specific limit on the number of data staging initiators. Since each task of a data staging job step consumes one initiator from the **data_stage** class on the specified machine, **DSTG_MAX_STARTERS** provides the maximum number of data staging tasks that can run at the same time on the machine.

Syntax:

```
DSTG_MAX_STARTERS = number
```

Notes:

1. If you have not set the **DSTG_MAX_STARTERS** value in either the global or local configuration files, there will not be any data staging initiators on the specified machine. In this configuration, the compute node will not be allowed to perform data staging tasks.
2. The value specified for **DSTG_MAX_STARTERS** will be the number of initiators available for the built-in **data_stage** class on that machine.

3. The value specified for **MAX_STARTERS** will not limit the value specified for **DSTG_MAX_STARTERS**.

Default value: 0

DSTG_MIN_SCHEDULING_INTERVAL
Specifies a minimum interval between scheduling inbound data staging job steps when they cannot be scheduled immediately. With a workload that involves a lot of data staging jobs, this keyword can be adjusted down from the default value of 900 seconds, if data staging jobs remain idle when there are data staging resources available. Setting this keyword to a smaller interval may impact scheduler performance when there is contention for data staging resources and a large number of idle jobs in the queue.

Syntax:

```
DSTG_MIN_SCHEDULING_INTERVAL = seconds
```

Notes:

1. You can only specify this keyword in the global configuration file; it will be ignored in local configuration files.
2. LoadLeveler ignores **DSTG_MIN_SCHEDULING_INTERVAL** when **DSTG_TIME=AT_SUBMIT**.

Default value: 900 seconds

DSTG_TIME
Specifies that either:

AT_SUBMIT
LoadLeveler can schedule data staging steps any time after a job requiring data staging has been submitted.

JUST_IN_TIME
LoadLeveler must schedule data staging job steps as close as possible to the application job steps that were submitted in the same job.

Syntax:

```
DSTG_TIME = AT_SUBMIT | JUST_IN_TIME
```

Note: You can only specify the **DSTG_TIME** keyword in the global configuration file. Any value specified for this keyword in local configuration files will be ignored.

Default value: AT_SUBMIT

ENFORCE_RESOURCE_MEMORY
Specifies whether the AIX Workload Manager is configured to limit, as precisely as possible, the real memory usage of a WLM class. For this keyword to be valid, ConsumableMemory must be set through the **ENFORCE_RESOURCE_USAGE** keyword.

Syntax:

```
ENFORCE_RESOURCE_MEMORY = true | false
```

Default value: false

ENFORCE_RESOURCE_POLICY
Specifies what type of resource entitlements will be assigned to the AIX Workload Manager classes. If the value specified is **shares**, it means a share value is assigned to the class based on the job step's requested resources (one unit of resource equals one share). This is the default policy. If the value

specified is **soft**, it means a percentage value is assigned to the class based on the job step's requested resources and the total machine resources. This percentage can be exceeded if there is no contention for the resource. If the value specified is **hard**, it means a percentage value is assigned to the class based on the job step's requested resources and the total machine resources. This percentage cannot be exceeded regardless of the contention for the resource. This keyword is only valid for CPU and real memory with either shares or percent limits. If desired, this keyword can be used in the **LoadL_config.local** file to set up a different policy for each machine. The **ENFORCE_RESOURCE_USAGE** keyword must be set for this keyword to be valid.

Syntax:

```
ENFORCE_RESOURCE_POLICY = hard |soft | shares
```

Default value: shares

ENFORCE_RESOURCE_SUBMISSION

Indicates whether jobs submitted should be checked for the **resources** and **node_resources** keywords. If the value specified is **true**, LoadLeveler will check all jobs at submission time for the **resources** and **node_resources** keywords. The job command file **resources** and **node_resources** keywords combined need to have at least the resources specified in the **ENFORCE_RESOURCE_USAGE** keyword in order for the job to be submitted successfully. When **RSET_MCM_AFFINITY** is enabled, the **task_affinity** or **parallel_threads** keyword can be used instead of the **resources** and **node_resources** keywords when the resource being enforced is **ConsumableCpus**.

If the value specified is **false**, no checking will be done and jobs submitted without the **resources** or **node_resources** keywords will not have resources enforced. In this instance, those jobs might interfere with other jobs whose resources are enforced.

Syntax:

```
ENFORCE_RESOURCE_SUBMISSION = true | false
```

Default value: false

ENFORCE_RESOURCE_USAGE

Specifies whether the AIX Workload Manager is used to enforce CPU and memory resources. This keyword accepts either a value of **deactivate** or a list of one or more of the following predefined resources:

- **ConsumableCpus**
- **ConsumableMemory**
- **ConsumableVirtualMemory**
- **ConsumableLargePageMemory**

Either memory or CPUs or both can be enforced but the resources must also be specified on the **SCHEDULE_BY_RESOURCES** keyword. If **deactivate** is specified, LoadLeveler will deactivate AIX Workload Manager on all the nodes in the LoadLeveler cluster.

Restriction: WLM enforcement is ignored by LoadLeveler for Linux.

Syntax:

```
ENFORCE_RESOURCE_USAGE = name name ... name | deactivate
```

EXECUTE
Specifies the local directory to store the executables of jobs submitted by other machines.

Syntax:

```
EXECUTE = local directory/execute
```

Default value: `$(tilde)/execute`

FAIR_SHARE_INTERVAL
Specifies, in units of hours, the time interval it takes for resource usage in fair share scheduling to decay to 5% of its initial value. Historic fair share data collected before the most recent time interval of this length will have little impact on fair share scheduling.

Syntax:

```
FAIR_SHARE_INTERVAL = hours
```

Default value: The default value is 168 hours (one week). If a negative value or 0 is specified, the default value is used.

FAIR_SHARE_TOTAL_SHARES
Specifies the total number of shares that the cluster CPU or Blue Gene resources are divided into. If this value is less than or equal to 0, fair share scheduling is turned off.

Syntax:

```
FAIR_SHARE_TOTAL_SHARES = shares
```

Default value: The default value is 0.

FEATURE
Specifies an optional characteristic to use to match jobs with machines. You can specify unique characteristics for any machine using this keyword. When evaluating job submissions, LoadLeveler compares any required features specified in the job command file to those specified using this keyword. You can have a maximum of 1024 characters in the feature statement.

Syntax:

```
Feature = {"string" ...}
```

Default value: No default value is set.

Example: If a machine has licenses for installed products ABC and XYZ in the local configuration file, you can enter the following:

```
Feature = {"abc" "xyz"}
```

When submitting a job that requires both of these products, you should enter the following in your job command file:

```
requirements = (Feature == "abc") && (Feature == "xyz")
```

Note: You must define a feature on all machines that will be able to run dynamic simultaneous multithreading (SMT). SMT is only supported on POWER6 and POWER5 processor-based systems.

Example: When submitting a job that requires the SMT function, first specify **smt = yes** in job command file (or select a class which had **smt = yes** defined). Next, specify **node_usage = not_shared** and last, enter the following in the job command file:

```
requirements = (Feature == "smt")
```

FLOATING_RESOURCES

Specifies which consumable resources are available collectively on all of the machines in the LoadLeveler cluster. The count for each resource must be an integer greater than or equal to zero, and each resource can only be specified once in the list. Any resource specified for this keyword that is not already listed in the **SCHEDULE_BY_RESOURCES** keyword will not affect job scheduling. If any resource is specified incorrectly with the **FLOATING_RESOURCES** keyword, then all floating resources will be ignored. **ConsumableCpus**, **ConsumableMemory**, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** may not be specified as floating resources.

Syntax:

```
FLOATING_RESOURCES = name(count) name(count) ... name(count)
```

Default value: No default value is set.

FS_INTERVAL

Defines the number of minutes used as the interval for checking free file system space or inodes. If your file system receives many log messages or copies large executables to the LoadLeveler spool, the file system will fill up quicker and you should perform file size checking more frequently by setting the interval to a smaller value. LoadLeveler will not check the file system if the value of FS_INTERVAL is:

- Set to zero
- Set to a negative integer

Syntax:

```
FS_INTERVAL = minutes
```

Default value: If FS_INTERVAL is not specified but any of the other file-system keywords (FS_NOTIFY, FS_SUSPEND, FS_TERMINATE, INODE_NOTIFY, INODE_SUSPEND, INODE_TERMINATE) are specified, the FS_INTERVAL value will default to 5 and the file system will be checked. If no file-system or inode keywords are set, LoadLeveler does not monitor file systems at all.

For more information related to using this keyword, see “Setting up file system monitoring” on page 54.

FS_NOTIFY

Defines the lower and upper amounts, in bytes, of free file-system space at which LoadLeveler is to notify the administrator:

- If the amount of free space becomes less than the lower threshold value, LoadLeveler sends a mail message to the administrator indicating that logging problems may occur.
- When the amount of free space becomes greater than the upper threshold value, LoadLeveler sends a mail message to the administrator indicating that problem has been resolved.

Syntax:

```
FS_NOTIFY = lower threshold, upper threshold
```

Specify space in bytes with the unit B. A metric prefix such as K, M, or G may precede the B. The valid range for both the lower and upper thresholds are -1B and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

Default value: In bytes: 1KB, -1B

For more information related to using this keyword, see "Setting up file system monitoring" on page 54.

FS_SUSPEND

Defines the lower and upper amounts, in bytes, of free file system space at which LoadLeveler drains and resumes the Schedd and startd daemons running on a node.

- If the amount of free space becomes less than the lower threshold value, then LoadLeveler drains the Schedd and the startd daemons if they are running on a node. When this happens, logging is turned off and mail notification is sent to the administrator.
- When the amount of free space becomes greater than the upper threshold value, LoadLeveler signals the Schedd and the startd daemons to resume. When this happens, logging is turned on and mail notification is sent to the administrator.

Syntax:

```
FS_SUSPEND = lower threshold, upper threshold
```

Specify space in bytes with the unit B. A metric prefix such as K, M, or G may precede the B. The valid range for both the lower and upper thresholds are -1B and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

Default value: In bytes: -1B, -1B

For more information related to using this keyword, see "Setting up file system monitoring" on page 54.

FS_TERMINATE

Defines the lower and upper amounts, in bytes, of free file system space at which LoadLeveler is terminated. This keyword sends the SIGTERM signal to the Master daemon which then terminates all LoadLeveler daemons running on the node.

- If the amount of free space becomes less than the lower threshold value, all LoadLeveler daemons are terminated.
- An upper threshold value is required for this keyword. However, since LoadLeveler has been terminated at the lower threshold, no action occurs.

Syntax:

```
FS_TERMINATE = lower threshold, upper threshold
```

Specify space in bytes with the unit B. A metric prefix such as K, M, or G may precede the B. The valid range for the lower threshold is -1B and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

Default value: In bytes: -1B, -1B

For more information related to using this keyword, see "Setting up file system monitoring" on page 54.

GLOBAL_HISTORY

Identifies the directory that will contain the global history files produced by **llacctmrg** command when no directory is specified as a command argument.

Syntax:

```
GLOBAL_HISTORY = directory
```

Default value: The default value is **$(SPOOL)** (the local spool directory).

For more information related to using this keyword, see "Collecting the accounting information and storing it into files" on page 66.

GSMONITOR
Location of the gsmonitor executable (**LoadL_GSmonitor**).

Restriction: This keyword is ignored by LoadLeveler for Linux.

Syntax:

```
GSMONITOR = directory
```

Default value: $(BIN)/LoadL_GSmonitor

GSMONITOR_COREDUMP_DIR
Local directory for storing **LoadL_GSmonitor** core dump files.

Restriction: This keyword is ignored by LoadLeveler for Linux.

Syntax:

```
GSMONITOR_COREDUMP_DIR = directory
```

Default value: The **/tmp** directory.

For more information related to using this keyword, see "Specifying file and directory locations" on page 47.

GSMONITOR_DOMAIN
Specifies the peer domain, on which the GSMONITOR daemon will execute.

Restriction: This keyword is ignored by LoadLeveler for Linux.

Syntax:

```
GSMONITOR_DOMAIN = PEER
```

Default value: No default value is set.

For more information related to using this keyword, see "The gsmonitor daemon" on page 14.

GSMONITOR_RUNS_HERE
Specifies whether the gsmonitor daemon will run on the host.

Restriction: This keyword is ignored by LoadLeveler for Linux.

Syntax:

```
GSMONITOR_RUNS_HERE = TRUE | FALSE
```

Default value: FALSE

For more information related to using this keyword, see "The gsmonitor daemon" on page 14.

HISTORY
Defines the path name where a file containing the history of local LoadLeveler jobs is kept.

Syntax:

```
HISTORY = directory
```

Default value: $(SPOOL)/history

For more information related to using this keyword, see "Collecting the accounting information and storing it into files" on page 66.

HISTORY_PERMISSION
Specifies the owner, group, and world permissions of the history file associated with a **LoadL_schedd** daemon.

Syntax:

```
HISTORY_PERMISSION = permissions | rw-rw----
```

permissions must be a string with a length of nine characters and consisting of the characters, **r**, **w**, **x**, or **-**.

Default value: The default settings are 660 (**rw-rw----**). **LoadL_schedd** will use the default setting if the specified permission are less than **rw-------**.

Example: A specification such as `HISTORY_PERMISSION = rw-rw-r--` will result in permission settings of 664.

INODE_NOTIFY

Defines the lower and upper amounts, in inodes, of free file-system inodes at which LoadLeveler is to notify the administrator:

- If the number of free inodes becomes less than the lower threshold value, LoadLeveler sends a mail message to the administrator indicating that logging problems may occur.
- When the number of free inodes becomes greater than the upper threshold value, LoadLeveler sends a mail message to the administrator indicating that problem has been resolved.

Syntax:

```
INODE_NOTIFY = lower threshold, upper threshold
```

The valid range for both the lower and upper thresholds are -1 and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

Default value: In inodes: 1000, -1

For more information related to using this keyword, see "Setting up file system monitoring" on page 54.

INODE_SUSPEND

Defines the lower and upper amounts, in inodes, of free file system inodes at which LoadLeveler drains and resumes the Schedd and startd daemons running on a node.

- If the number of free inodes becomes less than the lower threshold value, then LoadLeveler drains the Schedd and the startd daemons if they are running on a node. When this happens, logging is turned off and mail notification is sent to the administrator.
- When the number of free inodes becomes greater than the upper threshold value, LoadLeveler signals the Schedd and the startd daemons to resume. When this happens, logging is turned on and mail notification is sent to the administrator.

Syntax:

```
INODE_SUSPEND = lower threshold, upper threshold
```

The valid range for both the lower and upper thresholds are -1 and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

Default value: In inodes: -1, -1

For more information related to using this keyword, see "Setting up file system monitoring" on page 54.

INODE_TERMINATE

Defines the lower and upper amounts, in inodes, of free file system inodes at

which LoadLeveler is terminated. This keyword sends the SIGTERM signal to the Master daemon which then terminates all LoadLeveler daemons running on the node.

- If the number of free inodes becomes less than the lower threshold value, all LoadLeveler daemons are terminated.
- An upper threshold value is required for this keyword. However, since LoadLeveler has been terminated at the lower threshold, no action occurs.

Syntax:

```
INODE_TERMINATE = lower threshold, upper threshold
```

The valid range for the lower threshold is -1 and all positive integers. If the value is set to -1, the transition across the threshold is not checked.

Default value: In inodes: -1, -1

For more information related to using this keyword, see "Setting up file system monitoring" on page 54.

JOB_ACCT_Q_POLICY

Specifies the amount of time, in seconds, that determines how often the startd daemon updates the Schedd daemon with accounting data of running jobs. This controls the accuracy of the **llq -x** command.

Syntax:

```
JOB_ACCT_Q_POLICY = number
```

Default value: 300 seconds

For more information related to using this keyword, see "Gathering job accounting data" on page 61.

JOB_EPILOG

Path name of the epilog program.

Syntax:

```
JOB_EPILOG = program name
```

Default value: No default value is set.

For more information related to using this keyword, see "Writing prolog and epilog programs" on page 77.

JOB_LIMIT_POLICY

Specifies the amount of time, in seconds, that LoadLeveler checks to see if **job_cpu_limit** has been exceeded. The smaller of **JOB_LIMIT_POLICY** and **JOB_ACCT_Q_POLICY** is used to control how often the **startd** daemon collects resource consumption data on running jobs, and how often the **job_cpu_limit** is checked.

Syntax:

```
JOB_LIMIT_POLICY = number
```

Default value: The default for **JOB_LIMIT_POLICY** is **POLLING_FREQUENCY** multiplied by **POLLS_PER_UPDATE**.

JOB_PROLOG

Path name of the prolog program.

Syntax:

```
JOB_PROLOG = program name
```

Default value: No default value is set.

For more information related to using this keyword, see “Writing prolog and epilog programs” on page 77.

JOB_USER_EPILOG
Path name of the user epilog program.

Syntax:
`JOB_USER_EPILOG = program name`

Default value: No default value is set.

For more information related to using this keyword, see “Writing prolog and epilog programs” on page 77.

JOB_USER_PROLOG
Path name of the user prolog program.

Syntax:
`JOB_USER_PROLOG = program name`

Default value: No default value is set.

For more information related to using this keyword, see “Writing prolog and epilog programs” on page 77.

KBDD
Location of kbdd executable (**LoadL_kbdd**).

Syntax:
`KBDD = directory`

Default value: `$(BIN)/LoadL_kbdd`

KBDD_COREDUMP_DIR
Local directory for storing **LoadL_kbdd** daemon core dump files.

Syntax:
`KBDD_COREDUMP_DIR = directory`

Default value: The **/tmp** directory.

For more information related to using this keyword, see “Specifying file and directory locations” on page 47.

KILL
Determines whether or not vacated jobs should be sent the SIGKILL signal and replaced in the queue. It is used to remove a job that is taking too long to vacate.

Syntax:
`KILL: expression that evaluates to T or F (true or false)`

When **T**, vacated LoadLeveler jobs are removed from the machine with no attempt to take checkpoints.

For information about time-related variables that you may use for this keyword, see “Variables to use for setting times” on page 320.

LIB
Defines the directory where LoadLeveler libraries are kept.

Syntax:
`LIB = directory`

Default value: `$(RELEASEDIR)/lib`

LL_RSH_COMMAND

Specifies an administrator provided executable to be used by **llctl start** when starting LoadLeveler on remote machines in the administration file. The **LL_RSH_COMMAND** keyword is any executable that can be used as a substitute for **/usr/bin/rsh**. The **llctl start** command passes arguments to the executable specified by **LL_RSH_COMMAND** in the following format:

```
LL_RSH_COMMAND hostname -n llctl start options
```

Syntax:

```
LL_RSH_COMMAND = full_path_to_executable
```

Default value: /usr/bin/rsh. This keyword must specify the full path name to the executable provided. If no value is specified, LoadLeveler will use **/usr/bin/rsh** as the default when issuing a start. If an error occurred while locating the executable specified, an error message will be displayed.

Example: This example shows that using the secure shell (**/usr/bin/ssh**) is the preferred method for the **llctl start** command to communicate with remote nodes. Specify the following in the configuration file:

```
LL_RSH_COMMAND=/usr/bin/ssh
```

LOADL_ADMIN

Specifies a list of LoadLeveler administrators.

Syntax:

```
LOADL_ADMIN = list of user names
```

Where *list of user names* is a blank-delimited list of those individuals who will have administrative authority. These users are able to invoke the administrator-only commands such as **llctl**, **llfavorjob**, and **llfavoruser**. These administrators can also invoke the administrator-only GUI functions. For more information, see Chapter 7, "Using LoadLeveler's GUI to perform administrator tasks," on page 169.

Default value: No default value is set, which means no one has administrator authority until this keyword is defined with one or more user names.

Example: To grant administrative authority to users `bob` and `mary`, enter the following in the configuration file:

```
LOADL_ADMIN = bob mary
```

For more information related to using this keyword, see "Defining LoadLeveler administrators" on page 43.

LOCAL_CONFIG

Specifies the path name of the optional local configuration file containing information specific to a node in the LoadLeveler network.

Syntax:

```
LOCAL_CONFIG = directory
```

Default value: No default value is set.

Examples:

- If you are using a distributed file system like NFS, some examples are:

```
LOCAL_CONFIG = $(tilde)/$(host).LoadL_config.local
LOCAL_CONFIG = $(tilde)/LoadL_config.$(host).$(domain)
LOCAL_CONFIG = $(tilde)/LoadL_config.local.$(hostname)
```

See "LoadLeveler variables" on page 314 for information about the **tilde**, **host**, and **domain** variables.

- If you are using a local file system, an example is:

  ```
  LOCAL_CONFIG = /var/LoadL/LoadL_config.local
  ```

LOG

Defines the local directory to store log files. It is not necessary to keep all the log files created by the various LoadLeveler daemons and programs in one directory, but you will probably find it convenient to do so.

Syntax:

```
LOG = local directory/log
```

Default value: `$(tilde)/log`

LOG_MESSAGE_THRESHOLD

Specifies the maximum amount of memory, in bytes, for the message queue. Messages in the queue are waiting to be written to the log file. When the message logging thread cannot write messages to the log file as fast as they arrive, the memory consumed by the message queue can exceed the threshold. In this case, LoadLeveler will curtail logging by turning off all debug flags except **D_ALWAYS**, therefore, reducing the amount of logging that takes place. If the threshold is exceeded by the curtailed message queue, message logging is stopped. Special log messages are written to the log file, which indicate that some messages are missing. Mail is also sent to the administrator indicating that messages are missing. A value of -1 for this keyword will turn off the buffer threshold meaning that the threshold is unlimited.

Syntax:

```
LOG_MESSAGE_THRESHOLD = bytes
```

Default value: 20*1024*1024 (bytes)

MACHINE_AUTHENTICATE

Specifies whether machine validation is performed. When set to **true**, LoadLeveler only accepts connections from machines specified in the administration file. When set to **false**, LoadLeveler accepts connections from any machine.

When set to **true**, every communication between LoadLeveler processes will verify that the sending process is running on a machine which is identified via a machine stanza in the administration file. The validation is done by capturing the address of the sending machine when the **accept** function call is issued to accept a connection. The **gethostbyaddr** function is called to translate the address to a name, and the name is matched with the list derived from the administration file.

Note: You must not set the **MACHINE_AUTHENTICATE** keyword to **true** for a cluster which is configured to be a main scale-across cluster. The main scale-across cluster must permit communication with LoadLeveler daemons running on any machine in any cluster participating in the scale-across multicluster environment.

Syntax:

```
MACHINE_AUTHENTICATE = true | false
```

Default value: false

For more information related to using this keyword, see "Defining a LoadLeveler cluster" on page 44.

MACHINE_UPDATE_INTERVAL
Specifies the time, in seconds, during which machines must report to the central manager.

Syntax:

```
MACHINE_UPDATE_INTERVAL = number
```

Where *number* specifies the time period, in seconds, during which machines must report to the central manager. Machines that do not report in this number of seconds are considered *down*. *number* must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 300 seconds.

For more information related to using this keyword, see "Setting negotiator characteristics and policies" on page 45.

MACHPRIO
Machine priority expression.

Syntax:

```
MACHPRIO = expression
```

You can use the following LoadLeveler variables in the **MACHPRIO** expression:

- **LoadAvg**
- **Connectivity**
- **Cpus**
- **Speed**
- **Memory**
- **VirtualMemory**
- **Disk**
- **CustomMetric**
- **MasterMachPriority**
- **ConsumableCpus**
- **ConsumableMemory**
- **ConsumableVirtualMemory**
- **ConsumableLargePageMemory**
- **PagesFreed**
- **PagesScanned**
- **FreeRealMemory**

For detailed descriptions of these variables, see "LoadLeveler variables" on page 314.

Default value: (0 - LoadAvg)

Examples:

- Example 1

  This example orders machines by the Berkeley one-minute load average.

  ```
  MACHPRIO : 0 - (LoadAvg)
  ```

  Therefore, if **LoadAvg** equals .7, this example would read:

  ```
  MACHPRIO : 0 - (.7)
  ```

  The **MACHPRIO** would evaluate to -.7.
- Example 2

This example orders machines by the Berkeley one-minute load average normalized for machine speed:

```
MACHPRIO : 0 - (1000 * (LoadAvg / (Cpus * Speed)))
```

Therefore, if **LoadAvg** equals .7, **Cpus** equals 1, and **Speed** equals 2, this example would read:

```
MACHPRIO : 0 - (1000 * (.7 / (1 * 2)))
```

This example further evaluates to:

```
MACHPRIO : 0 - (350)
```

The **MACHPRIO** would evaluate to -350.

Notice that if the speed of the machine were increased to 3, the equation would read:

```
MACHPRIO : 0 - (1000 * (.7 / (1 * 3)))
```

The **MACHPRIO** would evaluate to approximately -233. Therefore, as the speed of the machine increases, the **MACHPRIO** also increases.

- Example 3

  This example orders machines accounting for real memory and available swap space (remembering that Memory is in Mbytes and VirtualMemory is in Kbytes):

  ```
  MACHPRIO : 0 - (10000 * (LoadAvg / (Cpus * Speed))) +
  (10 * Memory) + (VirtualMemory / 1000)
  ```

- Example 4

  This example sets a relative machine priority based on the value of the **CUSTOM_METRIC** keyword.

  ```
  MACHPRIO : CustomMetric
  ```

  To do this, you must specify a value for the **CUSTOM_METRIC** keyword or the **CUSTOM_METRIC_COMMAND** keyword in either the **LoadL_config.local** file of a machine or in the global **LoadL_config** file. To assign the same relative priority to all machines, specify the **CUSTOM_METRIC** keyword in the global configuration file. For example:

  ```
  CUSTOM_METRIC = 5
  ```

  You can override this value for an individual machine by specifying a different value in that machine's **LoadL_config.local** file.

- Example 5

  This example gives master nodes the highest priority:

  ```
  MACHPRIO : (MasterMachPriority * 10000)
  ```

- Example 6

  This example gives nodes the with highest percentage of switch adapters with connectivity the highest priority:

  ```
  MACHPRIO : Connectivity
  ```

For more information related to using this keyword, see "Setting negotiator characteristics and policies" on page 45.

MAIL

Name of a local mail program used to override default mail notification.

Syntax:

```
MAIL = program name
```

Default value: No default value is set.

For more information related to using this keyword, see "Using your own mail program" on page 81.

MASTER
Location of the master executable (**LoadL_master**).

Syntax:

```
MASTER = directory
```

Default value: `$(BIN)/LoadL_master`

For more information related to using this keyword, see "How LoadLeveler daemons process jobs" on page 8.

MASTER_COREDUMP_DIR
Local directory for storing **LoadL_master** core dump files.

Syntax:

```
MASTER_COREDUMP_DIR = directory
```

Default value: The **/tmp** directory.

For more information related to using this keyword, see "Specifying file and directory locations" on page 47.

MASTER_DGRAM_PORT
The port number used when connecting to the daemon.

Syntax:

```
MASTER_DGRAM_PORT = port number
```

Default value: The default is 9617.

For more information related to using this keyword, see "Defining network characteristics" on page 47.

MASTER_STREAM_PORT
Specifies the port number to be used when connecting to the daemon.

Syntax:

```
MASTER_STREAM_PORT = port number
```

Default value: The default is 9616.

For more information related to using this keyword, see "Defining network characteristics" on page 47.

MAX_CKPT_INTERVAL
The maximum number of seconds between checkpoints for running jobs.

Syntax:

```
MAX_CKPT_INTERVAL = number
```

Default value: 7200 (2 hours)

For more information related to using this keyword, see "LoadLeveler support for checkpointing jobs" on page 139.

MAX_JOB_REJECT
Determines the number of times a job is rejected before it is canceled or put in User Hold or System Hold status.

Syntax:

```
MAX_JOB_REJECT = number
```

number must be a numerical value and cannot be an arithmetic expression. **MAX_JOB_REJECT** may be set to unlimited rejects by specifying a value of –1.

Default value: The default value is 0, which indicates a rejected job will immediately be canceled or placed on hold.

For related information, see the **NEGOTIATOR_REJECT_DEFER** keyword.

MAX_RESERVATIONS
Specifies the maximum number of reservations that this LoadLeveler cluster can have. Only reservations in waiting and in use are counted toward this limit; LoadLeveler does not count reservations that have already ended or are in the process of being canceled.

Notes:

1. Having too many reservations in a LoadLeveler cluster can have performance impacts. Administrators should select a suitable value for this keyword.
2. A recurring reservation only counts as one reservation towards the **MAX_RESERVATIONS** limit regardless of the number of times that the reservation recurs.

Syntax:

```
MAX_RESERVATIONS = number
```

The value for this keyword can be 0 or a positive integer.

Default value: The default is 10.

MAX_STARTERS
Specifies the maximum number of tasks that can run simultaneously on a machine. In this case, a task can be a serial job step or a parallel task. **MAX_STARTERS** defines the number of initiators on the machine (the number of tasks that can be initiated from a **startd**).

Syntax:

```
MAX_STARTERS = number
```

Default value: If this keyword is not specified, the default is the number of elements in the **Class** statement.

For more information related to using this keyword, see "Specifying how many jobs a machine can run" on page 55.

MAX_TOP_DOGS
Specifies the maximum total number of top dogs that the central manager daemon will allocate. When scheduling jobs, after **MAX_TOP_DOGS** total top dogs have been allocated, no more will be considered.

Syntax:

```
MAX_TOP_DOGS = k | 1
```

where: *k* is a non-negative integer specifying the global maximum top dogs limit.

Default value: The default value is **1**.

For more information related to using this keyword, see "Using the BACKFILL scheduler" on page 110.

MIN_CKPT_INTERVAL
The minimum number of seconds between checkpoints for running jobs.

Syntax:

```
MIN_CKPT_INTERVAL = number
```

Default value: 900 (15 minutes)

For more information related to using this keyword, see "LoadLeveler support for checkpointing jobs" on page 139.

NEGOTIATOR
Location of the negotiator executable (**LoadL_negotiator**).

Syntax:

```
NEGOTIATOR = directory
```

Default value: `$(BIN)/LoadL_negotiator`

For more information related to using this keyword, see "How LoadLeveler daemons process jobs" on page 8.

NEGOTIATOR_COREDUMP_DIR
Local directory for storing **LoadL_negotiator** core dump files.

Syntax:

```
NEGOTIATOR_COREDUMP_DIR = directory
```

Default value: The **/tmp** directory.

For more information related to using this keyword, see "Specifying file and directory locations" on page 47.

NEGOTIATOR_CYCLE_DELAY
Specifies the minimum time, in seconds, the negotiator delays between periods when it attempts to schedule jobs. This time is used by the negotiator daemon to respond to queries, reorder job queues, collect information about changes in the states of jobs, and so on. Delaying the scheduling of jobs might improve the overall performance of the negotiator by preventing it from spending excessive time attempting to schedule jobs.

Syntax:

```
NEGOTIATOR_CYCLE_DELAY = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 0 seconds

NEGOTIATOR_CYCLE_TIME_LIMIT
Specifies the maximum amount of time, in seconds, that LoadLeveler will allow the negotiator to spend in one cycle trying to schedule jobs. The negotiator cycle will end, after the specified number of seconds, even if there are additional jobs waiting for dispatch. Jobs waiting for dispatch will be considered at the next negotiator cycle. The **NEGOTIATOR_CYCLE_TIME_LIMIT** keyword applies only to the BACKFILL scheduler.

Syntax:

```
NEGOTIATOR_CYCLE_TIME_LIMIT = number
```

Where *number* must be a positive integer or zero and cannot be an arithmetic expression.

Default value: If the keyword value is not specified or a value of zero is used, the negotiator cycle will be unlimited.

NEGOTIATOR_INTERVAL
The time interval, in seconds, at which the negotiator daemon updates the status of jobs in the LoadLeveler cluster and negotiates with machines that are available to run jobs.

Syntax:

```
NEGOTIATOR_INTERVAL = number
```

Where *number* specifies the interval, in seconds, at which the negotiator daemon performs a "negotiation loop" during which it attempts to assign available machines to waiting jobs. A negotiation loop also occurs whenever job states or machine states change. *number* must be a numerical value and cannot be an arithmetic expression.

When this keyword is set to zero, the central manager's automatic scheduling activity is been disabled, and LoadLeveler will not attempt to schedule any jobs unless instructed to do so through the **llrunscheduler** command or **ll_run_scheduler** subroutine.

Default value: The default is 30 seconds.

For more information related to using this keyword, see "Controlling the central manager scheduling cycle" on page 73.

NEGOTIATOR_LOADAVG_INCREMENT
Specifies the value the negotiator adds to the startd machine's load average whenever a job in the Pending state is queued on that machine. This value is used to compensate for the increased load caused by starting another job.

Syntax:

```
NEGOTIATOR_LOADAVG_INCREMENT = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default value is .5

NEGOTIATOR_PARALLEL_DEFER
Specifies the amount of time, in seconds, that defines how long a job stays out of the queue after it fails to get the correct number of processors. This keyword applies only to the default LoadLeveler scheduler. This keyword must be greater than the **NEGOTIATOR_INTERVAL**. value; if it is not, the default is used.

Syntax:

```
NEGOTIATOR_PARALLEL_DEFER = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is **NEGOTIATOR_INTERVAL** multiplied by 5.

NEGOTIATOR_PARALLEL_HOLD
Specifies the amount of time, in seconds, that defines how long a job is given to accumulate processors. This keyword applies only to the default LoadLeveler scheduler. This keyword must be greater than the **NEGOTIATOR_INTERVAL** value; if it is not, the default is used.

Syntax:

```
NEGOTIATOR_PARALLEL_HOLD = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is **NEGOTIATOR_INTERVAL** multiplied by 5.

NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL
Specifies the amount of time, in seconds, between calculation of the **SYSPRIO** values for waiting jobs. Recalculating the priority can be CPU-intensive; specifying low values for the **NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL** keyword may lead to a heavy CPU load on the **negotiator** if a large number of jobs are running or waiting for resources. A value of 0 means the **SYSPRIO** values are not recalculated.

You can use this keyword to base the order in which jobs are run on the current number of running, queued, or total jobs for a user or a group.

Syntax:

```
NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 120 seconds.

NEGOTIATOR_REJECT_DEFER
Specifies the amount of time in seconds the negotiator waits before it considers scheduling a job to a machine that recently rejected the job.

Syntax:

```
NEGOTIATOR_REJECT_DEFER = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 120 seconds.

For related information, see the **MAX_JOB_REJECT** keyword.

NEGOTIATOR_REMOVE_COMPLETED
Specifies the amount of time, in seconds, that you want the negotiator to keep information regarding completed and removed jobs so that you can query this information using the **llq** command.

Syntax:

```
NEGOTIATOR_REMOVE_COMPLETED = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 0 seconds.

NEGOTIATOR_RESCAN_QUEUE
specifies the amount of time in seconds that defines how long the negotiator waits to rescan the job queue for machines which have bypassed jobs which could not run due to conditions which may change over time. This keyword must be greater than the **NEGOTIATOR_INTERVAL** value; if it is not, the default is used.

Syntax:

```
NEGOTIATOR_RESCAN_QUEUE = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 900 seconds.

NEGOTIATOR_STREAM_PORT
Specifies the port number used when connecting to the daemon.

Syntax:

```
NEGOTIATOR_STREAM_PORT = port number
```

Default value: The default is 9614.

For more information related to using this keyword, see "Defining network characteristics" on page 47.

OBITUARY_LOG_LENGTH
Specifies the number of lines from the end of the file that are appended to the mail message. The master daemon mails this log to the LoadLeveler administrators when one of the daemons dies.

Syntax:

```
OBITUARY_LOG_LENGTH = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 25.

POLLING_FREQUENCY
Specifies the interval, in seconds, with which the startd daemon evaluates the load on the local machine and decides whether to suspend, resume, or abort jobs. This time is also the minimum interval at which the kbdd daemon reports keyboard or mouse activity to the startd daemon.

Syntax:

```
POLLING_FREQUENCY = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 5.

POLLS_PER_UPDATE
Specifies how often, in **POLLING_FREQUENCY** intervals, startd daemon updates the central manager. Due to the communication overhead, it is impractical to do this with the frequency defined by the **POLLING_FREQUENCY** keyword. Therefore, the startd daemon only updates the central manager every *n*th (where *n* is the number specified for **POLLS_PER_UPDATE**) local update. Change **POLLS_PER_UPDATE** when changing the **POLLING_FREQUENCY**.

Syntax:

```
POLLS_PER_UPDATE = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 24.

PRESTARTED_STARTERS
Specifies how many prestarted starter processes LoadLeveler will maintain on an execution node to manage jobs when they arrive. The startd daemon starts the number of starter processes specified by this keyword. You may specify this keyword in either the global or local configuration file.

Syntax:

```
PRESTARTED_STARTERS = number
```

number must be less than or equal to the value specified through the MAX_STARTERS keyword. If the value of PRESTARTED_STARTERS specified is greater then MAX_STARTERS, LoadLeveler records a warning message in the startd log and assigns PRESTARTED_STARTERS the same value as MAX_STARTERS.

If the value PRESTARTED_STARTERS is zero, no starter processes will be started before jobs arrive on the execution node.

Default value: The default is 1.

PREEMPT_CLASS

Defines the preemption rule for a job class.

Syntax: The following forms illustrate correct syntax.

PREEMPT_CLASS[*incoming_class***] = ALL[:***preempt_method***] { *outgoing_class1* [*outgoing_class2* ...] }**

Using this form, ALL indicates that job steps of *incoming_class* have priority and will not share nodes with job steps of *outgoing_class1*, *outgoing_class2*, or other outgoing classes. If a job step of the *incoming_class* is to be started on a set of nodes, all job steps of *outgoing_class1*, *outgoing_class2*, or other outgoing classes running on those nodes will be preempted.

Note: The **ALL** preemption rule does not apply to Blue Gene jobs.

PREEMPT_CLASS[*incoming_class***] = ENOUGH[:***preempt_method***] {** *outgoing_class1* **[***outgoing_class2* **...] }**

Using this form, ENOUGH indicates that job steps of *incoming_class* will share nodes with job steps of *outgoing_class1*, *outgoing_class2*, or other outgoing classes if there are sufficient resources. If a job step of the *incoming_class* is to be started on a set of nodes, one or more job steps of *outgoing_class1*, *outgoing_class2*, or other outgoing classes running on those nodes may be preempted to get needed resources.

Combinations of these forms are also allowed.

Note:

1. The optional specification *preempt_method* indicates which method LoadLeveler is to use to preempt the jobs; this specification is valid only for the BACKFILL scheduler. Valid values for this specification in keyword syntax are the highlighted abbreviations in parentheses:
   - Remove (**rm**)
   - System hold (**sh**)
   - Suspend (**su**)
   - Vacate (**vc**)
   - User hold (**uh**)

   For more information about preemption methods, see "Steps for configuring a scheduler to preempt jobs" on page 130.
2. Using the "ALL" value in the PREEMPT_CLASS keyword places implied restrictions on when a job can start. See "Planning to preempt jobs" on page 128 for more information.
3. The incoming class is designated inside [ ] brackets.
4. Outgoing classes are designated inside { } curly braces.
5. The job classes on the right hand (outgoing) side of the statement must be different from incoming class, or it may be **allclasses**. If the outgoing side is defined as **allclasses** then all job classes are preemptable with the exception of the incoming class specified within brackets.

6. A class name or **allclasses** should not be in both the ALL list and the ENOUGH list. If you do so, the entire statement will be ignored. An example of this is:

   ```
   PREEMPT_CLASS[Class_A]=ALL{allclasses} ENOUGH {allclasses}
   ```

7. If you use **allclasses** as an outgoing (preemptable) class, then no other class names should be listed at the right hand side as the entire statement will be ignored. An example of this is:

   ```
   PREEMPT_CLASS[Class_A]=ALL{Class_B} ENOUGH {allclasses}
   ```

8. More than one ALL statement and more than one ENOUGH statement may appear at the right hand side. Multiple statements have a cumulative effect.
9. Each ALL or ENOUGH statement can have multiple class names inside the curly braces. However, a blank space delimiter is required between each class name.
10. Both the ALL and ENOUGH statements can include an optional specification indicating the method LoadLeveler will use to preempt the jobs. Valid values for this specification are listed in the description of the DEFAULT_PREEMPT_METHOD keyword. If a value is specified on the PREEMPT_CLASS ALL or ENOUGH statement, that value overrides the value set on the DEFAULT_PREEMPT_METHOD keyword, if any.
11. ALL and ENOUGH may be in mixed cases.
12. Spaces are allowed around the brackets and curly braces.
13. PREEMPT_CLASS [allclasses] will be ignored.

Default value: No default value is set.

Examples:

```
PREEMPT_CLASS[Class_B]=ALL{Class_E Class_D} ENOUGH {Class_C}
```

This indicates that all Class_E jobs and all Class_D jobs and enough Class_C jobs will be preempted to enable an incoming Class_B job to run.

```
PREEMPT_CLASS[Class_D]=ENOUGH:VC {Class_E}
```

This indicates that zero, one, or more Class_E jobs will be preempted using the vacate method to enable an incoming Class_D job to run.

PREEMPTION_SUPPORT

For the BACKFILL or API schedulers only, specifies the level of preemption support for a cluster.

Syntax:

```
PREEMPTION_SUPPORT= full | no_adapter | none
```

- When set to **full**, preemption is fully supported.
- When set to **no_adapter**, preemption is supported but the adapter resources are not released by preemption.
- When set to **none**, preemption is not supported, and preemption requests will be rejected.

Note:

1. If the value of this keyword is set to any value other than **none** for the default scheduler, LoadLeveler will not start.

2. For the BACKFILL or API scheduler, when this keyword is set to **full** or **no_adapter** and preemption by the suspend method is required, the configuration keyword **PROCESS_TRACKING** must be set to **true**.

Default value: The default value for all schedulers is **none**; if you want to enable preemption under these schedulers, you must set a value for this keyword.

PROCESS_TRACKING
Specifies whether or not LoadLeveler will cancel any processes (throughout the entire cluster), left behind when a job terminates.

Syntax:

```
PROCESS_TRACKING = TRUE | FALSE
```

When **TRUE** ensures that when a job is terminated, no processes created by the job will continue running.

Note: It is necessary to set this keyword to **true** to do preemption by the suspend method with the BACKFILL or API scheduler.

Default value: FALSE

PROCESS_TRACKING_EXTENSION
Specifies the directory containing the kernel module **LoadL_pt_ke** (AIX) or **proctrk.ko** (Linux).

Syntax:

```
PROCESS_TRACKING_EXTENSION = directory
```

Default value: The directory **$HOME/bin**

For more information related to using this keyword, see "Tracking job processes" on page 70.

PUBLISH_OBITUARIES
Specifies whether or not the master daemon sends mail to the administrator when any daemon it manages ends abnormally. When set to **true**, this keyword specifies that the master daemon sends mail to the administrators identified by **LOADL_ADMIN** keyword.

Syntax:

```
PUBLISH_OBITUARIES = true | false
```

Default value: true

REJECT_ON_RESTRICTED_LOGIN
Specifies whether the user's account status will be checked on every node where the job will be run by calling the AIX **loginrestrictions** function with the **S_DIST_CLNT** flag.

Restriction: Login restriction checking is ignored by LoadLeveler for Linux.

Login restriction checking includes:
- Does the account still exist?
- Is the account locked?
- Has the account expired?
- Do failed login attempts exceed the limit for this account?
- Is login disabled via **/etc/nologin**?

If the AIX **loginrestrictions** function indicates a failure then the user's job will be rejected and will be processed according to the LoadLeveler configuration parameters **MAX_JOB_REJECT** and **ACTION_ON_MAX_REJECT**.

Syntax:

```
REJECT_ON_RESTRICTED_LOGIN = true | false
```

Default value: false

RELEASEDIR
Defines the directory where all the LoadLeveler software resides.

Syntax:

```
RELEASEDIR = release directory
```

Default value: $(RELEASEDIR)

RESERVATION_CAN_BE_EXCEEDED
Specifies whether LoadLeveler will schedule job steps that are bound to a reservation when their end times (based on hard wall-clock limits) exceed the reservation end time.

Syntax:

```
RESERVATION_CAN_BE_EXCEEDED = true | false
```

When this keyword is set to false, LoadLeveler schedules only those job steps that will complete before the reservation ends. When set to true, LoadLeveler schedules job steps to run under a reservation even if their end times are expected to exceed the reservation end time. When the reservation ends, however, the reserved nodes no longer belong to the reservation, and so these nodes might not be available for the jobs to continue running. In this case, LoadLeveler might preempt the running jobs.

Note that this keyword setting does not change the actual end time of the reservation. It only affects how LoadLeveler manages job steps whose end times exceed the end time of the reservation.

Default value: true

RESERVATION_HISTORY
Defines the name of a file that is to contain the local history of reservations.

Syntax:

```
RESERVATION_HISTORY = file name
```

LoadLeveler appends a single line to the reservation history file for each completed occurrence of each reservation. For an example, see "Collecting accounting data for reservations" on page 63.

Default value: $(SPOOL)/reservation_history

RESERVATION_MIN_ADVANCE_TIME
Specifies the minimum time, in minutes, between the time at which a reservation is created and the time at which the reservation is to start.

Syntax:

```
RESERVATION_MIN_ADVANCE_TIME = number of minutes
```

By default, the earliest time at which a reservation may start is the current time plus the value set for the **RESERVATION_SETUP_TIME** keyword.

Default value: 0 (zero)

RESERVATION_PRIORITY
Specifies whether LoadLeveler administrators may reserve nodes on which running jobs are expected to end after the reservation start time. This keyword value applies only for LoadLeveler administrators; other reservation owners do not have this capability.

Syntax:

```
RESERVATION_PRIORITY = NONE | HIGH
```

When you set this keyword to HIGH, before activating the reservation, LoadLeveler preempts the job steps running on the reserved nodes (Blue Gene job steps are handled the same way). The only exceptions are non-preemptable jobs; LoadLeveler will not preempt those jobs because of any reservations.

Default value: NONE

RESERVATION_SETUP_TIME
Specifies how much time, in seconds, that LoadLeveler may use to prepare for a reservation before it is to start. The tasks that LoadLeveler performs during this time include checking and reporting node conditions, and preempting job steps still running on the reserved nodes.

For a given reservation, LoadLeveler uses the **RESERVATION_SETUP_TIME** keyword value that is set at the time that the reservation is created, not whatever value might be set when the reservation starts. If the start time of the reservation is modified, however, LoadLeveler uses the **RESERVATION_SETUP_TIME** keyword value that is set at the time of the modification.

Syntax:

```
RESERVATION_SETUP_TIME = number of seconds
```

Default value: 60

RESTARTS_PER_HOUR
Specifies how many times the master daemon attempts to restart a daemon that dies abnormally. Because one or more of the daemons may be unable to run due to a permanent error, the master only attempts **$(RESTARTS_PER_HOUR)** restarts within a 60 minute period. Failing that, it sends mail to the administrators identified by the **LOADL_ADMIN** keyword and exits.

Syntax:

```
RESTARTS_PER_HOUR = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 12.

RESUME_ON_SWITCH_TABLE_ERROR_CLEAR
Specifies whether or not the **startd** that was drained when the switch table failed to unload will automatically resume once the unload errors are cleared. The unload error is considered cleared after LoadLeveler can successfully unload the switch table. For this keyword to work, the **DRAIN_ON_SWITCH_TABLE_ERROR** option in the configuration file must be turned on and not disabled. Flushing, suspending, or draining of a **startd** manually or automatically will disable this option until the **startd** is manually resumed.

Syntax:

```
RESUME_ON_SWITCH_TABLE_ERROR_CLEAR = true | false
```

Default value: false

RSET_SUPPORT
Indicates the level of RSet support present on a machine.

Syntax:

```
RSET_SUPPORT = option
```

The available options are:

RSET_MCM_AFFINITY
Indicates that the machine can run jobs requesting MCM (memory or adapter) and processor (cache or SMT) affinity.

RSET_NONE
Indicates that LoadLeveler RSet support is not available on the machine.

RSET_USER_DEFINED
Indicates that the machine can be used for jobs with a user-created RSet in their job command file.

Default value: RSET_NONE

SAVELOGS
Specifies the directory in which log files are archived.

Syntax:

```
SAVELOGS = directory
```

Where *directory* is the directory in which log files will be archived.

Default value: No default value is set.

For more information related to using this keyword, see "Configuring recording activity and log files" on page 48.

SAVELOGS_COMPRESS_PROGRAM
Compresses logs after they are copied to the **SAVELOGS** directory. If not specified, **SAVELOGS** are copied, but are not compressed.

Syntax:

```
SAVELOGS_COMPRESS_PROGRAM = program
```

Where *program* is a specific executable program. It can be a system-provided facility (such as, **/bin/gzip**) or an administrator-provided executable program. The value must be a full path name and can contain command-line arguments. LoadLeveler will call the program as: *program filename*.

Default value: If blank, the logs are not compressed.

Example: In this example, LoadLeveler will run the **gzip -f** command. The log file in **SAVELOGS** will be compressed after it is copied to **SAVELOGS**. If the *program* cannot be found or is not executable, LoadLeveler will log the error and *SAVELOGS* will remain uncompressed.

```
SAVELOGS_COMPRESS_PROGRAM = /bin/gzip -f
```

SCALE_ACROSS_SCHEDULING_TIMEOUT
Defines the amount of time a central manager will wait:

- For the main cluster central manager, this value defines the wait time for responses from the non-main cluster central managers when it is scheduling scale-across jobs.

- For the non-main cluster central managers, this value limits how long the central manager on each non-main cluster will hold resources for a scale-across job step while waiting for an order to start the job.

Syntax:

```
scale_across_scheduling_timeout = number
```

Default value: **300** seconds

SCHEDD

Location of the Schedd executable (**LoadL_schedd**).

Syntax:

```
SCHEDD = directory
```

Default value: `$(BIN)/LoadL_schedd`

For more information related to using this keyword, see "How LoadLeveler daemons process jobs" on page 8.

SCHEDD_COREDUMP_DIR

Specifies the local directory for storing **LoadL_schedd** core dump files.

Syntax:

```
SCHEDD_COREDUMP_DIR = directory
```

Default value: The **/tmp** directory.

For more information related to using this keyword, see "Specifying file and directory locations" on page 47.

SCHEDD_INTERVAL

Specifies the interval, in seconds, at which the Schedd daemon checks the local job queue and updates the negotiator daemon.

Syntax:

```
SCHEDD_INTERVAL = number
```

number must be a numerical value and cannot be an arithmetic expression.

Default value: The default is 60 seconds.

SCHEDD_RUNS_HERE

Specifies whether the Schedd daemon runs on the host. If you do not want to run the Schedd daemon, specify **false**.

This keyword does not designate a machine as a public scheduling machine. Unless configured as a public scheduling machine, a machine configured to run the Schedd daemon will only accept job submissions from the same machine running the Schedd daemon. A public scheduling machine accepts job submissions from other machines in the LoadLeveler cluster. To configure a machine as a public scheduling machine, see the **schedd_host** keyword description in "Administration file keyword descriptions" on page 327.

Syntax:

```
SCHEDD_RUNS_HERE = true | false
```

Default value: true

SCHEDD_SUBMIT_AFFINITY

Specifies whether job submissions are directed to a locally running Schedd daemon. When the keyword is set to **true**, job submissions are directed to a Schedd daemon running on the same machine where the submission takes place, provided there is a Schedd daemon running on that machine. In this

case the submission is said to have ″affinity″ for the local Schedd daemon. If there is no Schedd daemon running on the machine where the submission takes place, or if this keyword is set to **false**, the job submission will only be directed to a Schedd daemon serving as a public scheduling machine. In this case, if there are no public scheduling machines configured the job cannot be submitted. A public scheduling machine accepts job submissions from other machines in the LoadLeveler cluster. To configure a machine as a public scheduling machine, see the **schedd_host** keyword description in "Administration file keyword descriptions" on page 327.

Installations with a large number of nodes should consider setting this keyword to **false** to more evenly distribute dispatching of jobs among the Schedd daemons. For more information, see "Scaling considerations" on page 719.

Syntax:

```
SCHEDD_SUBMIT_AFFINITY = true | false
```

Default value: true

SCHEDD_STATUS_PORT
Specifies the port number used when connecting to the daemon.

Syntax:

```
SCHEDD_STATUS_PORT = port number
```

Default value: The default is 9606.

For more information related to using this keyword, see "Defining network characteristics" on page 47.

SCHEDD_STREAM_PORT
Specifies the port number used when connecting to the daemon.

Syntax:

```
SCHEDD_STREAM_PORT = port number
```

Default value: The default is 9605.

For more information related to using this keyword, see "Defining network characteristics" on page 47.

SCHEDULE_BY_RESOURCES
Specifies which consumable resources are considered by the LoadLeveler schedulers. Each consumable resource name may be an administrator-defined alphanumeric string, or may be one of the following predefined resources:

- **ConsumableCpus**
- **ConsumableMemory**
- **ConsumableVirtualMemory**
- **ConsumableLargePageMemory**
- **RDMA**

Each string may only appear in the list once. These resources are either floating resources, or machine resources. If any resource is specified incorrectly with the **SCHEDULE_BY_RESOURCES** keyword, then all scheduling resources will be ignored.

Syntax:

```
SCHEDULE_BY_RESOURCES = name name ... name
```

Default value: No default value is set.

SCHEDULER_TYPE
Specifies the LoadLeveler scheduling algorithm:

LL_DEFAULT
Specifies the default LoadLeveler scheduling algorithm. If SCHEDULER_TYPE has not been defined, LoadLeveler will use the default scheduler (LL_DEFAULT).

BACKFILL
Specifies the LoadLeveler BACKFILL scheduler. When you specify this keyword, you should use only the default settings for the **START** expression and the other job control expressions described in "Managing job status through control expressions" on page 68.

API Specifies that you will use an external scheduler. External schedulers communicate to LoadLeveler through the job control API. For more information on setting an external scheduler, see "Using an external scheduler" on page 115.

Syntax:

```
SCHEDULER_TYPE = LL_DEFAULT | BACKFILL | API
```

Default value: LL_DEFAULT

Note:

1. If a scheduler type is not set, LoadLeveler will start, but it will use the default scheduler.
2. If you have set **SCHEDULER_TYPE** with an option that is not valid, LoadLeveler will not start.
3. If you change the scheduler option specified by **SCHEDULER_TYPE**, you must stop and restart LoadLeveler using **llctl** or recycle using **llctl**.

For more information related to using this keyword, see "Defining a LoadLeveler cluster" on page 44.

SEC_ADMIN_GROUP
When security services are enabled, this keyword points to the name of the UNIX group that contains the local identities of the LoadLeveler administrators.

Restriction: CtSec security is not supported on LoadLeveler for Linux.

Syntax:

```
SEC_ADMIN_GROUP = name of lladmin group
```

Default value: No default value is set.

For more information related to using this keyword, see "Configuring LoadLeveler to use cluster security services" on page 57.

SEC_ENABLEMENT
Specifies the security mechanism to be used.

Restriction: Do not set this keyword to CtSec in the configuration file for a Linux machine. CtSec security is not supported on LoadLeveler for Linux.

Syntax:

```
SEC_ENABLEMENT = COMPAT | CTSEC
```

Default value: No default value is set.

SEC_SERVICES_GROUP
When security services are enabled, this keyword specifies the name of the LoadLeveler services group.

Restriction: CtSec security is not supported on LoadLeveler for Linux.

Syntax:

```
SEC_SERVICES_GROUP=group name
```

Where *group name* defines the identities of the LoadLeveler daemons.

Default value: No default value is set.

SEC_IMPOSED_MECHS
Specifies a blank-delimited list of LoadLeveler's permitted security mechanisms when Cluster Security (CtSec) services are enabled.

Restriction: CtSec security is not supported on LoadLeveler for Linux.

Syntax: Specify a blank delimited list containing combinations of the following values:

none If this is the only value specified, then users *will* run unauthenticated and, if authorization is necessary, the job will fail. If this is not the only value specified, then users *may* run unauthenticated and, if authorization is necessary, the job will fail.

unix If this is the only value specified, then UNIX host-based authentication will be used; otherwise, other mechanisms may be used.

Default value: No default value is set.

Example:

```
SEC_IMPOSED_MECHS = none unix
```

SPOOL
Defines the local directory where LoadLeveler keeps the local job queue and checkpoint files

Syntax:

```
SPOOL = local directory/spool
```

Default value: `$(tilde)/spool`

START
Determines whether a machine can run a LoadLeveler job.

Syntax:

```
START: expression that evaluates to T or F (true or false)
```

When the expression evaluates to **T**, LoadLeveler considers dispatching a job to the machine. When you use a START expression that is based on the CPU load average, the negotiator may evaluate the expression as **F** even though the load average indicates the machine is Idle. This is because the negotiator adds a compensating factor to the startd machine's load average every time the negotiator assigns a job. For more information, see the NEGOTIATOR_INTERVAL keyword.

Default value: No default value is set, which means that no jobs will be started.

For information about time-related variables that you may use for this keyword, see "Variables to use for setting times" on page 320.

START_CLASS

Specifies the rule for starting a job of the *incoming_class*. The START_CLASS rule is applied whenever the BACKFILL scheduler decides whether a job step of the *incoming_class* should start or not.

Syntax:

```
START_CLASS[incoming_class] = (start_class_expression) [ && (start_class_expression) ...]
```

Where *start_class_expression* takes the form:

run_class < number_of_tasks

Which indicates that a job step of the *incoming_class* is only allowed to run on a node when the number of tasks of *run_class* running on that node is less than *number_of_tasks*.

Note:

1. START_CLASS **[allclasses]** will be ignored.
2. The job class specified by *run_class* may be the same as or different from the class specified by *incoming_class*.
3. You can also define *run_class* as **allclasses**. If you do, the total number of all job tasks running on that node cannot exceed the value specified by *number_of_tasks*.
4. A class name or **allclasses** should not appear twice on the right-hand side of the keyword statement. However, you can use other class names with **allclasses** on the right hand side of the statement.
5. If there is more than one *start_class_expression*, you must use && between adjacent *start_class_expression*s.
6. Both the START keyword and the START_CLASS keyword have to be true before a new job can start.
7. Parenthesis ( ) are optional around *start_class_expression*.

For information related to using this keyword, see "Planning to preempt jobs" on page 128.

Default value: No default value is set.

Examples:

START_CLASS[Class_A] = (Class_A < 1)

This statement indicates that a Class_A job can only start on nodes that do not have any Class_A jobs running.

START_CLASS[Class_B] = allclasses < 5

This statement indicates that a Class_B job can only start on nodes with maximum 4 tasks running.

START_DAEMONS

Specifies whether to start the LoadLeveler daemons on the node.

Syntax:

```
START_DAEMONS = true | false
```

Default value: true

When **true**, the daemons are started. In most cases, you will probably want to set this keyword to **true**. An example of why this keyword would be set to **false** is if you want to run the daemons on most of the machines in the cluster but some individual users with their own local configuration files do not want their machines to run the daemons. The individual users would modify their

local configuration files and set this keyword to **false**. Because the global configuration file has the keyword set to **true**, their individual machines would still be able to participate in the LoadLeveler cluster.

Also, to define the machine as strictly a submit-only machine, set this keyword to **false**.

STARTD
Location of the startd executable (**LoadL_startd**).

Syntax:

```
STARTD = directory
```

Default value: `$(BIN)/LoadL_startd`

For more information related to using this keyword, see "How LoadLeveler daemons process jobs" on page 8.

STARTD_COREDUMP_DIR
Local directory for storing **LoadL_startd** core dump files.

Syntax:

```
STARTD_COREDUMP_DIR = directory
```

Default value: The **/tmp** directory.

For more information related to using this keyword, see "Specifying file and directory locations" on page 47.

STARTD_DGRAM_PORT
Specifies the port number used when connecting to the daemon.

Syntax:

```
STARTD_DGRAM_PORT = port number
```

Default value: The default is 9615.

For more information related to using this keyword, see "Defining network characteristics" on page 47.

STARTD_RUNS_HERE = true | false
Specifies whether the startd daemon runs on the host. If you do not want to run the startd daemon, specify **false**.

Syntax:

```
STARTD_RUNS_HERE = true | false
```

Default value: true

STARTD_STREAM_PORT
Specifies the port number used when connecting to the daemon.

Syntax:

```
STARTD_STREAM_PORT = port number
```

Default value: The default is 9611.

For more information related to using this keyword, see "Defining network characteristics" on page 47.

STARTER
Location of the starter executable (**LoadL_starter**).

Syntax:

```
STARTER = directory
```

Default value: `$(BIN)/LoadL_starter`

For more information related to using this keyword, see "How LoadLeveler daemons process jobs" on page 8.

STARTER_COREDUMP_DIR
Local directory for storing **LoadL_starter** coredump files.

Syntax:

```
STARTER_COREDUMP_DIR = directory
```

Default value: The **/tmp** directory.

For more information related to using this keyword, see "Specifying file and directory locations" on page 47.

SUBMIT_FILTER
Specifies the program you want to run to filter a job script when the job is submitted.

Syntax:

```
SUBMIT_FILTER = full_path_to_executable
```

Where *full_path_to_executable* is called with the job command file as the standard input. The standard output is submitted to LoadLeveler. If the program returns with a nonzero exit code, the job submission is canceled. A submit filter can only make changes to LoadLeveler job command file keyword statements.

Default value: No default value is set.

Multicluster use: In a multicluster environment, if you specified a valid cluster list with either the **llsubmit -X** option or the **ll_cluster** API, then the **SUBMIT_FILTER** will instead be invoked with a modified job command file that contains a **cluster_list** keyword generated from either the **llsubmit -X** option or the **ll_cluster** API.

The modified job command file will contain an inserted `# @ cluster_list = cluster` statement just prior to the first `# @ queue` statement. This **cluster_list** statement takes precedence and overrides all previous specifications of any **cluster_list** statements from the original job command file.

Example: SUBMIT_FILTER in a multicluster environment

The following job command file, job.cmd, requests to be run remotely on cluster1:

```
#!/bin/sh
# @ cluster_list = cluster1
# @ error = job1.$(Host).$(Cluster).$(Process).err
# @ output = job1.$(Host).$(Cluster).$(Process).out
# @ queue
```

After issuing `llsubmit -X cluster2 job.cmd`, the modified job command file statements will be run on cluster2:

```
#!/bin/sh
# @ cluster_list = cluster1
# @ error = job1.$(Host).$(Cluster).$(Process).err
# @ output = job1.$(Host).$(Cluster).$(Process).out
# @ cluster_list = cluster2
# @ queue
```

For more information related to using this keyword, see "Filtering a job script" on page 76.

SUSPEND
Determines whether running jobs should be suspended.

Syntax:

```
SUSPEND: expression that evaluates to T or F (true or false)
```

When **T**, LoadLeveler temporarily suspends jobs currently running on the machine. Suspended LoadLeveler jobs will either be continued or vacated. This keyword is not supported for parallel jobs.

Default value: No default value is set.

For information about time-related variables that you may use for this keyword, see "Variables to use for setting times" on page 320.

SYSPRIO
System priority expression.

Syntax:

```
SYSPRIO : expression
```

You can use the following LoadLeveler variables to define the **SYSPRIO** expression:

- **ClassSysprio**
- **GroupQueuedJobs**
- **GroupRunningJobs**
- **GroupSysprio**
- **GroupTotalJobs**
- **GroupTotalShares**
- **GroupUsedBgShares**
- **GroupUsedShares**
- **JobIsBlueGene**
- **QDate**
- **UserHoldTime**
- **UserPrio**
- **UserQueuedJobs**
- **UserRunningJobs**
- **UserSysprio**
- **UserTotalJobs**
- **UserTotalShares**
- **UserUsedBgShares**
- **UserUsedShares**

For detailed descriptions of these variables, see "LoadLeveler variables" on page 314.

Default value: 0 (zero)

Note:

1. The **SYSPRIO** keyword is valid only on the machine where the central manager is running. Using this keyword in a local configuration file has no effect.
2. It is recommended that you do not use **UserPrio** in the **SYSPRIO** expression, since user jobs are already ordered by **UserPrio**.
3. The string SYSPRIO can be used as both the name of an expression (SYSPRIO: *value*) and the name of a variable (SYSPRIO = *value*).

   To specify the expression to be used to calculate job priority you must use the syntax for the SYSPRIO expression. If the variable is

mistakenly used for the SYSPRIO expression, which requires a colon (:) after the name, the job priority value will always be 0 because the SYSPRIO expression has not been defined.

4. When the **UserRunningJobs**, **GroupRunningJobs**, **UserQueuedJobs**, **GroupQueuedJobs**, **UserTotalJobs**, **GroupTotalJobs**, **GroupTotalShares**, **GroupUsedShares**, **UserTotalShares**, **UserUsedShares**, **GroupUsedBgShares**, **JobIsBlueGene**, and **UserUsedBgShares** variables are used to prioritize the queue based on current usage, you should also set **NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL** so that the priorities are adjusted according to current usage rather than usage only at submission time.

Examples:

- Example 1

  This example creates a FIFO job queue based on submission time:

  ```
  SYSPRIO : 0 - (QDate)
  ```

- Example 2

  This example accounts for Class, User, and Group system priorities:

  ```
  SYSPRIO : (ClassSysprio * 100) + (UserSysprio * 10) + (GroupSysprio * 1) - (QDate)
  ```

- Example 3

  This example orders the queue based on the number of jobs a user is currently running. The user who has the fewest jobs running is first in the queue. You should set **NEGOTIATOR_RECALCULATE_SYSPRIO_INTERVAL** in conjunction with this **SYSPRIO** expression.

  ```
  SYSPRIO : 0 - UserRunningJobs
  ```

- Example 4

  This example shows one possible way to set up the SYSPRIO expression for fair share scheduling. For those jobs whose owner has no unused shares ($(UserHasShares)= 0), that job priority depends only on QDate, making it a simple FIFO queue as in Example 1.

  For those jobs whose owner has unused shares ($(UserHasShares)= 1), job priority depends not only on QDate, but also on a uniform boost of 31 536 000 (the equivalent to the job being submitted one year earlier). These jobs still have priority differences because of submit time differences. It is like forming two priority tiers: the higher priority tier for jobs with unused shares and the lower priority tier for jobs without unused shares.

  ```
  SYSPRIO: 31536000 * $(UserHasShares) - QDate
  ```

- Example 5

  This example divides the jobs into three priority tiers:

  – Those jobs whose owner and group both have unused shares are at the top tier

  – Those jobs whose owner or group has unused shares are at the middle tier

  – Those jobs whose owner and group both have no shares remaining are at the bottom tier

  A user can submit two jobs to two different groups, the first job to a group with shares remaining and the second job to a group without any unused shares. If the user has unused shares, the first job will belong to the top tier and the second job will belong to the middle tier. If the user has no shares remaining, the first job will belong to the middle tier and the second job will

belong to the bottom tier. The jobs in the top tier will be considered to run first, then the jobs in the middle tier, and lastly the jobs in the bottom tier.

```
SYSPRIO: 31536000 * ($(UserHasShares)+$(GroupHasShares)) - (QDate)
```

For more information related to using this keyword, see "Setting negotiator characteristics and policies" on page 45.

- Example 6

  This example show one possible way to prevent a job in user hold from increasing in priority relative to other jobs in the queue:

  ```
  SYSPRIO : 0 - QDate - UserHoldTime
  ```

SYSPRIO_THRESHOLD_TO_IGNORE_STEP

Specifies a threshold value for system priority. When the system priority assigned to a job step is less than the value set for this keyword, the scheduler ignores the job, which will remain in Idle state.

Syntax:

```
SYSPRIO_THRESHOLD_TO_IGNORE_STEP = integer
```

Any integer is a valid value.

Default value: INT_MIN

For more information related to using this keyword, see "Controlling the central manager scheduling cycle" on page 73.

TRUNC_GSMONITOR_LOG_ON_OPEN

When **true**, specifies that the log file is restarted with every invocation of the daemon.

Syntax:

```
TRUNC_GSMONITOR_LOG_ON_OPEN = true | false
```

Default value: false

For more information related to using this keyword, see "Configuring recording activity and log files" on page 48.

TRUNC_KBDD_LOG_ON_OPEN

When **true**, specifies the log file is restarted with every invocation of the daemon.

Syntax:

```
TRUNC_KBDD_LOG_ON_OPEN = true | false
```

Default value: false

For more information related to using this keyword, see "Configuring recording activity and log files" on page 48.

TRUNC_MASTER_LOG_ON_OPEN

When **true**, specifies the log file is restarted with every invocation of the daemon.

Syntax:

```
TRUNC_MASTER_LOG_ON_OPEN = true | false
```

Default value: false

For more information related to using this keyword, see "Configuring recording activity and log files" on page 48.

TRUNC_NEGOTIATOR_LOG_ON_OPEN
When **true**, specifies the log file is restarted with every invocation of the daemon.

Syntax:

```
TRUNC_NEGOTIATOR_LOG_ON_OPEN = true | false
```

Default value: false

For more information related to using this keyword, see "Configuring recording activity and log files" on page 48.

TRUNC_SCHEDD_LOG_ON_OPEN
When **true**, specifies the log file is restarted with every invocation of the daemon.

Syntax:

```
TRUNC_SCHEDD_LOG_ON_OPEN = true | false
```

Default value: false

For more information related to using this keyword, see "Configuring recording activity and log files" on page 48.

TRUNC_STARTD_LOG_ON_OPEN
When **true**, specifies the log file is restarted with every invocation of the daemon.

Syntax:

```
TRUNC_STARTD_LOG_ON_OPEN = true | false
```

Default value: false

For more information related to using this keyword, see "Configuring recording activity and log files" on page 48.

TRUNC_STARTER_LOG_ON_OPEN
When **true**, specifies the log file is restarted with every invocation of the daemon.

Syntax:

```
TRUNC_STARTER_LOG_ON_OPEN = true | false
```

Default value: false

For more information related to using this keyword, see "Configuring recording activity and log files" on page 48.

UPDATE_ON_POLL_INTERVAL_ONLY
Specifies whether or not the LoadLeveler **startd** daemons will send machine update transactions to the central manager. Normally the LoadLeveler startd daemons running on executing nodes will send transactions to the central manager to provide updates of machine information at various times. An update is sent every polling interval. The polling interval is calculated by multiplying the values for the two keywords, **POLLING_FREQUENCY** and **POLLS_PER_UPDATE**, specified in the LoadLeveler configuration file.

In addition, updates are sent at other times such as when new jobs are started and when jobs terminate on the executing node. If you have a large and highly active cluster (the workload consists of a large number of short running jobs), the normal method for updating the central manager can add excessive network traffic. **UPDATE_ON_POLL_INTERVAL_ONLY** can help reduce this source of network traffic.

When **true** is specified, the LoadLeveler startd daemon will only send machine updates to the central manager at every polling interval and not at other times.

Syntax:

```
UPDATE_ON_POLL_INTERVAL_ONLY = false | true
```

Default value: false

VACATE

Determines whether suspended jobs should be vacated.

Syntax:

```
VACATE: expression that evaluates to T or F (true or false)
```

When **T**, suspended LoadLeveler jobs are removed from the machine and placed back into the queue (provided you specify **restart=yes** in the job command file). If a checkpoint was taken, the job restarts from the checkpoint. Otherwise, the job restarts from the beginning.

Default value: No default value is set.

For information about time-related variables that you may use for this keyword, see "Variables to use for setting times" on page 320.

VM_IMAGE_ALGORITHM

Specifies the virtual memory algorithm, which is used for checking the image_size requirement. This keyword is used together with the **large_page** job command file keyword to specify which algorithm the central manager uses to decide whether a machine has enough virtual memory to run a job step.

This keyword is critical for job steps that must use Large Page memory (specified by the job command file keyword **large_page=M**). If the **VM_IMAGE_ALGORITHM** keyword is set to **FREE_PAGING_SPACE**, the Large Page job step will never be scheduled to run. This keyword must be set to **FREE_PAGING_SPACE_PLUS_FREE_REAL_MEMORY** to run Large Page jobs.

When **FREE_PAGING_SPACE** is specified, LoadLeveler considers only free paging space when determining if a machine has enough virtual memory to run a job step.

When **FREE_PAGING_SPACE_PLUS_FREE_REAL_MEMORY** is specified and the job step specifies:

- **large_page=N** (does not use Large Page memory), LoadLeveler considers free paging space and free regular memory when determining if a machine has enough virtual memory to run a job step.
- **large_page=Y** (uses Large Page memory, if available), LoadLeveler considers free paging space, free regular memory, and free Large Page memory when determining if a machine has enough virtual memory to run a job step, although Large Page memory is only considered for machines configured to exploit the Large Page feature.
- **large_page=M** (must use Large Page memory), LoadLeveler considers only Large Page memory when determining if a machine has enough virtual memory to run a job step. Only machines configured to exploit the Large Page feature are considered.

IBM suggests that you set this keyword to the value **FREE_PAGING_SPACE_PLUS_FREE_REAL_MEMORY** since more types of virtual memory are considered, increasing the chances of finding a machine with enough virtual memory to run the job step.

Syntax:

```
VM_IMAGE_ALGORITHM = FREE_PAGING_SPACE | FREE_PAGING_SPACE_PLUS_FREE_REAL_MEMORY
```

Default value: FREE_PAGING_SPACE

WALLCLOCK_ENFORCE
Specifies whether the job command file keyword **wall_clock_limit** will be enforced for this job. The **WALLCLOCK_ENFORCE** keyword is valid only when an external scheduler is enabled.

Syntax:

```
WALLCLOCK_ENFORCE = true | false
```

Default value: true

X_RUNS_HERE
Specifies whether the kbdd (keyboard) daemon runs on the host. If you want to run the kbdd daemon, specify **true**.

Syntax:

```
X_RUNS_HERE = true | false
```

Default value: false

User-defined keywords

This type of variable, which is generally created and defined by the user, can be named using any combination of letters and numbers.

A user-defined variable is set equal to values, where the *value* defines conditions, names files, or sets numeric values. For example, you can create a variable named **MY_MACHINE** and set it equal to the name of your machine named *iron* as follows:

```
MY_MACHINE = iron.ore.met.com
```

You can then identify the keyword using a dollar sign ($) and parenthesis. For example, the literal **$(MY_MACHINE)** following the definition in the previous example results in the automatic substitution of **iron.ore.met.com** in place of **$(MY_MACHINE)**.

User-defined definitions may contain references, enclosed in parenthesis, to previously defined keywords. Therefore:

```
A = xxx
C = $(A)
```

is a valid expression and the resulting value of **C** is *xxx*. Note that **C** is actually bound to **A**, not to its value, so that

```
A = xxx
C = $(A)
A = yyy
```

is also legal and the resulting value of **C** is *yyy*.

The sample configuration file shipped with the product defines and uses the following “user-defined” variables.

BackgroundLoad
Defines the variable **BackgroundLoad** and assigns to it a floating point constant. This might be used as a noise factor indicating no activity.

CPU_Busy
Defines the variable **CPU_Busy** and reassigns to it at each evaluation the Boolean value True or False, depending on whether the Berkeley one-minute load average is equal to or greater than the saturation level of 1.5.

CPU_Idle
Defines the variable **CPU_Idle** and reassigns to it at each evaluation the Boolean value True or False, depending on whether the Berkeley one-minute load average is equal or less than 0.7.

HighLoad
Is a keyword that the user can define to use as a saturation level at which no further jobs should be started.

HOUR
Defines the variable **HOUR** and assigns to it a constant integer value.

JobLoad
Defines the variable **JobLoad** which defines the load on the machine caused by running the job.

KeyboardBusy
Defines the variable **KeyboardBusy** and reassigns to it at each evaluation the Boolean value True or False, depending on whether the keyboard and mouse have been idle for fifteen minutes.

LowLoad
Defines the variable **LowLoad** and assigns to it the value of **BackgroundLoad**. This might be used as a restart level at which jobs can be started again and assumes only running 1 job on the machine.

mail
Specifies a local program you want to use in place of the LoadLeveler default mail notification method.

MINUTE
Defines the variable **MINUTE** and assigns to it a constant integer value.

StateTimer
Defines the variable **StateTimer** and reassigns to it at each evaluation the number of seconds since the current state was entered.

LoadLeveler variables

LoadLeveler provides the following variables that you can use in your configuration file statements.

LoadLeveler variables are evaluated by the LoadLeveler daemons at various stages. They do not require you to use any special characters (such as a parenthesis or a dollar sign) to identify them.

Arch
Indicates the system architecture. Note that **Arch** is a special case of a LoadLeveler variable called a machine variable. You specify a machine variable using the following format:

```
variable : $(value)
```

ClassSysprio
The priority for the class of the job step, defined in the class stanza in the administration file.

Default: 0

For additional information about using this variable, see the **SYSPRIO** keyword description.

Connectivity
The ratio of the number of active switch adapters on a node to the total number of switch adapters on the node. The value ranges from 0.0 (all switch adapters are down) to 1.0 (all switch adapters are active). A node with no switch adapters has a connectivity of 0.0. Connectivity can be used in a **MACHPRIO** expression to favor nodes that do not have any down switch adapters or in a job's **REQUIREMENTS** to require only nodes with a certain connectivity.

For additional information about using this variable, see the **MACHPRIO** keyword description.

ConsumableCpus
The number of **ConsumableCpus** currently available on the machine, if **ConsumableCpus** is defined in the configuration file keyword, **SCHEDULE_BY_RESOURCES**. If it is not defined in **SCHEDULE_BY_RESOURCES**, then it is equivalent to **Cpus**.

For additional information about using this variable, see the **MACHPRIO** keyword description.

ConsumableLargePageMemory
The amount of **ConsumableLargePageMemory**, in megabytes, currently available on the machine, if **ConsumableVirtualMemory** is defined in the **SCHEDULE_BY_RESOURCES** configuration file keyword. If it is not defined in **SCHEDULE_BY_RESOURCES**, then it is equal to the total amount of large page memory on the machine.

For additional information about using this variable, see the **MACHPRIO** keyword description.

ConsumableMemory
The amount of **ConsumableMemory**, in megabytes, currently available on the machine, if **ConsumableMemory** is defined in the configuration file keyword, **SCHEDULE_BY_RESOURCES**. If it is not defined in **SCHEDULE_BY_RESOURCES**, then it is equivalent to **Memory**.

For additional information about using this variable, see the **MACHPRIO** keyword description.

ConsumableVirtualMemory
The amount of **ConsumableVirtualMemory**, in megabytes, currently available on the machine, if **ConsumableVirtualMemory** is defined in the configuration file keyword, **SCHEDULE_BY_RESOURCES**. If it is not defined in **SCHEDULE_BY_RESOURCES**, then it is equivalent to **VirtualMemory**.

For additional information about using this variable, see the **MACHPRIO** keyword description.

Cpus
The number of processors of the machine, reported by the startd daemon.

For additional information about using this variable, see the **MACHPRIO** keyword description.

CurrentTime
The **UNIX date**; the current system time, in seconds, since January 1, 1970, as returned by the time() function.

CustomMetric
Sets a relative priority number for one or more machines, based on the value of the **CUSTOM_METRIC** keyword.

For additional information about using this variable, see the **MACHPRIO** keyword description.

Disk
The free disk space in kilobytes on the file system where the executables for the LoadLeveler jobs assigned to this machine are stored. This refers to the file system that is defined by the execute keyword.

For additional information about using this variable, see the **MACHPRIO** keyword description.

domain or domainname
Dynamically indicates the official name of the domain of the current host machine where the program is running. Whenever a machine name can be specified or one is assumed, a domain name is assigned if none is present.

EnteredCurrentState
The value of **CurrentTime** when the current state (START, SUSPEND, and so on) was entered.

FreeRealMemory
The amount of free real memory, in megabytes, on the machine. This value should track very closely with the ″fre″ value of the **vmstat** command and the ″free″ value of the **svmon -G** command (units are 4K blocks).

For additional information about using this variable, see the **MACHPRIO** keyword description.

GroupQueuedJobs
The number of job steps associated with a LoadLeveler group which are either running or queued. (That is, job steps which are in one of these states: Checkpointing, Preempted, Preempt Pending, Resume Pending, Running, Starting, Pending, or Idle.)

For additional information about using this variable, see the **SYSPRIO** keyword description.

GroupRunningJobs
The number of job steps for the LoadLeveler group which are in one of these states: Checkpointing, Preempted, Preempt Pending, Resume Pending, Running, Starting, or Pending.

For additional information about using this variable, see the **SYSPRIO** keyword description.

GroupSysprio
The priority for the group of the job step, defined in the group stanza in the administration file.

Default: 0

For additional information about using this variable, see the **SYSPRIO** keyword description.

GroupTotalJobs
The total number of job steps associated with this LoadLeveler group. Total job steps are all job steps reported by the **llq** command.

For additional information about using this variable, see the **SYSPRIO** keyword description.

GroupTotalShares
The total number of shares allocated to a group as specified by the **fair_shares** keyword in the group stanza.

For additional information about using this variable, see the **SYSPRIO** keyword description.

GroupUsedBgShares
The number of Blue Gene shares already used by a group or jobs owned by the group.

For additional information about using this variable, see the **SYSPRIO** keyword description.

GroupUsedShares
The number of shares already used by a group or jobs of the LoadLeveler group.

For additional information about using this variable, see the **SYSPRIO** keyword description.

host or hostname
Dynamically indicates the standard host name as returned by gethostname() for the machine where the program is running. **host** and **hostname** are equivalent, and contain the name of the machine without the domain name appended to it. If administrators need to specify the domain name in the configuration file, they may use **domain** or **domainname** along with **host** or **hostname**. For example:

```
$(host).$(domain)
```

JobIsBlueGene
Indicates whether the job whose priority is being calculated using the **SYSPRIO** keyword is a Blue Gene job.

For additional information about using this variable, see the **SYSPRIO** keyword description.

KeyboardIdle
The number of seconds since the keyboard or mouse was last used. It also includes any telnet or interactive activity from any remote machine.

LoadAvg
The Berkely one-minute load average, a measure of the CPU load on the system. The load average is the average of the number of processes ready to run or waiting for disk I/O to complete. The load average does not map to CPU time.

For additional information about using this variable, see the **MACHPRIO** keyword description.

Machine
Indicates the name of the current machine. Note that **Machine** is a special case of a LoadLeveler variable called a machine variable. See the description of the **Arch** variable for more information.

MasterMachPriority
A value that is equal to 1 for nodes which are master nodes (those with **master_node_exclusive = true**); this value is equal to 0 for nodes which are not master nodes. Assigning a high priority to master nodes may help job scheduling performance for parallel jobs which require master node features.

For additional information about using this variable, see the **MACHPRIO** keyword description.

Memory
The size of real memory, in megabytes, of the machine, reported by the startd daemon.

For additional information about using this variable, see the **MACHPRIO** keyword description.

OpSys
Indicates the operating system on the host where the program is running. This value is automatically determined and should not be defined in the configuration file. Note that **OpSys** is a special case of a LoadLeveler variable called a machine variable. See the description of the **Arch** variable for more information about machine variables.

PagesFreed
The number of pages freed per second by the page replacement algorithm of the virtual memory manager.

For additional information about using this variable, see the **MACHPRIO** keyword description.

PagesScanned
The number of pages scanned per second by the page replacement algorithm of the virtual memory manager.

For additional information about using this variable, see the **MACHPRIO** keyword description.

QDate
The difference in seconds between the UNIX date when the job step enters the queue and the UNIX date when the negotiator daemon starts up.

For additional information about using this variable, see the **SYSPRIO** keyword description.

Speed
The relative speed of the machine, defined in a machine stanza in the administration file.

Default: 1

For additional information about using this variable, see the **MACHPRIO** keyword description.

State
The state of the startd daemon.

tilde
The home directory for the LoadLeveler user ID.

UserHoldTime
The total time that a job is in User Hold state.

For additional information about using this variable, see the **SYSPRIO** keyword description.

UserPrio
The user-defined priority of the job step, specified in the job command file with the **user_priority** keyword. The priority ranges from 0 to 100, with higher numbers corresponding to greater priority.

Default: 50

For additional information about using this variable, see the **SYSPRIO** keyword description.

UserQueuedJobs
The number of job steps either running or queued for the user. (That is, job steps that are in one of these states: Checkpointing, Preempted, Preempt Pending, Resume Pending, Running, Starting, Pending, or Idle.)

For additional information about using this variable, see the **SYSPRIO** keyword description.

UserRunningJobs
The number of job step steps for the user which are in one of these states: Checkpointing, Preempted, Preempt Pending, Resume Pending, Running, Starting, or Pending.

For additional information about using this variable, see the **SYSPRIO** keyword description.

UserSysprio
The priority of the user who submitted the job step, defined in the user stanza in the administration file.

Default: 0

For additional information about using this variable, see the **SYSPRIO** keyword description.

UserTotalJobs
The total number of job steps associated with this user. Total job steps are all job steps reported by the **llq** command.

For additional information about using this variable, see the **SYSPRIO** keyword description.

UserTotalShares
The total number of shares allocated to a user as specified by the **fair_shares** keyword in the user stanza.

For additional information about using this variable, see the **SYSPRIO** keyword description.

UserUsedBgShares
The number of Blue Gene shares already used by a user or jobs owned by the user.

For additional information about using this variable, see the **SYSPRIO** keyword description.

UserUsedShares
The number of shares already used by a user or jobs owned by the user.

For additional information about using this variable, see the **SYSPRIO** keyword description.

VirtualMemory
The size of available swap space (free paging space) on the machine, in kilobytes, reported by the startd daemon.

For additional information about using this variable, see the **MACHPRIO** keyword description.

Variables to use for setting dates

There are several date variables.

You can use the following date variables:

tm_mday
The number of the day of the month (1-31).

tm_mon
Number of months since January (0-11).

tm_wday
Number of days since Sunday (0-6).

tm_yday
Number of days since January 1 (0-365).

tm_year
The number of years since 1900 (0-9999). For example:

```
tm_year == 100
```

Denotes the year 2000.

tm4_year
The integer representation of the current year. For example:

```
tm4_year == 2010
```

Denotes the year 2010.

Variables to use for setting times

You can use the following time variables in the START, SUSPEND, CONTINUE, VACATE, and KILL expressions.

If you use these variables in the START expression and you are operating across multiple time zones, unexpected results may occur. This is because the negotiator daemon evaluates the START expressions and this evaluation is done in the time zone in which the negotiator resides. Your executing machine also evaluates the START expression and if your executing machine is in a different time zone, the results you may receive may be inconsistent. To prevent this inconsistency from occurring, ensure that both your negotiator daemon and your executing machine are in the same time zone.

tm_hour
The number of hours since midnight (0-23).

tm_isdst
Daylight Savings Time flag: positive when in effect, zero when not in effect, negative when information is unavailable. For example, to start jobs between 5 PM and 8 AM during the month of October, factoring in an adjustment for Daylight Savings Time, you can issue:

```
START: (tm_mon == 9) && (tm_hour < 8) && (tm_hour > 17) && (tm_isdst = 1)
```

tm_min
Number of minutes after the hour (0-59).

tm_sec
Number of seconds after the minute (0-59).

Chapter 13. Administration file reference

The administration file lists and defines the machines in the LoadLeveler cluster, as well as and the characteristics of classes, users, groups, and clusters.

LoadLeveler does not prevent you from having multiple copies of administration files, but having only one administration file prevents confusion and avoids potential problems that might arise from having multiple files to update. To use only one administration file that is available to all machines in a cluster, you must place the file in a shared file system.

Table 71 lists the administration file subtasks:

Table 71. Administration file subtasks

Subtask	Associated information (see . . .)
To find out what administrator tasks you can accomplish by using the administration file	Chapter 4, "Configuring the LoadLeveler environment," on page 41
To learn how to correctly specify the contents of an administration file	• "Administration file structure and syntax" • "Administration file keyword descriptions" on page 327

Administration file structure and syntax

The administration file is called **LoadL_admin** and it lists and defines the *machine*, *user*, *class*, *group*, and *adapter* stanzas.

Machine stanza
Defines the roles that the machines in the LoadLeveler cluster play. See "Defining machines" on page 84 for more information.

User stanza
Defines LoadLeveler users and their characteristics. See "Defining users" on page 97 for more information.

Class stanza
Defines the characteristics of the job classes. To define characteristics that apply to specific users, user substanzas can be added within a class stanza. See "Defining classes" on page 89 and "Defining user substanzas in class stanzas" on page 94 for more information.

Group stanza
Defines the characteristics of a collection of users that form a LoadLeveler group. See "Defining groups" on page 99 for more information.

Adapter stanza
Defines the network adapters available on the machines in the LoadLeveler cluster. See "Defining adapters" on page 86 for more information.

Cluster stanza
Defines the characteristics of a LoadLeveler cluster for use in a multicluster environment. See "Defining clusters" on page 100 for more information.

Stanzas have the following general format:

```
label: type = type_of_stanza
keyword1 = value1
keyword2 = value2
  ...
```

Figure 37. Format of administration file stanzas

Substanzas have the following general format:

```
label: {
   type = type_of_stanza
   keyword1 = value1
   keyword2 = value2
   ...
   substanza_label: {
      type = type_of_substanza
      keyword3 = value3
   }
}
```

Figure 38. Format of administration file substanzas

Keywords are *not* case sensitive. This means you can enter them in lower case, upper case, or mixed case.

The following is a simple example of an administration file illustrating several stanzas:

```
machine_a: type = machine
      central_manager = true       # defines this machine as the central manager
      adapter_stanzas = adapter_a  # identifies an adapter stanza

class_a: type = class
      priority = 50    # priority of this class

user_a: type  = user
      priority  = 50   # priority of this user

group_a: type = group
      priority  = 50   # priority of this group

adapter_a: type = adapter
      adapter_name = en0  #defines an adapter
```

Figure 39. Sample administration file stanzas

The following is a simple example of an administration file illustrating a class stanza that contains user substanzas:

```
default:
     type = machine
     central_manager = false
     schedd_host = true

default:
     type = class
     wall_clocK-limit = 60:00, 30:00

parallel: {
     type = class

     # Allow at most 50 running jobs for class parallel
     maxjobs = 50

     # Allow at most 10 running jobs for any single
     # user of class parallel
     default: {
          type = user
          maxjobs = 10
     }

     # Allow user dept_head to run as many as 20 jobs
     # of class parallel
     dept_head: {
          type = user
          maxjobs = 20
     }
}

dept_head:
     type = user
     maxjobs = 30
```

Figure 40. Sample administration file stanza with user substanzas

Stanza characteristics

There are a number of characteristics associated with stanzas.

The characteristics of a stanza are:

- Every stanza has a label associated with it. The label specifies the name you give to the stanza.
- Every stanza has a **type** field that specifies it as a user, class, machine, group, or adapter stanza.
- New line characters are ignored. This means that separate parts of a stanza can be included on the same line. However, it is not recommended to have parts of a stanza cross line boundaries.
- White space is ignored, other than to delimit keyword identifiers. This eliminates confusion between tabs and spaces at the beginning of lines.
- A crosshatch sign (#) identifies a comment and can appear anywhere on the line. All characters following this sign on that line are ignored.
- Multiple stanzas of the same label are allowed, but only the first label is used.
- Default stanzas specify the default values for any keywords which are not otherwise specified. Each stanza type can have an associated default stanza. A default stanza must appear in the administration file ahead of any specific stanza entries of the same type. For example, a default class stanza must appear ahead of any specific class stanzas you enter.

- Stanzas can be nested within other stanzas (these are known as *substanzas*). See "Defining user substanzas in class stanzas" on page 94 for more information.
- The use of opening and closing braces ({ and }) to mark the beginning and end of a stanza is optional for stanzas that *do not* contain substanzas. A stanza that contains substanzas *must* be specified using braces as delimiting characters. Only user substanzas within class stanzas are supported. No types of stanzas other than class support substanzas and no types of stanzas other than user can be provided as substanzas within a class.
- If a syntax error is encountered, the remainder of the stanza is ignored and processing resumes with the next stanza.

Syntax for limit keywords

There is a syntax for limit keywords.

The syntax for setting a limit is:

```
limit_type = hardlimit,softlimit
```

For example:

```
core_limit = 120kb,100kb
```

To specify only a hard limit, you can enter, for example:

```
core_limit = 120kb
```

To specify only a soft limit, you can enter, for example:

```
core_limit = ,100kb
```

In a keyword statement, you cannot have any blanks between the numerical value (100 in the above example) and the units (kb). Also, you cannot have any blanks to the left or right of the comma when you define a limit in a job command file.

For limit keywords that refer to a data limit — such as **data_limit**, **core_limit**, **file_limit**, **stack_limit**, **rss_limit**, **as_limit**, and **memlock_limit** — the hard limit and the soft limit are expressed as:

```
integer[.fraction][units]
```

The allowable units for these limits are:

```
b bytes
w words
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes  (2**60 bytes)
ew exawords  (2**62 bytes)
```

If no units are specified for data limits, then bytes are assumed.

For limit keywords that refer to a number limit — such as **nproc_limit**, **locks_limit**, and **nofile_limit** — the hard limit and the soft limit are expressed as:

```
integer[.fraction][units]
```

The allowable units for these limits are:

```
K    Kilo     (2**10)
M    Mega     (2**20)
G    Giga     (2**30)
T    Tera     (2**40)
P    Peta     (2**50)
E    Exa      (2**60)
```

For limit keywords that refer to a time limit — such as **ckpt_time_limit**, **cpu_limit**, **job_cpu_limit**, and **wall_clock_limit** — the hard limit and the soft limit are expressed as:

[[hours:]minutes:]seconds[.fraction]

Fractions are rounded to seconds.

You can use the following character strings with all limit keywords except the **copy** keyword for **wall_clock_limit**, **job_cpu_limit**, and **ckpt_time_limit**:

rlim_infinity
: Represents the largest positive number.

unlimited
: Has same effect as **rlim_infinity**.

copy Uses the limit currently active when the job is submitted.

64-bit support for administration file keywords

Administrators can assign 64-bit integer values to selected keywords in the administration file. System resource limits, with the exception of CPU limits, are treated by LoadLeveler daemons and commands as 64-bit limits.

Table 72 describes 64-bit support for specific administration file keywords.

Table 72. Notes on 64-bit support for administration file keywords

Keyword	Stanza	Notes
as_limit	Class	See the notes for **core_limit** and **data_limit**.
core_limit **data_limit**	Class	64-bit integer values can be assigned to these limits. Fractional specifications are allowed and will be converted to 64-bit integer values. Unit specifications are accepted and can be one of the following: b, w, kb, kw, mb, mw, gb, gw, tb, tw, pb, pw, eb, ew. **Example:** `core_limit = 8gb,4.25gb`
default_resources **default_node_resources**	Class	Consumable resources associated with the **default_resources** and **default_node_resources** keywords can be assigned 64-bit integer values. Fractional specifications are not allowed. Unit specifications are valid only when specifying the values of the predefined **ConsumableMemory**, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** resources. **Example:** `default_resources = ConsumableVirtualMemory(12 gb)db2_license(112)`
file_limit	Class	See the notes for **core_limit** and **data_limit**.
locks_limit	Class	See the notes for **nproc_limit**.
memlock_limit	Class	See the notes for **core_limit** and **data_limit**.
nofile_limit	Class	See the notes for **nproc_limit**.

Table 72. Notes on 64-bit support for administration file keywords (continued)

Keyword	Stanza	Notes
nproc_limit	Class	64-bit integer values can be assigned to these limits. Fractional specifications are allowed and will be converted to 64-bit integer values. Unit specifications is number. Unit specification is a number that can be used in conjunction with the following abbreviations: **K** kilo **M** mega **G** giga **T** tera **P** peta **E** exa **Examples:** `nproc_limit = 1000,285`

resources	Machine	Consumable resources associated with the **resources** keyword can be assigned 64-bit integer values. Fractional specifications are not allowed. Unit specifications are valid only when specifying the values of the predefined **ConsumableMemory**, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** resources.
		
		Examples:
		`resources = spice2g6(9123456789012) ConsumableMemory(10 gw)`
		`resources = ConsumableVirtualMemory(15 pb) db2_license(1234567890)`

rss_limit **stack_limit**	Class	See the notes for **core_limit** and **data_limit**. **Example:** `rss_limit = 1.25eb,3.33pw`

64-bit limits on Linux systems

Applications managed by LoadLeveler for AIX can be 64-bit applications if the hardware architecture on which AIX is running is capable of supporting 64-bit processes.

Resource limits, such as data limits and stack limits, can be 64-bit limits. When a value of *unlimited* is specified for a process limit (**cpu_limit** excepted) in the LoadLeveler administration file or job command file, the AIX version of LoadLeveler stores this value internally as `INT64_MAX`. Before starting the user job, **LoadL_starter** sets the appropriate limit to this value. This behavior is correct because, on AIX, `RLIM64_INFINITY` is the same as `INT64_MAX (= 0x7FFFFFFFFFFFFFFFLL)`.

On Linux systems, `RLIM64_INFINITY` is equal to `UINT64_MAX (= 0xFFFFFFFFFFFFFFFFULL)`. To maintain compatibility with AIX, LoadLeveler for Linux also stores *unlimited* internally as `INT64_MAX`. However, **LoadL_starter** on Linux sets all process limits (**cpu_limit** excepted) that are in the range (`INT64_MAX`, `UINT64_MAX`) to `UINT64_MAX` before starting the jobs managed by LoadLeveler.

For historical reasons, LoadLeveler for AIX treats the hard and soft time limits, such as **cpu_limit**, **job_cpu_limit**, and **wall_clock_limit**, as 32-bit limits and *unlimited* means `INT32_MAX`. For consistency reasons, LoadLeveler for Linux assumes the same behavior.

Administration file keyword descriptions

This topic contains an alphabetical list of the LoadLeveler administration file keywords.

account
Specifies a list of account numbers available to a user submitting jobs.

Syntax:

```
account =list
```

Where *list* is a blank-delimited list of account numbers that identifies the account numbers a user can use when submitting jobs.

Default: A null list.

adapter_name
Specifies the name the operating system uses to refer to an interface card installed on a node.

Syntax:

```
adapter_name = string
```

Where *string* is the name of a particular interface card installed on the node. Some examples are **en0** and **tk1**. This keyword defines the adapters a user can specify in a job command file using the **network** keyword.

adapter_stanzas
Specifies a list of adapter stanza names that define the adapters on a machine that can be requested.

Syntax:

```
adapter_stanzas = stanza_list
```

Where *stanza_list* is a blank-delimited list of one or more adapter stanza names which specify adapters available on this machine. To take advantage of dynamic adapter configuration you must *exclude* this keyword from the machine stanza. LoadLeveler will then dynamically obtain the adapter configuration for this machine from the RSCT.All adapter stanzas you define must be specified on this keyword. If the keyword is specified without defining any adapter stanza names no adapter will be configured for the machine.

adapter_type
Specifies the type of switch adapter to be used. This keyword is used for the High Performance Switch in a peer domain. The **llextRPD** command will not generate an **adapter_type** statement if no AdapterType is found in the cluster.

Syntax:

```
adapter_type = type
```

Where *type* is the designation for the type of switch adapter.

admin
Specifies a list of administrators for a group or class.

Syntax:

```
admin = list
```

Where *list* is a blank-delimited list of administrators for either this class or this group, depending on whether this keyword appears in a class or group stanza, respectively. These administrators can hold, release, and cancel jobs in this class or this group.

alias

Lists one or more alias names to associate with the machine name.

Syntax:

```
alias = machine_name
```

Where *machine_name* is a blank-delimited list of one or more machine names. Depending upon your network configurations, you can need to add **alias** keywords for machines that have multiple interfaces.

In general, if your cluster is configured with machine host names which match the host names corresponding to the IP address configured for the LAN adapters which LoadLeveler is expected to use, you will not have to specify the **alias** keyword. For example, if all of the machines in your cluster are configured like this sample machine, you should not have to specify the **alias** keyword.

```
Machine porsche.kgn.ibm.com
```

- The hostname command returns porsche.kgn.ibm.com.
- The Ethernet adapter address 129.40.8.20 resolves to hostname porsche.kgn.ibm.com.

However, if any machine in your cluster is configured like either of the following two sample machines, then you will have to specify the **alias** keyword for those machines:

1. Machine `yugo.kgn.ibm.com`
   - The hostname command returns yugo.kgn.ibm.com.
   - The Ethernet adapter address 129.40.8.21 resolves to hostname chevy.kgn.ibm.com.
   - No adapter address resolves to yugo.

   You need to code the machine stanza as:

   ```
   chevy: type = machine
   alias = yugo
   ```
2. Machine `rover.kgn.ibm.com`
   - The hostname command returns rover.kgn.ibm.com.
   - The FDDI adapter address 129.40.9.22 resolves to hostname rover.kgn.ibm.com.
   - The Ethernet adapter address 129.40.8.22 resolves to hostname bmw.kgn.ibm.com.
   - No route exists via the FDDI adapter to the clusters central manager machine.
   - A route exists from this machine to the central manager via the Ethernet adapter.

   You need to code the machine stanza as:

   ```
   bmw:   type = machine
   alias = rover
   ```

allow_scale_across_jobs

allow_scale_across_jobs can be specified within a class stanza and a cluster stanza.

Class stanza:

When used in the class stanza, specifies whether a given class allows jobs that require scale-across scheduling. If you specify false, the class will not accept scale-across jobs. The default value is **true**.

Syntax:

```
allow_scale_across_jobs = true | false
```

Cluster stanza:

When used in the cluster stanza, specifies whether a given cluster will accept jobs from the main cluster for scale-across scheduling. If you specify false, the cluster will not accept scale-across jobs.

Syntax:

```
allow_scale_across_jobs = true | false
```

Default: true

as_limit

Specifies the hard limit, soft limit, or both for the address space to be used by each process of the submitted job.

Syntax:

```
as_limit = hardlimit,softlimit
```

Examples:

```
as_limit = 125621          # hardlimit = 125621 bytes
as_limit = 5621kb          # hardlimit = 5621 kilobytes
as_limit = 2mb             # hardlimit = 2 megabytes
as_limit = 2.5mw           # hardlimit = 2.5 megawords
as_limit = unlimited       # hardlimit = 9,223,372,036,854,775,807 \
                             bytes (X'7FFFFFFFFFFFFFFF')
as_limit = rlim_infinity   # hardlimit = 9,223,372,036,854,775,807 \
                             bytes (X'7FFFFFFFFFFFFFFF')
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

central_manager

Determines whether the machine is the LoadLeveler central manager.

Syntax:

```
central_manager = true| false | alt
```

Where:

- **true** designates this machine as the LoadLeveler central manager host, where the negotiator daemon runs. You must specify one and only one machine stanza identifying the central manager. For example:

  ```
  machine_a: type = machine
  central_manager = true
  ```

- **false** specifies that this machine is not the central manager.
- **alt** specifies that this machine can serve as an alternate central manager in the event that the primary central manager is not functioning. For more information on recovering if the primary central manager is not operating, refer to "What happens if the central manager isn't operating?" on page 708. Submit-only machines cannot have their machine stanzas set to this value.

  If you are going to select machines to serve as alternate central managers, you should look at the following keywords in the configuration file:

– **CENTRAL_MANAGER_HEARTBEAT_INTERVAL**
– **CENTRAL_MANAGER_TIMEOUT**

For information on setting these keywords, see "Specifying alternate central managers" on page 46.

Default: false

ckpt_dir
Specifies the directory to be used for checkpoint files for jobs that did not specify this directory in the job command file.

Syntax:

```
ckpt_dir = directory
```

Where *directory* is the directory location to be used for checkpoint files that did not have a directory name specified in the job command file. If the value specified does not have a fully qualified directory path (including the beginning forward slash), the initial working directory will be inserted before the specified value.

The value specified by the **ckpt_dir** keyword is only used when the **ckpt_file** keyword in the job command file does not contain a full path name and the **ckpt_dir** keyword in the job command file is not specified. For more information on determining the checkpoint directory, see "Naming checkpoint files and directories" on page 145.

Default: Initial working directory

ckpt_time_limit
Specifies the hard limit, soft limit, or both limits for the elapsed time that checkpointing a job can take.

Syntax:

```
ckpt_time_limit = hardlimit,softlimit
```

Where *hardlimit,softlimit* defines the maximum time that checkpointing a job can take. When LoadLeveler detects that the softlimit has been exceeded, it attempts to end the checkpoint and allow the job to continue. If this is not possible, and the hard limit is exceeded, LoadLeveler will terminate the job. The start time of the checkpoint is defined as the time when the Startd daemon receives status from the starter that a checkpoint has started.

Default: Unlimited

Examples:

```
ckpt_time_limit = 30:45          #hardlimit - 30 minutes 45 seconds
ckpt_time_limit = 30:45,25:00    #hardlimit - 30 minutes 44 seconds
                                 #soflimit  - 25 minutes
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

class_comment
Text characterizing the class.

Syntax:

```
class_comment = "string"
```

Where *string* is text characterizing the class. This information appears when the user is building a job command file using the GUI and requests Choice

information on the classes to which he or she is authorized to submit jobs. The comment string associated with this keyword cannot contain an equal sign (=) or a colon (:) character. The length of the string cannot exceed 1024 characters.

Default: No default value is set.

core_limit
Specifies the hard limit, soft limit, or both limits for the size of a core file a job can create.

Syntax:

```
core_limit = hardlimit,softlimit
```

Examples:

```
core_limit = unlimited
core_limit = 30mb
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

cpu_limit
Specifies hard limit, soft limit, or both limits for the CPU time to be used by each individual process of a job step.

Syntax:

```
cpu_limit = hardlimit,softlimit
```

For example, if you impose a **cpu_limit** of five hours and you have a job step composed of five processes, each process can consume five CPU hours; the entire job step can therefore consume 25 total hours of CPU.

Examples:

```
cpu_limit = 12:56:21       # hardlimit = 12 hours 56 minutes 21 seconds
cpu_limit = 56:00,50:00    # hardlimit = 56 minutes 0 seconds
                           # softlimit = 50 minutes 0 seconds
cpu_limit = 1:03           # hardlimit = 1 minute 3 seconds
cpu_limit = unlimited      # hardlimit = 2,147,483,647 seconds
                           # (X'7FFFFFFF')
cpu_limit = rlim_infinity  # hardlimit = 2,147,483,647 seconds
                           # (X'7FFFFFFF')
cpu_limit = copy           # current CPU hardlimit value on the
                           # submitting machine.
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

cpu_speed_scale
Determines whether CPU time is normalized according to machine speed.

Syntax:

```
cpu_speed_scale = true | false
```

Where **true** specifies that CPU time (which is used, for example, in setting limits, in accounting information, and reported by the **llq -x** command), is in normalized units for each machine. **false** specifies that CPU time is in native units for each machine. For an example of using this keyword to normalize accounting information, see "Example: Setting up job accounting files" on page 67.

Default: false

data_limit
Specifies hard limit, soft limit, or both for the data segment to be used by each process of the submitted job.

Syntax:

```
data_limit = hardlimit,softlimit
```

Examples:

```
data_limit = 125621         # hardlimit = 125621 bytes
data_limit = 5621kb         # hardlimit = 5621 kilobytes
data_limit = 2mb            # hardlimit = 2 megabytes
data_limit = 2.5mw          # hardlimit = 2.5 megawords
data_limit = unlimited      # hardlimit = 9,223,372,036,854,775,807 bytes
                            # (X'7FFFFFFFFFFFFFFF')
data_limit = rlim_infinity  # hardlimit = 9,223,372,036,854,775,807 bytes
                            # (X'7FFFFFFFFFFFFFFF')
data_limit = copy           # copy data hardlimit value from
                            # submitting machine.
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

default_class
Specifies a class name that is the default value assigned to jobs submitted by users for which no class statement appears.

Syntax:

```
default_class = list
```

Where *list* is a blank-delimited list of class names used for jobs which do not include a **class** statement in the job command file. If you specify only one default class name, this class is assigned to the job. If you specify a list of default class names, LoadLeveler searches the list to find a class which satisfies the resource limit requirements. If no class satisfies these requirements, LoadLeveler rejects the job.

Suppose a job requests a CPU limit of 10 minutes. Also, suppose the default class list is `default_class = short long`, where `short` is a class for jobs up to five minutes in length and `long` is a class for jobs up to one hour in length. LoadLeveler will select the `long` class for this job because the `short` class does not have sufficient resources.

Default: If no **default_class** is specified in the user stanza, or if there is no user stanza at all, then jobs submitted without a **class** statement are assigned to the **default_class** that appears in the default user stanza. If you do not define a **default_class**, jobs are assigned to the class called **No_Class**.

default_group
Specifies the default group name to which the user belongs.

Syntax:

```
default_group = group_name
```

Where *group_name* is the default group assigned to jobs submitted by the user.

If you specify **default_group = Unix_Group**, LoadLeveler sets the user's LoadLeveler group to the user's current UNIX group.

Default: If a **default_group** statement does not appear in the user stanza, or if there is no user stanza at all, then jobs submitted by the user without a **group**

statement are assigned to the **default_group** that appears in the default user stanza. If you do not define a **default_group**, jobs are assigned to the group called **No_Group**.

default_interactive_class
Specifies a class to which interactive jobs are assigned for jobs submitted by users who do not specify a class using the LOADL_INTERACTIVE_CLASS variable. You can specify only one default interactive class name.

Syntax:

```
default_interactive_class = class_name
```

Where *class_name* is the class to which an interactive job submitted by this user is assigned if the user does not specify a class using the LOADL_INTERACTIVE_CLASS environment variable.

Default: If you do not set a **default_interactive_class** value in the user stanza, or if there is no user stanza at all, then interactive jobs submitted without a **class** statement are assigned to the **default_interactive_class** that appears in the default user stanza. If you do not define a **default_interactive_class**, interactive jobs are assigned to the class called **No_Class**.

See "Examples: User stanzas" on page 98 for more information on how LoadLeveler assigns a default interactive class to jobs.

default_node_resources
Specifies quantities of the consumable resources consumed by each node of a job step provided that a **node_resources** keyword is not coded for the step in the job command file. If a **node_resources** keyword is coded for a job step, it overrides any default node resources associated with the associated job class. The resources must be machine resources; floating resources cannot be assigned with the **node_resources** keyword.

Syntax:

```
default_node_resources = name(count) name(count) ... name(count)
```

The administrator defines the name and count for **default_node_resources**. In addition, *name(count)* could be **ConsumableCpus**(*count*), **ConsumableMemory**(*count units*), **ConsumableLargePageMemory**(*count units*), or **ConsumableVirtualMemory**(*count units*).

The **ConsumableMemory**, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** can be specified with both a *count* and *units*. **ConsumableMemory** or **ConsumableVirtualMemory** specified resource *count* must be an integer greater than zero. **ConsumableLargePageMemory** specified resource *count* must be an integer greater than or equal to zero. The allowable *units* are those normally used with LoadLeveler data limits:

```
b bytes
w words
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes  (2**60 bytes)
ew exawords  (2**62 bytes)
```

The **ConsumableMemory**, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** values are stored in MB (megabytes) and are rounded up. For **ConsumableMemory** or **ConsumableVirtualMemory** the smallest amount that you can request is 1 MB. If no units are specified, then megabytes are assumed. Resources defined here that are not in the **SCHEDULE_BY_RESOURCES** list in the global configuration file will not affect the scheduling of the job.

default_resources

Specifies the default amount of resources consumed by a task of a job step, provided that the **resources** or **dstg_resources** keyword is not coded for the step in the job command file. If a resources keyword is coded for a job step, then it overrides any **default resources** associated with the associated job class.

Syntax:

```
default_resources = name(count) name(count)...name(count)
```

The administrator defines the name and count values for **default_resources**. In addition, *name(count)* could be **ConsumableCpus***(count)*, **ConsumableMemory***(count units)*, **ConsumableVirtualMemory***(count units)*, or **ConsumableLargePageMemory***(count units)*.

The **ConsumableMemory**, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** can be specified with both a *count* and *units*. **ConsumableMemory** or **ConsumableVirtualMemory** specified resource *count* must be an integer greater than zero. **ConsumableLargePageMemory** specified resource *count* must be an integer greater than or equal to zero. The allowable *units* are those normally used with LoadLeveler data limits:

```
b bytes
w words
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes  (2**60 bytes)
ew exawords  (2**62 bytes)
```

The **ConsumableMemory** and **ConsumableVirtualMemory** values are stored in MB (megabytes) and are rounded up. Therefore, the smallest amount of **ConsumableMemory** or **ConsumableVirtualMemory** that you can request is 1 MB. If no units are specified, then megabytes are assumed. Resources defined here that are not in the **SCHEDULE_BY_RESOURCES** list in the global configuration file will not effect the scheduling of the job.

default_wall_clock_limit

Sets a default value for jobs not specifying a wall clock limit in the job command file. The **wall_clock_limit** keyword serves only as the maximum value allowed for the class. The **default_wall_clock_limit** value can be overridden by a job using the **wall_clock_limit** job command file keyword, but that limit cannot exceed the **wall_clock_limit** configured in the class stanza.

Note: If **default_wall_clock_limit** is not specified, it will be assigned the value of **wall_clock_limit** for the same class.

Syntax:

default_wall_clock_limit = *hardlimit*,*softlimit*

An example is:

```
default_wall_clock_limit = 5:00,4:30
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

device_driver_name

Specifies the device driver interface needed for user space function.

Syntax:

```
device_driver_name = name
```

Where *name* specifies the device driver interface. A **device_driver_name** will be present for all adapter stanzas whose name begins with **sn** This keyword is for peer domain switch adapters.

env_copy

Specifies a default value for the job command file **env_copy** keyword for the class, group or user stanza containing the keyword.

Syntax:

env_copy = **all** | master

Table 73 states the value that LoadLeveler uses depending on the combination of values set in the user, group, or class stanzas.

Table 73. Summary of possible values set for the **env_copy** *keyword in the administration file*

env_copy keyword setting in applicable stanzas in the administration file	**Resulting LoadLeveler default behavior for copying the job environment**
All stanzas that set the **env_copy** keyword specify **env_copy** = master	master becomes the default value for the job command file **env_copy** keyword.
One or more stanzas explicitly set **env_copy** = all	all becomes the default value for the job command file **env_copy** keyword.
The **env_copy** keyword is not specified in any stanza	

Default value: No default value is set.

For more information, see:
- The job command file env_copy keyword description.
- "Steps for reducing job launch overhead for parallel jobs" on page 105.

exclude_bg

Specifies that jobs using this class cannot run using the specified list of Blue Gene resources.

Syntax:

```
exclude_bg = list
```

Where *list* is a blank-delimited list of Blue Gene resources that cannot be used by jobs in this class.

An item on the *list* can be the name of a base partition (for example, R00-M0 for Blue Gene/P and R000 for Blue Gene/L), the name of a rack (for example,

R00), or the name of a row of racks (for example, R0). Other types of Blue Gene resources are not subject to any restrictions by the **include_bg** or **exclude_bg** keyword.

If both **exclude_bg** and **include_bg** are specified, **exclude_bg** takes precedence.

Default: The default is that no Blue Gene resources are excluded.

Examples:

In a 4x2x2 Blue Gene/L system, if job class **ClassB** has:

```
exclude_bg = R0 R11 R301
```

then jobs in **ClassB** cannot use racks on row 0 (which includes racks R00, R01 and base partitions R000, R001, R010, R011, rack R11 (which includes base partitions R110 and R111) and base partition R301 in rack R30 of row 3.

exclude_classes

exclude_classes can be specified within a cluster stanza.

Specifies a blank-delimited list of one or more job classes that will not accept remote jobs within the cluster.

Syntax:

```
exclude_classes = class_name[(cluster_name)] ...
```

Where *class_name* specifies a class to be excluded and *cluster_name* can be used to specify that remote jobs from *cluster_name* submitted under *class_name* will be excluded but any other jobs submitted under *class_name* from other clusters will be allowed.

Do not specify a list of **exclude_classes** and **include_classes**. Only one of these keywords can be used within any cluster stanza. **exclude_classes** takes precedence over **include_classes** if both are specified.

Default: The default is that no classes are excluded.

exclude_groups

exclude_groups can be specified within a class stanza and a cluster stanza.

Class stanza:

When used within a class stanza, **exclude_groups** specifies a list of group names identifying those who cannot submit jobs of a particular class.

Syntax:

```
exclude_groups = list
```

Where *list* is a blank-delimited list of groups who are *not* allowed to submit jobs of *class name*.

This list can contain individual user names. To allow a list of users to be included with the list of group names, add a plus sign (+) to each user name that you add to the list. LoadLeveler treats these names as implicit groups.

For example, to add user **mike** to a list of group names, specify:

```
exclude_groups = prod +mike
```

If the string **+mike** is also the actual name of a group stanza, LoadLeveler treats this name as a group, not an implicit group. In this case, LoadLeveler will not prevent user **mike** from submitting jobs to this class unless the user is a member of the **prod** or **+mike** group.

If this keyword is specified, this list limits groups and users of that class to those on the list.

Do not specify both a list of included groups and a list of excluded groups. Only one of these may be used for any class stanza. **exclude_groups** takes precedence over **include_groups** if both are specified.

Default: The default is that no groups are excluded.

Cluster stanza:

When used within a cluster stanza, **exclude_groups** specifies a blank-delimited list of one or more groups that will not accept remote jobs within the cluster.

Syntax:

```
exclude_groups = group_name[(cluster_name)] ...
```

Where *group_name* specifies a group that is not allowed to submit remote jobs and *cluster_name* can be used to specify that remote jobs from *cluster_name* submitted under *group_name* will be excluded but any other jobs submitted under *group_name* from other clusters will be allowed.

Do not specify a list of **exclude_groups** and **include_groups**. Only one of these may be used within any cluster stanza. **exclude_groups** takes precedence over **include_groups** if both are specified.

Default: The default is that no groups are excluded.

exclude_users

exclude_users may be specified within a class, group, and cluster stanza.

Class or group stanza:

When used within a class or group stanza **exclude_users** specifies a list of user names identifying those who cannot submit jobs of a particular class or who are not members of the group.

Syntax:

```
exclude_users = list
```

The definition of this keyword varies slightly, depending on the type of administration file stanza in which the keyword appears:

- In a class stanza: *list* is a blank-delimited list of users who are *not* permitted to submit jobs of *class_name*.
- In a group stanza: *list* is a blank-delimited list of users who do not belong to the group.

Do not specify both a list of included users and a list of excluded users. Only one of these may be used for any class or group. **exclude_users** takes precedence over **include_users** if both are specified. In a class stanza, **exclude_users** also takes precedence over any user substanzas.

Default: The default is that no users are excluded.

Cluster stanza:

When used within a cluster stanza, **exclude_users** specifies a blank-delimited list of one or more users who cannot submit jobs to the cluster.

Syntax:

```
exclude_users = user_name[(cluster_name)] ...
```

Where *user_name* specifies a user that is not allowed to submit remote jobs and *cluster_name* can be used to specify that remote jobs from *cluster_name* submitted under the *user_name* will be excluded but any other jobs submitted under that *user_name* from other clusters will be allowed.

Do not specify a list of **exclude_users** and **include_users**. Only one of these may be used within any cluster stanza. **exclude_users** takes precedence over **include_users** if both are specified.

Default: The default is that no users are excluded.

fair_shares
Specifies the number of shares allocated to jobs of this user or group for fair share scheduling. If the user or group stanza does not specify **fair_shares**, or if there is no user or group stanza at all, the value in the default user or group stanza is used (which defaults to zero if not explicitly specified). The user or group has this number of shares of the cluster CPU resources as well as this number of shares of the Blue Gene resources (if Blue Gene resources are also available in the cluster).

Syntax:

```
fair_shares = number
```

For additional information about the fair share scheduling keyword, see "Using fair share scheduling" on page 160.

file_limit
Specifies the hard limit, soft limit, or both limits for the size of a file that a job can create.

Syntax:

```
file_limit = hardlimit,softlimit
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

inbound_hosts
Specifies a blank-delimited list of hostnames that define the machines configured for inbound connections from other clusters.

Syntax:

```
inbound_hosts = hostname[(cluster_name)] ...
```

Where *hostname* specifies a machine configured for inbound connections from other clusters and *cluster_name* can be used to specify a specific cluster if the host is not connected to all clusters in the multicluster. These hostnames must be fully qualified with domain names if the machines exist in a different domain. This keyword is required in a multicluster environment.

Note: The same machine can be defined as both an inbound host and an outbound host.

inbound_schedd_port
Specifies the port number to use to connect to the Schedd for inbound transactions to this cluster.

Syntax:

```
inbound_schedd_port = port_number
```

Where *port_number* is a positive integer which specifies the port number used to connect to the Schedd for inbound transactions to this cluster.

Default: The default port is 9605.

include_bg

Specifies that jobs using this class will run only on the list of specified Blue Gene resources.

Syntax:

```
include_bg = list
```

Where *list* is a blank-delimited list of Blue Gene resources that can be used by jobs in this class.

An item on the *list* can be the name of a base partition (for example, R00-M0 for Blue Gene/P and R000 for Blue Gene/L), the name of a rack (for example, R00), or the name of a row of racks (for example, R0). Other types of Blue Gene resources are not subject to any restrictions by the **include_bg** or **exclude_bg** keyword.

If both **exclude_bg** and **include_bg** are specified, **exclude_bg** takes precedence.

Default: The default is that all Blue Gene resources are included.

Examples:

In a 4x2x2 Blue Gene/P system, if job class **ClassA** has:

```
include_bg = R00
```

then jobs in **ClassA** can use all base partitions in rack R00 (R00-M0 and R00-M1).

include_classes

include_classes can be specified within a cluster stanza.

Specifies a blank-delimited list of one or more job classes that will accept remote jobs within the cluster.

Syntax:

```
include_classes = class_name[(cluster_name)] ...
```

Where *class_name* specifies a class to be included and *cluster_name* can be used to specify that remote jobs from *cluster_name* will be included but any other jobs submitted under *class_name* from other clusters will not be allowed.

Do not specify a list of **exclude_classes** and **include_classes**. Only one of these can be used within any cluster stanza. **exclude_classes** takes precedence over **include_classes** if both are specified.

Default: The default is that all classes are included.

include_groups

include_groups can be specified within a class stanza and a cluster stanza.

Class stanza:

When used within a class stanza, **include_groups** specifies a list of group names identifying those who can submit jobs of a particular class.

Syntax:

```
include_groups = list
```

Where *list* is a blank-delimited list of groups who are allowed to submit jobs of *class name*.

This list can contain individual user names. To allow a list of users to be included with the list of group names, add a plus sign (+) to each user name that you add to the list. LoadLeveler treats these names as implicit groups.

For example, to add user **mike** to a list of group names, specify:

```
exclude_groups = prod +mike
```

If the string **+mike** is also the actual name of a group stanza, LoadLeveler treats this name as a group, not an implicit group. In this case, LoadLeveler will not allow user **mike** to submit jobs to this class unless the user is a member of the **prod** or **+mike** group.

If this keyword is specified, this list limits groups and users of that class to those on the list.

Do not specify both a list of included groups and a list of excluded groups. Only one of these may be used for any class stanza. **exclude_groups** takes precedence over **include_groups** if both are specified.

Default: The default is that all groups are included.

Cluster stanza:

When used within a cluster stanza, **include_groups** specifies a blank-delimited list of one or more groups that will accept remote jobs within the cluster.

Syntax:

```
include_groups = group_name[(cluster_name)] ...
```

Where *group_name* specifies a group that is allowed to submit remote jobs and *cluster_name* can be used to specify that remote jobs from *cluster_name* submitted under *group_name* will be included but any other jobs submitted under *group_name* from other clusters will not be allowed.

Do not specify a list of **exclude_groups** and **include_groups**. Only one of these may be used within any cluster stanza. **exclude_groups** takes precedence over **include_groups** if both are specified.

Default: The default is that all groups are included.

include_users

include_users may be specified within a class, group, and cluster stanza.

Class or group stanza:

When used within a class or group stanza **include_users** specifies a list of user names identifying those who can submit jobs of a particular class or who are members of the group.

Syntax:

```
include_users = list
```

The definition of this keyword varies slightly, depending on the type of administration file stanza in which the keyword appears:

- In a class stanza: *list* is a blank-delimited list of users who are permitted to submit jobs of *class_name*.
- In a group stanza: *list* is a blank-delimited list of users who belong to the group.

Do not specify both a list of included users and a list of excluded users. Only one of these may be used for any class or group. **exclude_users** takes precedence over **include_users** if both are specified. In a class stanza, users in user substanzas are also permitted to submit jobs of *class_name*, even if those users are not in the **include_users** list.

Default: The default is that all users are included.

Cluster stanza:

When used within a cluster stanza, **include_users** specifies a blank-delimited list of one or more users who can submit jobs to the cluster.

Syntax:

```
include_users = user_name[(cluster_name)] ...
```

Where *user_name* specifies a user that is allowed to submit remote jobs and *cluster_name* can be used to specify that remote jobs from *cluster_name* submitted under the *user_name* will be included but any other jobs submitted under that *user_name* from other clusters will not be allowed.

Do not specify a list of **exclude_users** and **include_users**. Only one of these may be used within any cluster stanza. **exclude_users** takes precedence over **include_users** if both are specified.

Default: The default is that all users are included.

interface_address
Specifies the IP address by which the adapter is known to other nodes in the network.

Syntax:

```
interface_address = string
```

Where *string* is the IP address by which the adapter is known to other nodes in the network. For example: 7.14.21.28. This keyword is required.

interface_name
Specifies the name by which the adapter is known to other nodes in the network.

Syntax:

```
interface_name = string
```

Where *string* is the name by which the adapter is known by other nodes in the network.

job_cpu_limit
Specifies the hard limit, soft limit, or both limits for the total amount of CPU time that all tasks of an individual job step can use per machine.

Syntax:

```
job_cpu_limit = hardlimit,softlimit
```

Example:

```
job_cpu_limit = 10000
```

For more information on this keyword, see:

- JOB_LIMIT_POLICY keyword
- For additional information about limit keywords, see the following topics:
  - "Syntax for limit keywords" on page 324
  - "Using limit keywords" on page 89

local
Specifies the scope of the cluster definition.

Syntax:

```
local = true| false
```

This keyword is required in the local cluster's administration file in a multicluster environment.

Default: false

locks_limit
Specifies the hard limit, soft limit, or both for the file locks to be used by each process of the submitted job.

Syntax:

```
locks_limit = hardlimit,softlimit
```

Examples:

```
locks_limit = 125621            # hardlimit = 125621
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

logical_id
Specifies the logical ID that uniquely identifies the adapter on its network.

Syntax:

```
logical_id = id
```

This keyword is for peer domain switch adapters.

machine_mode
Specifies the type of jobs this machine can run.

Syntax:

```
machine_mode = batch | interactive | general
```

Where:

batch Specifies this machine can run only batch jobs.

interactive
Specifies this machine can run only interactive jobs. Only POE is currently enabled to run interactively.

general
Specifies this machine can run both batch jobs and interactive jobs.

Default: general

main_scale_across_cluster
Specifies whether a cluster is the main cluster. The main cluster schedules, dispatches, and maintains the scale-across jobs. Specifying true identifies the cluster as the main cluster.

Note: If you do not specify a main cluster or if you specify more than one main cluster in the administration file for your cluster, then that cluster cannot participate in scale-across scheduling.

Syntax:

```
main_scale_across_cluster = true | false
```

Default: false

master_node_exclusive
Specifies whether or not this machine is used only as a master node.

Syntax:

```
master_node_exclusive = true| false
```

Where **true** specifies that the machine accepts only jobs (serial or parallel) submitted to classes that have **master_node_requirement** set to **true**. If the job type is parallel, only the master task is run on a machine with **master_node_exclusive** set to **true**.

Default: false

master_node_requirement
Specifies whether or not parallel jobs in this class require the master node feature.

Syntax:

```
master_node_requirement = true|false
```

Where **true** specifies that parallel jobs do require the master node feature. For these jobs, LoadLeveler allocates the first node (called the "master") on a machine having the **master_node_exclusive = true** setting in its machine stanza. If most or all of your parallel jobs require this feature, you should consider placing the statement **master_node_requirement = true** in your default class stanza. Then, for classes that do not require this feature, you can use the statement **master_node_requirement = false** in their class stanzas to override the default setting. One machine per class should have the **true** setting; if more than one machine has this setting, normal scheduling selection is performed.

Default: false

max_jobs_scheduled
Specifies the maximum number of job steps that this machine can run.

Syntax:

```
max_jobs_scheduled = number
```

Where *number* is the maximum number of jobs submitted from this scheduling (Schedd) machine that can run (or start running) in the LoadLeveler cluster at one time. If *number* of jobs are already running, no other jobs submitted from this machine will run, even if resources are available in the LoadLeveler cluster. When one of the running jobs completes, any waiting jobs then become eligible to be run.

Default: The default is -1, which means there is no maximum.

max_node
Specifies the maximum number of nodes that can be requested for a particular class or by a particular user or group for a parallel job.

Syntax:

```
max_node = number
```

Where *number* specifies the maximum number of nodes for a parallel job in a job command file using the **node** keyword.

Default: The default is -1, which means there is no limit.

max_node_resources
Specifies the maximum number of consumable resources that you can request for all tasks of a job step running on the same node.

Syntax:

```
max_node_resources = name(count) name(count) ... name(count)
```

Notes:

1. If the requirement in a job command file for the **node_resources** keyword exceeds what the administrator allows in the **max_node_resources** keyword of the corresponding class, the job will not be submitted to LoadLeveler.
2. If the **default_node_resources** specified in the class stanza exceed what is allowed by **MAX_NODE_RESOURCES**:
   - An error will be logged while reading the administration file.
   - The **max_node_resources** keyword will be ignored for the class.

Default value: No default value is set.

max_protocol_instances
Specifies the maximum number of instances on the network statement.

Syntax:

```
max_protocol_instances = number
```

Where *number* specifies the maximum value allowed on the instances keyword on the network statement for jobs submitted on this class.

Default: The default is 2.

max_reservation_duration
Specifies the maximum time, in minutes, that advance reservations made for this user or group can last.

Syntax:

```
max_reservation_duration = number of minutes
```

When the duration is defined in both the user and group stanza for a specific user, LoadLeveler uses the more restrictive of the two values to determine the maximum duration.

Default: The default is -1, which means that no limit is placed on the duration of the reservation.

For more information, see "Steps for configuring reservations in a LoadLeveler cluster" on page 132.

max_reservation_expiration
Specifies the time, in days, before a recurring reservation for a user or group must expire.

Syntax:

```
MAX_RESERVATION_EXPIRATION = number_of_days
```

The expiration date of a recurring reservation owned by this user or group can be at most **MAX_RESERVATION_EXPIRATION** days from the start time of the next occurrence of the reservation. For example, if **MAX_RESERVATION_EXPIRATION = 180** for a user, any reservation created by that user can be in the system for at most 180 days from the start of the first occurrence to the start of the last occurrence. When the maximum

expiration is defined in both the user and group stanza for a specific user, LoadLeveler uses the more restrictive of the two values to determine the maximum expiration.

A value of -l means that no limit is placed on the expiration date; otherwise, the value must be a positive integer.

Default value: The default is 180.

max_reservations
Specifies the maximum number of advance reservations that this user or group can make.

Syntax:

```
max_reservations = number of reservations
```

This number includes all reservations except those in COMPLETE or CANCEL state.

Note: A recurring reservation only counts as one reservation towards the **MAX_RESERVATIONS** limit regardless of the number of times that the reservation recurs.

Table 74 summarizes the resulting behavior for various sample combinations of **max_reservations** settings in user and group stanzas.

Table 74. Sample user and group settings for the max_reservations keyword

When the user stanza value is:	And the group stanza value is:	Then the user can create this number of reservations in this group:
Not defined	Not defined	0 (zero)
2	Not defined	2 (with any group as the owning group)
Not defined	1	1
3	1	1 (the user can create more reservations in other groups)
1	2	1
0	2	0
1	0	0 (the user can create one reservation in another group)

Default: Undefined, which means that no reservations will be authorized or disallowed. LoadLeveler considers this keyword undefined if negative values are set for it.

max_resources
Specifies the maximum number of consumable resources that you can request for a task of a job step.

Syntax:

```
max_resources = name(count) name(count) ... name(count)
```

Notes:

1. If the requirement in a job command file for the **resources** keyword or the **dstg_resources** keyword exceeds what the administrator allows in the **max_resources** keyword of the corresponding class, the job will not be submitted to LoadLeveler.

2. If the **DEFAULT_RESOURCES** specified in the class stanza exceed what is allowed by **max_resources**:
   - An error will be logged while reading the administration file.
   - The **max_resources** keyword will be ignored for the class.

Default value: No default value is set.

max_top_dogs
Specifies the maximum total number of top dogs that the central manager daemon will allocate per class.

Syntax:

```
max_top_dogs = number
```

where *number* is any positive integer.

Default: The default value for this keyword is 1 for each class, unless a default is specified in the default class stanza

max_total_tasks
Specifies the maximum number of tasks that the BACKFILL scheduler allows a user, group, or class to run at any given time.

Syntax:

```
max_total_tasks = number
```

where *number* is -1, 0, or any positive integer.

Note: This keyword can be specified in a user substanza within a class when the BACKFILL scheduler is in use. This limits the number of tasks that user can run in that class at any given time.

Default: The default value for this keyword is -1, which allows an unlimited number of tasks.

maxidle
Specifies the maximum number of idle job steps this user or group can have simultaneously.

Syntax:

```
maxidle = number
```

Where *number* is the maximum number of idle jobs either this user or this group can have in queue, depending on whether this keyword appears in a user or group stanza. That is, *number* is the maximum number of jobs which the negotiator will consider for dispatch for the user or group. Jobs above this maximum are placed in the NotQueued state. This action prevents one of the following situations:

- Individual users from dominating the number of jobs that are either running or are being considered to run.
- Groups from flooding the job queue.

Note:

1. This keyword can be specified in a user substanza within a class.
2. For the purposes of enforcing the number of idle job steps this user or group can have in queue, a job step is considered idle even if **llq** reports the state as Pending or Starting.

Default: If the user or group stanza does not specify **maxidle** or if there is no user or group stanza at all, the maximum number of jobs that can be simultaneously in queue for the user or group is defined in the default stanza. If no value is found, or the limit found is -1, then no limit is placed on the number of jobs that can be simultaneously idle for the useror group.

For more information, see "Controlling the mix of idle and running jobs" on page 721.

maxjobs
Specifies the maximum number of job steps this user, class, or group can have running simultaneously.

Syntax:

```
maxjobs = number
```

Note: This keyword can be specified in a user substanza within a class when the BACKFILL scheduler is in use.

Default: If the stanza does not specify **maxjobs**, or if there is no class, user, or group stanza at all, the maximum jobs is defined in the default stanza. The default is -1.

For more information, see "Controlling the mix of idle and running jobs" on page 721.

maxqueued
Specifies the maximum number of job steps a single group or user can have queued at the same time.

Syntax:

```
maxqueued = number
```

Where *number* is the maximum number of jobs allowed in the queue for this user or group, depending on whether this keyword appears in a user or group stanza. This is the maximum number of jobs which can be either running or being considered to be dispatched by the negotiator for that user or group. Jobs above this maximum are placed in the NotQueued state. This action prevents one of the following situations:

- Individual users from dominating the number of jobs that are either running or are being considered to run.
- Groups from flooding the job queue.

Note: This keyword can be specified in a user substanza within a class.

Default: If the user or group stanza does not specify **maxqueued** or if there is no user or group stanza at all, the maximum number of jobs that can be simultaneously in queue for the user or group is defined in the default stanza. If no value is found, or the limit found is -1, then no limit is placed on the number of jobs that can be simultaneously idle for the user or group. Regardless of this limit, there is no limit to the number of jobs a user or group can submit.

For more information, see "Controlling the mix of idle and running jobs" on page 721.

memlock_limit
Specifies the hard limit, soft limit, or both for the memory that can be locked by each process of the submitted job.

Syntax:

```
memlock_limit = hardlimit,softlimit
```

Examples:

```
memlock_limit = 125621          # hardlimit = 125621 bytes
memlock_limit = 5621kb          # hardlimit = 5621 kilobytes
memlock_limit = 2mb             # hardlimit = 2 megabytes
memlock_limit = 2.5mw           # hardlimit = 2.5 megawords
memlock_limit = unlimited       # hardlimit = 9,223,372,036,854,775,807 \
                                  bytes (X'7FFFFFFFFFFFFFFF')
memlock_limit = rlim_infinity   # hardlimit = 9,223,372,036,854,775,807 \
                                  bytes (X'7FFFFFFFFFFFFFFF')
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

multicluster_security
Specifies a security mechanism to use for authentication and authorization of intercluster communications.

Syntax:

```
multicluster_security = SSL
```

The only valid specification for this keyword is **SSL**. When **SSL** is specified, LoadLeveler uses the OpenSSL library to provide secure intercluster transactions. If this keyword is omitted or left blank and the **MACHINE_AUTHENTICATE** in the configuration file is set to **true**, then LoadLeveler will accept intercluster transactions only from machines listed as **inbound_hosts** or **outbound_hosts** in the administration file. Otherwise, intercluster transactions are accepted from any machine.

For more information, see "Steps for securing communications within a LoadLeveler multicluster" on page 153.

multilink_address
Specifies the multilink address used for IP striping on the associated adapter.

Syntax:

```
multilink_address = ip_address
```

Where *ip_address* indicates the IP address that includes the adapters that can be striped across.

multilink_list
Specifies the IP addresses of the adapters that this multilink device stripes across.

Syntax:

```
multilink_list = adapter_name <, adapter_name>*
```

Where *adapter_name* indicates multilinked devices which stripes IP addresses across the adapters given in the list.

name_server
Specifies a list of name servers used for a machine.

Syntax:

```
name_server = list
```

Where *list* is a blank-delimited list of character strings that is used to specify which nameservers are used for the machine. Valid strings are DNS, NIS, and LOCAL. LoadLeveler uses the list to determine when to append a DNS

domain name for machine names specified in LoadLeveler commands issued from the machine described in this stanza.

If DNS is specified alone, LoadLeveler will always append the DNS domain name to machine names specified in LoadLeveler commands. If NIS or LOCAL is specified, LoadLeveler will never append a DNS domain name to machine names specified in LoadLeveler commands. If DNS is specified with either NIS or LOCAL, LoadLeveler will always look up the name in the administration file to determine whether to append a DNS domain name. If the name is specified with a trailing period, it doesn't append the domain name.

network_id
Specifies a unique numerical network identifier. This value is set by the **llextRPD** command and should not be changed.

Syntax:

```
network_id = number
```

Default: No default value is set.

network_type

Syntax:

```
network_type = string
```

Where *string* specifies the type of network that the adapter supports (for example, Ethernet). This should be unique for each communication path. This is an administrator defined name. This keyword defines the types of networks a user can specify in a job command file using the **network** keyword.

Default: No default value is set.

nice
Increments the *nice* value of a job.

Syntax:

```
nice = value
```

Where *value* is the amount by which the current UNIX *nice* value is incremented. The *nice* value is one factor in a job's run priority. The lower the number, the higher the run priority. If two jobs are running on a machine, the *nice* value determines the percentage of the CPU allocated to each job.

The default value is 0. If the administrator has decided to enforce consumable resources, the *nice* value will only adjust priorities of processes within the same WLM class. Because LoadLeveler defines a single class for every job step, the *nice* value has no effect.

For more information, consult the appropriate UNIX documentation.

nofile_limit
Specifies the hard limit, soft limit, or both for the number of open file descriptors that can be used by each process of the submitted job.

Syntax:

```
nofile_limit = hardlimit,softlimit
```

Examples:

```
nofile_limit = 1000             # hardlimit = 1000
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

nproc_limit
Specifies the hard limit, soft limit, or both for the number of processes that can be created for the real user ID of the submitted job.

Syntax:

```
nproc_limit = hardlimit,softlimit
```

Examples:

```
nproc_limit = 256               # hardlimit = 256
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

outbound_hosts
Blank-delimited list of hostnames that define the machines configured for outbound connections to other clusters.

Syntax:

```
outbound_hosts = hostname[(cluster_name)] ...
```

Where *hostname* specifies a machine configured for outbound connections to other clusters and *cluster_name* can be used to specify a specific cluster if the host is not connected to all clusters in the multicluster. These hostnames must be fully qualified with domain names if the machines exist in a different domain. This keyword is required in a multicluster environment.

Note: The same machine can be defined as both an outbound host and an inbound host.

pool_list
Specifies a list of pool numbers to which the machine belongs. Do not use negative numbers in a machine pool_list.

Syntax:

```
pool_list = pool_numbers
```

Where *pool_numbers* is a blank-delimited list of non-negative numbers identifying pools to which the machine belongs. These numbers can be any positive integers including zero.

port_number
Specifies the port number of the InfiniBand adapter port.

Syntax:

```
port_number = number
```

Where *port_number* is the port number of the InfiniBand adapter port. The adapter stanza for InfiniBand support only contains the adapter port number; there is no InfiniBand adapter information in the adapter stanza.

priority
Identifies the priority of the appropriate user, class, or group.

Syntax:

```
priority = number
```

Where *number* is a integer that specifies the priority for jobs either in this class, or submitted by this user or group, depending on whether this keyword appears in a class, user, or group stanza, respectively.

The number specified for priority is referenced as either **ClassSysprio**, **UserSysprio**, or **GroupSysprio** in the configuration file. You can use **ClassSysprio**, **UserSysprio**, or **GroupSysprio** when assigning job priorities. If the variable **ClassSysprio**, **UserSysprio**, or **GroupSysprio** does not appear in the **SYSPRIO** expression in the configuration file, then the priority specified in the administration file is ignored. See "LoadLeveler variables" on page 314 for more information about the **ClassSysprio**, **UserSysprio**, or **GroupSysprio** keywords.

Default: The default is 0.

reservation_permitted
Specifies whether the machine can be reserved through new reservation requests.

Syntax:

```
reservation_permitted = true | false
```

If the value of this keyword is changed to false for this machine when it already is reserved through existing reservations, LoadLeveler will reserve this machine until those existing reservations complete or are canceled.

Default: **true**, which means that this machine can be reserved through new reservation requests.

resources
Specifies quantities of the consumable resources initially available on the machine.

Syntax:

```
resources = name(count) name(count) ... name(count)
```

Where *name(count)* is an administrator-defined name and count, or could also be **ConsumableCpus***(count)*, **ConsumableMemory***(count units)*, **ConsumableVirtualMemory***(count units)*, or **ConsumableLargePageMemory***(count units)*.

The **ConsumableMemory**, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** can be specified with both a count and units. The **ConsumableMemory** or **ConsumableVirtualMemory** specified resource count must be an integer greater than zero. The **ConsumableLargePageMemory** specified resource count must be an integer greater than or equal to zero. The allowable units are those normally used with LoadLeveler data limits:

```
b bytes
w words
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes (2**60 bytes)
ew exawords (2**62 bytes)
```

The **ConsumableMemory**, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** values are stored in MB (megabytes) and rounded up. For **ConsumableMemory** or **ConsumableVirtualMemory**, the

smallest amount that you can request is one megabyte. If no units are specified, then megabytes are assumed. Resources defined here that are not in the **SCHEDULE_BY_RESOURCES** list in the global configuration file will not effect the scheduling of the job.

For the **ConsumableCpus** resource, a value of **all** can be specified instead of count. This indicates that the CPU resource value will be obtained from the Startd daemons. However, these resources will not be available for scheduling until the first **Startd** update.

A list within < > angle brackets indicates a list of CPU IDs. Only CPUs with logical IDs specified in the list will be considered available for LoadLeveler jobs. The following example specifies a list of CPUs:

```
resources = ConsumableCpus< 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 >
```

CPU IDs can also be specified using a list of ranges:

```
resources = ConsumableCpus< 0-6 10-16 >
```

Jobs requesting processor affinity with the **task_affinity** keyword in the job command file will only run on machines where the resource statement contains the **ConsumableCpus** keyword.

The logical IDs of the CPUs available on a machine can be found issuing the `bindprocessor -q` command.

Default: No default value is set.

rss_limit
Specifies the hard limit, soft limit, or both limits for the resident set size for a job.

Syntax:

```
rss_limit = hardlimit,softlimit
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

schedd_fenced
Specifies whether or not the central manager is to ignore connections from the Schedd daemon running on this machine.

Syntax:

```
schedd_fenced = true | false
```

Where **true** specifies that the central manager ignores connections from the Schedd daemon running on this machine. Use the **true** setting together with the **llmovespool** command when you want to attempt to recover resources lost when a node running the Schedd daemon fails. A **true** setting prevents conflicts when you use the **llmovespool** command to move jobs from one Schedd machine to another. For more information, see "How do I recover resources allocated by a Schedd machine?" on page 710.

Default: false

schedd_host
Specifies whether or not this machine is used to help submit-only machines access LoadLeveler hosts that run LoadLeveler jobs.

Syntax:

```
schedd_host = true | false
```

When **true** this keyword specifies that if a Schedd is running on a machine that it will serve as a public scheduling machine. A public scheduling machine accepts job submissions from other machines in the LoadLeveler cluster. Jobs are submitted to a public scheduling machine if:

- The submission occurs on a machine which does not run the Schedd daemon. These include submit-only machines and machines which are configured to run other LoadLeveler daemons but not the Schedd daemon.
- The submission occurs on a machine which runs the Schedd daemon but is configured to submit jobs to a public scheduling machine by having the **SCHEDD_SUBMIT_AFFINITY** keyword set to **false** in the global or local configuration file.

This keyword does not configure LoadLeveler to run the Schedd daemon on a node. Use the configuration keyword **SCHEDD_RUNS_HERE** to run the Schedd daemon on a node. Refer to the SCHEDD_RUNS_HERE keyword for more information.

Default: false

secure_schedd_port
Specifies the port number to use to connect to the Schedd for secure inbound transactions to this cluster.

Syntax:

```
secure_schedd_port = port_number
```

Where *port_number* is a positive integer that specifies the port number used to connect to the Schedd for secure inbound transactions to this cluster. This port is only used if the **multicluster_security** keyword is set to **SSL**. The secure Schedd port should be different from the normal Schedd port.

Default: 9607

smt
Indicates the required simultaneous multithreading (SMT) state for all job steps assigned to the class.

Syntax:

```
smt = yes | no | as_is
```

Where:

yes The job step requires SMT to be enabled.

no The job step requires SMT to be disabled.

as_is The SMT state will not be changed.

Default value: as_is

Examples:

```
smt = yes
```

speed
Specifies the weight associated with the machine for scheduling purposes.

Syntax:

```
speed = number
```

Where *number* is a floating point number that is used for machine scheduling purposes in the **MACHPRIO** expression. For more information on machine scheduling and the MACHPRIO expression, see "Setting negotiator

characteristics and policies" on page 45. In addition, the **speed** keyword is also used to define the weight associated with the machine. This weight is used when gathering accounting data on a machine basis.

To distinguish speed among different machines, you must include this value in the local configuration file. For information on how the **speed** keyword can be used to schedule machines, refer to "Setting negotiator characteristics and policies" on page 45.

Default: The default is 1.0.

ssl_cipher_list
Specifies a cipher list defining what encryption methods are available to OpenSSL when securing multicluster connections.

Syntax:

```
ssl_cipher_list = cipher_list
```

Where *cipher_list* is a valid cipher list as documented by the OpenSSL **ciphers** command.

Default: This keyword will default to the "ALL:eNULL:!aNULL" string.

stack_limit
Specifies the hard limit, soft limit, or both limits for the size of a stack.

Syntax:

```
stack_limit = hardlimit,softlimit
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

striping_with_minimum_networks
Specifies whether or not nodes which have more than half of their networks in READY state are considered for **sn_all** jobs. This makes certain that at least one network is UP and in READY state between any two nodes assigned for the job.

Syntax:

```
striping_with_minimum_networks = true| false
```

When set to true, then the nodes which have more than half the minimum number of networks in the READY state are considered for **sn_all** jobs. If set to **false**, then only nodes which have all networks in the READY state are considered for **sn_all** jobs.

Default: false

submit_only
Specifies whether or not this machine is a submit-only machine.

Syntax:

```
submit_only = true| false
```

Where **true** designates this as a submit-only machine. If you set this keyword to **true**, in the administration file set **central_manager** and **schedd_host** to **false**.

Default: false

total_tasks
Specifies the maximum number of tasks that can be requested for a particular class or by a particular user or group for a parallel job.

Syntax:

```
total_tasks = number
```

Where *number* specifies the maximum number of tasks for a parallel job in a job command file using the **total_tasks** keyword.

Default: The default is -1, which means there is no limit.

type
Identifies the type of stanza in the administration file.

Syntax:

```
type = stanza_type
```

Where *stanza_type* is one of the following:
- Adapter
- Class
- Group
- Machine
- User

Default: No default value is set.

wall_clock_limit
Specifies the hard limit, soft limit, or both limits for the amount of elapsed time for which a job can run.

Syntax:

```
wall_clock_limit = hardlimit,softlimit
```

Note that LoadLeveler uses the time the negotiator daemon dispatches the job as the start time of the job. When a job is checkpointed, vacated, and then restarted, the **wall_clock_limit** is not adjusted to account for the amount of time that elapsed before the checkpoint occurred.

If you are running the BACKFILL scheduler, you must set a wall clock limit either in the job command file or in a class stanza (for the class associated with the job you submit). LoadLeveler administrators should consider setting a default wall clock limit in a default class stanza. For more information on setting a wall clock limit when using the BACKFILL scheduler, see "Choosing a scheduler" on page 44.

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

Chapter 14. Job command file reference

A LoadLeveler job consists of one or more job steps, each of which is defined in a single job command file. A job command file specifies the name of the job, as well as the job steps that you want to submit, and can contain other LoadLeveler statements.

Table 75 lists the job command file subtasks:

Table 75. Job command file subtasks

Subtask	Associated information (see . . .)
To find out how to work with a job command file	Chapter 8, "Building and submitting jobs," on page 179
To learn how to correctly specify the contents of a job command file	• "Job command file syntax" • "Job command file keyword descriptions" on page 359

Job command file syntax

There are general rules that apply to job command files.

- Keyword statements begin with # @. There can be any number of blanks between the # and the @.
- Comments begin with #. Any line whose first non-blank character is a pound sign (#) and is not a LoadLeveler keyword statement is regarded as a comment.
- Statement components are separated by blanks. You can use blanks before or after other delimiters to improve readability but they are not required if another delimiter is used.
- The back-slash (\) is the line continuation character. Note that the continued line must not begin with # @. If your job command file is the script to be executed, you must start the continued line with a #. See Example 2 and Example 3 in topic "Examples: Job command files" on page 181 for examples that use the back-slash for line continuation.
- Keywords are *not* case sensitive. This means you can enter them in lower case, upper case, or mixed case.

Serial job command file

The serial job command file is run from the current working directory.

Figure 41 on page 358 is an example of a simple serial job command file which is run from the current working directory. The job command file reads the input file, **longjob.in1**, from the current working directory and writes standard output and standard error files, **longjob.out1** and **longjob.err1**, respectively, to the current working directory.

```
#   The name of this job command file is file.cmd.
#   The input file is longjob.in1 and the error file is
#   longjob.err1. The queue statement marks the end of
#   the job step.
#
# @ executable = longjob
# @ input = longjob.in1
# @ output = longjob.out1
# @ error = longjob.err1
# @ queue
```

Figure 41. Serial job command file

Parallel job command file

In addition to building job command files to submit serial jobs, you can also build job command files to submit parallel jobs.

Before constructing parallel job command files, consult your LoadLeveler system administrator to see if your installation is configured for parallel batch job submission.

For more information on submitting parallel jobs, see "Working with parallel jobs" on page 194.

Syntax for limit keywords

There is a syntax for limit keywords.

See "Syntax for limit keywords" on page 324 for additional information about limit keywords.

64-bit support for job command file keywords

Users can assign 64-bit integer values to selected keywords in the job command file.

System resource limits, with the exception of CPU limits, are treated by LoadLeveler daemons and commands as 64-bit limits.

Table 76 describes 64-bit support for specific job command file keywords.

Table 76. Notes on 64-bit support for job command file keywords

Keyword name	Notes
as_limit	64-bit integer values can be assigned to these limits. Fractional specifications are allowed and will be converted to 64-bit integer values. Refer to the allowable units for these limits listed under the "Syntax for limit keywords" on page 324 topic.
ckpt_time_ limit	Not supported. The hard and soft time limits associated with this keyword are 32-bit integers. If a value that cannot be contained in a 32-bit integer is assigned to this limit, the value will be truncated to either 2147483647 or -2147483648.
core_limit	64-bit integer values may be assigned to this limit. Fractional specifications are allowed and will be converted to 64-bit integer values. Refer to the allowable units for these limits listed under "Syntax for limit keywords" on page 324.
cpu_limit	Not supported. The hard and soft time limits associated with this keyword are 32-bit integers. If a value that cannot be contained in a 32-bit integer is assigned to this limit, the value will be truncated to either 2147483647 or -2147483648.

Table 76. Notes on 64-bit support for job command file keywords (continued)

Keyword name	Notes
data_limit **file_limit**	64-bit integer values may be assigned to these limits. Fractional specifications are allowed and will be converted to 64-bit integer values. Refer to the allowable units for these limits listed under "Syntax for limit keywords" on page 324.
image_size	64-bit integer values may be assigned to this keyword. Fractional and unit specifications are not allowed. The default unit of **image_size** is kb. **Example:** `image_size = 12345678901`
job_cpu_limit	Not supported. The hard and soft time limits associated with this keyword are 32-bit integers. If a value that cannot be contained in a 32-bit integer is assigned to this limit, the value will be truncated to either 2147483647 or -2147483648.
locks_limit	64-bit integer values can be assigned to these limits. Fractional specifications are allowed and will be converted to 64-bit integer values. Refer to the allowable units for these limits listed under the "Syntax for limit keywords" on page 324 topic.
memlock_limit	See notes for **as_limit**.
nofile_limit	See notes for **locks_limit**.
nproc_limit	See notes for **locks_limit**.

preferences
requirements
	64-bit integer values may be associated with the LoadLeveler variables ″Memory″ and ″Disk″ in the expressions assigned to these keywords. Fractional and unit specifications are not allowed.
	Examples:
	`requirements = (Arch == "R6000") && (Disk > 500000000) && (Memory > 6000000000)`
	`preferences = (Disk > 6000000000) && (Memory > 9000000000)`

resources
node_resources
	Consumable resources associated with the **resources** keyword may be assigned 64-bit integer values. Fractional specifications are not allowed. Unit specifications are valid only when specifying the values of the predefined ConsumableMemory, ConsumableVirtualMemory, and ConsumableLargePageMemory resources.
	Examples:
	`resources = spice2g6(123456789012) ConsumableMemory(10 gb)`
	`resources = ConsumableVirtualMemory(15 pb) db2_license(1)`
	`resources = ConsumableLargePageMemory(2048mb)`

rss_limit **stack_limit**	64-bit integer values may be assigned to these limits. Fractional specifications are allowed and will be converted to 64-bit integer values. Refer to the allowable units for these limits listed under "Syntax for limit keywords" on page 324.
wall_clock_ limit	Not supported. The hard and soft time limits associated with this keyword are 32-bit integers. If a value that cannot be contained in a 32-bit integer is assigned to this limit, the value will be truncated to either 2147483647 or -2147483648.

Job command file keyword descriptions

This topics contains an alphabetical list of the keywords you can use in a LoadLeveler script.

This topic also provides examples of statements that use these keywords. For most keywords, if you specify the keyword in a job step of a multistep job, its value is inherited by all proceeding job steps. Exceptions to this are noted in the keyword description.

If a blank value is used after the equal sign, it is as if no keyword was specified.

account_no

Supports centralized accounting. Allows you to specify an account number to associate with a job. This account number is stored with job resource information in local and global history files. It may also be validated before LoadLeveler allows a job to be submitted. For more information, see "Gathering job accounting data" on page 61.

Syntax:

```
account_no = string
```

where *string* is a text string that can consist of a combination of numbers and letters.

Default value: No default value is set.

Example: If the job accounting group charges for job time based upon the department to which you belong, your account number would be similar to:

```
account_no = dept34ca
```

arguments

Specifies the list of arguments to pass to your program when your job runs.

Syntax:

```
arguments = arg1 arg2 ...
```

Default value: No default arguments are set.

Example: If your job requires the numbers 5, 8, 9 as input, your arguments keyword would be similar to:

```
arguments = 5 8 9
```

as_limit

Specifies the hard limit, soft limit, or both limits for the size of address space that the submitted job can use. This limit is a per process limit.

Syntax:

```
as_limit = hardlimit,softlimit
```

Default value: No default value is set.

Example:

```
as_limit = ,125621
as_limit = 5621kb
as_limit = 2mb
as_limit = 2.5mw,2mb
```

For additional information about limit keywords, see the following topics:

- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

bg_connection

Specifies the type of wiring requested for the Blue Gene partition in which the job step will run.

Syntax:

```
bg_connection = TORUS | MESH | PREFER_TORUS
```

where:

TORUS
Specifies that the admissible partitions must be wireable as a torus.

MESH
Specifies that the admissible partitions must be wireable as a mesh.

PREFER_TORUS
Specifies that the admissible partitions should be wireable as a torus, but if there are no such partitions then the selected partition must be wireable as a mesh.

This keyword is only valid for job type **bluegene**. This keyword cannot be used if the **bg_partition** keyword is specified. This keyword is not inherited by other job steps.

Default value: MESH is the default value.

bg_partition

Specifies the ID of the Blue Gene partition that the job will run in.

Syntax:

```
bg_partition = partition_id
```

where *partition_id* is a string identifying a partition in the Blue Gene system.

This keyword is only valid for job type **bluegene**. This keyword cannot be used if the **bg_connection**, **bg_requirements**, **bg_shape**, or the **bg_size** keyword is specified. This keyword is not inherited by other job steps.

Default value: No default is set.

bg_requirements

Specifies the requirements which a Blue Gene base partition in the LoadLeveler cluster must meet to run any job steps.

Syntax:

```
bg_requirements = Boolean_expression
```

The only requirement supported at this time is memory, where memory specifies the amount, in megabytes, of regular physical memory required in the C-nodes of the Blue Gene base partition where you want your job step to run.

Example 1: To require Blue Gene base partitions with 512 megabytes of physical memory in their C-nodes, enter:

```
bg_requirements = (Memory == 512)
```

Example 2: To require Blue Gene base partitions with more than 512 megabytes of physical memory in their C-nodes, enter:

```
bg_requirements = (Memory > 512)
```

This keyword is only valid for job type **bluegene**. This keyword cannot be used if the **bg_partition** keyword is specified. This keyword is not inherited by other job steps.

Default value: No default value is set.

bg_rotate

Specifies whether the scheduler should consider all possible rotations of the given shape of the job when searching for a partition for the job.

Syntax:

```
bg_rotate = true | false
```

where **true** implies that the shape can be rotated to fit some free resource and **false** implies that the shape will not be rotated.

Assigning a value of **true** to this keyword will increase the likelihood of the scheduler finding a partition to run the job and optimizes overall scheduling of Blue Gene resources. **bg_rotate** must be set to **false** when using the **mapfile** argument of **mpirun** to specify how the job's tasks are to be assigned to the allocated compute nodes.

This keyword is only valid for job type **bluegene**. This keyword is not inherited by other job steps.

Note: This keyword can only be used in conjunction with the **bg_shape** job command file keyword. If **bg_shape** is not present, this keyword is ignored.

Default value: The default value is true.

bg_shape

Specifies the requested shape of the Blue Gene job to be started in the system.

Syntax:

```
bg_shape = XxYxZ
```

where *X*, *Y*, and *Z* are positive integers indicating the number of base partitions in the X-direction, Y-direction, and Z-direction, respectively, of the requested job shape. The values of *X*, *Y*, and *Z* or their rotations, if **bg_rotate** is **true**, must not be greater than the corresponding X, Y, and Z sizes of the Blue Gene system, otherwise the job will never be able to start.

This keyword is only valid for job type **bluegene**. This keyword can not be used if the **bg_partition** or **bg_size** keyword is specified. This keyword is not inherited by other job steps.

Note: The X, Y, and Z dimensions of the allocated partition will be exactly as defined by the **bg_shape** job command file keyword ***unless*** the job command file keyword **bg_rotate** is specified as **true**, in which case all possible rotations of the dimensions are possible.

Default value: No default is set.

bg_size

Specifies the requested size of the Blue Gene job to be started in the system.

Syntax:

```
bg_size = bg_size
```

where *bg_size* is an integer indicating the size of the job in units of compute nodes. No guarantees are made as to the shape of the allocated partition for a given size. The only guarantee is that the size of the allocated shape will be no smaller than the requested size and as close to the request size as possible.

This keyword is only valid for job type **bluegene**. This keyword can not be used if the **bg_partition** or **bg_shape** keyword is specified. This keyword is not inherited by other job steps.

Note: Not all values given for **bg_size** are representable. For example, consider an 8x4x4 Blue Gene system in units of base partitions and a requested **bg_size** of *5632* (equivalent to 11 base partitions). Since 11 is a prime number, it cannot be decomposed. Futhermore, it is greater than any one dimension of the system. In this case, a 3x4x1 partition is allocated, since it is the smallest number of base partitions larger than the requested size.

Default value: If **bg_size**, **bg_shape**, or **bg_partition** are not specified then **bg_size** defaults to the configured minimum partition size. This is the value of the **BG_MIN_PARTITION_SIZE** keyword in the configuration file.

blocking

Blocking specifies that tasks be assigned to machines in multiples of a certain integer. Unlimited blocking specifies that tasks be assigned to each machine until it runs out of initiators, at which time tasks will be assigned to the machine which is next in the order of priority. If the total number of tasks are not evenly divisible by the blocking factor, the remainder of tasks are allocated to a single node.

This keyword is supported by the BACKFILL and API schedulers.

Syntax:

blocking = *integer* | **unlimited**

where:

integer
Specifies the blocking factor to be used. The blocking factor must be a positive integer. With a blocking factor of 4, LoadLeveler will allocate 4 tasks at a time to each machine with at least 4 initiators available. This keyword must be specified with the total_tasks keyword. **Example:**

```
blocking = 4
total_tasks = 17
```

LoadLeveler will allocate tasks to machines in an order based on the values of their MACHPRIO expressions (beginning with the highest MACHPRIO value). In cases where total_tasks is not a multiple of the blocking factor, LoadLeveler assigns the remaining number of tasks as soon as possible (even if that means assigning the remainder to a machine at the same time as it assigns another block).

unlimited
Specifies that LoadLeveler allocate as many tasks as possible to each machine, until all of the tasks have been allocated. LoadLeveler will prioritize machines based on the number of initiators each machine currently has available. Unlimited blocking is the only means of allocating tasks to nodes that does not prioritize machines primarily by MACHPRIO expression.

Default value: No default is set, which means that no blocking is requested.

bulkxfer
Indicates whether the communication subsystem will use bulk data transfer for user space communication.

Syntax:

bulkxfer = yes | **no**

Default: no

For additional information about bulk data transfer, see "Using bulk data transfer" on page 188.

checkpoint

Indicates if a job is able to be checkpointed. Checkpointing a job is a way of saving the state of the job so that if the job does not complete it can be restarted from the saved state rather than starting the job from the beginning.

If you specify a value that is not valid for the **checkpoint** keyword, an error message is generated and the job is not submitted.

Syntax:

```
checkpoint = interval | yes | no
```

where:

interval
: Specifies that LoadLeveler will automatically checkpoint your program at preset intervals. The time interval is specified by the settings in the **MIN_CKPT_INTERVAL** and **MAX_CKPT_INTERVAL** keywords in the configuration file. Since a job with a setting of **interval** is considered checkpointable, you can initiate a checkpoint using any method in addition to the automatic checkpoint. The difference between **interval** and **yes** is that **interval** enables LoadLeveler to automatically take checkpoints on the specified intervals while the value **yes** does not enable that ability.

yes
: Enables a job step to be checkpointed. With this setting, a checkpoint can be initiated either under the control of an application or by a method external to the application. With a setting of **yes**, LoadLeveler will not checkpoint on the intervals specified by the **MIN_CKPT_INTERVAL** and **MAX_CKPT_INTERVAL** keywords in the configuration file. The difference between **yes** and **interval** is that **interval** enables LoadLeveler to automatically take checkpoints on the specified intervals while the value **yes** does not enable that ability.

no
: The step cannot be checkpointed.

Default value: no

Restriction: On Linux machines only: If a job with **checkpoint = interval** or **checkpoint = yes** is dispatched, it is rejected.

Example: If a checkpoint is initiated from within the application but checkpoints are not to be taken automatically by LoadLeveler you can use:

```
checkpoint = yes
```

For detailed information on checkpointing, see "LoadLeveler support for checkpointing jobs" on page 139.

ckpt_dir

Specifies the directory which contains the checkpoint file.

Checkpoint files can become quite large. When specifying ckpt_dir, make sure that there is sufficient disk space to contain the files. Guidelines can be found in "LoadLeveler support for checkpointing jobs" on page 139.

Syntax:

```
ckpt_dir = pathname
```

The values for **ckpt_dir** are case sensitive.

Default value: The value of the **ckpt_dir** keyword in the class stanza of the administration file

Restriction: The keyword **ckpt_dir** is not allowed in the command file for interactive POE sessions.

Example: If checkpoint files were to be stored in the /tmp directory the job command file would include:

```
ckpt_dir = /tmp
```

For more information on naming directories for checkpointing, see "Naming checkpoint files and directories" on page 145.

ckpt_execute_dir

Specifies the directory where the job step's executable will be saved for checkpointable jobs. You may specify this keyword in either the configuration file or the job command file; different file permissions are required depending on where this keyword is set. For additional information, see "Planning considerations for checkpointing jobs" on page 140.

Syntax:

```
ckpt_execute_dir = directory
```

This directory cannot be the same as the current location of the executable file, or LoadLeveler will not stage the executable. In this case, the user must have execute permission for the current executable file.

Default value: No default value is set.

ckpt_file

Used to specify the base name of the checkpoint file. The checkpoint file is created by the AIX checkpoint functions and is derived from the filename specified in the **ckpt_file** keyword in the job command file or the default file name.

Syntax:

```
ckpt_file = filename
```

The value for the **ckpt_file** keyword is case sensitive.

Default value: [jobname.]job_step_id.ckpt

Restriction: The keyword **ckpt_file** is not allowed in the command file for interactive POE sessions.

Example: If you are storing checkpoint files in a file with the base name "myckptfiles" which is placed in the directory named by the **ckpt_dir** keyword, the job command file would contain:

```
ckpt_file = myckptfiles
```

Alternatively, if you are naming the checkpoint files "myckptfiles" and storing them in the directory /tmp, the keyword in the job command file can contain:

```
ckpt_file = /tmp/myckptfiles
```

Or the combination of **ckpt_dir** and **ckpt_file** keywords can be used, producing the same result.

```
ckpt_dir  = /tmp
ckpt_file = myckptfiles
```

For more information on naming files for checkpointing, see "Naming checkpoint files and directories" on page 145.

ckpt_time_limit

Specifies the hard or soft limit, or both limits for the elapsed time checkpointing a job can take. When the soft limit is exceeded, LoadLeveler will attempt to stop the checkpoint and allow the job to continue. If the checkpoint is not able to be stopped and the hard limit is exceeded, LoadLeveler will terminate the job.

Syntax:

ckpt_time_limit = *hardlimit*,*softlimit*

Default value: The value of the **ckpt_time_limit** keyword in the class stanza of the administration file

Examples:

```
ckpt_time_limit =  00:10:00,00:05:00
ckpt_time_limit = 12:30,7:10
ckpt_time_limit = rlim_infinity
ckpt_time_limit = unlimited
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

class

Specifies the name of a job class defined locally in your cluster. You can use the **llclass** command to find out information on job classes.

Syntax:

class = *name*

Default value: If you do not specify a value for this keyword, the default job class, **No_Class**, is assigned.

Example: If you are allowed to submit jobs belonging to a class called "largejobs", your class keyword would look like the following:

```
class = largejobs
```

cluster_input_file

Specifies an individual file to be copied from the local path name to the remote path name when the job is run.

Syntax:

cluster_input_file = *local_pathname*, *remote_pathname*

where:

local_pathname
Specifies the full path name of the file to be copied from the local cluster. This file must be accessible by the submitting user on the node where the local gateway Schedd runs. *local_pathname* must be specified.

remote_pathname
Specifies the full path name the file will be copied to on the assigned cluster. This file must be accessible by the mapped user on the Schedd node of the selected cluster. *remote_pathname* must be specified. Normally the file specified by *remote_pathname* will be deleted following the job termination. It will not be deleted if the cluster selected to run the job is the same cluster where the job was submitted and *remote_pathname* resolves to the same path name specified as *local_pathname*.

If LoadLeveler fails to copy an input file to the selected cluster, the assignment of the job to the selected cluster will fail. If the cluster was assigned by the administrator using the **llmovejob** command, an error message will be displayed in the command response describing the reason for failure and the job will remain in the cluster it was in and be placed in system hold. If the

cluster was assigned during job submission, the job submission fails and an error message will be displayed in the command response describing the reason for failure.

Default value: No default value is set.

cluster_list

Allows you to specify that a job is to run on a particular cluster or that LoadLeveler is to decide which cluster is best from the list of clusters specified. If this keyword is specified, it must be in the first job step of a multistep job. Any definitions in other steps are ignored.

Syntax:

```
cluster_list = cluster_list
```

where *cluster_list* is a blank-delimited list of cluster names or the reserved word **any**. Depending on the specified value, **cluster_list** can have one of three effects:

- Specifying a single cluster name indicates that a job is to be submitted to that cluster.
- Specifying a list of multiple cluster names indicates that the job is to be submitted to one of the clusters specified with the installation exit **CLUSTER_METRIC** choosing from the list.
- Specifying the reserved word **any** indicates the job is to be submitted to any cluster defined by the installation exit **CLUSTER_METRIC**.

Note: If a cluster list is specified using either the **llsubmit -X** command or the **ll_cluster** API, then that cluster list takes precedence over a **cluster_list** specified in the job command file.

cluster_option

Specifies the job will use multicluster, scale-across processing.

Syntax:

```
cluster_option = scale_across | none
```

Note: Specifying any of the following job control file keywords when `cluster_option = scale_across` (or if you specify **llsubmit -S**) causes job submission failure and error message generation:

- The **job_type=bluegene** or any keyword beginning with "**bg**"
- **checkpoint**
- **cluster_input_file**
- **cluster_output_file**
- **coschedule = yes**
- **dstg_environment**
- **dstg_in_script**
- **dstg_in_wall_clock_limit**
- **dstg_node**
- **dstg_out_script**
- **dstg_out_wall_clock_limit**
- **dstg_resources**
- **host_file**
- **ll_res_id**
- **restart_from_ckpt = yes**
- **restart_on_same_nodes = yes**
- **task_geometry**
- **network** statement options:

- **US** mode
- **sn_all** or **sn_single** type

Default: none

cluster_output_file

Specifies an individual output file to be copied to the submitting cluster from the cluster selected to run the job after the job completes.

Syntax:

```
cluster_output_file = local_pathname, remote_pathname
```

where:

local_pathname
Specifies the full path name the file will be copied to on the local cluster. This file must be accessible by the submitting user on the node where the local gateway Schedd runs. *local_pathname* must be specified.

remote_pathname
Specifies the full path name of the file that will be copied from the assigned cluster. This file must be accessible by the mapped user on the Schedd node of the selected cluster. *remote_pathname* must be specified. Normally the file specified by *remote_pathname* will be deleted following the job termination. It will not be deleted if the cluster selected to run the job is the same cluster where the job was submitted and *remote_pathname* resolves to the same path name specified as *local_pathname*.

If LoadLeveler fails to copy an output file from a selected cluster to the local cluster during job termination, the job termination will proceed and the remote file will not be deleted. Mail will be sent to the user describing the reason for the failed copy.

Default value: No default value is set.

comment

Specifies text describing characteristics or distinguishing features of the job.

core_limit

Specifies the hard limit, soft limit, or both limits for the size of a core file. This limit is a per process limit.

Syntax:

```
core_limit = hardlimit,softlimit
```

Default value: No default value is set.

Examples:

```
core_limit = 125621,10kb
core_limit = 5621kb,5000kb
core_limit = 2mb,1.5mb
core_limit = 2.5mw
core_limit = unlimited
core_limit = rlim_infinity
core_limit = copy
```

For additional information about limit keywords, see the following topics:

- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

coschedule

Specifies the steps within a job that are to be scheduled and dispatched at the same time.

This keyword is supported only by the BACKFILL scheduler.

Syntax:

coschedule = yes | **no**

where **yes** implies that the step is to be coscheduled with all other steps in the job that have the value of this keyword set to **yes**. This keyword is not inherited by other job steps.

Default value: The default value is set to **no**.

Examples:

```
coschedule = yes
```

cpu_limit

Specifies the hard limit, soft limit, or both limits for the amount of CPU time that a submitted job step can use. This limit is a per process limit.

Syntax:

cpu_limit = *hardlimit*,*softlimit*

Default value: No default value is set.

Examples:

```
cpu_limit = 12:56:21,12:50:00
cpu_limit = 56:21.5
cpu_limit = 1:03,21
cpu_limit = unlimited
cpu_limit = rlim_infinity
cpu_limit = copy
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

cpus_per_core

Customizes the affinity scheduling request specific to the SMT environment.

This keyword specifies the number of logical CPUs per processor core that needs to be allocated to each task of a job with the processor-core affinity requirement. By default, LoadLeveler will try to allocate all of the CPUs from a core while trying to meet the processor-core affinity requirement of a job specified by the **task_affinity** keyword. If the value was set to 0, then all of the CPUs from a core will be allocated to the task. This keyword can only be used along with the **task_affinity** keyword.

Syntax:

cpus_per_core = *number*

Default value: 0

data_limit

Specifies the hard limit, soft limit, or both limits for the size of the data segment to be used by the job step. This limit is a per process limit.

Syntax:

data_limit = *hardlimit*,*softlimit*

Default value: No default value is set.

Examples:

```
data_limit = ,125621
data_limit = 5621kb
data_limit = 2mb
data_limit = 2.5mw,2mb
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

dependency

Specifies the dependencies between job steps. A job dependency, if used in a given job step, must be explicitly specified for that step.

Syntax:

dependency = *step_name operator value*

where:

step_name
Is the name of a previously defined job step (as described in the step_name keyword).

operator
Is one of the following:

==	Equal to
!=	Not equal to
<=	Less than or equal to
>=	Greater than or equal to
<	Less than
>	Greater than
&&	And
||	Or

value
Is usually a number that specifies the job return code to which the *step_name* is set. It can also be one of the following LoadLeveler defined job step return codes:

CC_NOTRUN
The return code set by LoadLeveler for a job step which is not run because the dependency is not met. The value of CC_NOTRUN is 1002.

CC_REMOVED
The return code set by LoadLeveler for a job step which is removed from the system (because, for example, **llcancel** was issued against the job step). The value of CC_REMOVED is 1001.

Default value: No default value is set.

Examples: The following are examples of dependency statements:

- **Example 1:** In the following example, the step that contains this dependency statement will run if the return code from step 1 is zero:

  ```
  dependency = (step1 == 0)
  ```

- **Example 2:** In the following example, step1 will run with the executable called **myprogram1**. Step2 will run only if LoadLeveler removes step1 from the system. If step2 does run, the executable called **myprogram2** gets run.

  ```
  # Beginning of step1
  # @ step_name = step1
  # @ executable = myprogram1
  ```

```
# @ ...
# @ queue
# Beginning of step2
# @ step_name = step2
# @ dependency = step1 == CC_REMOVED
# @ executable = myprogram2
# @ ...
# @ queue
```

- **Example 3:** In the following example, step1 will run with the executable called **myprogram1**. Step2 will run if the return code of step1 equals zero. If the return code of step1 does not equal zero, step2 does not get executed. If step2 is not run, the dependency statement in step3 gets evaluated and it is determined that step2 did not run. Therefore, **myprogram3** gets executed.

```
# Beginning of step1
# @ step_name = step1
# @ executable = myprogram1
# @ ...
# @ queue
# Beginning of step2
# @ step_name = step2
# @ dependency = step1 == 0
# @ executable = myprogram2
# @ ...
# @ queue
# Beginning of step3
# @ step_name = step3
# @ dependency = step2 == CC_NOTRUN
# @ executable = myprogram3
# @ ...
# @ queue
```

- **Example 4:** In the following example, the step that contains step2 returns a non-negative value if successful. This step should take into account the fact that LoadLeveler uses a value of 1001 for CC_REMOVED and 1002 for CC_NOTRUN. This is done with the following dependency statement:

```
dependency = (step2 >= 0) && (step2 < CC_REMOVED)
```

dstg_environment
Specifies the environment that must be passed to the data staging scripts. **dstg_environment** is similar to the **environment** keyword and the usage rules for this keyword are identical to the **environment** keyword. For example, with both keywords, **COPY_ALL** will copy all the environment variables from your user environment.

Syntax:

dstg_environment = *env1; env2* **...;COPY_ALL**

Default value: No default value is set.

dstg_in_script
Specifies the script or executable that is used to stage in data. You are only allowed to have one instance of this keyword in a job command file. Any arguments must be included as part of the value specified for this keyword. No arguments can be separately or explicitly passed to the script or executable.

Note: If you specify the **dstg_in_wall_clock_limit** keyword, then you must specify a value for the **dstg_in_script** keyword. If you do not do so, the job will not be submitted to LoadLeveler.

Syntax:

dstg_in_script = *name*

Default value: No default value is set.

dstg_in_wall_clock_limit
Specifies both the hard wall clock limit and the soft wall clock limit for an inbound data staging script. You can assign the value in either seconds or using the *HH:MM:SS,HH:MM:SS* format. The usage rules will be the same as those for the **wall_clock_limit** keyword.

Note: If you specify the **dstg_in_wall_clock_limit** keyword, then you must specify a value for the **dstg_in_script** keyword. If you do not do so, the job will not be submitted to LoadLeveler.

Syntax:

```
dstg_in_wall_clock_limit = HH:MM:SS,HH:MM:SS
```

Default value: No default value is set.

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

dstg_node
Specifies which node to use for running the staging steps.

Syntax:

```
dstg_node = any | master| all
```

Default value: any

The possible values for this keyword are:

any Specifies a shared staging area is accessible from any compute node. The staging task will be executed on any node in the cluster that has an available data staging initiator and any other required data staging resources.

master
Specifies the data staging job step must run on the master node of the application job step. If this value is specified, the central manager will schedule the application job step first and get the host list on which the step will run. It will then ensure that data staging resources are available on the master node and schedule the data staging job step to run on the master node. This option can be specified only if the **dstg_time** configuration keyword is set to **JUST_IN_TIME**.

all Specifies that a data staging task needs to run on each node allocated to the application job step. A possible use of this value is when data has to be staged to or from the local disk on the compute node. The central manager will ensure that resources are available on the required nodes for data staging. The central manager will also schedule the application job step in the future to determine the nodes that have to be used and then schedule the data staging master task. Usually, the data staging master task is a POE command or an MPI script that spawns data staging tasks on all the selected nodes. This option can be specified only if the **dstg_time** configuration keyword is set to **JUST_IN_TIME**.

Note: If you are using the **master** or **all** options for this keyword, the administrators should setup one or more data staging initiators on every compute node in the cluster. Although this is not mandatory, if you do not set up the initiators, jobs may remain in idle states for extended periods.

dstg_out_script

Specifies the script or executable that is used to stage out data. You are only allowed to have one instance of this keyword in a job command file. Any arguments must be included as part of the value specified for this keyword. No arguments can be separately or explicitly passed to the script or executable.

Note: If you specify the **dstg_out_wall_clock_limit** keyword, then you must specify a value for the **dstg_out_script** keyword. If you do not do so, the job will not be submitted to LoadLeveler.

Syntax:

```
dstg_out_script = name
```

Default value: No default value is set.

dstg_out_wall_clock_limit

Specifies the hard wall clock limit and the soft wall clock limit for an outbound data staging script. You can assign a value using seconds or the *HH:MM:SS,HH:MM:SS* format. The usage rules for **dstg_out_wall_clock_limit** are the same as those for **wall_clock_limit** keyword.

Note: If you specify the **dstg_out_wall_clock_limit** keyword, then you must specify a value for the **dstg_out_script** keyword. If you do not do so, the job will not be submitted to LoadLeveler.

Syntax:

```
dstg_out_wall_clock_limit = HH:MM:SS,HH:MM:SS
```

Default value: No default value is set.

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

dstg_resources

Specifies the quantities of consumable resources consumed by each task of both the inbound and outbound data staging job steps. These resources may be either machine resources or floating resources. The syntax and usage of this keyword are the same as those used for the **resources** keyword in the job command file. However, **dstg_resources** applies to data staging job steps while the **resources** keyword applies to all other job steps. The **dstg_resources** are checked at job submit time to ensure their availability. They are not enforced at runtime.

Note: The limits specified in the **max_resources** keyword of the **data_stage** class stanza also apply to **dstg_resources**. If the resources you requested for the data staging step of the job exceed what is allowed in the **max_resources** keyword, the job will not be submitted and an error message stating this will be displayed by the **llsubmit** command.

Syntax:

```
dstg_resources = name(count) name(count) ... name(count)
```

Default value: If you do not specify **dstg_resources** in the job command file, then the **default_resources** applicable to the **data_stage** class in the administration file will be applied to each task of a data staging job step.

env_copy

Specifies whether environment variables for a batch or interactive parallel job are copied to all executing nodes, or to only the master node. When **all** is

specified either explicitly or by default, any environment variables (specified by the **environment** keyword in the job command file) will be copied to all nodes where the job step runs. When **master** is specified, the environment variables will be copied only to the node selected to run the master task of the parallel job.

Although a LoadLeveler administrator may set this keyword in one or more class, group, or user stanzas in the administration file, an explicit setting in the job command file overrides any settings in the administration file that are relevant for the parallel job.

LoadLeveler ignores this keyword if it is set for a serial job.

Syntax:

```
env_copy = all | master
```

Default value: LoadLeveler uses the default value **all** only when both of the following conditions are true:

- The **env_copy** keyword is not specified in the job command file.
- The **env_copy** keyword is not specified in any class, group, or user stanza that is relevant to the parallel job.

environment

Specifies login initial environment variables set by LoadLeveler when your job step starts. If the same environment variables are set in the user's initialization files (such as the .profile), those set by the login initialization files will supersede those set by LoadLeveler.

You may use the **env_copy** keyword to instruct LoadLeveler to copy these environment variables to all executing nodes, or to only the master executing node.

Syntax:

```
environment = env1 ; env2 ; ...
```

Separate environment specifications (*env1, env2,* and so on) with semicolons. An environment specification may be one of the following:

COPY_ALL
: Specifies that all the environment variables from your shell be copied.

$var
: Specifies that the environment variable *var* be copied into the environment of your job when LoadLeveler starts it.

!var
: Specifies that the environment variable *var* not be copied into the environment of your job when LoadLeveler starts it. This specification is most useful together with COPY_ALL.

var=value
: Specifies that the environment variable *var* be set to the value "value" and copied into the environment of your job when LoadLeveler starts it.

  When processing the string you specify for *var*, LoadLeveler first removes any leading or trailing blanks, and copies the remaining string, as is, into the environment.

Default value: No default value is set.

Additional considerations:

If you specify the **environment** job command file keyword with **COPY_ALL**, the **$USER** and **$HOME** environment variables from your shell are not copied and set when your job step starts. The **$USER** and **$HOME** environment

variables of the user ID on the executing node will be set. If you explicitly specify **$USER** or **$HOME** it will be copied and set when your job step starts.

If more than one environment specification is defined for the same environment keyword, the rightmost specification takes precedence. For example if you specify:

```
environment = COPY_ALL; USER=jsmith
```

The **$USER** environment variable will be set to `jsmith`.

However, if you specify:

```
environment = USER=jsmith; COPY_ALL
```

The **$USER** environment variable is not set to `jsmith`. Instead, the **$USER** environment variable of the user ID on the executing node is set.

If the **executable** keyword is not specified, the job command file is run as a shell script. In this case, LoadLeveler initializes the environment as described previously and then starts the **shell** command. Any environment variable set during shell startup overrides values initialized by LoadLeveler.

Examples:

- This example illustrates how to specify that LoadLeveler is to copy all the environment variables from your shell except for `env2`:

  ```
  environment = COPY_ALL; !env2;
  ```

- This example illustrates how LoadLeveler processes the string you specify with *var*: If you specify the following:

  ```
  environment = env3 = "quoted string"; env4 = imbedded blanks;
  ```

  LoadLeveler uses these values:
  - For `env3`: **"quoted string"**
  - For `env4`: **imbedded blanks**

error

Specifies the name of the file to use as standard error (stderr) when your job step runs.

Syntax:

error = *filename*

Default value: If you do not specify a value for this keyword, the file **/dev/null** is used.

Example:

```
error = $(jobid).$(stepid).err
```

executable

Identifies the name of the program to run, which can be a shell script or a binary. For parallel jobs, **executable** must be the parallel job launcher (POE or mpirun), or the name of a program that invokes the parallel job launcher.

Note that the **executable** statement automatically sets the **$(base_executable)** variable, which is the file name of the executable without the directory component. See Example 2 in topic "Examples: Job command files" on page 181 for an example of using the **$(base_executable)** variable.

Syntax:

executable = *name*

Default value: If you do not include this keyword, then it will default to the job command file that is being submitted, and LoadLeveler will assume that the file is a valid shell script.

Examples:

- `# @ executable = a.out`
- `# @ executable = /usr/bin/poe` (for POE jobs)

file_limit

Specifies the hard limit, soft limit, or both limits for the size of a file. This limit is a per process limit.

Syntax:

file_limit = *hardlimit*,*softlimit*

Default value: No default value is set.

Example:

```
file_limit = 100pb,50tb
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

group

Specifies the LoadLeveler group.

Syntax:

group = *group_name*

Default value: If you do not specify a value for this keyword, LoadLeveler uses the default group, **No_Group**.

Example:

```
group = my_group_name
```

hold

Specifies whether you want to place a hold on your job step when you submit it. There are three types of holds:

user Specifies user hold

system
Specifies system hold

usersys
Specifies user and system hold

To remove the hold on the job, you can use either the GUI or the **llhold -r** command.

Syntax:

hold = user | system | usersys

Default value: No default is set, which means that no hold is requested.

Example: To put a user hold on a job, the keyword statement would be:

```
hold = user
```

host_file

Specifies the name of the file containing the host list for task allocation.

Syntax:

host_file = *host_list_file_name*

If a full path name is not specified, the *host_file_name* will be under the current working directory. The *host_file_name* is an ASCII file that must contain one host name per line (using a new line separator).

Host file usage notes:
- Leading and trailing tabs and spaces will be removed
- Blank lines are deleted
- Comment lines that start with a # will be skipped
- Tabs or spaces before the first comment line are allowed
- No more than one word per line is allowed; otherwise, the entire line will be treated as a host name

Default value: The default is empty (a NULL file pointer) meaning no host file input.

Example: To specify host file **my_host_file** in the current working directory in the job command file, the keyword statement would be:

```
host_file = my_host_file
```

image_size

Specifies the maximum virtual image size to which your program will grow during execution. LoadLeveler tries to execute your job steps on a machine that has enough resources to support executing and checkpointing your job step. If your job command file has multiple job steps, the job steps will not necessarily run on the same machine, unless you explicitly request that they do.

If you underestimate the image size of your job step, your job step may crash due to the inability to acquire more address space. If you overestimate the image size, LoadLeveler may have difficulty finding machines that have the required resources.

Syntax:

image_size = *number*

where *number* must be a positive integer. If you do not specify the units associated with this keyword, LoadLeveler uses the default unit, which is kilobytes. For a list of allowable units, see the resources keyword description.

Default value: If you do not specify the image size of your job command file, the image size is that of the executable.

Example: To set an image size of 11 KB, the keyword statement would be:

```
image_size = 11
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

initialdir

Specifies the path name of the directory to use as the initial working directory during execution of the job step. File names mentioned in the command file which do not begin with a slash **(/)** are relative to the initial directory. The initial directory must exist on the submitting machine as well as on the machine where the job runs.

Syntax:

initialdir = *pathname*

Note: When operating in a multicluster environment, access to **initialdir** will be verified on the cluster selected to run the job. If access to **initialdir** fails, the submission or move job will fail.

Default value: If you do not specify a value for this keyword, the initial directory is the current working directory at the time you submitted the job.

Example:

```
initialdir  = /var/home/mike/ll_work
```

input

Specifies the name of the file to use as standard input (stdin) when your job step runs.

Syntax:

input = *filename*

Default value: If you do not specify an input file, LoadLeveler uses the file **/dev/null**

Example:

```
input = input.$(process)
```

job_cpu_limit

Specifies the hard limit, soft limit, or both limits for the CPU time used by all processes of a serial job step. For example, if a job step runs as multiple processes, the total CPU time consumed by all processes is added and controlled by this limit.

For parallel job steps, LoadLeveler enforces these limits differently. Parallel job steps usually have tasks running on several different nodes and each task can have several processes associated with it. In addition, the parallel tasks running on a node are descendants of a **LoadL_starter** process. Therefore, if you specify a hard or soft CPU time limit of S seconds and if a **LoadL_starter** has N tasks running under it, then all tasks associated with that **LoadL_starter** will be terminated if the total CPU time of the **LoadL_starter** process and its children is greater than S*N seconds.

If several **LoadL_starter** processes are involved in running a parallel job step, then LoadLeveler enforces the limits associated with the job_cpu_limit keyword independently for each **LoadL_starter**. LoadLeveler determines how often to check the job_cpu_limit by looking at the values for JOB_LIMIT_POLICY and JOB_ACCT_Q_POLICY. The smaller value associated with these two configuration keywords sets the interval for checking the job_cpu_limit. For more information on JOB_LIMIT_POLICY and JOB_ACCT_Q_POLICY see “Collecting job resource data on serial and parallel jobs” on page 62.

Syntax:

job_cpu_limit = *hardlimit*,*softlimit*

Default value: No default is set.

Example:

```
job_cpu_limit = 12:56,12:50
```

For additional information about limit keywords, see the following topics:

- “Syntax for limit keywords” on page 324
- “Using limit keywords” on page 89

job_name

Specifies the name of the job. This keyword must be specified in the first job step. If it is specified in other job steps in the job command file, it is ignored.

The job_name only appears in the long reports of the **llq**, **llstatus**, and **llsummary** commands, and in mail related to the job.

Syntax:

job_name = *job_name*

You can name the job using any combination of letters, numbers, or both.

Default value: No default value is set.

Example:

```
job_name = my_first_job
```

job_type

Specifies the type of job step to process.

Syntax:

```
job_type = serial | parallel | bluegene | MPICH
```

This keyword is inherited by each job step in the job command file.

Default value: serial

large_page

Specifies whether or not a job step requires Large Page support from AIX.

Restriction: Large Page memory is not supported in LoadLeveler for Linux. In this case, specifying **M** would cause the job to never be sent.

Syntax:

large_page = *value*

where *value* can be **Y**, **M**, or **N**. **Y** informs LoadLeveler to use Large Page memory, if available, but to otherwise use regular memory. **M** means use of Large Page memory is mandatory.

Default value: N, which means to not use Large Page memory.

Example: To ask LoadLeveler to use Large Page memory for the job step, if available, specify:

```
large_page = Y
```

ll_res_id

Specifies the reservation to which the job is submitted.

This keyword, if specified, overrides the LL_RES_ID environment variable.

If the keyword is present in the job command file with no value, the job will not be bound to any reservation. If the keyword is not present in the job command file, the LL_RES_ID environment variable determines the reservation to which the job is submitted.

The value of this keyword is ignored when the job command file is used by the **llmkres -f** or the **llchres -f** command. The reservation ID can be obtained from the **llqres** command or when the **llmkres** command is issued.

The format of the reservation identifier is [*host*.]*rid*[.**r**[.*oid*]].

where:

- *host* is the name of the machine that assigned the reservation identifier.

- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional if *oid* is not specified).
- *oid* is the occurrence ID of a recurring reservation (*oid* is optional).

When `oid` is specified, the job step will not be considered for scheduling until that occurrence of the reservation becomes active. The step will remain in Idle state during all earlier occurrences. When `oid` is not specified, the job will be bound to the first occurrence of the reservation, including a currently active occurrence.

Syntax:

```
ll_res_id = reservation ID
```

Default value: No default value is set.

locks_limit

Specifies the hard limit, soft limit, or both limits for the number of file locks that the submitted job can use. This limit is a per process limit.

Syntax:

```
locks_limit = hardlimit,softlimit
```

Default value: No default value is set.

Example:

```
locks_limit = 200,65
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

mcm_affinity_options

Specifies the affinity options for a job.

Syntax:

```
mcm_affinity_options = affinity_option
```

where *affinity_option* is a blank-delimited list of one, two, or three keywords chosen from the three groupings of keywords in the list that follows. Only one option from each group may be specified.

task affinity options

The following options are task affinity options. These options are mutually exclusive.

mcm_accumulate

Specifying this option tells the central manager to accumulate tasks on the same MCM whenever possible.

mcm_distribute

Specifying this option tells the central manager to distribute tasks across all available MCMs on a machine.

memory affinity options

The following options are memory affinity options. These options are mutually exclusive.

mcm_mem_none

When you specify **mcm_mem_none**, the job does not request memory affinity.

mcm_mem_pref

When you specify **mcm_mem_pref**, the job requests memory affinity as a preference.

mcm_mem_req
When you specify **mcm_mem_req**, the job requests memory affinity as a requirement.

adapter affinity options
The following options are adapter affinity options. These options are mutually exclusive.

mcm_sni_none
Specifying this option indicates the job has no adapter affinity requirement.

mcm_sni_pref
Specifying this option indicates the job request adapter affinity.

mcm_sni_req
Specifying this option indicates the job requires adapter affinity.

Your job containing the keyword **mcm_affinity_options** will not be submitted to LoadLeveler unless the **rset** keyword is set to **RSET_MCM_AFFINITY**.

Default value: Table 77 describes the default values for **mcm_affinity_options** depending on the type of affinity (MCM affinity or task affinity) and network requirements.

Table 77. mcm_affinity_options default values

If the following keywords are specified in the job command file:	Memory Affinity	Task Allocation	Adapter Affinity
#@ rset = rset_mcm_affinity #@ network.*protocol* = sn_all,,,,	mcm_mem_req	mcm_accumulate	mcm_sni_none
#@ rset = rset_mcm_affinity #@ network.*protocol* = sn_single,,,,	mcm_mem_req	mcm_accumulate	mcm_sni_pref
#@ task_affinity = **cpu**(*number*) | **core**(*number*) #@ network.*protocol* = sn_all,,,,	mcm_mem_pref	mcm_accumulate	mcm_sni_none
#@ task_affinity = **cpu**(*number*) | **core**(*number*) #@ network.*protocol* = sn_single,,,,	mcm_mem_pref	mcm_accumulate	mcm_sni_pref

Example:

```
mcm_affinity_options = mcm_mem_req mcm_sni_pref mcm_distribute
```

This example shows how to have a job set memory affinity as a requirement, adapter affinity as a preference, and MCM task allocation method as distribute.

memlock_limit

Specifies the hard limit, soft limit, or both limits for the memory that can be locked by each process of the submitted job. This limit is a per process limit.

Syntax:

```
memlock_limit = hardlimit,softlimit
```

Default value: No default value is set.

Example:

```
memlock_limit = 1gb,256mb
```

For additional information about limit keywords, see the following topics:

- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

network

Specifies communication protocols, adapters, and their characteristics. You need to specify this keyword when you want a task of a parallel job step to request a specific adapter that is defined in the LoadLeveler administration file. You do not need to specify this keyword when you want a task to access a shared, default adapter through TCP/IP. (A default adapter is an adapter whose name matches a machine stanza name.)

Note that you cannot specify both the **network** statement and the **Adapter** requirement in a job command file. Also, the value of the **network** keyword applies only to the job step in which you specify the keyword. (That is, this keyword is not inherited by other job steps.)

This keyword is supported by the BACKFILL and API schedulers.

Syntax:

```
network.protocol = type[, usage[, mode[,comm_level[, instances=<number|max> \
[, rcxtblocks=number]]]]]
```

where:

protocol
Specifies the communication protocols that are used with an adapter, and can be the following:

MPI Specifies the message passing interface (MPI). You can specify in a job step both **network.MPI** and **network.LAPI**.

LAPI Specifies the low-level application programming interface (LAPI). You can specify in a job step both **network.MPI** and **network.LAPI**.

LAPI is not supported on LoadLeveler for Linux.

MPI_LAPI
Specifies sharing adapter windows between MPI and LAPI. When you specify **network.MPI_LAPI** in a job step, you cannot specify any other network statements in that job step.

LAPI is not supported on LoadLeveler for Linux.

type This field is required and specifies one of the following:

adapter_name
The possible values are the names associated with the interface cards installed on a node (for example, en0 and tk1).

network_type
Specifies a **network_type** as specified in the LoadLeveler administration file. The LoadLeveler administrator must specify values used as **network_type** in the adapter stanza of the LoadLeveler administration file using the **network_type** keyword. For example, an installation can define a network type of ″switch″ to identify adapters on a common network. For more information on specifying **network_type**, see “Defining adapters” on page 86.

sn_single
When used for the HPS switch it specifies that LoadLeveler use a common, single switch network.

sn_all Specifies that striped communication should be used over all available switch networks. The networks specified must be accessible by all machines selected to run the job. For more information on striping, see “Submitting jobs that use striping” on page 198.

The following are optional and if omitted their position must be specified with a comma:

usage Specifies whether the adapter can be shared with tasks of other job steps. Possible values are **shared**, which is the default, or **not_shared**. If **not_shared** is specified, LoadLeveler can only guarantee that the adapter will not be shared by other jobs running on the same OSI. If the adapter is shared by more than one OSI, LoadLeveler can not guarantee that the adapter is not shared with jobs running on a different OSI.

mode Specifies the communication subsystem mode used by the communication protocol that you specify, and can be either **IP** (Internet Protocol), which is the default, or **US** (User Space). Note that each instance of the US mode requested by a task running on the High Performance Switch (HPS) requires an adapter window. For example, if a task requests both the MPI and LAPI protocols such that both protocol instances require US mode, two adapter windows will be used.

comm_level

Note: This keyword is obsolete and will be ignored, however it is being retained for compatibility and because the parameters in the network statement are positional.

The **comm_level** keyword should be used to suggest the amount of inter-task communication that users *expect* to occur in their parallel jobs. This suggestion is used to allocate adapter device resources. Specifying a level that is higher than what the job actually needs will not speed up communication, but may make it harder to schedule a job (because it requires more resources). The **comm_level** keyword can only be specified with **US** mode. The three communication levels are:

LOW Implies that minimal inter-task communication will occur.

AVERAGE
This is the default value. Unless you know the specific communication characteristics of your job, the best way to determine the comm_level is through trial-and-error.

HIGH Implies that a great deal of inter-task communication will occur.

instances=<*number* **| max>**
If **instances** is specified as a number, it indicates the number of parallel communication paths made available to the protocol on each network. The number actually used will depend on the implementation of the protocol subsystem. If **instances** is specified by **max**, the actual value used is determined by the **MAX_PROTOCOL_INSTANCES** for the class to which the job is submitted. The default value for **instances** is 1.

For the best performance set **MAX_PROTOCOL_INSTANCES** so that the communication subsystem uses every available adapter before it reuses any of the adapters.

rcxtblocks=*number*
Integer value specifying the number of user rCxt blocks requested for each window used by the associated protocol. The values of this keyword are not inherited between steps in a multistep job.

Note: Use of this keyword will prevent adapters from the SP Switch2 family from being used by the job.

Default value: If you do not specify the **network** keyword, LoadLeveler allows the task to access a shared, default adapter through TCP/IP. The default adapter is the adapter associated with the machine name.

Examples:

- **Example 1:** To use the MPI protocol with an adapter in User Space mode without sharing the adapter, enter the following:

  ```
  network.MPI = sn_single,not_shared,US,HIGH
  ```

- **Example 2:** To use the MPI protocol with a shared adapter in IP mode, enter the following:

  ```
  network.MPI = sn_single,,IP
  ```

  Because a shared adapter is the default, you do not need to specify **shared**.

- **Example 3:** A communication level can only be specified if User Space mode is also specified:

  ```
  network.MPI = sn_single,,US,AVERAGE
  ```

  Note that LoadLeveler can ensure that an adapter is dedicated (not shared) if you request the adapter in US mode, since any user who requests a user space adapter must do so using the **network** statement. However, if you request a dedicated adapter in IP mode, the adapter will only be dedicated if all other LoadLeveler users who request this adapter do so using the **network** statement.

node

Specifies the minimum and maximum number of nodes requested by a job step. You must specify at least one of these values. The value of the **node** keyword applies only to the job step in which you specify the keyword. (That is, this keyword is not inherited by other job steps.)

When you use the **node** keyword together with the **total_tasks** keyword, the *min* and *max* values you specify on the **node** keyword must be equal, or you must specify only one value. For example:

```
node = 6
total_tasks = 12
```

This keyword is supported by the BACKFILL and API schedulers.

Syntax:

node = [*min*][,max]

where:

min Specifies the minimum number of nodes requested by the job step.

max Specifies the maximum number of nodes requested by the job step. The maximum number of nodes a job step can request is limited by the **max_node** keyword in the administration file (provided this keyword is specified). That is, the maximum must be less than or equal to any **max_node** value specified in a user, group, or class stanza.

Default value: The default value for *min* is 1; the default value for *max* is the *min* value for this keyword.

Example: To specify a range of six to twelve nodes, enter the following:

```
node = 6,12
```

To specify a maximum of seventeen nodes, enter the following:

```
node =  ,17
```

For information about specifying the number of tasks you want to run on a node, see "Task-assignment considerations" on page 196 and the **task_geometry**, **tasks_per_node**, and **total_tasks** job command file keywords.

node_resources

Specifies quantities of the consumable resources consumed by each node of a job step. The resources must be machine resources; floating resources cannot be requested with the **node_resources** keyword.

Syntax:

```
node_resources =name(count) name(count) ... name(count)
```

where *name(count)* is one of the following:

- An administrator-defined name and count
- **ConsumableCpus***(count)*
- **ConsumableMemory***(count units)*
- **ConsumableVirtualMemory***(count units)*
- **ConsumableLargePageMemory***(count units)*

The count for each specified resource must be an integer greater than or equal to zero, except for the following instances in which the integer must be greater than zero:

- **ConsumableMemory**
- **ConsumableVirtualMemory**
- **ConsumableCpus** when the enforcement policy is *hard* or *soft*

ConsumableCpus can have a value of zero when the administrator has not requested that consumable resources be enforced, or when the enforcement policy is *shares*.

When you set **ConsumableCpus** to zero, the meaning varies depending on whether use is being enforced. With no enforcement, zero means that the job is requesting a negligible amount of CPU. With an enforcement policy of *shares*, it means that the job is requesting a small percentage of available shares.

If the count is not valid, LoadLeveler will issue a message and the job will not be submitted. The allowable units are those normally used with LoadLeveler data limits:

```
b bytes
w words      (4 bytes)
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes  (2**60 bytes)
ew exawords  (2**62 bytes)
```

ConsumableMemory, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** values are stored in megabytes (MB) and are rounded up. For **ConsumableMemory** and **ConsumableVirtualMemory**, the smallest amount you can request is 1 MB. If no units are specified, megabytes are assumed. Resources defined here that are not in the **SCHEDULE_BY_RESOURCES** list in the global configuration file will not affect the scheduling of the job.

When resource usage and resource submission is enforced, either the **resources** or **node_resources** keyword must specify requirements for the resources defined in the **ENFORCE_RESOURCE_USAGE** keyword.

Both **resources** and **node_resources** can be specified in a single job step provided that the resources requested in each are different.

ConsumableCpus cannot be used in the **node_resources** list when the **rset** keyword is also specified in the job command file.

Default value: If the **node_resources** keyword is not specified in the job step, then the **default_node_resources** (if any) defined in the administration file for the class will be used for each task of the job step.

node_usage

Specifies whether this job step shares nodes with other job steps.

This keyword is supported by the BACKFILL and API schedulers.

Syntax:

```
node_usage = shared | not_shared
```

where:

shared
Specifies that nodes can be shared with other tasks of other job steps.

not_shared
Specifies that nodes are not shared. No other job steps are scheduled on this node.

Default value: shared

nofile_limit

Specifies the hard limit, soft limit, or both for the number of open file descriptors that can be used by each process of the submitted job. This limit is a per process limit.

Syntax:

```
nofile_limit = hardlimit,softlimit
```

Default value: No default value is set.

Example:

```
nofile_limit = 1000,386
```

For additional information about limit keywords, see the following topics:

- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

notification

Specifies when the user specified in the **notify_user** keyword is sent mail.

Syntax:

```
notification = always|error|start|never|complete
```

where:

always
Notify the user when the job begins, ends, or if it incurs error conditions.

error Notify the user only if the job fails.

start Notify the user only when the job begins.

never Never notify the user.

complete
Notify the user only when the job ends.

Default value: complete

Examples:

- If you want to be notified with mail only when your job step completes, your notification keyword would be:

  ```
  notification = complete
  ```

- When a LoadLeveler job ends, you may receive mail notification indicating the job exit status. For example, you could get the following mail message:

  ```
  Your LoadLeveler job
  myjob1
  exited with status 4.
  ```

  The return code 4 is from the user's job. LoadLeveler retrieves the return code and returns it in the mail message, but it is not a LoadLeveler return code.

notify_user

Specifies the user to whom mail is sent based on the **notification** keyword.

Syntax:

notify_user = *userID*

Default value: The default is the submitting user at the submitting machine.

Example: If you are the job step owner but you want a coworker whose name and user ID is **bob**, to receive mail regarding the job step, your notify keyword would be:

```
notify_user = bob@mailserv.pok.ibm.com
```

nproc_limit

Specifies the hard limit, soft limit, or both for the number of processes that can be created for the real user ID of the submitted job. This limit is a per process limit.

Syntax:

nproc_limit = *hardlimit*,*softlimit*

Default value: No default value is set.

Example:

```
nproc_limit = 288,200
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

output

Specifies the name of the file to use as standard output (stdout) when your job step runs.

Syntax:

output = *filename*

Default value: If you do not specify this keyword, LoadLeveler uses the file **/dev/null**

Example:

```
output = out.$(jobid)
```

parallel_threads

Requests OpenMP thread-level binding.

This keyword assigns separate CPUs to individual threads of an OpenMP task. The CPUs assigned to threads are selected from the set of CPUs or cores assigned to the task. The CPUs for individual OpenMP threads of the tasks are selected based on the number of parallel threads in each task and set of CPUs or cores assigned to the task. The CPUs are assigned to the threads only when at least one CPU is available for each thread from the set of CPUs or cores assigned to the task. If cores are assigned to the task instead of CPUs, then parallel threads are assigned to the CPUs of the cores in a round-robin method until all threads are bound.

LoadLeveler uses the **parallel_threads** value to set the value for the OMP_NUM_THREADS OpenMP runtime environment variable and the **'parthds'** suboption of the XLSMPORTS runtime environment variable. See the XL C/C++ and XL Fortran compilers documentation for more details about the OpenMP runtime environment.

Syntax:

```
parallel_threads = number
```

where *number* specifies the number of parallel threads in each OpenMP task of the job.

Default value: No default value is set.

preferences

Specifies the characteristics that you prefer be available on the machine that executes the job steps. LoadLeveler attempts to run the job steps on machines that meet your preferences. If such a machine is not available, LoadLeveler will then assign machines that meet only your requirements.

The values you can specify in a **preferences** statement are the same values you can specify in a **requirements** statement, with the exception of the **Adapter** requirement.

Syntax:

```
preferences = Boolean_expression
```

Default value: No default preferences are set.

Examples:

```
preferences = (Memory <=16) && (Arch == "R6000")
preferences = Memory >= 64
```

queue

Places one copy of the job step in the queue. This statement is required. The **queue** statement essentially marks the end of the job step. Note that you can specify statements between **queue** statements.

Syntax:

```
queue
```

recurring

Indicates whether the job will be run in every occurrence of the reservation to which it is bound.

Syntax:

```
recurring = yes | no
```

This keyword applies to all steps of a job. When all steps of a job have terminated that had **recurring = yes** specified, all steps will be automatically bound to the next occurrence of the reservation that they are bound to and are scheduled to run again. If the steps are not bound to any reservation or the reservation has expired, the job will be removed from the system upon termination of all steps as though the **recurring** keyword had not been set.

If a step specifies both **recurring = yes** and **restart =yes**, it is not a conflict. The **recurring** keyword indicates that once the step has terminated, it will be able to run again in the next occurrence of the reservation to which it is bound. Termination could be the result of successful completion, cancellation by the job's owner or an administrator, or a vacate or rejection, or some other failure. The **restart** keyword allows the same occurrence of the step to be restarted in the event of a vacate or rejection. A step could be restarted several times, then finally run to completion, then be requeued as a recurring job to run again. Similarly, a job could be rejected up to the maximum allowed rejects for a job, be removed as a result, then requeued as a recurring job to run in the next occurrence of its reservation.

Note that to permanently remove a recurring job, the job must first be unbound from its reservation, then removed with the **llcancel** command. As long as a recurring job is still bound to a reservation, it will continue to be requeued upon termination to run in the next occurrence of that reservation.

Default value: no

requirements

Specifies the requirements which a machine in the LoadLeveler cluster must meet to execute any job steps. You can specify multiple requirements on a single requirements statement.

Syntax:

```
requirements = Boolean_expression
```

When strings are used as part of a Boolean expression that must be enclosed in double quotes. Sample requirement statements are included following the descriptions of the supported requirements, which are:

Adapter

Specifies the predefined type of network you want to use to run a parallel job step. In any new job command files you create, you should use the **network** keyword to request adapters and types of networks.

It is also the way to specify when running with the default LoadLeveler scheduler. When using the default scheduler, the **Adapter** requirement is specified as the physical name of the device, such as *en0*.

This keyword is supported by the LL_DEFAULT and BACKFILL schedulers.

Note that you cannot specify both the **Adapter** requirement and the **network** statement in a job command file.

For the BACKFILL scheduler you can use the predefined network types. The predefined network types are:

ethernet
Refers to Ethernet.

fddi Refers to Fiber Distributed Data Interface (FDDI).

tokenring
Refers to Token Ring.

fcs Refers to Fiber Channel Standards.

Note that LoadLeveler converts the network types to the **network** statement.

Arch
Specifies the machine architecture on which you want your job step to run. It describes the particular kind of platform for which your executable has been compiled.

Connectivity
Connectivity is the ratio of the number of active switch adapters on a node to the total number of switch adapters on the node. The value ranges from 0.0 (all switch adapters are down) to 1.0 (all switch adapters are active). A node with no switch adapters has a connectivity of 0.0 . Connectivity can be used in a **MACHPRIO** expression to favor nodes that do not have any down switch adapters or in a job **REQUIREMENTS** statement to require only nodes with a certain connectivity.

Disk
Specifies the amount of disk space in kilobytes you believe is required in the LoadLeveler **execute** directory to run the job step.

Note: The Disk variable in an expression associated with the **requirements** and **preferences** keywords are 64-bit integers.

Feature
Specifies the name of a feature defined on a machine where you want your job step to run. Be sure to specify a feature in the same way in which the feature is specified in the configuration file. To find out what features are available, use the **llstatus** command.

LargePageMemory
Specifies the amount, in megabytes, of Large Page memory required to run the job.

Note: The Memory variable in an expression associated with the **requirements** and **preferences** keywords are 64-bit integers.

LL_Version
Specifies the LoadLeveler version, in dotted decimal format, on which you want your job step to run. For example, LoadLeveler Version 3 Release 4 (with no modification levels) is written as 3.4.0.0.

Machine
Specifies the names of machines on which you want the job step to run. Be sure to specify a machine in the same way in which it is specified in the machine configuration file.

Memory
Specifies the amount, in megabytes, of regular physical memory required in the machine where you want your job step to run.

Note: The Memory variable in an expression associated with the **requirements** and **preferences** keywords are 64-bit integers.

OpSys
Specifies the operating system on the machine where you want your job step to run. It describes the particular kind of platform for which your executable has been compiled.

Pool
Specifies the number of a pool where you want your job step to run.

SMT
Specifies the SMT state of the machines where the job request is to run. Accepted values are ″Disabled″ and ″Enabled.″

If ″Enabled″ is specified, only machines on which SMT is enabled are considered for the job request. If ″Disabled″ is specified, only machines on which either SMT is disabled or machines that do not support SMT are considered for the job request.

TotalMemory
Specifies the amount, in megabytes, of regular physical memory and Large Page memory required in the machine where you want your job step to run.

Note: The Memory variable in an expression associated with the **requirements** and **preferences** keywords are 64-bit integers.

Default value: No default requirements are set.

Examples:

- **Example 1:** To specify a memory requirement and a machine architecture requirement, enter:

  ```
  requirements = (Memory >=16) && (Arch == "R6000")
  ```

- **Example 2:** To specify that your job requires multiple machines for a parallel job, enter:

  ```
  requirements = (Machine == { "l16" "l15" "l10" })
  ```

- **Example 3:** You can set a machine equal to a job step name. This setting means that you want the job step to run on the same machine on which the previous job step ran. For example:

  requirements = (Machine == machine.*step_name***)**

  where *step_name* is a step name previously defined in the job command file. The use of **Machine == machine.***step_name* is limited to serial jobs.

  Example:

  ```
  # @ step_name    = step1
  # @ executable   = c1
  # @ output       = $(executable).$(jobid).$(step_name).out
  # @ queue
  # @ step_name    = step2
  # @ dependency   = (step1 == 0)
  # @ requirements = (Machine == machine.step1)
  # @ executable   = c2
  # @ output       = $(executable).$(jobid).$(step_name).out
  # @ queue
  ```

- **Example 4:** To specify a requirement for a specific pool number, enter:

  ```
  requirements = (Pool == 7)
  ```

- **Example 5:** To specify a requirement that the job runs on LoadLeveler Version 3 Release 4 or any follow-on release, enter:

  ```
  requirements = (LL_Version >= "3.4")
  ```

  Note that the statement **requirements = (LL_Version == ″3.4″)** matches only the value 3.4.3.0.

- **Example 6:** To specify the job runs if all switch connections are up, enter:

  ```
  # @ requirements = (Connectivity == 1.0)
  ```

  To specify the job runs if at least half of the switch connections are up, enter:

  ```
  # @ requirements = (Connectivity >= .5)
  ```

To specify the job runs if there is at least some connectivity, enter:

```
# @ requirements = (Connectivity > 0)
```

- **Example 7:** To specify a requirement for SMT-enabled machines, enter:

```
# @ requirements = (SMT == "Enabled")
```

resources

Specifies quantities of the consumable resources consumed by each task of a job step. The resources may be machine resources or floating resources.

Syntax:

resources=*name(count) name(count) ... name(count)*

where *name(count)* is one of the following:

- An administrator defined name and count
- **ConsumableCpus***(count)*
- **ConsumableMemory***(count units)*
- **ConsumableVirtualMemory***(count units)*
- **ConsumableLargePageMemory***(count units)*

The count for each specified resource must be an integer greater than or equal to zero, except for the following instances in which the integer must be greater than zero:

- **ConsumableMemory**
- **ConsumableVirtualMemory**
- **ConsumableCpus** when the enforcement policy is *hard* or *soft*

ConsumableCpus can have a value of zero when the administrator has not requested that consumable resources be enforced, or when the enforcement policy is *shares*.

When you set **ConsumableCpus** to zero, the meaning varies depending on whether use is being enforced. With no enforcement, zero means the job is requesting a negligible amount of CPU. With an enforcement policy of *shares*, it means the job is requesting a tiny percentage of available shares.

If the count is not valid then LoadLeveler will issue a message and the job will not be submitted. The allowable units are those normally used with LoadLeveler data limits:

```
b  bytes
w  words     (4 bytes)
kb kilobytes (2**10 bytes)
kw kilowords (2**12 bytes)
mb megabytes (2**20 bytes)
mw megawords (2**22 bytes)
gb gigabytes (2**30 bytes)
gw gigawords (2**32 bytes)
tb terabytes (2**40 bytes)
tw terawords (2**42 bytes)
pb petabytes (2**50 bytes)
pw petawords (2**52 bytes)
eb exabytes  (2**60 bytes)
ew exawords  (2**62 bytes)
```

ConsumableMemory, **ConsumableVirtualMemory**, and **ConsumableLargePageMemory** values are stored in MB (megabytes) and rounded up. For **ConsumableMemory** or **ConsumableVirtualMemory** the smallest amount which you can request is 1 MB. If no units are specified, then megabytes are assumed. However, **image_size** units are in kilobytes. Resources defined here that are not in the **SCHEDULE_BY_RESOURCES** list in the global configuration file will not affect the scheduling of the job.

When resource usage and resource submission is enforced, the **resources** keyword must specify requirements for the resources defined in the **ENFORCE_RESOURCE_USAGE** keyword.

Default value: If the **resources** keyword is not specified in the job step, then the **default_resources** (if any) defined in the administration file for the class will be used for each task of the job step.

restart

Specifies whether LoadLeveler considers a job to be "restartable."

Syntax:

```
restart = yes|no
```

If **restart=yes**, and the job is vacated from its executing machine before completing, the central manager requeues the job. It can start running again when a machine on which it can run becomes available. If **restart=no**, a vacated job is canceled rather than requeued.

Note that jobs which are checkpointable (**checkpoint = yes | interval**) are always considered ″restartable″.

Default value: yes

restart_from_ckpt

Indicates whether a job step is to be restarted from a checkpoint file.

Restriction: This keyword is ignored by LoadLeveler for Linux.

Syntax:

```
restart_from_ckpt = yes | no
```

where:

yes Indicates LoadLeveler will restart the job step from the checkpoint file specified by the job command file keyword **ckpt_file**. The location of the **ckpt_file** will be determined by the values of the job command file keyword **ckpt_file** or **ckpt_dir**, the administrator defined location or the default location. See "Naming checkpoint files and directories" on page 145 for a description of how the checkpoint directory location is determined. This value is valid only when a job is being restarted from a previous checkpoint.

no The job step will be started from the beginning, not from the checkpoint file.

Default value: no

If you specify a value for this keyword that is not valid, the system generates an error message and the job is not submitted.

restart_on_same_nodes

Indicates that a job step is to be restarted on the same set of nodes that it was run on previously. This keyword applies only to restarting a job step after a vacate (this condition is when the job step is terminated and then returned to the LoadLeveler job queue).

Syntax:

```
restart_on_same_nodes = yes | no
```

where:

yes Indicates that the job step is to be restarted on the same set of nodes on which it had run.

no Indicates that it is not required to restart a vacated job on the same nodes.

Default value: no

rset

This keyword indicates that the job tasks need to be attached to RSets with CPUs selected by different LoadLeveler scheduling algorithms or RSets created by users.

Syntax:

```
rset = value
```

value can be a user-defined RSet name or the following keyword:

RSET_MCM_AFFINITY
Specifying this value requests affinity scheduling with memory affinity as a requirement, adapter affinity as a preference, and the task MCM allocation method set to accumulate. The affinity options may be changed from these defaults by using the **mcm_affinity_options** keyword.

When anything other than the **RSET_MCM_AFFINITY** is specified, LoadLeveler considers the value to be a user-defined RSet name and schedules the job to nodes with **RSET_SUPPORT** set to **RSET_USER_DEFINED**.

Default value: If **task_affinity** is specified, then the default is **rset = RSET_MCM_AFFINITY**; otherwise, no default is set.

Example:

```
rset = RSET_MCM_AFFINITY
```

This example shows how to request affinity scheduling for a job. To request processor-core affinity, the jobs needs to specify the **task_affinity** keyword.

shell

Specifies the name of the shell to use for the job step.

Syntax:

```
shell = name
```

Default value: If you do not specify a value for this keyword, LoadLeveler uses the shell used in the owner's password file entry. If none is specified, LoadLeveler uses `/bin/sh`

Example: If you want to use the Korn shell, the shell keyword would be:

```
shell = /bin/ksh
```

smt

Indicates the required simultaneous multithreading (SMT) state for the job step.

LoadLeveler can satisfy this job request on AIX by dynamically enabling SMT if a node has SMT disabled. Once the job completes, LoadLeveler will return SMT to its original state.

Syntax:

```
smt = yes | no | as_is
```

where:
yes
The job step requires SMT to be enabled.
no The job step requires SMT to be disabled.
as_is
The SMT state will not be changed.

Default value: as_is.

Examples:

```
smt = yes
```

stack_limit

Specifies the hard limit, soft limit, or both limits for the size of the stack that is created.

Syntax:

stack_limit = *hardlimit*,*softlimit*

Default value: No default is set.

Example:

```
stack_limit = 120000,100000
```

Because no units have been specified in this example, LoadLeveler assumes that the figure represents a number of bytes.

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

startdate

Specifies when you want to run the job step.

Syntax:

startdate = *date time*

date is expressed as *MM/DD/YYYY*, and *time* is expressed as *HH:mm(:ss)*.

Default value: If you do not specify a start date, LoadLeveler uses the current date and time.

Example: If you want the job to run on August 28th, 2010 at 1:30 PM, issue:

```
startdate = 08/28/2010 13:30
```

If you specify a start date that is in the future, your job is kept in the Deferred state until that start date.

step_name

Specifies the name of the job step. You can name the job step using any combination of letters, numbers, underscores (_) and periods (.). You cannot, however, name it T or F, or use a number in the first position of the step name. The step name you use must be unique and can be used only once.

Syntax:

step_name = *step_name*

Default value: If you do not specify a step name, by default the first job step is named the character string ″0″, the second is named the character string ″1″, and so on.

Example:

```
step_name = step_3
```

task_affinity

Requests affinity scheduling in an SMT environment.

This keyword accepts either **core** or **cpu** as values. Optionally, you can specify an integer quantity for **core** or **cpu** by specifying a quantity within parenthesis '(' and ')'. If not specified, the default quantity is one.

The job will be scheduled to run only to the machines having LoadLeveler **ConsumableCpus** and **rset_mcm_affinity** configurations. When **core** is specified, each task of the job is bound to run on as many processor cores as specified. If **cpu** is specified, each task of the job is bound to run on the specified number of logical CPUs selected from the same cores. The CPUs allocated to the tasks of a processor-core affinity job will not be shared by other tasks. The processor cores allocated to the tasks of a processor-core affinity job can only be shared by tasks from other jobs, but not by tasks from the same job. If **task_affinity** is specified without the **rset** job command file keyword, **rset** is set to **rset_mcm_affinity** and **mcm_affinity_options** is set to **"mcm_mem_pref mcm_accumulate mcm_sni_pref"** for an **sn_single** parallel job; otherwise, it is set to **"mcm_mem_pref mcm_accumulate mcm_sni_none"**.

Syntax:

task_affinity = core[(*number*)] | **cpu**[(*number*)]

Default value: If **parallel_threads =** *number* is specified, then the default is **task_affinity = cpu(***number***)**; otherwise, no default is set.

Example:

```
1. task_affinity = core

2. task_affinity = core(2)
   cpus_per_core = 1

3. task_affinity = cpu(4)
   cpus_per_core = 1
```

task_geometry

The **task_geometry** keyword allows you to group tasks of a parallel job step to run together on the same node. Although **task_geometry** allows for a great deal of flexibility in how tasks are grouped, you cannot specify the particular nodes that these groups run on; the scheduler will decide which nodes will run the specified groupings.

This keyword is supported by the BACKFILL and API schedulers.

Syntax:

task_geometry={(*task id***,***task id***,...)(***task id***,***task id***, ...) ... }**

Default value: No default value is set.

Example: A job with 6 tasks will run on 4 different nodes:

```
task_geometry={(0,1) (3) (5,4) (2)}
```

Each number in this example represents a task ID in a job, each set of parenthesis contains the task IDs assigned to one node. The entire range of tasks specified must begin with 0, and must be complete; no number can be skipped (the largest task id number should end up being the value that is one less than the total number of tasks). The entire statement following the keyword must be enclosed in braces, and each grouping of nodes must be

enclosed in parenthesis. Commas can only appear between task IDs, and spaces can only appear between nodes and task IDs.

The **task_geometry** keyword cannot be specified under **any** of the following conditions:

- The step is serial.
- **job_type** is anything other than **parallel**
- Any of the following keywords are specified:
  - **tasks_per_node**
  - **total_tasks**
  - **node**
  - **blocking**

For more information, see "Task-assignment considerations" on page 196.

tasks_per_node

Specifies the number of tasks of a parallel job you want to run per node. Use this keyword together with the **node** keyword. The value you specify on the **node** keyword can be a range or a single value. If the node keyword is not specified, then the default value is one node.

The maximum number of tasks a job step can request is limited by the **total_tasks** keyword in the administration file (provided this keyword is specified). That is, the maximum must be less than any **total_tasks** value specified in a user, group, or class stanza.

The value of the **tasks_per_node** keyword applies only to the job step in which you specify the keyword. (That is, this keyword is not inherited by other job steps.)

Also, you cannot specify both the **tasks_per_node** keyword and the **total_tasks** keyword within a job step.

This keyword is supported by the BACKFILL and API schedulers.

Syntax:

```
tasks_per_node = number
```

where *number* is the number of tasks you want to run per node.

Default value: The default is one task per node.

Example: To specify a range of seven to 14 nodes, with four tasks running on each node, enter the following:

```
node = 7,14
tasks_per_node = 4
```

This job step runs 28 to 56 tasks, depending on the number of nodes allocated to the job step.

total_tasks

Specifies the total number of tasks of a parallel job you want to run on all available nodes. Use this keyword together with the **node** keyword. The value you specify on the **node** keyword must be a single value rather than a range of values. If the node keyword is not specified, then the default value is one node.

The maximum number of tasks a job step can request is limited by the **total_tasks** keyword in the administration file (provided this keyword is specified). That is, the maximum must be less than any **total_tasks** value

specified in a user, group, or class stanza. The value of the **total_tasks** keyword applies only to the job step in which you specify the keyword. (That is, this keyword is not inherited by other job steps.) Also, you cannot specify both the **total_tasks** keyword and the **tasks_per_node** keyword within a job step.

If you specify an unequal distribution of tasks per node, LoadLeveler allocates the tasks on the nodes in a round-robin fashion. For example, if you have three nodes and five tasks, two tasks run on the first two nodes and one task runs on the third node.

This keyword is supported by the BACKFILL and API schedulers.

Syntax:

total_tasks = *number*

where *number* is the total number of tasks you want to run.

Default value: No default is set.

Example: To run two tasks on each of 12 available nodes for a total of 24 tasks, enter the following:

```
node = 12
total_tasks = 24
```

user_priority

Sets the initial priority of your job step. Priority only affects your job steps. It orders job steps you submitted with respect to other job steps submitted by you, not with respect to job steps submitted by other users.

Syntax:

user_priority = *number*

where *number* is a number between 0 and 100, inclusive. A higher number indicates the job step will be selected before a job step with a lower number. Note that this keyword is not the UNIX *nice* priority.

This priority guarantees the order the jobs are considered for dispatch. It does not guarantee the order in which they will run.

Default value: The default priority is 50.

wall_clock_limit

Sets the hard limit, soft limit, or both limits for the elapsed time for which a job can run. In computing the elapsed time for a job, LoadLeveler considers the start time to be the time the job is dispatched.

If you are running the BACKFILL scheduler, you must either set a wall clock limit in the job command file or the administrator must define a wall clock limit value for the class to which a job is assigned. In most cases, this wall clock limit value should not be **unlimited**. For more information, see "Choosing a scheduler" on page 44.

Syntax:

wall_clock_limit = *hardlimit*,*softlimit*

An example is:

```
wall_clock_limit = 5:00,4:30
```

For additional information about limit keywords, see the following topics:
- "Syntax for limit keywords" on page 324
- "Using limit keywords" on page 89

Job command file variables

LoadLeveler has several variables you can use in a job command file.

These variables are useful for distinguishing between output and error files.

You can refer to variables in mixed case, but you must specify them using the following syntax:

$(*variable_name***)**

The following variables are available to you:

$(domain)
The domain of the host from which the job was submitted.

$(home)
The home directory for the user on the cluster selected to run the job. Since the user may differ from the submitting user when a remote cluster is selected to run the job and user mapping is used, so may the home directory differ.

$(host)
The hostname of the machine from which the job was submitted. In a job command file, the **$(host)** variable and the **$(hostname)** variable are equivalent.

$(jobid)
The sequential number assigned to this job by the Schedd daemon. The **$(jobid)** variable and the **$(cluster)** variable are equivalent.

$(schedd_host)
The hostname of the scheduling machine.

$(schedd_hostname)
The hostname and domain name of the scheduling machine.

$(stepid)
The sequential number assigned to this job step when multiple queue statements are used with the job command file. The **$(stepid)** variable and the **$(process)** variable are equivalent.

$(user)
The user name on the cluster selected to run the job. This might be a different user name than the user name who submitted the job. It is possible for the value of this variable to differ from the submitting user name when a remote cluster is selected to run the job and user name mapping is being used.

In addition, the following keywords are also available as variables. However, you must define them in the job command file. These keywords are described in detail in "Job command file keyword descriptions" on page 359.

- **$(executable)**
- **$(class)**
- **$(comment)**
- **$(job_name)**
- **$(step_name)**

Note that for the **$(comment)** variable, the keyword definition must be a single string with no blanks. Also, the **executable** statement automatically sets the **$(base_executable)** variable, which is the file name of the executable without the directory component. See Figure 22 on page 183 for an example of using the **$(base_executable)** variable.

Run-time environment variables

The following environment variables are set by LoadLeveler for all jobs.

These environment variables are also set before running prolog and epilog programs. For more information on prolog and epilog programs, see "Writing prolog and epilog programs" on page 77.

LOADL_ACTIVE
The LoadLeveler version.

LOADL_BG_BPS
The base partitions of the allocated partition.

LOADL_BG_CONNECTION
The connection of the allocated partition.

LOADL_BG_IONODES (for Blue Gene/P only)
The I/O nodes in a base partition of the allocated partition.

LOADL_BG_PARTITION
The name of the allocated partition.

LOADL_BG_SHAPE
The shape of the allocated partition.

LOADL_BG_SIZE
The size of the allocated partition.

LOADLBATCH
Set to **yes** to indicate that the job is running under LoadLeveler.

LOADL_CKPT_FILE
Identifies the directory and file name for checkpointing files. LoadLeveler will only set this environmental variable if checkpointing is enabled.

LOADL_HOSTFILE
Specifies the full path name of the file that contains the host names assigned to all the tasks of the step. This environment variable is available only when the **job_type** is set to **parallel** or **MPICH**. This file is created in the execute directory and is deleted once the step has completed. The host names are stored in the file as one host name per line. The base name of this file is **step_hosts.step_id**.

LOADL_JOB_NAME
The three part job identifier.

LOADL_PID
The process ID of the starter process.

LOADL_PROCESSOR_LIST
A blank-delimited list of hostnames allocated for the step. This environment variable is limited to 128 hostnames. If the value is greater than the 128 limit, the environment variable is not set.

LOADL_STARTD_PORT
The port number where the startd daemon runs.

LOADL_STEP_ACCT
The account number of the job step owner.

LOADL_STEP_ARGS
Any arguments passed by the job step.

LOADL_STEP_CLASS
The job class for serial jobs.

LOADL_STEP_COMMAND
The name of the executable (or the name of the job command file if the job command file is the executable).

LOADL_STEP_ERR
The file used for standard error messages (stderr).

LOADL_STEP_GROUP
The UNIX group name of the job step owner.

LOADL_STEP_ID
The job step ID.

LOADL_STEP_IN
The file used for standard input (stdin).

LOADL_STEP_INITDIR
The initial working directory.

LOADL_STEP_NAME
The name of the job step.

LOADL_STEP_NICE
The UNIX *nice* value of the job step. This value is determined by the **nice** keyword in the class stanza. For more information, see "Defining classes" on page 89.

LOADL_STEP_OUT
The file used for standard output (stdout).

LOADL_STEP_OWNER
The job step owner.

LOADL_STEP_TYPE
The job type (SERIAL or PARALLEL)

LOADL_TOTAL_TASKS
Specifies the total number of tasks of the MPICH job step. This variable is available only when the job_type is set to MPICH.

LL_DSTG_IN_EXIT_CODE
The exit code from the inbound data staging program. LoadLeveler sets the environment variable to the value obtained from executing **WEXITSTATUS** on the status returned in the wait3 system call when the inbound data staging program terminates.

Job command file examples

These job command file examples may apply to your situation.

1. The following job command file creates an output file called **stance.78.out**, where `stance` is the host and 78 is the job ID:

```
# @ executable = my_job
# @ arguments  = 5
# @ output     = $(host).$(jobid).out
# @ queue
```

2. The following job command file creates an **output** file called **computel.step1.March05**:

```
# @ comment    = March05
# @ job_name   = computel
# @ step_name  = step1
# @ executable = my_job
# @ output     = $(job_name).$(step_name).$(comment)
# @ queue
```

3. For a Blue Gene/P job using two base partitions, the values for the new runtime environment variables could be set similar to the following:

```
LOADL_BG_PARTITION=LL07042914305594

LOADL_BG_SIZE=1024

LOADL_BG_SHAPE=1x1x2
LOADL_BG_CONNECTION=TORUS

LOADL_BG_BPS=R00-M0,R00-M1

LOADL_BG_IONODES=N00-J00,N04-J00,N08-J00,N12-J00
```

   The maximum number of I/O nodes for **LOADL_BG_IONODES** will be 32 for Blue Gene/P, which is a fully populated Blue Gene/P base partition.

   In this example, each base partition has four I/O nodes, which is the minimum number of I/O nodes that a base partition must have.

   Each base partition in a partition should have the same set of I/O nodes. The **LOADL_BG_BPS** and **LOADL_BG_IONODES** values can be used to form the full names of all of the I/O nodes in the partition:

```
R00-M0-N00-J00 R00-M0-N04-J00 R00-M0-N08-J00 R00-M0-N12-J00

R00-M1-N00-J00 R00-M1-N04-J00 R00-M1-N08-J00 R00-M1-N12-J00
```

For additional information, see "Examples: Job command files" on page 181.

Chapter 15. Graphical user interface (GUI) reference

Note: This is the last release that will provide the Motif-based graphical user interface **xloadl**. The function available in **xloadl** has been frozen since TWS LoadLeveler 3.3.2.

For more information Chapter 7, "Using LoadLeveler's GUI to perform administrator tasks," on page 169 or Chapter 11, "Using LoadLeveler's GUI to build, submit, and manage jobs," on page 237.

If this is the first time you are using a Motif-based GUI, you should refer to the appropriate Motif documentation for general GUI information.

In "Customizing the GUI" on page 407 you will also find information on customizing the GUI by:
- Modifying windows and buttons
- Creating pull-down menus
- Customizing window fields
- Modifying help panels
- Setting up administrative tasks

Note: LoadLeveler provides two types of graphical user interfaces. One interface is for users whose machines interact fully with LoadLeveler. The second interface is available to users of submit-only machines that participate on a limited basis with LoadLeveler.

Starting the GUI

Before starting the GUI, check your PATH variable to ensure that it is pointing to the LoadLeveler binaries. Also, check to see that your DISPLAY variable is set to your display.

Type one of the following to start the GUI in the background:
- **xloadl_so &** (if you are running a submit-only machine)
- **xloadl &** (for all other users)

Note: When you invoke the GUI in a multicluster environment, an additional window appears. This window allows you to start additional local instances of **xloadl** or **xloadl_so** for each remote cluster present in your multicluster environment. These instances of **xloadl** are distinguished through the instance window titles:
  - The **xloadl** instances for remote clusters have titles of the form ***local_cluster_name→remote_cluster_name***, for instance, **MY_C2→MY_C3**, where MY_C2 and MY_C3 are cluster names (local and remote, respectively).
  - The **xloadl** instance for the local cluster has a title of the form ***local_cluster_name***, for instance, **MY_C2**, where MY_C2 is the name of the local cluster.

Specifying GUI options

You can specify GUI options in several ways.

In general, you can specify GUI options in any of the following ways:

- Within the GUI using menu selections
- On the **xloadl** (or **xloadl_so**) command line. Enter **xloadl -h** or **xloadl_so -h** to see a list of the available options.
- In the **Xloadl** file. See "Customizing the GUI" on page 407 for more information.

The LoadLeveler main window

LoadLeveler's main window has three sub-windows, titled Jobs, Machines, and Messages.

These are shown in Figure 42 on page 405. Each of these sub-windows has its own menu bar.

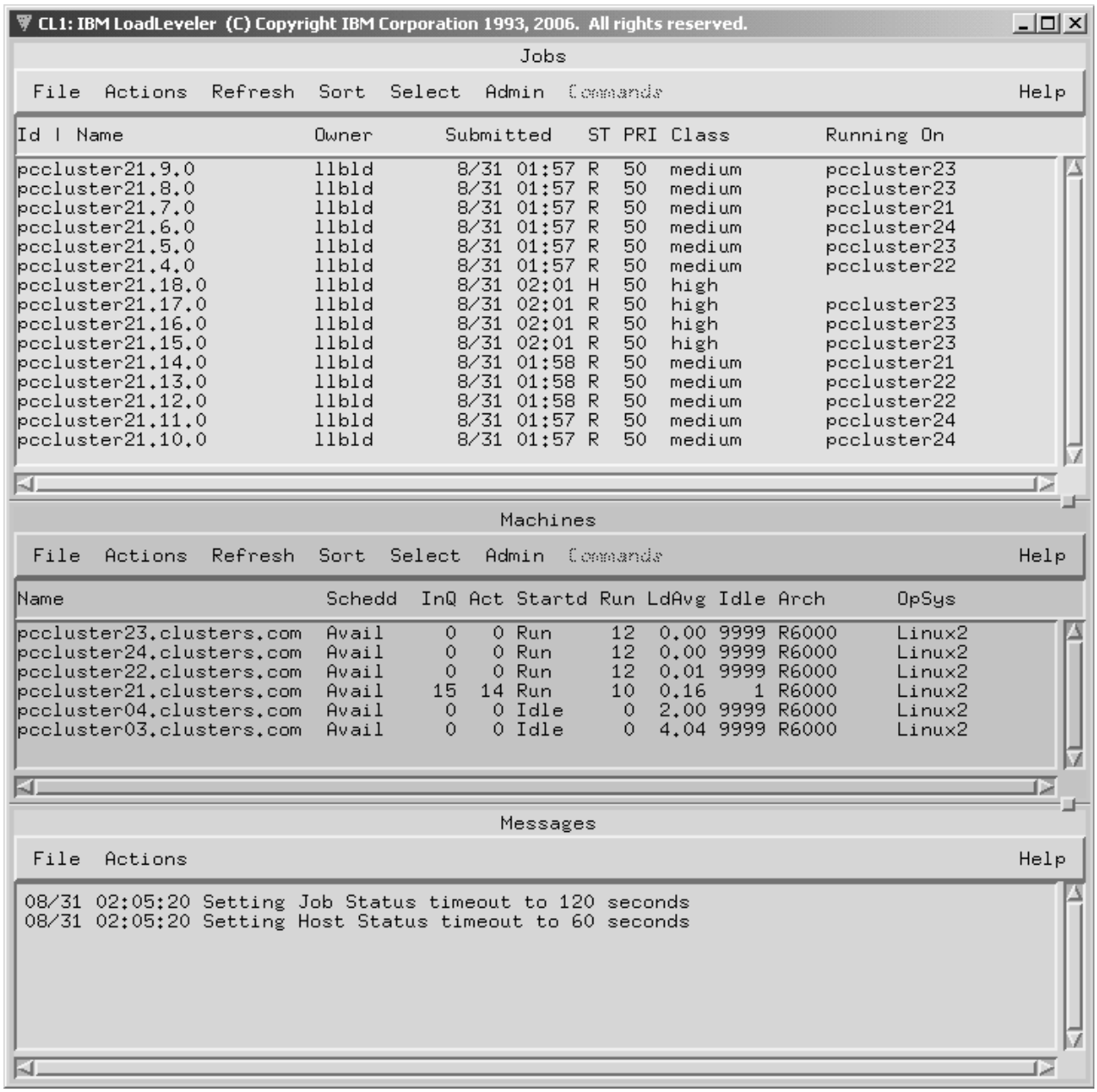

Figure 42. Main window of the LoadLeveler GUI

The menu bar on the Jobs window relates to actions you can perform on jobs. The menu bar on the Machines window relates to actions you can perform on machines. Similarly, the menu bar on the Messages window displays actions you can perform related to LoadLeveler generated messages.

When you select an item from a menu bar, a pull-down menu appears. You can select an item from the pull-down menu to carry out an action or to bring up another pull-down menu originating from the first one.

Getting help using the GUI

You can get help when using the GUI by pressing the Help key.

This key is function key 1 (F1) on most keyboards. To receive help on specific parts of the LoadLeveler GUI, click the mouse on the area or field for which you want help and press F1. A help screen appears describing that area. You can also get help by using the Help pull-down menu and the Help push buttons available in pop-up windows.

Before you invoke the GUI, make sure your PATH statement includes the directory containing the LoadLeveler executables. Otherwise, some GUI functions may not work correctly.

Differences between LoadLeveler's GUI and other graphical user interfaces

LoadLeveler's GUI contains many items common to other GUIs.

There are, however, some differences that you should be aware of. These differences are:

- Accelerators or mnemonics do not appear on the menu bars.
- Submerged windows do not necessarily rise to the top when refreshed.

GUI typographic conventions

Typographic conventions are used when describing the way tasks are accomplished using the GUI.

The following typographic conventions are used when describing the way tasks are accomplished using the GUI.

Task step conventions

Each task step includes a user action and a system response. User actions appear in **UPPERCASE BOLDFACE** type and the system response to an action follows a ▲ . For example:

SELECT

Refresh → Set Auto Refresh

▲ A window appears.

An action is sometimes represented by itself, for example:

SELECT

OK

Selection table and decision table conventions

Some actions require a selection or decision. Selection and decision actions are presented in tables.

Selection tables list all possible selections in the left column of the table. Table 78 is an example of a selection table:

Table 78. Example of a selection table

To	Do This
Submit a job	Refer to "Submitting a job command file" on page 250.
Cancel a job	Refer to "Canceling a job" on page 254.

Decision tables present a question or series of questions before indicating the action. Table 79 on page 407 is an example of a decision table and Table 80 on page 407 shows the actions:

Table 79. Decision table

Did the job you submitted complete processing?

Table 80. Decision table actions

Decision	Action
Yes	Submit another job.
No	Check the status of the job.

Menu selection conventions

Selections from a menu bar are indicated with an →. For example, if a menu bar included an option called **Actions** and **Actions** included an option called **Cancel**, the instructions would read:

SELECT

Actions → Cancel

64-bit support for the GUI

The LoadLeveler Graphical User Interface (**xloadl** or **xloadl_so**) accepts and displays 64-bit information where appropriate.

Customizing the GUI

You can customize the GUI to suit your needs by overriding the default settings of the LoadLeveler resource variables. For example, you can set the color, initial size, and location of the main window.

This topic tells you how to customize the GUI by modifying either (or both) of the following files:

Xloadl For fully participating machines

Xloadl_so

For submit-only machines

If the LoadLeveler administrator has set up these resource files, the files are located in the **/usr/lib/X11/app-defaults** directory. Otherwise, the files are located in the lib directory of the LoadLeveler release directory:

- For AIX, in **/usr/lpp/LoadL/full/lib** and **/usr/lpp/LoadL/so/lib**, respectively.
- For Linux, in **/opt/ibmll/LoadL/full/lib** and **/opt/ibmll/LoadL/so/lib**, respectively.

These files contain the default values for the graphical user interface. This topic discusses the syntax of these files, and gives you an overview of some of the resources you can modify.

An administrator with root authority can make changes to the resources for the entire installation by editing the **Xloadl** file. Any user can make local changes by placing the resource names with their new values in the user's **.Xdefaults** file.

Syntax of an Xloadl file

This is the syntax of an Xloadl file.

- Comments begin with !
- Resource variables may begin with *
- Colons follow resource variables
- Resource variable values follow colons.

Modifying windows and buttons

All of the windows and buttons that are part of the GUI have certain characteristics in common.

For example, they all have a foreground and background color, as well as a size and a location. Each one of these characteristics is represented by a resource variable. For example, the foreground characteristic is represented by the resource variable **foreground**. In addition, every resource variable has a value associated with it. The values of the resource variable **foreground** are a range of colors.

Before customizing a window, you need to locate the resource variables associated with the desired window. To do this, search for the window identifier in your **Xloadl** file. Table 81 lists the windows and their respective identifiers:

Table 81. Window identifiers in the Xloadl file

Window	Identifier
Account Report Data	reporter
Build a Job	builder
Checkpoint Fields	ckpt
Jobs	job_status
Limits	limits
Machines	machine_status
Messages	message_area
Network	network
Nodes	nodes
Preferences	preferences
Requirements	requirements
Script	script
Submit a Job	submit
Task Geometry	tgeometry

Table 82 lists the resource variables for all the windows and the buttons along with a description of each resource variable. Use the information in this table to modify your graphical user interface by changing the values of desired resource variables. The values of these resource variables depend upon Motif requirements.

Table 82. Resource variables for all the windows and the buttons

Resource Variable	Description
background	The background color of the object
foreground	The foreground color of the object
geometry	The location of the object
height	The height of the object
labelString	The text associated with the object
width	The width of the object

Creating your own pull-down menus

You can add a pull-down menu to both the Jobs window and the Machines window.

To add a pull-down menu to the Jobs window, in the **Xloadl** file:

1. Set **userJobPulldown** to **True**
2. Set **userJob.labelString** to the name of your menu.
3. Fill in the appropriate information for your first menu item, **userJob_Option1**
4. To define more menu items, fill in the appropriate information for **userJob_Option2**, **userJob_Option3**, and so on. You can define up to ten menu items.

For more information, refer to the comments in the **Xloadl** file.

To add a pull-down menu to the Machines window, in the **Xloadl** file:

1. Set **userMachinePulldown** to **True**
2. Set **userMachine.labelString** to the name of your menu.
3. Fill in the appropriate information for your first menu item, **userMachine_Option1**
4. To define more menu items, fill in the appropriate information for **userMachine_Option2**, **userMachine_Option3**, and so on. You can define up to ten menu items.

Example – creating a new pull-down

Suppose that you want to create a new menu bar item containing a selection which executes the **ping** command against a machine you select on the Machines window.

```
*userMachinePulldown: True
*userMachine.labelString: Commands
*userMachine_Option1: True
*userMachine_Option1_command: ping -c1
*userMachine_Option1.labelString: ping
*userMachine_Option1_parameter: True
*userMachine_Option1_output: Window
```

Figure 43. Creating a new pull-down menu

The **Xloadl** definitions shown in the Figure 43 create a menu bar item called "Commands". The first item in the Commands pull-down menu is called "ping". When you select this item, the command **ping -c1** is executed, with the machine you selected on the Machines window passed to this command. Your output is displayed in an informational window.

For more information, refer to the comments in the **Xloadl** file.

Customizing fields on the Jobs window and the Machines window

You can control which fields are displayed and which fields are not displayed on the Jobs window and the Machine window by changing the **Xloadl** file.

Look in the **Xloadl** file for "Resources for specifying lengths of fields displayed in the Jobs and Machines windows".

In most cases, you can remove a field from a window by setting its associated resource value to 0. To remove the Arch field from the Machines window, enter the following:

```
*mach_arch_len : 0
```

Note that the Job ID and Machine Name fields must always be displayed and therefore cannot be set to 0.

All fields have a minimum length value. If you specify a smaller value, the minimum is used.

Modifying help panels

Help panels have the same characteristics as all of the windows plus a few unique ones.

Help panels have the same characteristics as all of the windows plus a few unique ones as shown in Table 83:

Table 83. Modifying help panels

Resource Variable	Values	Description
help*work_area.width	Any integer*	The width of the help panel.
help*work_area.height	Any integer*	The height of the help panel.
help*scrollHorizontal	[true | false] The default is False.	Sets the scrolling option on or off.
help*wordWrap	[true | false] The default is True.	Sets word wrapping on or off.

Note: * The work area and height depend upon your screen limitations.

Chapter 16. Commands

LoadLeveler provides two types of commands: those that are available to all users of LoadLeveler, and those that are reserved for LoadLeveler administrators.

If security services are not configured, then administrators are identified by the **LOADL_ADMIN** keyword in the configuration file. If security services are configured, the configuration file must identify the administrator's group. Refer to "Defining security mechanisms" on page 56 for more information.

The administrator commands can operate on the entire LoadLeveler job queue and all machines configured. The user commands mainly affect those jobs submitted by that user. Some commands, such as **llhold**, include options that can only be performed by an administrator.

Table 84 lists:
- All of the LoadLeveler commands
- The intended users
- The supported operating systems
- Whether the command can be issued across clusters to all clusters, a single cluster, or only within the local cluster
- A reference to the full description of each command

Table 84. LoadLeveler command summary

Command name	Intended users	Supported operating systems	Multicluster support	For more information, see...
llacctmrg	Administrators only	AIX and Linux	No	"llacctmrg - Collect machine history files" on page 413
llbind	Both administrators and general users	AIX and Linux	No	"llbind - Bind job steps to a reservation" on page 415
llcancel	Both administrators and general users	AIX and Linux	Single cluster	"llcancel - Cancel a submitted job" on page 421
llchres	Both administrators and general users	AIX and Linux	No	"llchres - Change attributes of a reservation" on page 424
llckpt	Both administrators and general users	AIX and Linux[1]	Yes	"llckpt - Checkpoint a running job step" on page 430
llclass	Both administrators and general users	AIX and Linux	Yes	"llclass - Query class information" on page 433
llclusterauth	Administrators only	AIX and Linux	No	"llclusterauth - Generates public and private keys" on page 438
llctl	Administrators only	AIX and Linux	No	"llctl - Control LoadLeveler daemons" on page 439
llextRPD	Both administrators and general users	AIX and Linux	No	"llextRPD - Extract data from an RSCT peer domain" on page 443
llfavorjob	Administrators only	AIX and Linux	No	"llfavorjob - Reorder system queue by job" on page 447
llfavoruser	Administrators only	AIX and Linux	No	"llfavoruser - Reorder system queue by user" on page 449

Table 84. LoadLeveler command summary (continued)

Command name	Intended users	Supported operating systems	Multicluster support	For more information, see...
llfs	Administrators only	AIX and Linux	No	"llfs - Fair share scheduling queries and operations" on page 450
llhold	Both administrators and general users	AIX and Linux	Single cluster	"llhold - Hold or release a submitted job" on page 454
llinit	Administrators only	AIX and Linux	No	"llinit - Initialize machines in the LoadLeveler cluster" on page 457
llmkres	Both administrators and general users	AIX and Linux	No	"llmkres - Make a reservation" on page 459
llmodify	Both administrators and general users	AIX and Linux	Single cluster (not supported with **-p**, **-s**, **-x**, or **-W**)	"llmodify - Change attributes of a submitted job step" on page 464
llmovejob	Administrators only	AIX and Linux	No	"llmovejob - Move a single idle job from the local cluster to another cluster" on page 470
llmovespool	Administrators only	AIX and Linux	No	"llmovespool - Move job records" on page 472
llpreempt	Administrators only	AIX and Linux	No	"llpreempt - Preempt a submitted job step" on page 474
llprio	Both administrators and general users	AIX and Linux	Single cluster	"llprio - Change the user priority of submitted job steps" on page 477
llq	Both administrators and general users	AIX and Linux	Yes (not supported with **-d**, **-w** or **-x**)	"llq - Query job status" on page 479
llqres	Both administrators and general users	AIX and Linux	No	"llqres - Query a reservation" on page 500
llrmres	Both administrators and general users	AIX and Linux	No	"llrmres - Cancel a reservation" on page 508
llrunscheduler	Administrators only	AIX and Linux	No	"llrunscheduler - Run the central manager's scheduling algorithm" on page 511
llstatus	Both administrators and general users	AIX and Linux	Yes	"llstatus - Query machine status" on page 512
llsubmit	Both administrators and general users	AIX and Linux	Yes	"llsubmit - Submit a job" on page 531
llsummary	Both administrators and general users	AIX and Linux	No	"llsummary - Return job resource information for accounting" on page 535

[1] This command will run on LoadLeveler for Linux platforms, but it can only checkpoint jobs on AIX.

llacctmrg - Collect machine history files

Use the **llacctmrg** command to collect individual machine history files together into a single file.

Syntax

llacctmrg [**-?**] [**-H**] [**-v**] [**-R**] [**-h** *hostlist*] [**-d** *directory*]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-R Merges individual machine reservation history files into a single history file.

-h *hostlist*
Specifies a blank-delimited list of machines from which to collect data. The default is all machines in the LoadLeveler cluster.

-d *directory*
Specifies the directory to hold the new global history file. If not specified, the directory specified in the **GLOBAL_HISTORY** keyword in the configuration file is used.

Description

This command by default collects data from all the machines identified in the administration file. To override the default, specify a machine or a list of machines using the **-h** flag.

When the **llacctmrg** command ends, accounting information is stored in a file called **globalhist.***YYYYMMDDHHmm*.

where:
YYYY Indicates the year
MM Indicates the month
DD Indicates the day
HH Indicates the hour
mm Indicates the minute.

Information such as the amount of resources consumed by the job and other job-related data is stored in this file.

Note that when the collection of accounting information to the global history file is complete, the accounting information is cleared in the history file.

For job data, you can use this file as input to the **llsummary** command. For example, if you created the file **globalhist.199808301050**, you can issue **llsummary globalhist.199808301050** to process the accounting information stored in this file.

When the **-R** flag is used to merge reservation history files instead of job history files, a file named **reservation_globalhist.***YYYYMMDDHHmm* is created in the specified directory. You can view reservation data with any text editor. For more

information on the format of the reservation history file, see the accounting information in Chapter 4, "Configuring the LoadLeveler environment," on page 41.

Data on processes which fork child processes will be included in the file only if the parent process waits for the child process to end. Therefore, complete data may not be collected for jobs which are not composed of simple parent/child processes. For example, if a LoadLeveler job invokes an **rsh** command to execute some function on another machine, the resources consumed on the other machine will not be collected as part of the accounting data.

Examples

1. The following example collects data from machines named `mars` and `pluto`:

   ```
   llacctmrg -h mars pluto
   ```

2. The following example collects data from the machine named `mars` and places the data in an existing directory called **merge**:

   ```
   llacctmrg -h mars -d merge
   ```

3. The following example collects reservation history data from all machines in the LoadLeveler cluster:

   ```
   llacctmrg -R
   ```

   You should receive a response similar to the following:

   ```
   llacctmrg: History transferred successfully from
              c94n04.ppd.pok.ibm.com (98 bytes).
   ```

   A file named **reservation_globlhist.200802130915** is generated in the global history file location, assuming **llacctmrg** is issued at the time of 09:15 02/13/2008.

Results

The following shows a sample system response from the **llacctmrg -h mars -d merge** command:

```
llacctmrg: History transferred successfully from mars (10080 bytes)
```

Security

LoadLeveler administrators can issue this command.

llbind - Bind job steps to a reservation

Use the **llbind** command to bind job steps to a reservation in LoadLeveler, or unbind job steps from the reservations to which they currently belong. The bound job steps will only be scheduled to run on the nodes reserved by the reservation.

Syntax

llbind { **-?** | **-H** | **-v** | **[-q] [-m soft | firm]** { **-r** | **-R** *reservation_ID* } *job_step_list* }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-m soft | firm
Specifies the type of binding.

soft Indicates soft binding. The bound job steps will be allowed to use the reservation's resources, but will also be considered for scheduling prior to the reservation becoming active. Soft-bound job steps are not limited to running on only the reserved resources, but can be scheduled to run on any available resources in the cluster.

firm Indicates firm binding. The bound job steps will only be scheduled to run on the nodes reserved by the reservation, and only during the time that the reservation is active.

-r Specifies an unbind operation. LoadLeveler eliminates any association between the job steps and a reservation.

-R *reservation_ID*
Specifies the reservation identifier to be modified. The format of a full LoadLeveler reservation identifier is [*host*.]*rid*[.**r**[.*oid*]].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional if *oid* is not specified).
- *oid* is the occurrence ID of a recurring reservation (*oid* is optional).

The reservation identifier can be specified in an abbreviated form, *rid*[.**r**[.*oid*]], when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

job_step_list
Is a blank-delimited list of job steps to be bound to the reservation or unbound from their respective reservations. The name of each job step should be in the form [*host*].*jobid*[.*stepid*].

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

Note: For coscheduled job steps, even if all coscheduled job steps are not in the list of targeted job steps, the requested command is run on all coscheduled job steps.

Description

The **llbind** command is for LoadLeveler administrators and owner or users of a reservation. Regular users can only bind their own job steps to a reservation that they are allowed to use, while a LoadLeveler administrator can bind any job steps to any reservation.

Only job steps in an idle-like state can be bound to a reservation. A job step that is in an idle-like state that is already bound to a reservation can be bound to a new reservation using the **llbind** command. The command will first unbind the job step from the reservation it is currently bound to and then bind it to the requested reservation.

A Blue Gene job step can only be bound to a reservation with Blue Gene resources. A non-Blue Gene job step can only be bound to a reservation with non-Blue Gene resources.

The following conditions will cause the bind or unbind request for a job step to be ignored:

- The job step does not exist.
- The user is not the owner of the job step or a LoadLeveler administrator.
- The job step is requested to be bound to a specific occurrence of a reservation that has already passed.
- The job step is requested to be bound to a specific occurrence (*oid*) of a reservation that is beyond the reservation's expiration. For example, if a reservation occurs daily at 4 p.m. and will expire at 4 p.m. on Friday, and the *oid* of that final occurrence is 11, if the command `llbind -j mystepid -R myresid.r.12` were issued, it would not be a valid request because *oid* 12 would occur on Saturday at 4 p.m., after the reservation was set to expire.
- The job step is not associated with any reservation for an unbind request.
- Binding a Blue Gene job step to a reservation without Blue Gene resources.
- Binding a non-Blue Gene job step to a reservation with Blue Gene resources.

Note: A bind or unbind request for a coscheduled job step applies to all of the coscheduled job steps. If any of the coscheduled job steps meet one of these conditions, the requested operation will fail. The **llq -l** command can be used to check whether the request is successful (see "llq - Query job status" on page 479 for more information).

If a binding method is not specified, the binding method specified for the reservation will be used by default.

Job steps bound using the firm binding method will be scheduled to run only on the reserved resources. The only exception is that the front end node (FEN) needed by a Blue Gene job step will be satisfied from outside of the reservation. A reservation for a Blue Gene resource does not reserve resources for a FEN. The **mpirun** launch program needs to run on a front end node.

Job steps bound using the soft binding method can be scheduled to run on any node. These soft-bound job steps compete for the same resources as nonbound job steps, but nonbound job steps are not allowed to use any reserved resources, while soft-bound job steps are allowed to use the reserved resources. Soft-bound job steps can neither preempt other running job steps, nor can they be preempted by other steps.

If a job step is bound to a recurring reservation and no occurrence ID is specified, the job step will be bound to the first occurrence of the reservation, including a currently active occurrence. When a job step is bound to a specific occurrence of a reservation, it can be scheduled to run in that occurrence or any subsequent occurrence. If the job step cannot be scheduled while the requested reservation occurrence is active, the job step will automatically be bound to the next reservation occurrence.

If the step is part of a recurring job, all steps of that job will be bound to the reservation. If any step of the job cannot be bound (for example, if a step is already running), the bind request will fail.

Only existing job steps queued in LoadLeveler can be bound to a reservation through this command. You can set the LL_RES_ID environment variable to bind an interactive Parallel Operating Environment (POE) job to a reservation or cause **llsubmit** to both submit and bind a batch job to a reservation. For batch jobs, you can set the **ll_res_id** job command file keyword instead of setting the LL_RES_ID environment variable.

The same format for the reservation ID is used for the LL_RES_ID environment variable, the **ll_res_id** job command file keyword, or the **llbind** command **-R** option. The **llqres** command can be used to view the list of job steps bound to the reservation.

When the LL_RES_ID environment variable or the **ll_res_id** job command file keyword is used, the binding method cannot be specified and the binding method specified by the reservation will be used. The binding method can be changed later using this command provided that the job step is still idle.

Scale-across steps cannot be bound to reservations.

This command is for the BACKFILL scheduler only.

Examples

1. To request to bind the job step c188f2n01.6.0 to reservation c188f1n03.2.r, issue:

   ```
   llbind -R c188f1n03.2.r c188f2n01.6.0
   ```

   You should receive a response similar to the following:

   ```
   Request to bind job steps to reservation c188f1n03.2.r has been sent to
   LoadLeveler
   ```

2. To request to unbind the job step c188f2n01.6.0 from the reservation to which it is currently bound, issue:

```
llbind -r c188f2n01.6.0
```

You should receive a response similar to the following:

```
Request to unbind job steps from their respective reservations has been sent to
LoadLeveler.
```

3. To submit a new job and automatically bind it to a reservation using the LL_RES_ID environment variable, issue:

```
LL_RES_ID=c197blade3b11.ppd.pok.ibm.com.1.r llsubmit myjob.cmd
```

You should receive a response similar to the following:

```
llsubmit: The job "c197blade3b11.ppd.pok.ibm.com.3" has been submitted.
```

You can use the **llq -l** command to verify that the job's steps have been bound to the reservation:

```
llq -l c197blade3b11.ppd.pok.ibm.com.3
```

You should receive a response similar to the following:

```
============== Job Step c197blade3b11.ppd.pok.ibm.com.3.0 =============
        Job Step Id: c197blade3b11.ppd.pok.ibm.com.3.0
           Job Name: myjob
          Step Name: 0
  Structure Version: 10
              Owner: llbld
         Queue Date: Mon 11 Aug 2008 11:40:38 AM EDT
             Status: Idle
    Reservation ID: c197blade3b11.ppd.pok.ibm.com.1.r
  Requested Res. ID:
          Recurring: False
...
```

Note: Alternatively, the **ll_res_id** job command file keyword can be used instead of the LL_RES_ID environment variable.

4. To bind a job step to the first occurrence of a recurring reservation, issue:

```
llbind -R c197blade3b11.ppd.pok.ibm.com.1.r \
       c197blade3b11.ppd.pok.ibm.com.8.0
```

You should receive a response similar to the following:

```
llbind: Request to bind job steps to reservation
c197blade3b11.ppd.pok.ibm.com.1.r has been sent to LoadLeveler.
```

You can use the **llqres -l** command to verify that the step is bound to the next occurrence of the reservation:

```
llqres -l -R c197blade3b11.ppd.pok.ibm.com.1.r
```

You should receive a response similar to the following:

```
============== Reservation c197blade3b11.ppd.pok.ibm.com.1.r.2 ========
               ID: c197blade3b11.ppd.pok.ibm.com.1.r.2
    Creation Time: Fri 08 Aug 2008 12:55:17 PM EDT
            Owner: llbld
            Group: No_Group
       Start Time: Mon 11 Aug 2008 04:00:00 PM EDT

...

            Nodes: 1
                   c197blade3b11.ppd.pok.ibm.com
        Job Steps: 2
                   c197blade3b11.3.0
                   c197blade3b11.8.0
-------------------------- Future Occurrences -------------------------
       Expiration: Thu 21 Aug 2008 04:00:00 PM EDT
```

```
       Recurrence: 0 16 * * *
                   04:00 PM of
                   every day
       Start Time: (3) (Tue 12 Aug 2008 04:00:00 PM EDT)
                   (4) (Wed 13 Aug 2008 04:00:00 PM EDT)
                   (5) (Thu 14 Aug 2008 04:00:00 PM EDT)

...

        Job Steps: 3
                   c197blade3b11.2.0
                   c197blade3b11.3.0
                   c197blade3b11.8.0
```

5. To bind a job step to a specific occurrence of a recurring reservation, issue:

   ```
   llbind -R c197blade3b11.ppd.pok.ibm.com.2.r.4 \
          c197blade3b11.ppd.pok.ibm.com.13.0
   ```

   You should receive a response similar to the following:

   ```
   llbind: Request to bind job steps to reservation
   c197blade3b11.ppd.pok.ibm.com.2.r.4 has been sent to LoadLeveler.
   ```

   You can use the **llq -l** command to verify that the step is bound to occurrence 4 of reservation c197blade3b11.ppd.pok.ibm.com.2.r:

   ```
   llq -l c197blade3b11.ppd.pok.ibm.com.13.0
   ```

   You should receive a response similar to the following:

   ```
   =============== Job Step c197blade3b11.ppd.pok.ibm.com.13.0 ============
           Job Step Id: c197blade3b11.ppd.pok.ibm.com.13.0
              Job Name: myjob
             Step Name: 0
     Structure Version: 10
                 Owner: llbld
            Queue Date: Mon 11 Aug 2008 12:24:01 PM EDT
                Status: Idle
       Reservation ID: c197blade3b11.ppd.pok.ibm.com.2.r.4
     Requested Res. ID:
             Recurring: False
   ...
   ```

   You can also use the **llqres -l** command:

   ```
   llqres -l -R c197blade3b11.ppd.pok.ibm.com.2.r
   ```

   You should receive a response similar to the following:

   ```
   =============== Reservation c197blade3b11.ppd.pok.ibm.com.2.r.0 ========
                  ID: c197blade3b11.ppd.pok.ibm.com.2.r.0
       Creation Time: Mon 11 Aug 2008 11:57:41 AM EDT
               Owner: llbld
               Group: No_Group
          Start Time: Mon 11 Aug 2008 06:00:00 PM EDT

   ...

               Nodes: 1
                      c197blade3b11.ppd.pok.ibm.com
           Job Steps: 0
   -------------------------- Future Occurrences -------------------------
          Expiration: Thu 28 Aug 2008 04:00:00 PM EDT
          Recurrence: 0 18 * * *
                      06:00 PM of
                      every day
          Start Time: (0) (Mon 11 Aug 2008 06:00:00 PM EDT)
                      (1) (Tue 12 Aug 2008 06:00:00 PM EDT)
                      (2) (Wed 13 Aug 2008 06:00:00 PM EDT)
                      (3) (Thu 14 Aug 2008 06:00:00 PM EDT)
                      (4) (Fri 15 Aug 2008 06:00:00 PM EDT)
                      (5) (Sat 16 Aug 2008 06:00:00 PM EDT)
   ```

```
...

        Job Steps: 1
                   c197blade3b11.13.0
```

6. To submit a new job and automatically bind it to a specific occurrence of a recurring reservation using the LL_RES_ID environment variable, issue:

   ```
   LL_RES_ID=c197blade3b11.ppd.pok.ibm.com.2.r.4 llsubmit myjob.cmd
   ```

   You should receive a response similar to the following:

   ```
   llsubmit: The job "c197blade3b11.ppd.pok.ibm.com.15" has been submitted.
   ```

   You can use the **llq -l** command to verify that the step is bound to occurrence 4 of reservation c197blade3b11.ppd.pok.ibm.com.2.r:

   ```
   llq -l c197blade3b11.ppd.pok.ibm.com.15.0
   ```

   You should receive a response similar to the following:

   ```
   =============== Job Step c197blade3b11.ppd.pok.ibm.com.15.0 ============
           Job Step Id: c197blade3b11.ppd.pok.ibm.com.15.0
              Job Name: myjob
             Step Name: 0
     Structure Version: 10
                 Owner: llbld
            Queue Date: Mon 11 Aug 2008 12:32:15 PM EDT
                Status: Idle
       Reservation ID: c197blade3b11.ppd.pok.ibm.com.2.r.4
     Requested Res. ID:
            Recurring: False
   ...
   ```

   You can also use the **llqres -l** command:

   ```
   llqres -l -R c197blade3b11.ppd.pok.ibm.com.2.r
   ```

   You should receive a response similar to the following:

   ```
   =============== Reservation c197blade3b11.ppd.pok.ibm.com.2.r.0 ========
                  ID: c197blade3b11.ppd.pok.ibm.com.2.r.0
       Creation Time: Mon 11 Aug 2008 11:57:41 AM EDT
               Owner: llbld
               Group: No_Group
          Start Time: Mon 11 Aug 2008 06:00:00 PM EDT

   ...

               Nodes: 1
                      c197blade3b11.ppd.pok.ibm.com
           Job Steps: 0
   -------------------------- Future Occurrences -------------------------
          Expiration: Thu 28 Aug 2008 04:00:00 PM EDT
          Recurrence: 0 18 * * *
                      06:00 PM of
                      every day
          Start Time: (0) (Mon 11 Aug 2008 06:00:00 PM EDT)
                      (1) (Tue 12 Aug 2008 06:00:00 PM EDT)
                      (2) (Wed 13 Aug 2008 06:00:00 PM EDT)
                      (3) (Thu 14 Aug 2008 06:00:00 PM EDT)
                      (4) (Fri 15 Aug 2008 06:00:00 PM EDT)
                      (5) (Sat 16 Aug 2008 06:00:00 PM EDT)

   ...

           Job Steps: 2
                      c197blade3b11.13.0
                      c197blade3b11.15.0
   ```

Security

LoadLeveler administrators and users can issue this command.

llcancel - Cancel a submitted job

Use the **llcancel** command to cancel one or more jobs from the LoadLeveler queue.

Syntax

llcancel

{ **-?** | **-H** | **-v** | **-f** *hostlist* | [**-q**] [**-X** *cluster_name*]
[**-u** *userlist*] [**-h** *hostlist*] [*joblist*] }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-f *hostlist*
Forces all jobs that are running on the machines in the *hostlist* to be vacated. Those machines in the *hostlist* are then marked as "Down" in the LoadLeveler cluster. The *hostlist* for the **-f** option should only specify machines that have gone down and should only be used for those machines that still have jobs displayed in the LoadLeveler queue.

The **-f** option is intended to be used by administrators for cleanup and recovery after a machine has permanently crashed or was inadvertently removed from the cluster before all activity has quiesced. If you need to return the machine to the cluster later, you must clear all files from the spool and execute directory of the machines in the *hostlist*.

-q Specifies quiet mode: print no messages other than error messages.

-X *cluster_name*
Specifies the name of a single cluster where the command is to run.

-u *userlist*
Is a blank-delimited list of users. When used with the **-h** option, only the user's jobs monitored on the machines in the *hostlist* are canceled. When used alone, only the user's jobs monitored by the machine issuing the command are canceled.

-h *hostlist*
Is a blank-delimited list of machine names. All jobs monitored on machines in this list are canceled. When issued with the **-u** option, the *userlist* is used to further select jobs for cancellation.

joblist
Is a blank-delimited list of job and step identifiers. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned

the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

Note: For coscheduled jobs, even if all coscheduled job steps are not in the list of targeted job steps, the requested operation is performed on all coscheduled job steps.

The **-u** or **-h** flags override the *joblist* parameter.

When the **-h** flag is specified by a non-administrator, all jobs submitted from the machines in *hostlist* by the user issuing the command are canceled.

When the **-h** flag is specified by an administrator, all jobs submitted by the administrator are canceled, unless the **-u** is also specified, in which case all jobs both submitted by users in *userlist* and monitored on machines in *hostlist* are canceled.

Group administrators and class administrators are considered normal users unless they are also LoadLeveler administrators.

Description

When you issue **llcancel**, the command is sent to the negotiator. You should then use the **llq** command to verify your job was canceled. A job state of CA (Canceled) indicates the job was canceled. A job state of RP (Remove Pending) indicates the job is in the process of being canceled.

When cancelling a job from a submit-only machine, you must specify the machine name that scheduled the job. For example, if you submitted the job from machine A, a submit-only machine, and machine B, a scheduling machine, scheduled the job to run, you must specify machine B's name in the cancel command. If machine A and B are in different sub-domains, you must specify the fully qualified name of the job in the cancel command. You can use the **llq -l** command to determine the fully qualified name of the job.

The **llcancel** command can be issued for a scale-across step on any cluster that is being considered for running the step. The **llcancel** command will remove the scale-across step from all clusters that might be participating in scheduling or running the step.

Note that to permanently remove a recurring job, the job must first be unbound from its reservation, then removed with the **llcancel** command. As long as a recurring job is still bound to a reservation, it will continue to be requeued upon termination to run in the next occurrence of that reservation.

Examples

1. This example cancels the job step 3 that is part of the job 18 that is scheduled by the machine named bronze:

   ```
   llcancel bronze.18.3
   ```

2. This example cancels all the job steps that are a part of job 8 that are scheduled by the machine named **gold**:

   ```
   llcancel gold.8
   ```

   You should receive a response similar to the following:

   ```
   llcancel: Cancel command has been sent to the central manager.
   ```

3. This example cancels the job steps that are a part of job 5 that is scheduled to run in **cluster1**:

   ```
   llcancel -X cluster1 silver.5
   ```

   You should receive a response similar to the following:

   ```
   llcancel: Cancel command has been sent to the central manager.
   ```

4. This example shows a scale-across job being canceled from the main scale-across cluster, where **clusterA** is the main scale-across cluster and **clusterB** is another cluster:

   ```
   llq -X all
   ```

   You should receive a response similar to the following:

   ```
   ================== Cluster clusterA ==================================

   Id                  Owner      Submitted   ST PRI Class      Running On
   ------------------ ---------- ----------- -- --- ---------- -----------
   xydev.7.0           loadl       7/29 16:38 R  50  large      scale_across
   xydev.8.0           loadl       7/29 16:39 I  50  large

   2 job step(s) in queue, 1 waiting, 0 pending, 1 running, 0 held,
   0 preempted


   ================ Cluster clusterB ====================================

   Id                  Owner      Submitted   ST PRI Class      Running On
   ------------------ ---------- ----------- -- --- ---------- -----------
   xydev.7.0           loadl       7/29 16:38 R  50  large      scale_across
   xydev.8.0           loadl       7/29 16:39 I  50  large
   llcancel xydev.8.0
   llq -X all
   ```

   You should receive a response similar to the following:

   ```
   ================ Cluster clusterA ====================================

   Id                  Owner      Submitted   ST PRI Class      Running On
   ------------------ ---------- ----------- -- --- ---------- -----------
   xydev.7.0           loadl       7/29 16:38 R  50  large      scale_across

   1 job step(s) in queue, 0 waiting, 0 pending, 1 running, 0 held,
   0 preempted


   ================ Cluster clusterB ====================================

   Id                  Owner      Submitted   ST PRI Class      Running On
   ------------------ ---------- ---------   -- --- ---------- -----------
   xydev.7.0           loadl       7/29 16:38 R  50  large      scale_across
   ```

Security

LoadLeveler administrators and users can issue this command.

llchres - Change attributes of a reservation

Use the **llchres** command to change one or more of the attributes of a LoadLeveler reservation.

Syntax

llchres

{ **-?** | **-H** | **-v** | **[-q]** **[-o]** **[-t** *start_time* | **-t** {**+**|**-**} *minutes*]
[-d **[+**|**-]** *duration*] **[-n** **[+**|**-]** *number_of_nodes* | **-h free** |
-h **[+**|**-]** *host_list* | **-j** *job_step* | **-f** *job_command_file* |
-c *number_of_bg_cnodes* | **-F** *host_file*] **[-U** **[+**|**-** *user_list*]
[-G **[+**|**-]** *group_list*] **[-s** {**yes**|**no**}] **[-i** {**yes**|**no**}] **[-u** *user*]
[-g *group*] **[-m** *binding_method*] **[-e** *expiration*] **-R** *reservation* }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-q Specifies quiet mode: print no messages other than error messages.

-o Modify only the first occurrence of a recurring reservation; either the next occurrence to become active, or if the reservation is currently active, the current active occurrence.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-t *start_time*
Specifies the *start_time* for a one-time reservation using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*. Hours must be specified using a 24-hour clock. When the **-o** flag is used, the start time of the first occurrence of a recurring reservation can be modified using this format.

For a recurring reservation, *start_time* is a string that specifies when the reservation is to recur. The format of the string is '*minute hour day_of_month month day_of_week* [[*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*]' where the first part, '*minute hour day_of_month month day_of_week*', is the same as the format used by **crontab**. For each field, lists (for example, 1,3,5) and ranges (for example, 1-10) can be specified.

The second, optional part, '[*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*', is the start of the first occurrence and must be consistent with the **crontab** portion of the string. For example, if a reservation is needed at 4 p.m. every day, but not starting until December 1st, you would specify: `'0 16 * * * 12/01 16:00'`.

-t {+|-} *minutes*
Modifies the start time for a reservation using *minutes*. When *minutes* is preceded by a plus (**+**) sign or minus (**-**) sign, the current start time is postponed or moved closer, respectively, by the number of minutes specified.

-d [+|-] *duration*
Specifies a new duration for the reservation in minutes. If *duration* is preceded by a plus (**+**) sign or minus (**-**) sign, the current duration of the reservation is increased or decreased, respectively, by the value specified.

-n [+|-] *number_of_nodes*
Specifies a new request for the number of nodes to reserve. If *number_of_nodes* is preceded by a plus (**+**) sign or minus (**-**) sign, the current number of nodes in the reservation is increased or decreased, respectively, by the value specified.

-h free

-h [+|-] *host_list*

Specifies a change to the list of machines to be reserved. When a blank-delimited host list is specified, it indicates that a new list of hosts are to be reserved. Specifying a plus (**+**) sign before host list adds the listed machines to the reservation. Specifying a minus (**-**) sign removes the listed machines from the reservation. Note that when a host list is specified, the first character of any host name cannot be a plus (**+**) or minus (**-**) sign. Specifying the reserved word **free** reserves all machines available for this reservation, which currently have an active **LoadL_startd** daemon. The reservation change request will succeed if at least one node can be included in the reservation.

-j *job_step*

Specifies a new request that a set of nodes or Blue Gene compute nodes (C-nodes) that the job step can run on be reserved. The job step must be in an idle-like state and takes the form [*host*.]*jobid.stepid*.

where:

- *host* is the name of the machine that assigned the step identifier.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The step identifier can be specified in an abbreviated form, *jobid.stepid*, when the command is invoked on the same machine that assigned the step identifier. In this case, LoadLeveler will use the local machine's hostname to construct the full step identifier.

You must be an administrator or the owner of both the reservation and job step to make this request. If the request to modify the reservation is successful, the job step will be bound to the reservation.

-f *job_command_file*

Specifies the full path to a new *job_command_file* that will be submitted and the first job step used to determine what resources to reserve. The job identifier of the newly created job will be displayed. All job steps will be bound to the reservation, or if the modification request fails, will be placed in the **NotQueued** state. The job identifier of the newly created job will be displayed.

-c *number_of_bg_cnodes*

Specifies the number of C-nodes to reserve in the Blue Gene system. The shape of the allocated resource for a given size cannot be guaranteed, but the size of the allocated shape will be no smaller than the requested size and will be as close to the requested size as possible.

-F *host_file*

Specifies the name of a file containing a list of machines to reserve. If the full path is not specified, then the current working directory is assumed. The format of the file is to have one host name per line. It can also contain blank lines and comment lines. Comment lines start with a '#'. The machines listed in the host file replace all of the machines reserved by the reservation. The reservation change request will succeed if at least one node can be included in the reservation.

-U [+|-] *user_list*

Specifies a new blank-delimited list of users who can use the reservation. If the list of users is preceded by a plus (**+**) sign or minus (**-**) sign, add those users to or remove those users from the existing list of users that can use the reservation, respectively.

-G [+|-] *group_list*
Specifies a new blank-delimited list of LoadLeveler groups that can use the reservation. If the list of groups is preceded by a plus (**+**) sign or minus (**-**) sign, those groups will be added to or removed from the existing list of groups, respectively. The first character of any group name cannot be plus (**+**) sign or minus (**-**) sign.

-s {yes|no}
SHARED mode is enabled when the reserved word **yes** is specified. When the reserved word **no** is specified, SHARED mode is disabled.

-i {yes|no}
When **yes** is specified, REMOVE_ON_IDLE mode is enabled. When **no** is specified, REMOVE_ON_IDLE mode is disabled.

-u *user*
Specifies a new user ID that will own the reservation.

-g *group*
Specifies a new LoadLeveler group that will own the reservation.

-m *binding_method*
Specifies the method that will be used when job steps are bound to the reservation. Possible options are:

firm Use firm binding by default, but allow soft binding (default).

soft Use soft binding by default, but allow firm binding.

-e *expiration*
Modify the expiration date for a recurring reservation using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*. Hours must be specified using a 24-hour clock.

-R *reservation*
Specifies the reservation identifier to be modified. The format of a full LoadLeveler reservation identifier is [*host*.]*rid*[.**r**].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional).

The reservation identifier can be specified in an abbreviated form, *rid*[.**r**], when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

An occurrence ID cannot be specified by the **llchres** command. Changes apply to all occurrences of the reservation unless the **-o** flag is used to change only the first occurrence.

Note: When a plus (**+**) sign or minus (**-**) sign is used to increase or decrease a value, there cannot be spaces between the plus (**+**) sign or minus (**-**) sign and the value.

Description

The **llchres** command is for LoadLeveler administrators and the owner of a reservation. Either all requested changes will be made and a message indicating the reservation request has been sent will be displayed, or none of the changes will

be made and a message describing the reason for the failure will be displayed along with the message that the request was sent. If a connection error occurs and the request cannot be sent, a message will be displayed.

Note that it is possible for a time out to occur while this command is waiting for a response from the LoadLeveler central manager. Even if a time out occurs or the command process is killed, the command may still succeed. To determine if the request has been granted, issue the **llqres** command.

Modification requests are subject to resource availability checks and reservation policies.

Notes on changing a reservation:

- Administrators can change the attributes of any reservation, including the user ID that owns the reservation, while non-administrators can change attributes of only the reservations they own and cannot change the reservation owner.
- A reservation owner who is not a LoadLeveler administrator cannot change the start time, duration or reserved resources if the start time is not at least later than the current time by the number of minutes specified by the **RESERVATION_MIN_ADVANCE_TIME** keyword.
- The new reservation start time must be later than the current time by at least the amount of time specified by the **RESERVATION_SETUP_TIME** keyword.
- A reservation in the CANCEL or COMPLETE state cannot be changed.
- When a reservation is not in the WAITING state, the start time cannot be changed.
- When a reservation is not in the WAITING state, the only ways to change reserved nodes are to add a number of nodes, or to add or delete a list of nodes. Blue Gene resources cannot be changed for a reservation not in the WAITING state.
- A reserved node with a bound step running cannot be removed from the reservation.
- When changing the reservation duration, the end time of the reservation must be later than the current time.
- You cannot delete all reserved resources from a reservation; a reservation must have at least one reserved node or Blue Gene C-node.
- You cannot add a node that is already reserved to a reservation when using **llchres -h +***host_list*.
- You cannot delete a node that is not reserved from a reservation when using **llchres -h -***host_list*.
- If you want to change the owner of a reservation, the new owner must be able to own an additional reservation (**max_reservations** for the user is not specified or if specified, the quota is not used up yet). If you want to change the group that owns the reservation, the new group must be able to own an additional reservation (**max_reservations** for the group is not specified or if specified, the quota is not used up yet). If the change request is granted, the new owner and group must have the permission to own a new reservation (they cannot both have **max_reservations** unspecified).
- A coscheduled job step cannot be specified when using the **-j** or **-f** flags.
- You cannot change a reservation to reserve a number of nodes if the reservation already has some Blue Gene C-nodes reserved.
- You cannot change a reservation to reserve a number of Blue Gene C-nodes if the reservation already has some nodes reserved.

- The **llchres -s no** option will fail for a reservation in the Active_Shared (AS) state.
- Shared mode must be **yes** for a reservation to change from Active (A) state to the AS state. Once the reservation is in the AS state, the shared mode cannot be changed again.
- You cannot use the **-j** flag to specify a scale-across step.
- You cannot use the **-f** flag to specify a scale-across job command file.

Notes on changing a recurring reservation:

- When changing only one occurrence of a recurring reservation using the **-o** option, the expiration, binding method, owner, and group cannot be modified.
- The start time of the first occurrence of a recurring reservation can be modified using **-o** and **-t** together only when the first occurrence is not already ACTIVE.
- The start times of all occurrences of a recurring reservation can be modified using **-t** with the **crontab** format.
- The expiration of a recurring reservation cannot be modified in a way that would cause the reservation to immediately expire. In other words, the new expiration time must result in there being at least one more occurrence of the reservation.
- If the recurring reservation is not in the WAITING state, changes will apply only to future occurrences of the reservation. The occurrence currently in the SETUP or ACTIVE state will not be modified unless the **-o** option is used to specifically change the one occurrence.
- The **-e** option cannot be used when changing a one-time reservation.

This command is for the BACKFILL scheduler only.

Examples

1. To have reservation c94n16.20.r start an hour later than currently scheduled with four fewer nodes, issue:

   ```
   llchres -t +60 -n -4 -R c94n16.20.r
   ```

   You should receive a response similar to the following:

   ```
   Request to change reservation c94n16.20.r has been sent to LoadLeveler.
   ```

2. To change the duration from 20 to 50 minutes and enable only users chris, jay, and dave to use the reservation c94n16.31.r, issue:

   ```
   llchres -U chris jay dave -d 50 -R c94n16.31.r
   ```

   You should receive a response similar to the following:

   ```
   Request to change reservation c94n16.31.r has been sent to LoadLeveler.
   ```

3. To change the number of Blue Gene C-nodes in reservation c94n03.2.r, issue:

   ```
   llchres -c 512 -R c94n03.2.r
   ```

   You should receive a response similar to the following:

   ```
   Request to change reservation c94n03.2.r has been sent to LoadLeveler.
   ```

4. To change the hosts listed in reservation c94n03.55.r using a host file, issue:

   ```
   llchres -F myhostlistfile -R c94n03.2.r
   ```

   where myhostlistfile resides in the current directory.

```
myhostlistfile:
# This is myhostlistfile
c94n01
c94n03
c94n05
c94n09
```

5. To change a reservation using a full path name for a host file, issue:

   ```
   llchres -F /tmp/myhostlistfile -R c94n03.2.r
   ```

6. To extend the duration of only the next occurrence of the reservation by 30 minutes, issue:

   ```
   llchres -o -d +30 -R c94n16.22.r
   ```

   You should receive a response similar to the following:

   ```
   Request to change reservation c94n16.22.r has been sent to LoadLeveler.
   ```

7. To modify a recurring reservation that starts every Friday at 6 p.m., so that it will start every Friday at 7 p.m. instead, issue:

   ```
   llchres -t '0 19 * * 5' -R c94n16.64.r
   ```

   You should receive a response similar to the following:

   ```
   Request to change reservation c94n16.64.r has been sent to LoadLeveler.
   ```

Security

LoadLeveler administrators and users can issue this command.

llckpt - Checkpoint a running job step

Use the **llckpt** command to checkpoint a single job step.

Syntax

llckpt { **-?** | **-H** | **-v** | [**-k** | **-u**] [**-r**] [**-q**] [**-X** *cluster_name*] *jobstep* }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-k Specifies that the job step is to be terminated after a successful checkpoint. The default is for the job to continue. Note that you cannot use the **-k** and **-u** flags together. If you need to restart the job on the same node, do not use the **-k** flag.

-u Specifies that the job step is to be put on user hold after a successful checkpoint. The default is for the job to continue. Note that you cannot use the **-k** and **-u** flags together.

-r When this flag is issued, it specifies that the command is to return without waiting for the checkpoint to complete. When using this flag you should be aware that information relating to the success or failure of the checkpoint will not be available to the command. The default is for the checkpoint to complete before returning.

-q Specifies quiet mode: print no messages other than error messages.

-X *cluster_name*
Specifies the name of a multicluster where the command is to run.

jobstep
Is the name of a job step to be checkpointed.

The format of a full LoadLeveler step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the step identifier.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The step identifier can be specified in an abbreviated form, *jobid.stepid*, when the command is invoked on the same machine that assigned the step identifier. In this case, LoadLeveler will use the local machine's hostname to construct the full step identifier.

Description

The **llckpt** command should be used to save the state of the job in the event it does not complete. Use the command only with jobs that are marked as checkpointable. You can mark a job step for checkpoint by specifying **checkpoint=yes** or **checkpoint=interval** in the job command file. Use **checkpoint=yes** to set checkpointing for an interactive job. For more information, see "LoadLeveler support for checkpointing jobs" on page 139.

When a job is checkpointed it can later be restarted from the checkpoint file rather than the beginning of the job. To restart a job from a checkpoint file, the original job command file should be used with the value of the **restart_from_ckpt** keyword set to **yes**. The name and location of the checkpoint file should be specified by the **ckpt_dir** and **ckpt_file** keywords.

If you need to restart the job on the same nodes, do not use the **-k** flag. Instead, use the **-u** flag to place the job in a hold state. You can later release the job from the hold state by issuing the **llhold -r** command. Note that a coscheduled job step cannot be specified with the **-u** flag.

Examples

1. This example checkpoints the job step 1 that is part of job 12 which was scheduled by the machine named **iron**. Upon successful completion of checkpoint, the job step will return to the RUNNING state.

   ```
   llckpt iron.12.1
   ```

2. This example checkpoints the job step 3 that is part of job 14 which was scheduled by the machine named **bronze**. Upon successful completion of checkpoint the job step will be put on user hold:

   ```
   llckpt -u bronze.14.3
   ```

Results

When the **-r** option is not used, the **llckpt** command will wait for the checkpoint to complete. Immediately upon executing the command **llckpt iron.12.1** the following message is displayed:

```
llckpt: The llckpt command will wait for the results of the checkpoint on
job step iron.12.1 before returning
```

Once the checkpoint has successfully completed, the following message is displayed:

```
llckpt: Checkpoint of job step iron.12.1 completed successfully
```

If there was a problem taking the checkpoint of an AIX job, the second message would have this form:

```
llckpt: Checkpoint FAILED for job step iron.12.1 with the following
error:

primary error code = <numeric error number>,
secondary error code = <secondary numeric error/extended numeric error>,
error msg len = <length of message>,
error msg = <text describing the error>
```

where: `primary error code` is defined by **/usr/include/sys/errno.h** and secondary error code is defined by **/usr/include/sys/chkerror.h**.

The **-r** option is used to return without waiting for the result of a checkpoint. The following output is displayed for the command **llckpt -r bronze.14.3**:

```
llckpt: The llckpt command will not wait for the checkpoint of
job step bronze.14.3 to complete before returning.
```

Due to delays in communication between LoadLeveler daemons, status information may not be returned at the same time that checkpoint termination is received. This indicates that the checkpoint has completed but the success or failure status is not known. When this happens, the following message is displayed:

```
llckpt: Checkpoint of job step iron.12.1 completed. No status information is
available.
```

Security

LoadLeveler administrators and users can issue this command.

llclass - Query class information

Use the **llclass** command to query information about classes.

Syntax

llclass [**-?**] [**-H**] [**-v**] [**-W**] [**-l**] [**-X** {*cluster_list* | **all**}] [-c *classlist* | *classlist*]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-W
Specifies that the width of columns in tabular output will be increased to fit the widest entry.

-l Specifies that a long listing be generated for each class for which status is requested. If **-l** is *not* specified, then the standard listing is generated.

-X {*cluster_list* | **all**}
Indicates that you can specify the **-X** flag with either:

cluster_list
Is a blank-delimited list of clusters where the command is to run.

all Is the reserved word indicating that the command is to run in all accessible clusters.

-c *classlist* | *classlist*
Is a blank-delimited list of classes for which you are requesting status. The **-c** *classlist* flag is used to distinguish a classlist when specified in combination with the **-X** flag. If a *classlist* is not specified, all classes are queried.

If you have more than a few classes configured for LoadLeveler, consider redirecting the output to a file when you use the **-l** flag.

Description

The **llclass** command queries information about job classes. The output of this command displays the number of defined classes and usage information.

Examples

1. To generate a standard listing for class `Parallel`, issue:

   ```
   llclass Parallel
   ```

   This example generates the standard listing where there are 24 initiators of class `Parallel` configured in the cluster, with one job step of class `Parallel` using 6 initiators currently running. You should receive output similar to the following:

   ```
   Name        MaxJobCPU     MaxProcCPU   Free    Max    Description
               d+hh:mm:ss    d+hh:mm:ss   Slots   Slots

   Parallel    2+02:45:00    05:30:00     18      24     Parallel job class
   ```

   The **standard listing** includes the following fields:

Description
Lists the information provided in the **class_comment** keyword for the specified class. The **class_comment** keyword is defined in the class stanza of the LoadLeveler administration file.

Free Slots
The number of initiators (slots) available for the specified class in the LoadLeveler cluster. A serial job step uses one initiator at run time. A parallel job step with N tasks uses N initiators at run time.

MaxJobCPU
The hard job CPU limit of job steps for the specified class. For a description of the job CPU limit for serial and parallel job steps, see the job_cpu_limit keyword.

MaxProcCPU
The hard CPU limit for the processes of the job steps of the specified class.

Max Slots
The number of configured initiators (slots) for the specified class in the LoadLeveler cluster.

Name The name of the class.

2. To generate a standard listing for all configured classes, issue:

```
llclass
```

You should receive a response similar to the following:

```
Name            MaxJobCPU      MaxProcCPU     Free  Max   Description
                d+hh:mm:ss     d+hh:mm:ss     Slots Slots
--------------- -------------- -------------- ----- ----- ------------
*data_stage     3+08:00:00     00:30:00       2     2     Data Staging
parallel        3+08:00:00     00:30:00       2     2     Parallel Jobs
large           3+08:00:00     00:30:00       4     4     Large Jobs
medium          3+08:00:00     00:30:00       4     4     Medium Jobs
small           3+08:00:00     00:30:00       6     6     Small Jobs
```

Note: An asterisk (*) indicates a LoadLeveler-defined class for data staging.

3. To generate a long listing for classes named *silver* and *gold*, issue:

```
llclass -l silver gold
```

The **long listing** includes the following fields:

Admin
The list of administrators for the specified class.

Allow_Scale_Across
Indicates whether the specified class accepts jobs for scale-across scheduling.

As_limit
The hard and soft address space limits of processes of job steps of the specified class.

Ckpt_limit
Hard and soft checkpoint limits of a job step of the specified class.

Class_ckpt_dir
The name of the directory containing the checkpointing files of job steps of the specified class.

Class_comment
Lists the information provided in the **class_comment** keyword for the specified class. The **class_comment** keyword is defined in the class stanza of the LoadLeveler administration file.

Core_limit
The hard and soft core size limits of processes of job steps of the specified class.

Cpu_limit
The hard and soft CPU limits of processes of job steps of the specified class.

Data_limit
The hard and soft data area limits of processes of job steps of the specified class.

Def_wall_clock_limit
The default wall clock limit to those jobs that have no wall clock limit specified in their job command files.

Exclude_Bg
Blue Gene base partitions that cannot be used by job steps of the specified class.

Exclude_Groups
Groups who are not allowed to submit jobs of the specified class.

Exclude_Users
Users who are not permitted to submit jobs of the specified class.

Free_slots
The number of available initiators (slots) for the specified class in the LoadLeveler cluster. A serial job step uses one initiator of the appropriate class at run time. A parallel job step with N tasks uses N initiators at run time.

File_limit
The hard and soft file size limits of processes of job steps of the specified class.

Include_Bg
Blue Gene base partitions that can be used by job steps of the specified class.

Include_Groups
Groups having permission to submit jobs of the specified class.

Include_Users
Users who are permitted to submit jobs of the specified class.

Job_cpu_limit
The hard and soft job CPU limits of job steps of the specified class. For a description of the job CPU limit for serial and parallel job steps, see the job_cpu_limit keyword.

Locks_limit
The hard and soft lock limits of processes of job steps of the specified class.

Max_Dstg_Starters
The maximum number of data staging tasks that can run simultaneously on that machine.

Maximum_slots
The total number of configured initiators (slots) for the specified class in the LoadLeveler cluster.

Maxjobs
The maximum number of job steps of the specified class that can run at any time in the LoadLeveler cluster.

Max_proto_instances
The maximum number of protocol instances allowed for a job step of the specified class.

Max_node
The maximum number of nodes that can be requested for a particular class or by a particular user or group for a parallel job.

Max Node Resources
The maximum number of consumable resources that can be requested for all tasks of a job step running on the same node, when the job step belongs to this class.

Max Resources
The maximum number of consumable resources that can be requested for a task of a job step belonging to the class.

Max_total_tasks
Used for BACKFILL scheduling only. Max_total_tasks sets the maximum number of tasks allowed to run at any given time for job steps of the specified class in the LoadLeveler cluster.

Memlock_limit
The hard and soft address memory limits of processes of job steps of the specified class.

Name The name of the class

Nice The *nice* value of jobs of the specified class.

Node Resource Req.
The default consumable resource requirement for each node for job steps of the specified class.

Nofile_limit
The hard and soft limits on the number of open files of processes of job steps of the specified class.

Nproc_limit
The hard and soft limits on the number of processes that can be created for the real user ID of the submitted job. These limits count processes owned by the owner of the job steps of the specified classes.

Preempt_class
Used for BACKFILL scheduling only, Preempt_class sets the preemption rule for job steps of the specified class.

Priority
The system priority of the specified class relative to other classes.

Resource_requirement
The default consumable resource requirement for each task for job steps of the specified class.

Rss_limit
The hard and soft rss size limits of processes of job steps of the specified class.

Stack_limit
The hard and soft stack size limits of processes of job steps of the specified class.

Start_class
Used for BACKFILL scheduling only. Start_class sets the starting rule for job steps of the specified class.

Stripe_min_networks
Indicates whether nodes that have more than half (the minimum), but not all, of the networks in the READY state are to be considered for **sn_all** jobs (**true** or **false**).

Wall_clock_limit
The hard and soft wall clock (elapsed time) limits of job steps of the specified class.

See Appendix B, "Sample command output," on page 725 for sample output of long listings.

4. This example generates the standard listing for all accessible clusters including the local cluster in a multicluster environment:

```
llclass -X all
```

The output representing a cluster is delineated with a cluster header similar to the following:

```
================== Cluster c556_Cluster1 ============================

Name         MaxJobCPU     MaxProcCPU  Free   Max    Description
             d+hh:mm:ss    d+hh:mm:ss  Slots  Slots
--------     ----------    ----------  -----  -----  -----------
mpich        3+08:00:00    12:30:00    100    132    MPICH Jobs
parallel       23:59:00    01:00:00     32    256    POE Parallel Jobs
No_Class       01:00:00    00:30:00    120    512    Default Class
large        2+08:00:00    18:30:00     50    128    Large Serial Jobs
medium         12:00:00    02:30:00     60    128    Medium Serial Jobs
small          01:00:00    00:30:00     12    128    Small Serial Jobs

================== Cluster c556_Cluster2 ============================

Name         MaxJobCPU     MaxProcCPU  Free   Max    Description
             d+hh:mm:ss    d+hh:mm:ss  Slots  Slots
--------     ----------    ----------  -----  -----  -----------
mpich        3+08:00:00    12:30:00    110    132    MPICH Jobs
parallel       23:59:00    01:00:00     48    256    POE Parallel Jobs
No_Class       01:00:00    00:30:00    128    512    Default Class
large        2+08:00:00    18:30:00     74    128    Large Serial Jobs
ESSL           23:00:00    12:30:00     55    128    ESSL Jobs
OSL            12:00:00    06:00:00     33    128    OSL Jobs
```

Related Information

Each machine periodically updates the central manager with a snapshot of its environment. Since the information returned by **llclass** is a collection of these snapshots, all taken at varying times, the total picture may not be completely consistent.

Security

LoadLeveler administrators and users can issue this command.

llclusterauth - Generates public and private keys

Use the **llclusterauth** command to generate public and private keys that are used to provide secure intercluster communications.

Syntax

llclusterauth [**-?**] | [**-H**] | [**-v**] | [**-k**]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-k Creates a public key, a private key, a security certificate, and a directory for authorized keys. The keys and certificate are created in the **/var/LoadL/ssl** directory for AIX and in the **/var/opt/LoadL/ssl** directory for Linux.
- The private key is stored in **id_rsa**
- The public key is stored in **id_rsa.pub**
- The security certificate is stored in **id_rsa.cert**
- The authorized keys are stored in **authorized_keys**

This command must run with **root** authority when using the **-k** flag to create key files.

If any directory in the path for the security files does not exist, the command will create the directory and set the owner to **root** and set the permissions to '0700'. The key and certificate files will be owned by **root** with permissions of '0600'.

Description

The **llclusterauth** command generates public and private keys that are used to provide secure intercluster communications. When multicluster security is configured to use Secure Sockets Layer (SSL), a connection on a secure port will be accepted only if the public key for the node requesting the connection is stored in a file in the authorized keys directory on the node being connected to.

Standard Error

An error message is issued and the command exits for the following error cases:
- The command process does not have **root** authority
- A required directory for the security files cannot be created
- A security file cannot be created

Security

LoadLeveler administrators can issue this command.

llctl - Control LoadLeveler daemons

Use the **llctl** command to control LoadLeveler daemons on all members of the LoadLeveler cluster.

Syntax

llctl [**-?**] [**-H**] [**-v**] [**-q**] [**-g** | **-h** *hostname*] *keyword*

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-g Indicates that the command applies globally to all machines, except submit-only machines, that are listed in the administration file.

-h *host*
Indicates that the command applies to only the *host* machine in the LoadLeveler cluster. If neither **-h** nor **-g** is specified, the default is the machine on which the **llctl** command is issued.

keyword
Must be specified after all flags and can be the following:

capture *eventname*
Captures accounting data for all jobs running on the designated machines. *eventname* is the name you associate with the data, and must be a character string containing no blanks. For more information, see "Collecting job resource data based on events" on page 64.

drain [schedd | startd [*classlist* **| allclasses]]**
When you issue **drain** with no options, the following happens: (1) no more LoadLeveler jobs can begin running on this machine, and (2) no more LoadLeveler jobs can be submitted through this machine. When you issue **drain schedd**, the following happens: (1) the Schedd machine accepts no more LoadLeveler jobs for submission, (2) job steps in the Starting or Running state in the Schedd queue are allowed to continue running, and (3) job steps in the Idle state in the Schedd queue are drained, meaning they will not get dispatched. When you issue **drain startd**, the following happens: (1) the startd machine accepts no more LoadLeveler jobs to be run, and (2) job steps already running on the startd machine are allowed to complete. When you issue **drain startd** *classlist*, the classes you specify which are available on the startd machine are drained (made unavailable). When you issue **drain startd allclasses**, all available classes on the startd machine are drained.

dumplogs
When the logging buffer is enabled, **llctl** dumplogs will cause the log messages in the logging buffer to be written to the related log file. For more information, see "Configuration file keyword descriptions" on page 265.

flush
Terminates running jobs on this machine and sends them back, in the Idle

state, to the negotiator to await redispatch (provided **restart=yes** in the job command file). No new jobs are sent to this machine until **resume** is issued. Forces a checkpoint if jobs are enabled for checkpointing. However, the checkpoint gets canceled if it does not complete within the time period specified in the **ckpt_time_limit** keyword in the job command file.

reconfig
Forces all daemons to reread the administration and configuration files.

recycle
Stops all LoadLeveler daemons and restarts them.

resume [schedd | startd [*classlist* **| allclasses]]**
When you issue **resume** with no options, job submission and job execution on this machine is resumed. When you issue **resume schedd**, the Schedd machine resumes the submission of jobs. When you issue **resume startd**, the startd machine resumes the execution of jobs. When you issue **resume startd** *classlist*, the startd machine resumes the execution of those job classes you specify which are also configured (defined on the machine). When you issue **resume startd allclasses**, the startd machine resumes the execution of all configured classes.

start [drained]
When you issue **start** with no options it starts the LoadLeveler daemons on the machine or machines designated, either explicitly or implicitly. When you issue **start** without the **-g** or **-h** flag the LoadLeveler daemons are started on the same machine that issued the command. When you issue **llctl start** with either the **-g** or **-h** flag, the command specified by the **LL_RSH_COMMAND** configuration file keyword is used to run the command on all machines specified in the administration file. If **LL_RSH_COMMAND** is not specified, remote shell (**rsh**) is used and you must have **rsh** privileges in order to use **llctl start** with either the **-g** or **-h** flag.

When you issue **start** with the **drained** option the LoadLeveler daemons are started, but the startd daemon is started in the drained state.

LoadLeveler commands that run **rshell** include **llctl version** and **llctl start**.

stop
Stops the LoadLeveler daemons on the specified machine.

suspend
Suspends all jobs on this machine. This is not supported for parallel jobs.

version
Displays release number, service level, service level date, and operating system information for every LoadLeveler executable.

When you issue **llctl version** with either the **-g** or **-h** flag, the command specified by the **LL_RSH_COMMAND** configuration file keyword is used to run the command on all machines specified in the administration file. If **LL_RSH_COMMAND** is not specified, remote shell (**rsh**) is used and you must have **rsh** privileges in order to use **llctl version** with either the **-g** or **-h** flag.

LoadLeveler commands that run **rshell** include **llctl version** and **llctl start**.

Description

This command sends a message to the master daemon on the target machine requesting that action be taken on the members of the LoadLeveler cluster. Note the following when using this command:

- To perform the control operations of the **llctl** command, you must be a LoadLeveler administrator. The only exception to this rule is the ″start″ operation.
- LoadLeveler will fail to start if any value has been set for the MALLOCTYPE environment variable.
- After you make changes to the administration and configuration files for a running cluster, be sure to issue **llctl reconfig**. This command causes the LoadLeveler daemons to reread these files, and prevents problems that can occur when the LoadLeveler commands are using a new configuration while the daemons are using an old configuration.

  Note: Changes to SCHEDULER_TYPE will not take effect at reconfiguration. The administrator must stop and restart or recycle LoadLeveler when changing SCHEDULER_TYPE.
- The **llctl drain startd** *classlist* command drains classes on the startd machine, and the startd daemon remains operational. If you reconfigure the daemon, the draining of classes remains in effect. However, if the startd goes down and is brought up again (either by the master daemon or by a LoadLeveler administrator), the startd daemon is configured according to the global or local configuration file in effect, and therefore the draining of classes is lost.

  Draining all the classes on a startd machine is *not* equivalent to draining the startd machine. When you drain all the classes, the startd enters the Idle state. When you drain the startd, the startd enters the Drained state. Similarly, resuming all the classes on a startd machine is *not* equivalent to resuming the startd machine.
- If a job step is running on a machine that receives the **llctl recycle** command, or the **llctl stop** and **llctl start** commands, the running job step is terminated. If the restart option in the job command file was set to yes, then the job step will be restarted when LoadLeveler is restarted. If the job step is checkpointable, it will be restarted from the last valid checkpoint file when LoadLeveler is restarted.
- If you find that the **llctl -g** command (even if it is specified with additional options) is taking a long time to complete, you should consider using the AIX command **dsh** to send **llctl** commands (omitting the **-g** flag) to multiple nodes in a parallel fashion.

Examples

1. This example stops LoadLeveler on the machine named *iron*:

   ```
   llctl -h iron stop
   ```
2. This example starts the LoadLeveler daemons on all members of the LoadLeveler cluster (with the exception of the submit-only machines), starting with the central manager, as defined in the machine stanzas of the administration file:

   ```
   llctl -g start
   ```
3. This example causes the LoadLeveler daemons on machine *iron* to re-read the administration and configuration files, which may contain new configuration information for the *iron* machine:

   ```
   llctl -h iron reconfig
   ```
4. This example drains the classes *medium* and *large* on the machine named *iron*.

```
llctl -h iron drain startd medium large
```

5. This example drains the classes *medium* and *large* on all machines.

   ```
   llctl -g drain startd medium large
   ```

6. This example stops all the jobs on the system, then allows only jobs of a certain class (*medium*) to run.

   ```
   llctl -g drain startd allclasses
   llctl -g flush
   llctl -g resume
   llctl -g resume startd medium
   ```

7. This example resumes the classes *medium* and *large* on the machine named *iron*.

   ```
   llctl -h iron resume startd medium large
   ```

8. This example illustrates how to capture accounting information on a work shift called *day* on the machine *iron*:

   ```
   llctl -h iron capture day
   ```

   You can capture accounting information on all the machines in the LoadLeveler cluster by using the **-g** option, or you can collect accounting information on the local machine by simply issuing the following:

   ```
   llctl capture day
   ```

   Capturing information on the local machine is the default. For more information, see "Collecting job resource data based on events" on page 64.

Security

LoadLeveler administrators can issue this command.

llextRPD - Extract data from an RSCT peer domain

Use the **llextRPD** command to extract the necessary data from a Reliable Scalable Cluster Technology (RSCT) peer domain (or local node if there is no active domain) to set up the administration file.

Syntax

llextRPD [-? | **-H** | **-v** | **[-m] [-a** *adapter_name*] **[-h** *hostlist*]]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-m Specifies that only machine stanzas are to be generated. The adapter stanzas (and the corresponding **adapter_stanzas** statement of the machine stanza) will be suppressed in the final output. This option is for Dynamic Adapter Configuration support for peer domains with AIX RSCT.

LoadLeveler will dynamically detect and handle adapters and adapter changes for any machine in these domains which do not specify an adapter stanza in the administration file.

-a *adapter_name*
Specifies that the interface name of the given *adapter_name* on each node is used as the label (machine stanza name) of the generated machine stanza.

If you do not specify an adapter (or if an adapter is specified but does not exist on a particular node) then the label used for that machine is the Name field from the RSCT IBM.PeerNode class for the machine in the cluster.

Note: If an administrator wants to configure LoadLeveler to communicate using the Switch Network Interface for High Performance Switch (HPS) adapters in a peer domain they should use the **-a** flag with **ml0** specified as the *adapter_name*. **ml0** is guaranteed to be present on every node that contains an HPS adapter.

It is recommended that you do not specify **sn** as the adapter name. If you do, the machine will be named with the IP name of the **sn** adapter. If that IP name becomes unavailable because the adapter changes, LoadLeveler will not be able to contact any daemons on that machine.

-h *hostlist*
Specifies one or more host match terms. If multiple host match terms are used, they must be blank delimited and the list must be enclosed in quotes. Each host match term is either a regular expression that specifies a set of machine names, or the name of a file that contains one or more host match terms with each term on a separate line.

Each machine name that is returned by RSCT is compared to all of the regular expressions that were found by processing the host match terms. If the machine name matches at least one of the regular expressions, the machine information is included in the output of the **llextRPD** command. If the **-h** flag is not used, all of the machines returned by RSCT are included in the **llextRPD** command output.

Description

This command extracts data for LoadLeveler to set up the administration file. If you plan to use the **llextRPD** command to construct machine and adapter stanzas for the LoadLeveler administration file, RSCT is required.

The **llextRPD** command must be run on one of the nodes in an active RSCT peer domain to obtain the RSCT peer nodes and network interface data from that cluster. If you are not running the command in an active RSCT peer domain you will just get information from the local machine. Adapter stanza names for HPS adapters are not included in the machine stanza alias. If you run an application which requires LoadLeveler to recognize a node by the interface name of a HPS adapter, you must manually add the adapter stanza name for the HPS adapter as an alias in the machine stanza.

Examples

1. The following example extracts the data from an RSCT peer domain:

   ```
   llextRPD -a ml0
   ```

   Results:

   ```
   #llextRPD: Cluster = "llcluster" ID = "0Jt9zGF7nbDWwWjjTDrxjG" on
              Mon Feb 18 15:24:13 2008

   c121san10.ppd.pok.ibm.com: type = machine adapter_stanzas =
      c121s0n10.ppd.pok.ibm.com c121s1n10.ppd.pok.ibm.com
      c121san10.ppd.pok.ibm.com c121f2rp02.ppd.pok.ibm.com
      alias = c121f2rp02.ppd.pok.ibm.com

   c121s0n10.ppd.pok.ibm.com: type = adapter
      adapter_name = sn0
      network_type = switch
      interface_address = 192.168.0.10
      interface_name = c121s0n10.ppd.pok.ibm.com
      multilink_address = 10.10.10.10
      logical_id = 2
      adapter_type = Switch_Network_Interface_For_HPS
      device_driver_name = sni0
      network_id = 1

   c121s1n10.ppd.pok.ibm.com: type = adapter
      adapter_name = sn1
      network_type = switch
      interface_address = 192.168.1.10
      interface_name = c121s1n10.ppd.pok.ibm.com
      multilink_address = 10.10.10.10
      logical_id = 0
      adapter_type = Switch_Network_Interface_For_HPS
      device_driver_name = sni1
      network_id = 1

   c121san10.ppd.pok.ibm.com: type = adapter
      adapter_name = ml0
      network_type = multilink
      interface_address = 10.10.10.10
      interface_name = c121san10.ppd.pok.ibm.com
      multilink_list = sn0,sn1

   c121f2rp02.ppd.pok.ibm.com: type = adapter
      adapter_name = en0
      network_type = ethernet
      interface_address = 9.114.66.74
      interface_name = c121f2rp02.ppd.pok.ibm.com
      device_driver_name = ent0
   ```

```
c121san04.ppd.pok.ibm.com: type = machine adapter_stanzas =
   c121s0n04.ppd.pok.ibm.com c121s1n04.ppd.pok.ibm.com
   c121san04.ppd.pok.ibm.com c121f1rp04.ppd.pok.ibm.com
   alias = c121f1rp04.ppd.pok.ibm.com

c121s0n04.ppd.pok.ibm.com: type = adapter
   adapter_name = sn0
   network_type = switch
   interface_address = 192.168.0.4
   interface_name = c121s0n04.ppd.pok.ibm.com
   multilink_address = 10.10.10.4
   logical_id = 11
   adapter_type = Switch_Network_Interface_For_HPS
   device_driver_name = sni0
   network_id = 1

c121s1n04.ppd.pok.ibm.com: type = adapter
   adapter_name = sn1
   network_type = switch
   interface_address = 192.168.1.4
   interface_name = c121s1n04.ppd.pok.ibm.com
   multilink_address = 10.10.10.4
   logical_id = 9
   adapter_type = Switch_Network_Interface_For_HPS
   device_driver_name = sni1
   network_id = 1

c121san04.ppd.pok.ibm.com: type = adapter
   adapter_name = ml0
   network_type = multilink
   interface_address = 10.10.10.4
   interface_name = c121san04.ppd.pok.ibm.com
   multilink_list = sn0,sn1

c121f1rp04.ppd.pok.ibm.com: type = adapter
   adapter_name = en0
   network_type = ethernet
   interface_address = 9.114.66.68
   interface_name = c121f1rp04.ppd.pok.ibm.com
   device_driver_name = ent0
```

2. The following example extracts the data from an RSCT peer domain for a dynamic adapter configuration:

   ```
   llextRPD -m -a ml0
   ```

   Results:

   ```
   #llextRPD: Cluster = "acc97" ID = "28jek7RdrHdGwr5C6zQwWm" on
              Mon Feb 18 14:37:33 2008

   c97ml0n13.ppd.pok.ibm.com: type = machine
       alias = c97n13.ppd.pok.ibm.com

   c97ml0n09.ppd.pok.ibm.com: type = machine
       alias = c97n09.ppd.pok.ibm.com

   c97ml0n01.ppd.pok.ibm.com: type = machine
       alias = c97n01.ppd.pok.ibm.com

   c97ml0n05.ppd.pok.ibm.com: type = machine
       alias = c97n05.ppd.pok.ibm.com
   ```

3. The following example shows an adapter stanza:

   ```
   .
   .
   .
   c197blade2b11.ppd.pok.ibm.com: type = adapter
   ```

```
        adapter_name = eth0
        network_type = ethernet
        interface_address = 9.114.198.43
        interface_name = c197blade2b11.ppd.pok.ibm.com

.
.
.
```

4. The following example would only include information for all the nodes in the RSCT peer domain with names that included work1, work02, work03, and work05:

   ```
   llextRPD -h "work1.* nodelist1.txt"
   ```

   if nodelist1.txt is in the current directory and contains the two lines:

   ```
   work02.*
   /home/steve/nodelist2.txt
   ```

   and /home/steve/nodelist2.txt contains the single line:

   ```
   work0[35].*
   ```

   To further explain this example:

   - The pattern work1.* is on the command line, which is the string work1 followed by any character (the dot) zero or more times (the asterisk).
   - The pattern work02.* is in nodelist1.txt, which is the string work02 followed by any character (the dot) zero or more times (the asterisk).
   - The pattern work0[35].* is in nodelist2.txt, which is the string work0 followed by a 3 or a 5 followed by any character (the dot) zero or more times (the asterisk).

   Therefore, any pattern that has work1, work02, work03, or work05 in it will be displayed by the **llextRPD** command.

Security

LoadLeveler administrators and users can issue this command.

llfavorjob - Reorder system queue by job

Use the **llfavorjob** command to set specified jobs to a higher system priority than all jobs that are not favored. This command also *unfavors* previously favored jobs, restoring the original priority, when you specify the **-u** flag.

Syntax

llfavorjob [**-?**] [**-H**] [**-v**] [**-q**] [**-u**] *joblist*

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-u Unfavors previously favored jobs, requeuing them according to their original priority levels.

joblist
Is a blank-delimited list of job and step identifiers. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

Description

If this command is issued against jobs that are already running, it has no effect. If the job vacates, however, and returns to the queue, the job gets re-ordered with the new priority.

If more than one job is affected by this command, then the jobs are ordered by the **sysprio** expression and are scanned before the not favored jobs. However, favored jobs which do not match the job requirements with available machines may run after not favored jobs. This command remains in effect until reversed with the **-u** option.

The **llfavorjob** command can be issued for a scale-across step on the main cluster or from any other cluster that is being considered for running the step. The change in priority or queue position is only applied to the scale-across step on the cluster from which the command is issued and will not change the step on any other cluster.

Examples

1. This example assigns job steps **iron.12.4** and **zinc.8.2** the highest priorities in the system, with the job steps ordered by the **sysprio** expression:

   ```
   llfavorjob iron.12.4 zinc.8.2
   ```

2. This example unfavors job steps **iron.12.4** and **zinc.8.2**:

   ```
   llfavorjob -u iron.12.4 zinc.8.2
   ```

Security

LoadLeveler administrators can issue this command.

llfavoruser - Reorder system queue by user

Use the **llfavoruser** command to set a user's jobs to the highest priority in the system, regardless of the current setting of the job priority. Jobs already running are not affected. This command also *unfavors* the user's jobs, restoring the original priority, when you specify the **-u** flag.

Syntax

llfavoruser [**-?**] [**-H**] [**-v**] [**-q**] [**-u**] *userlist*

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-u Unfavors previously favored users, reordering their jobs according to their original priority levels. If **-u** is **not** specified, the user's jobs are favored.

userlist
Is a blank-delimited list of users whose jobs are given the highest priority. If **-u** is specified, *userlist* jobs are *unfavored*.

Description

This command affects your current and future jobs until you remove the favor.

When the central manager daemon is restarted, any favor applied to users is revoked.

The user's jobs still remain ordered by user priority (which may cause jobs for the user to swap **sysprio**). If more than one user is affected by this command, the jobs of favored users are ordered by **sysprio** and are scanned before the jobs of not favored users. However, jobs of favored users which do not match job requirements with available machines may run after jobs of not favored users.

A user's steps affected by the **llfavoruser** can include scale-across steps. The change in priority or queue position is applied to the scale-across steps only on the cluster from which the command is issued and will not change the steps on any other cluster.

Examples

1. This example grants highest priority to all queued jobs submitted by users **ellen** and **fred** according to the **sysprio** expression:

   ```
   llfavoruser ellen fred
   ```

2. This example unfavors all queued jobs submitted by users **ellen** and **fred**:

   ```
   llfavoruser -u ellen fred
   ```

Security

LoadLeveler administrators can issue this command.

llfs - Fair share scheduling queries and operations

Use the **llfs** command to return information about fair share scheduling in LoadLeveler or to operate on fair share scheduling.

Syntax

llfs [**-?** | **-H** | **-v** | **-s** *savedir* | **-r** [*saved_file*] | [**-u** *user_list*] [**-g** *group_list*]]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-s *savedir*
Saves a snapshot of the historic fair share data in the specified directory. The central manager must be able to write to the *savedir* directory. The directory does not need to be accessible on the node where the command is issued.

-r [*saved_file*]
Resets fair share scheduling by either clearing all historic fair share data, or restoring fair share scheduling to a state corresponding to a file previously saved by the **llfs -s** command. The *saved_file* file must be readable by the central manager. A full path name should be specified for the file. The file does not need to be accessible on the node where the command is issued.

-u *user_list*
Is a blank-delimited list of users. Fair share allocation and utilization information for these users will be displayed.

-g *group_list*
Is a blank-delimited list of LoadLeveler groups. Fair share allocation and utilization information for these groups will be displayed.

Description

The **llfs** command can be used either as a query command or as a control command.

As a query command, **llfs** with no options displays current fair share scheduling information for all users and groups who have jobs completed in the LoadLeveler cluster. With the **-u** or **-g** options, information for the users or groups requested is displayed.

The **llfs** command displays the following information as a query command:
- The time the information is obtained
- The total number of shares that both the cluster CPU and Blue Gene resources are divided into (for example, if there are 100 shares, then there are 100 CPU shares and 100 Blue Gene shares).
- The time interval in which most of the used shares are consumed
- The number of shares allocated and used for each user and group

Note: Used shares are for the cluster CPU resources and the Blue Gene used shares are for the Blue Gene resources. Blue Gene shares are only displayed when Blue Gene is enabled.

The share usage affects the job scheduling priority according to the **SYSPRIO** expression used in the global configuration file.

As a control command, you can use the **llfs** to reset fair share scheduling or save historic fair share data to a file. The **-s** option saves a snapshot of all historic fair share data in the LoadLeveler cluster. If the value of **FAIR_SHARE_INTERVAL** is large (for example, an entire year) and if there are concerns about losing a lot of historic data, this option can be used on a regular basis to save a snapshot of the historic fair share data to a file. The saved file can be used by the **llfs -r** option to restore fair share scheduling to the state corresponding to the saved file. Without a saved file, the **llfs -r** option will discard all previous historic fair share data and restarts fair share scheduling again.

This command is for LoadLeveler administrators and the BACKFILL scheduler only.

Examples

When **BG_ENABLED** is set to **false** in the configuration file, the following examples apply.

1. To display current fair share information without any options, issue:

   ```
   llfs
   ```

   You should receive output similar to the following:

   ```
   Current Time: Fri Jan 25 13:45:55 EST 2008
   FAIR_SHARE_TOTAL_SHARES = 100
   FAIR_SHARE_INTERVAL = 180 hours

   Name                 Type   Allocated Shares  Used Shares
   -------------------  -----  ----------------  -----------
   uno                  user                 50           20
   zhong                user                 10           10
   loadl                user                  0            4
   systest              group                 0           30
   loadl                group                 0            4
   ```

2. To sort fair share information according to used shares in descending order, issue:

   ```
   llfs > /tmp/out; head -6 /tmp/out;  tail +7 /tmp/out |sort -rn +3
   ```

   You should receive output similar to the following:

   ```
   Current Time: Fri Jan 25 13:45:55 EST 2008
   FAIR_SHARE_TOTAL_SHARES = 100
   FAIR_SHARE_INTERVAL = 180 hours

   Name                 Type   Allocated Shares  Used Shares
   -------------------  -----  ----------------  -----------
   systest              group                 0           30
   uno                  user                 50           20
   zhong                user                 10           10
   loadl                user                  0            4
   loadl                group                 0            4
   ```

3. To display current fair share information for user **uno** and group **systest**, issue:

   ```
   llfs -u uno -g systest
   ```

   You should receive output similar to the following:

```
Name                 Type   Allocated Shares  Used Shares
-------------------  -----  ----------------  -----------
uno                  user                 50           20
systest              group                 0           30
```

4. To reset fair share scheduling by discarding all previous historic data, issue:

   ```
   llfs -r
   ```

   You should receive a response similar to the following:

   ```
   llfs: request has been sent to LoadLeveler.
   ```

5. To save a snapshot of the historic data to the **/shared/save** directory, issue:

   ```
   llfs -s /shared/save
   ```

   You should receive a response similar to the following:

   ```
   llfs: /shared/save/fair_share_data.200801251345 has been created.
   ```

6. To restart fair share scheduling from previously saved data, issue:

   ```
   llfs -r /shared/save/fair_share_data.200801251345
   ```

   You should receive a response similar to the following:

   ```
   llfs: request has been sent to LoadLeveler.
   ```

When **BG_ENABLED** is set to **true** in the configuration file, the following examples apply.

1. To display current fair share information without any options, issue:

   ```
   llfs
   ```

   You should receive output similar to the following:

   ```
   Current Time: Tue 15 Jan 2008 06:35:24 PM CDT
   FAIR_SHARE_TOTAL_SHARES = 100000
   FAIR_SHARE_INTERVAL = 1 hours

   Name                 Type  Allocated Shares Used Shares BG Used Shares
   -------------------- ----- ---------------- ----------- --------------
   varella              user                0           0              0
   No_Group             group               0          16            595
   ezhong               user                0          16            595
   ```

2. To sort fair share information according to the used shares of the cluster CPU resources in descending order, issue:

   ```
   llfs>/tmp/out; head -6 /tmp/out;tail +7 /tmp/out|sort -rn +4
   ```

   You should receive output similar to the following:

   ```
   Current Time: Tue 15 Jan 2008 06:38:03 PM CDT
   FAIR_SHARE_TOTAL_SHARES = 100000
   FAIR_SHARE_INTERVAL = 1 hours

   Name                 Type  Allocated Shares Used Shares BG Used Shares
   -------------------- ----- ---------------- ----------- --------------
   No_Group             group               0          14            521
   ezhong               user                0          14            521
   varella              user                0           0              0
   ```

3. To display current fair share information for user **ezhong** and group **group**, issue:

   ```
   llfs -u ezhong -g group
   ```

   You should receive output similar to the following:

   ```
   Current Time: Tue 15 Jan 2008 06:39:34 PM CDT
   FAIR_SHARE_TOTAL_SHARES = 100000
   FAIR_SHARE_INTERVAL = 1 hours

   Name                 Type  Allocated Shares Used Shares BG Used Shares
   ```

```
-------------------- ----- --------------- ----------- --------------
ezhong               user                0          13             483
group                group               0           0               0
```

Security

LoadLeveler administrators can issue this command.

llhold - Hold or release a submitted job

Use the **llhold** command to place jobs in user hold or system hold and to release jobs from both types of hold. Users can only move their own jobs into and out of user hold. Only LoadLeveler administrators can move jobs into and release them from system hold.

Syntax

llhold [**-?**] [**-H**] [**-v**] [**-q**] [**-s**] [**-r**] [**-X** *cluster_name*]
[**-u** *userlist*] [**-h** *hostlist*] [*joblist*]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-s Puts jobs in system hold. Only a LoadLeveler administrator can use this option.

If neither **-s** nor **-r** is specified, LoadLeveler puts the jobs in user hold.

-r Releases a job from hold. A job step in user hold can be released by the owner or a LoadLeveler administrator. A job step in system hold can only be released by a LoadLeveler administrator. If a job step that is in both system hold and user hold is released by a LoadLeveler administrator, the job step will be released from system hold but remains in user hold. If the owner releases a job step that is in both system hold and user hold, the job step is released from user hold but remains in system hold.

The **-r** flag can be used to restart jobs that were put on user hold by the **llckpt -u** command.

If neither **-s** nor **-r** is specified, LoadLeveler puts the jobs in user hold.

-X *cluster_name*
Specifies the name of a single cluster where the command is to run.

-u *userlist*
Is a blank-delimited list of users. When used with the **-h** option, only the user's jobs monitored on the machines in the *hostlist* are held or released. When used alone, only the user's jobs monitored on the Schedd machine are held or released.

-h *hostlist*
Is a blank-delimited list of machine names. All jobs monitored on machines in this list are held or released. When issued with the **-u** option, the *userlist* is used to further select jobs for holding or releasing.

When issued by a non-administrator, this option only acts upon jobs that user has submitted to the machines in *hostlist*.

When issued by an administrator, all jobs monitored on the machines are acted upon unless the **-u** option is also used. In that case, the *userlist* is also part of the selection process, and only jobs both submitted by users in *userlist* and monitored on the machines in the *hostlist* are acted upon.

joblist
Is a blank-delimited list of job and step identifiers. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

Note: For coscheduled jobs, even if all coscheduled job steps are not in the list of targeted job steps, the requested operation is performed on all coscheduled job steps.

Description

This command does not affect a job step that is running unless the job step attempts to enter the Idle state. At this point, the job step is placed in the Hold state.

To ensure that a job is released from both system hold and user hold, the administrator must issue the command with **-r** specified to release it from system hold. The administrator or the submitting user can reissue the command to release the job from user hold.

The **llhold** command can be issued for a scale-across step on the main cluster or any cluster that is being considered for running the step. A scale-across step will be removed from all clusters that are not main clusters and placed in Hold state on the main cluster.

This command will fail if:

- A nonadministrator attempts to move a job into or out of system hold.
- A nonadministrator attempts to move a job submitted by someone else into or out of user hold.

Examples

1. This example places job 23, job step 0 and job 19, job step 1 on hold:
   ```
   llhold 23.0 19.1
   ```
2. This example releases job 23, job step 0, job 19, job step 1, and job 20, job step 3 from a hold state:
   ```
   llhold -r 23.0 19.1 20.3
   ```
3. This example places all jobs from users abe, barbara, and carol2 in system hold:
   ```
   llhold -s -u abe barbara carol2
   ```
4. This example releases from a hold state all jobs on machines bronze, iron, and steel:
   ```
   llhold -r -h bronze iron steel
   ```

5. This example releases from a hold state all jobs on machines bronze, iron, and steel that smith submitted:

```
llhold -r -u smith -h bronze iron steel
```

Results

The following shows a sample system response for the **llhold -r -h bronze** command:

```
llhold: Hold command has been sent to the central manager.
```

Security

LoadLeveler administrators and users can issue this command.

llinit - Initialize machines in the LoadLeveler cluster

Use the **llinit** command to initialize a new machine as a member of the LoadLeveler cluster.

Syntax

llinit [**-?**] [**-H**] [**-q**] [**-prompt**] [**-local** *pathname*] [**-release** *pathname*] [**-cm** *machine*] [**-debug**]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-q Specifies quiet mode: print no messages other than error messages.

-prompt
Prompts or leads you through a set of questions that help you to complete the **llinit** command.

-local *pathname*
pathname is the local directory in which the spool, execute, and log subdirectories will be created. The default, if this flag is not used, is the home directory.

There must be a unique local directory for each LoadLeveler cluster member.

-release *pathname*
pathname is the release directory, where the LoadLeveler bin, lib, man, include, and samples subdirectories are located. The default, if this flag is not used, is the **/usr/lpp/LoadL/full** directory on AIX or the **/opt/ibmll/LoadL/full** directory on Linux.

-cm *machine*
machine is the central manager machine, where the negotiator daemon runs.

-debug
Displays debug messages during the execution of **llinit**.

Description

This command runs once on each machine during the installation process. It must be run by the user ID you have defined as the LoadLeveler user ID. The log, spool, and execute directories are created with the correct modes and ownerships. The LoadLeveler configuration and administration files, **LoadL_config** and **LoadL_admin**, respectively, are copied from LoadLeveler's release directory to LoadLeveler's home directory. The local configuration file, **LoadL_config.local**, is copied from LoadLeveler's release directory to LoadLeveler's local directory.

llinit initializes a new machine as a member of the LoadLeveler cluster by doing the following:

- Creates the following LoadLeveler subdirectories with the given permissions:
  - **spool** subdirectory, with permissions set to 700.
  - **execute** subdirectory, with permissions set to 1777.
  - **log** subdirectory, with permissions set to 775.
- Copies the **LoadL_config** and **LoadL_admin** files from the release directory samples subdirectory into the home directory of the LoadLeveler user ID.
- Copies the **LoadL_config.local** file from the release directory samples subdirectory into the local directory.

- Creates symbolic links from the loadl home directory to the spool, execute, and log subdirectories and the **LoadL_config.local** file in the local directory (if home and local directories are not identical).
- Creates symbolic links from the home directory to the bin, lib, man, samples, and include subdirectories in the release directory.
- Updates the **LoadL_config** with the release directory name.
- Updates the **LoadL_admin** with the central manager machine name.

Before running **llinit** ensure that your HOME environment variable is set to LoadLeveler's home directory. To run **llinit**, you must have:
- Write privileges in the LoadLeveler home directory
- Write privileges in the LoadLeveler release directory
- Write privileges in the LoadLeveler local directory.

Examples

The following example initializes a machine, assigning **/var/loadl** as the local directory, **/usr/lpp/LoadL/full** as the release directory, and the machine named **bronze** as the central manager.

```
llinit -local /var/loadl -release /usr/lpp/LoadL/full -cm bronze
```

Ensure that the local directory exists before running the preceding command.

Results

The command:

```
llinit -local /home/ll_admin -release /usr/lpp/LoadL/full -cm mars
```

will yield the following output:

```
llinit: creating directory "/home/ll_admin/spool"
llinit: creating directory "/home/ll_admin/log"
llinit: creating directory "/home/ll_admin/execute"
llinit: set permission "700" on "/home/ll_admin/spool"
llinit: set permission "775" on "/home/ll_admin/log"
llinit: set permission "1777" on "/home/ll_admin/execute"
llinit: creating file "/home/ll_admin/LoadL_admin"
llinit: creating file "/home/ll_admin/LoadL_config"
llinit: creating file "/home/ll_admin/LoadL_config.local"
llinit: editing file /home/ll_admin/LoadL_config
llinit: editing file /home/ll_admin/LoadL_admin
llinit: creating symbolic link "/home/ll_admin/bin ->
        /usr/lpp/LoadL/full/bin"
llinit: creating symbolic link "/home/ll_admin/lib ->
        /usr/lpp/LoadL/full/lib"
llinit: creating symbolic link "/home/ll_admin/man ->
        /usr/lpp/LoadL/full/man"
llinit: creating symbolic link "/home/ll_admin/samples ->
        /usr/lpp/LoadL/full/samples"
llinit: creating symbolic link "/home/ll_admin/include ->
        /usr/lpp/LoadL/full/include"
llinit: program complete.
```

Security

LoadLeveler administrators can issue this command.

llmkres - Make a reservation

Use the **llmkres** command to create a LoadLeveler reservation. A set of nodes can be reserved in advance for a period of time to run both interactive and batch jobs.

Syntax

llmkres

{ **-?** | **-H** | **-v** | [**-q**] **-t** *start_time* **-d** *duration* { **-n** *number_of_nodes* | **-h** *host_list* | **-h free** | **-j** *job_step* | **-f** *job_command_file* | **-c** *number_of_bg_cnodes* | **-F** *host_file* } [**-U** *user_list*] [**-G** *group_list*] [**-s** {**yes**|**no**}] [**-i** {**yes**|**no**}] [**-g** *group*] [**-m** *binding_method*] [**-e** *expiration*] }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-t *start_time*
Specifies the *start_time* for a one-time reservation using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*. Hours must be specified using a 24-hour clock.

For a recurring reservation, *start_time* is a string that specifies when the reservation is to recur. The format of the string is '*minute hour day_of_month month day_of_week* [[*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*]' where the first part, `'minute hour day_of_month month day_of_week,'` is the same as the format used by **crontab**. For each field, lists (for example, 1,3,5) and ranges (for example, 1-10) can be specified.

The second, optional part, '[*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*', is the start of the first occurrence and must be consistent with the **crontab** portion of the string. For example, if a reservation is needed at 4 p.m. every day, but not starting until December 1st, you would specify: `'0 16 * * * 12/01 16:00'`.

-d *duration*
Specifies the duration of the reservation in minutes.

-n *number_of_nodes*
Specifies the number of nodes to reserve. To reserve a number of Blue Gene C-nodes, use the **-c** flag.

-h free
-h *host_list*
Specifies a blank-delimited list of machines to reserve. To reserve every node in the LoadLeveler cluster, use the **-h** *host_list* flag. If any one of the nodes cannot be reserved, the request will fail. Specifying the reserved word **free** reserves all machines available for this reservation, which currently have an active **LoadL_startd** daemon. The reservation change request will succeed if at least one node can be included in the reservation.

-j *job_step*
Specifies a job step whose requirements will be used to determine what resources to reserve. The job step must be in an idle-like state and takes the form [*host*.]*jobid*.*stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The step identifier can be specified in an abbreviated form, *jobid.stepid*, when the command is invoked on the same machine that assigned the step identifier. In this case, LoadLeveler will use the local machine's host name to construct the full step identifier.

You must be an administrator or the job step owner to make this request. If the request to make the reservation is successful, the job step will be bound to the reservation. If the request is not successful, there is no change to the status of the job step.

Note: If the job step is of type **blue_gene**, then only Blue Gene compute nodes (C-nodes) will be reserved to satisfy the Blue Gene resource requirements of the job step.

-f *job_command_file*
Specifies the path to a *job_command_file* that will be submitted and the first job step used to determine what resources to reserve. All job steps will be bound to the reservation, or if the reservation request fails, be placed in the **NotQueued** state. The job ID of the newly created job will be displayed.

-c *number_of_bg_cnodes*
Specifies the number of C-nodes to reserve in the Blue Gene system. The shape of the allocated resource for a given size cannot be guaranteed, but the size of the allocated shape will be no smaller than the requested size and will be as close to the requested size as possible.

-F *host_file*
Specifies the name of a file containing a list of machines to reserve. If the full path is not specified, then the current working directory is assumed. The format of the file is to have one host name per line. It can also contain blank lines and comment lines. Comment lines start with a '#'. If any one of the nodes cannot be reserved, the request will fail.

-U *user_list*
Specifies a blank-delimited list of users who can use the reservation.

-G *group_list*
Specifies a blank-delimited list of LoadLeveler groups whose users can use the reservation.

-s {yes | no}
Specifies if the SHARED option is selected for the reservation. For a SHARED reservation, after all bound job steps that can run on the reserved nodes are scheduled to run, the remaining resources can be used to run job steps not bound to the reservation. Only bound job steps can be scheduled to run on a reservation that is not shared. The default is not to share the reservation.

-i {yes | no}
Specifies if the REMOVE_ON_IDLE option is selected for the reservation. For a REMOVE_ON_IDLE reservation, if all bound job steps are finished or if all bound job steps are Idle and none can run on the reserved nodes, the reservation will be removed (canceled) automatically by LoadLeveler. If this option is not set, the reservation will remain, regardless of whether is it is being used or not. The default is not to remove the reservation automatically.

When the REMOVE_ON_IDLE option is used with a recurring reservation, only the active occurrence will be removed once the conditions are met for that single occurrence.

-g *group*
Specifies a LoadLeveler group that will own the reservation. The default is what is specified as the *default_group* in the user stanza or No_Group. Ownership of a reservation by a group does not imply that all of the members of the group can use the reservation, but rather is used as a count toward the maximum number of reservations that a group can own.

-m *binding_method*
Specifies the method that will be used when job steps are bound to the reservation. Possible options are:

firm Use firm binding by default, but allow soft binding (default).

soft Use soft binding by default, but allow firm binding.

-e *expiration*
Specifies the expiration date for a recurring reservation using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*. Hours must be specified using a 24-hour clock.

Description

The **llmkres** command is for users authorized by LoadLeveler administrators. The user ID requesting the creation of a reservation becomes the owner of the reservation and can use the reservation. A unique reservation ID will be displayed upon successful creation of the reservation, otherwise a message will be printed out to indicate a failure.

Note that it is possible for a time out to occur while this command is waiting for a response from the LoadLeveler central manager. Even if a time out occurs or the command process is killed, the command may still succeed. To determine if the request has been granted, issue the **llqres** command.

The owner of a reservation maintains certain privileges beyond those allowed for users of the reservation. The owner of a reservation and LoadLeveler administrators can always use the reservation. The owner of a reservation (and the LoadLeveler administrator) can cancel or change a reservation. Users of a reservation are allowed to bind their jobs to a reservation. When a reservation is created, the **-U** and **-G** flag can be used to specify who can use the reservation.

For additional information on running interactive jobs with reservations, see Chapter 8, “Building and submitting jobs,” on page 179.

This command is for the BACKFILL scheduler only.

A coscheduled job step cannot be specified when using the **-j** or **-f** flags.

A scale-across job step cannot be specified when creating a reservation.

A job step that requests a size that fits into the size of a Blue Gene reservation might not always be able to run inside the reservation because of the internal topology of the Blue Gene system. For example, if a Blue Gene reservation was created using a Blue Gene job that requested 1024 compute nodes with a connection type of **MESH**, then a job requesting 1024 compute nodes with a connection type of **TORUS** will not be able to run inside that reservation.

When a Blue Gene reservation is made using a job step that requests a predefined partition through the **bg_partition** keyword, resources exactly the same as in the predefined partition are reserved. The reserved resources will not change even if the predefined partition is changed to contain a different set of resources. LoadLeveler selects resources to reserve in all other cases when the **bg_partition** keyword is not used. The field **BG Partition** in the **llqres -l** output shows the name of the predefined partition if any is used to select reserved resources.

Notes on recurring reservations:

- The reservation will not be created unless all occurrences of a recurring reservation can be honored.
- The last occurrence of a recurring reservation is the last one to start before the expiration date, regardless of the time it will complete.
- Occurrences of the same reservation cannot overlap with one another. The difference in start times between two occurrences of a recurring reservation must be at least as much as the duration plus the setup time.
- The first occurrence of a recurring reservation will start at the earliest time matching the description provided with the **-t** flag, and after RESERVATION_MIN_ADVANCE_TIME.
- The **-e** flag cannot be used when creating a one-time reservation.

Examples

1. To reserve 3 nodes for 2 hours starting at 2 p.m. of the current year allowing members of the LoadLeveler group **loadlusr** to use the reservation, issue:

   ```
   llmkres -t 01/16 14:00 -d 120 -n 3 -G loadlusr
   ```

   Note that if you specify a date that has already passed in the current year, you must include the year or an error will occur.

   You should receive a response similar to the following:

   ```
   The reservation c94n16.pok.ibm.com.20.r has been successfully made.
   ```

2. To reserve nodes based on the requirements of one user job, issue:

   ```
   llmkres -t 01/16/2008 02:00 -d 420 -f weather.cmd -i yes
   ```

   You should receive a response similar to the following:

   ```
   The job "c94n16.pok.ibm.com.25" has been submitted.

   The reservation c94n16.pok.ibm.com.31.r has been successfully made.
   ```

3. To reserve two nodes for use by the reservation owner and two additional users issue:

   ```
   llmkres -t 01/17 13:30 -d 240 -h c94n01 c94n16 -U jay chris
   ```

   You should receive a response similar to the following:

   ```
   The reservation c94n16.pok.ibm.com.55.r has been successfully made.
   ```

4. To reserve 1024 Blue Gene C-nodes, issue:

   ```
   llmkres -t 18:00 -d 60 -c 1024
   ```

   You should receive a response similar to the following:

   ```
   The reservation c94n03.pok.ibm.com.2.r has been successfully made.
   ```

5. To create a reservation using a host file, issue:

   ```
   llmkres -t 03/15 15:00 -d 240 -F myhostlistfile
   ```

   where myhostlistfile resides in the current directory.

```
myhostlistfile:
# This is myhostlistfile
c94n01
c94n03
c94n05
c94n09
```

6. To create a reservation using a full path name for a host file, issue:

   ```
   llmkres -t 03/15 15:00 -d 240 -F /tmp/myhostlistfile
   ```

7. To reserve 6 nodes every Friday for 2 hours beginning at 6 p.m. from now until the end of the year, issue:

   ```
   llmkres -t '0 18 * * 5' -d 120 -n 6 -e 12/31 23:59
   ```

   You should receive a response similar to the following:

   ```
   The reservation c94n16.pok.ibm.com.64.r has been successfully made.
   ```

8. To reserve 10 nodes every day from 9 a.m. to 10 a.m. from July 1st through September 30th, issue:

   ```
   llmkres -t '0 9 * * * 07/01 09:00' -d 60 -n 10 -e 09/30 09:00
   ```

   You should receive a response similar to the following:

   ```
   The reservation c94n16.pok.ibm.com.64.r has been successfully made.
   ```

Security

LoadLeveler administrators and users can issue this command.

llmodify - Change attributes of a submitted job step

Use the **llmodify** command to change the attributes or characteristics of a submitted job.

Syntax

llmodify

{ **-?** | **-H** | **-v** | **[-q]** [**-X** *cluster_name*]
| **-c** *consumable_cpus* | **-m** *consumable_real_memory* |
-W *wclimit_add_min* | **-C** *job_class* | **-a** *account_no* |
-s *q_sysprio* | **-p** {**preempt**|**nopreempt**} |
-k *keyword=value* } *jobstep* }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-X *cluster_name*
Specifies the name of a single cluster where the command is to run. This flag cannot be specified with the **-p**, **-s**, **-W**, or **-x** flags.

-c *consumable_cpus*
Specifies the consumable CPU value for an idle-like job step.

Allows the ConsumableCpus task resource requirement to be reset to the specified value. This value can be any integer equal to or greater than zero (0) and should follow the rules for the **resources** keyword in the job command file.

-m *consumable_real_memory*
Specifies the consumable real memory value for an idle-like job step.

Allows the ConsumableMemory task resource requirement to be reset to the specified value. No units should be specified, as megabytes (MB) is assumed. This value can be any integer greater than zero (0) and should follow the rules for the **resources** keyword in the job command file.

-W *wclimit_add_min*
Specifies additional time in minutes to add to the wall clock limits of a running-like job step. This option is for preventing a job step from being killed due to the wall clock limits. This is a LoadLeveler administrator only option.

Both the hard limit and soft limit are increased by the specified value. This value can be any integer greater than 0.

The increase will only be effective if a limit was originally set and not already exceeded. If you attempt to modify the wall clock limit for a job step that is approaching its current wall clock limit, it is possible for the current wall clock limit to expire before it can be changed.

Specifying **llmodify -W** will fail if the wall clock time of the job step is extended beyond the start time of any reservation that reserves resources currently used by the job step. The reservations in conflict must be canceled before the request to increase the job step's wall clock limit can be granted.

-C *job_class*
Specifies the job class name.

Allows the job class name to be reset to the specified value for an idle-like job step. This value can be any string without white spaces.

The job class for data staging steps cannot be changed using the **-C** flag.

-a *account_no*
Specifies the account number.

Allows the account number to be reset to the specified value for an idle-like job step.

-s *q_sysprio*
Specifies the job step priority.

This option allows the *q_sysprio* for a job step to be reset to the specified integer value. The new job step priority will be fixed. Once the priority has been modified, it will no longer be changed if the central manager recalculates priorities. This is a LoadLeveler administrator only option.

-p {preempt | nopreempt}
Specifies whether a job is preemptable or nonpreemptable.

No action will be taken when the **-p** flag is used to allow or disallow preemption of a data staging job step.

-k *keyword=value*
Modifies *keyword* to the new *value* provided.

where *keyword* is one of the following:

account_no
Changes the account number to the specified value for an idle-like job step.

bg_connection
Changes the connection option of an idle-like Blue Gene job. The subsequent *value* argument must be a string that is either **TORUS**, **MESH**, or **PREFER_TORUS**. **bg_connection** cannot be modified if **bg_partition** is already specified.

bg_partition
Changes the requested partition ID of an idle-like Blue Gene job. If this value is specified, **bg_requirements**, **bg_connection**, **bg_shape**, **bg_size**, and **bg_rotate** will be reset to their default values.

bg_requirements
Changes the memory requirement that a Blue Gene base partition in the LoadLeveler cluster must meet to run an idle-like Blue Gene job. The subsequent *value* option must be an expression. Memory is the only variable that is supported. **bg_requirements** cannot be modified if **bg_partition** is already specified.

bg_rotate
Changes the rotate option of an idle-like Blue Gene job. The subsequent *value* argument must be a string that is either **True** or **False**. **bg_rotate** cannot be modified if **bg_partition** is already specified.

bg_shape
Changes the shape of an idle-like Blue Gene job. The subsequent *value* argument must be of the form *"XxYxZ"*, where *X*, *Y*, and *Z* are integers

in units of the number of base partitions. If this value is specified, any value previously specified for **bg_size** or **bg_partition** will be reset to its default value.

bg_size
Changes the size of an idle-like Blue Gene job. The subsequent *value* argument must be an integer in units of compute nodes. If this value is specified, any value previously specified for **bg_shape** or **bg_partition** will be reset to its default value.

class Changes the job class name to the specified value for an idle-like job step. The value can be any string without white spaces.

cluster_option
Changes the **cluster_option** to the specified value for an idle-like job.

The **-k cluster_option** modifies the job to be considered for scale-across scheduling. When **cluster_option=scale_across** is specified on a job that is not a scale-across job, the job becomes a scale-across job. When **cluster_option** is specified with a value other than **scale_across** (for example, **none**), the job will no longer be considered a scale-across job.

consumableCpus
Changes the ConsumableCpus task resource requirement to the specified value. The value can be any integer equal to or greater than zero (0).

consumableMemory
Changes the ConsumableMemory task resource requirement to the specified value. No units should be specified, as megabytes (MB) is assumed. This value can be any integer greater than zero (0).

dstg_resources
Specifies the quantities of the consumable resources consumed by each task of the inbound and outbound data staging steps of a job. The resources can be machine resources or floating resources.

node_resources = *resources_string*
Replaces the node resource requirements specified in the job command file at submit time. The entire resource requirement must be specified. The rules for the syntax of the *resources_string* are the same as the rules for the corresponding job command file keywords. Only a job step in an idle-like state can be changed. Any resource requirement that was originally specified and is omitted from this string will be removed from the job step. The command will fail if you specify the same resources in both the **resources** and **node_resources** statements.

preemptable
Specifies whether a job is preemptable or nonpreemptable. The value must be either **yes** or **no**.

resources = *resources_string*
Replaces the task resource requirements specified in the job command file at submit time. The entire resource requirement must be specified. The rules for the syntax of the *resources_string* are the same as the rules for the corresponding job command file keywords. Only a job step in an idle-like state can be changed. Any resource requirement that was originally specified and is omitted from this string will be removed from the job step. The command will fail if you specify the same resources in both the **resources** and **node_resources** statements.

For example:

- If you requested "**resources = ConsumableCpus(1) ConsumableMemory(1024mb) ConsumableVirtualMemory(2048mb)**" at submit time and want to modify it, issue:

  ```
  llmodify -k "resources = ConsumableCpus(1) ConsumableMemory(1024mb)
          ConsumableVirtualMemory(4096mb)"
  ```

- If you requested "**node_resources = ConsumableCpus(2)**" at submit time, an attempt to change the request using **llmodify -k "resources = ConsumableCpus(1)**" will fail. You must first remove the **node_resources** requirement by issuing **llmodify -k "node_resources = "**, then reissue the **llmodify** command to set a new requirement.

  In this example, if consumable resources are being enforced and **ENFORCE_RESOURCE_SUBMISSION** is **true**, the job step will be placed in the system hold state after the first **llmodify** is issued and will remain in that state until another **llmodify** is issued to set consumable resources such that the enforced requirements are met.

sysprio
: Changes the *q_sysprio* for a job step to the specified integer value. The new job step priority will be fixed. This is a LoadLeveler administrator only option.

wclimit_add
: Increases the wall clock limit of a running-like job step by the number of specified minutes. This is a LoadLeveler administrator only option.

jobstep
: Is the name of a job step to be modified.

  The format of a full LoadLeveler step identifier is *host.jobid.stepid*.

  where:

  - *host* is the name of the machine that assigned the job and step identifiers.
  - *jobid* is the job number assigned to the job when it was submitted.
  - *stepid* is the job step number assigned to the job step when it was submitted.

  The step identifier can be specified in an abbreviated form, *jobid.stepid*, when the command is invoked on the same machine that assigned the step identifier. In this case, LoadLeveler will use the local machine's hostname to construct the full step identifier.

Description

All options are for the job step owner or a LoadLeveler administrator on an idle-like job step with the following exceptions:
- **-p**, **-s**, and **-W** are LoadLeveler administrator only options
- **-W** is valid only for a job step in a running-like state

The **-k cluster_option** modifies the job to be considered for scale-across scheduling. When **cluster_option=scale_across** is specified on a job that is not a scale-across job, the job becomes a scale-across job. When **cluster_option** is specified with a value other than **scale_across** (for example, **none**), the job will no longer be considered a scale-across job.

The **llmodify** command *cannot* remove the **scale_across cluster_option** from a scale-across job that is being scheduled by the main scale-across cluster.

The **-C** *job_class* (or **-k** *class*) and **-s** *q_sysprio* (or **-k** *sysprio*) options are the only ones that support scale-across jobs with the exception of the **cluster_option**. If either option is used for a scale-across job, the modification is applied to the local cluster (the cluster from which the command is issued). When applied to the local cluster, administrators can change a scale-across step priority or move a scale-across step to a more appropriate class in the local cluster without affecting the job on other clusters.

A request to mark a job step nonpreemptable will fail if the job step's expected end time extends into an existing reservation.

At the time a job step is modified, LoadLeveler does not check to make certain that the job step with the modified values can be scheduled to run.

To determine if a modification request is successful, issue the **llq -x -l** command and check the fields shown (see Table 85) in the output.

Table 85. llmodify options and keywords

Options and keywords	Field to check
-a or **-k** *account_no*	Account
-C or **-k** *class*	Class
-c or **-k** *consumableCpus*	Resources
-k *bg_connection*	Wiring Requested
-k *bg_partition*	Partition Requested
-k *bg_requirements*	BG Requirements
-k *bg_rotate*	Rotate
-k *bg_shape*	Shape Requested
-k *bg_size*	Size Requested
-k *cluster_option*	Cluster Option
-k *dstg_resources*	Resources
-k *node_resources*	Node Resources
-k *resources*	Resources
-m or **-k** *consumableMemory*	Resources
-p or **-k** *preemptable*	Preemptable
-s or **-k** *priority*	q_sysprio
-W or **-k** *wclimit_add*	Wall Clk Hard Limit/Wall Clk Soft Limit

An idle-like state is one of the following job states:
- Idle
- Deferred
- User Hold
- System Hold
- User & System Hold
- Not Queued
- Vacated
- Rejected

A running-like state is one of the following job states:
- Checkpointing

- Pending
- Preempted
- Preempt Pending
- Resume Pending
- Running
- Starting

Examples

1. This example puts the job step c163n07.12.0 in a nonpreemptable state:
   ```
   llmodify -p nopreempt c163n07.12.0
   ```
2. To extend the wall clock limits of job step c163n07.12.0 by 30 minutes:
   ```
   llmodify -W 30 c163n07.12.0
   ```
3. To change the shape of job step c193n04.11.0 to **4x5x4** base partitions:
   ```
   llmodify -k bg_shape=4x5x4 c193n04.11.0
   ```
4. To change the connection type of job step c193n04.11.0 to **MESH**:
   ```
   llmodify -k bg_connection=MESH c193n04.11.0
   ```
5. This example changes the ConsumableCpus resource requirement of job step c188f2n08.15.0 in cluster1 to the value 3:
   ```
   llmodify -X cluster1 -c 3 c188f2n08.15.0
   ```
6. To have mystepid be considered for scale-across scheduling, issue:
   ```
   llmodify -k cluster_option=scale_across mystepid
   ```

Results

The following shows a sample system response for **llmodify -s 109 c163n07.12.0**:

```
llmodify: request has been sent to LoadLeveler.
```

llmodify returns the following exit values:

0 The command ran successfully.

-1 An error occurred.

Security

LoadLeveler administrators and users can issue this command.

llmovejob - Move a single idle job from the local cluster to another cluster

Use the **llmovejob** command to move a single idle-like job from the local cluster to a remote cluster.

Syntax

llmovejob { **-?** | **-H** | **-v** | **-C** *cluster_name* **-j** *job_ID* }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-C *cluster_name*
Indicates the remote cluster the job specified by *job_ID* should be transferred to. The **-C** flag must be specified in combination with the **-j** flag.

-j *job_ID*
Indicates the *job_ID* to be transferred to the cluster specified by *cluster_name*. The **-j** flag must be specified in combination with the **-C** flag.

Description

The **llmovejob** command moves a single idle-like job from one cluster to another. Upon successful transfer, the job's submitting owner is notified of the move by mail. If any steps within the job are not idle, the transfer request is rejected and the command exits with an error message. The remote job retains the original *job_ID* from the local cluster. Upon transfer, the remote cluster performs any user mapping and remote job filtering necessary for the job. A scale-across job cannot be moved using the **llmovejob** command.

Any changes made to the idle job in the local cluster by the **llmodify** command will not be carried forward to the remote cluster. Any jobs submitted when the local cluster was not configured as a part of a multicluster cannot be moved once the cluster converts to a multicluster environment.

Prior to moving the job, the administrator can examine the LoadLeveler statements in the job command file using the **llq -x -d** command. This will show what values the moved job will use during submission to the remote cluster.

Only administrators can issue the **llmovejob** command. In a mixed operating system multicluster environment, administrators must ensure the binary compatibility of the job being transferred.

Standard Error

An error message is issued and the command exits for the following error cases:
- The cluster name is unknown
- The requested cluster cannot be accessed
- The job is not in the Idle state
- The job is unknown

- The **-C** and **-j** flags were not specified together

Examples

This example moves the idle job **silver.11** from the local cluster to the remote cluster **cluster1**:

```
llmovejob -C cluster1 -j silver.11
```

You should receive output similar to the following:

```
Job silver.11 has been submitted to cluster cluster1
```

Security

LoadLeveler administrators can issue this command.

llmovespool - Move job records

Use the **llmovespool** command to move the job records from the spool of one managing Schedd to another managing Schedd in the local cluster.

Syntax

llmovespool { **-?** | **-H** | **-v** | [**-d** *directory*] **-h** *hostname* }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-d *directory*
Indicates the directory containing the job queue whose job records are to be moved. If not specified, the job queue in the current working directory will be moved. The specified directory must be accessible from the machine upon which the command is issued.

-h *hostname*
Indicates the hostname of the machine running the Schedd daemon, which manages the job queue database that will receive the job records being moved. This flag has no default and is required.

Description

The **llmovespool** command is intended for recovery purposes only. The command moves the job records from the spool of one managing Schedd to another managing Schedd in the local cluster. The command must be run from a machine that has read and write access to the specified **spool** directory containing the job records being moved. This machine must also have network connectivity to the machine running the Schedd daemon that will receive the job records. Jobs to be moved can be in any state.

The Schedd that created the job records to be moved must not be running during the move operation. Jobs within the job queue database will be unrecoverable if the job queue is updated during the move by any process other than the **llmovespool** command. The Schedd that created the job records to be moved must have the **schedd_fenced** machine stanza keyword set to **true** prior to the **llmovespool** command being issued.

All moved jobs retain their original job identifiers. The **llmovespool** command reports the status of each job as it is processed. When the job records for a job are successfully transferred, the **schedd_host** of the job is updated to represent the new managing Schedd and the job records in the specified **spool** directory are deleted. The successful status is reported to standard output. If the transfer for any step within a job fails, the job records for that step remain in the specified **spool** directory and the error status is reported to standard error. If for some reason a job fails, the **llmovespool** command should be reissued against the specified **spool** directory to reprocess the job.

The **llmovespool** command does not move the reservation queue or fair share scheduling data found within the specified **spool** directory.

The command can be issued by administrators only.

Standard Error

An error message is issued and the command exits for the following error cases:

- The command was not issued with the required **-h** flag.
- The machine stanza for the machine running the Schedd daemon, which manages the job queue database that is receiving the job records, has the **schedd_fenced** keyword set to **true**.
- The machine stanza for the machine running the Schedd daemon, which manages the job queue database being moved, does not have the **schedd_fenced** keyword set to **true**.
- The specified hostname is not a valid machine.
- The command cannot make a connection to the specified hostname.
- The specified directory does not exist.
- The job records within the specified directory cannot be accessed.
- There are no job records within the specified **spool** directory.
- The Schedd on the specified hostname cannot accept the transferred job because a job with the same job identifier already exists.

Examples

This example moves the job records found in **/tmp/tmp_spool** to the Schedd running on the **c188f2n08** machine:

```
llmovespool -d /tmp/tmp_spool -h c188f2n08
```

You should receive output similar to the following:

```
The job spool records in /tmp/tmp_spool are being moved to c188f2n08.
The records for job c188f2n02.ppd.pok.ibm.com.1 were successfully transferred.

The transfer is complete.
```

Security

LoadLeveler administrators can issue this command.

llpreempt - Preempt a submitted job step

Use the **llpreempt** command to preempt the job steps specified in the *joblist* argument using the preempt method specified in the *preempt_method* argument or to resume the jobs steps specified in the *joblist* argument.

Syntax

llpreempt

-? | **-H** | **-v** | [**-q**] [**-r** | **-m** *method*] { [**-u** *userlist*] [**-h** *hostlist*] | [*joblist*] }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-r Resumes the specified jobs. This option is valid only for jobs that were preempted by the suspend method.

-m *preempt_method*

su Indicates preempted jobs that are to be suspended. Suspended jobs will stay in the preempted state until the action is undone with the **-r** flag. This is the default.

Preemption using the suspend method is not supported on LoadLeveler for Linux platforms which do not support process tracking. On these platforms, the **llpreempt** command will have no effect if the suspend method is specified either explicitly as a command line option (**-m su**), or implicitly through the **default_preempt_method = su** configuration keyword. Note that **su** is the default value of the **default_preempt_method** keyword.

vc Indicates that preempted jobs are to be vacated. The preempted jobs will be terminated and remain in the job queue. The job will be rescheduled to run as soon as resources for the job are available.

rm Indicates that preempted jobs are to be removed. The preempted jobs will be terminated and removed from the job queue. In order to rerun the job, you must resubmit the job to LoadLeveler.

sh Indicates that preempted jobs are to be put into system hold. The preempted jobs will be terminated and remain in the job queue in system hold state. The jobs will remain in system hold until released by a LoadLeveler administrator using the **llhold** command. After being released, the job will go into the idle state where it will be rescheduled to run as soon as resources for the job are available.

uh Indicates that preempted jobs are to be put into user hold. The preempted jobs will be terminated and remain in the job queue in user hold state. The jobs will remain in the user hold until released by the owner of the job step or by a LoadLeveler administrator using the **llhold** command. After being released, the job will go into the idle state where it will be rescheduled to run as soon as resources for the job are available.

-u *userlist*
Specifies a blank-delimited list of user names. When used with the **-h** option, only the user's job steps monitored on the machines in the *hostlist* are preempted. When used alone, only the user's jobs monitored by the machine issuing the command are preempted.

-h *hostlist*
Specifies a blank-delimited list of host names. All job steps monitored by these hosts are preempted. When used with the **-u** option, only the specified user's job steps monitored by these hosts are preempted.

joblist
Is a blank-delimited list of job and step identifiers to be preempted. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

If the **-u** or **-h** option is specified, the *joblist* is ignored.

Note: For coscheduled jobs, even if all coscheduled job steps are not in the list of targeted job steps, the requested operation is performed on all coscheduled job steps.

Description

This is a LoadLeveler administrator command used for BACKFILL and external schedulers only. Regular users do not have the authority to run this command. This command can only be used when the preemption function is enabled (BACKFILL or external schedulers with preemption enabled).

Only jobs that have been preempted with the preempt method of suspend through the **llpreempt** command or the **ll_preempt** subroutine can be resumed with this command. The **llpreempt** command cannot resume a job step that was preempted through the PREEMPT_CLASS rules or a job step that was preempted with a preempt method other than suspend.

Scale-across jobs cannot be preempted.

A data staging job step cannot be preempted.

Job steps with a **job_type** of **bluegene** cannot be made preemptable.

Examples

1. This example requests that job step c163n07.12.0 be preempted by the default preempt method:

```
llpreempt c163n07.12.0
```

2. This example requests that job step c163n07.12.0 be resumed:

   ```
   llpreempt -r c163n07.12.0
   ```

3. This example requests that all job steps owned by user frank and monitored by host c52n01 be preempted by the system hold method:

   ```
   llpreempt -m sh -u frank -h c52n01
   ```

Results

The following shows a sample system response for the **llpreempt** command:

```
llpreempt: request has been sent to LoadLeveler.
```

Security

LoadLeveler administrators can issue this command.

llprio - Change the user priority of submitted job steps

Use the **llprio** command to change the user priority of one or more job steps in the LoadLeveler queues.

Syntax

llprio [**-?**] [**-H**] [**-v**] [**-q**] [**-X** *cluster_name*] [**+***integer* | **-***integer* | **-p** *priority*] *joblist*

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-X *cluster_name*
Specifies the name of a single cluster where the command is to run.

+ | - *integer*
Operates on the current priority of the job step, making it higher (closer to execution) or lower (further from execution) by adding or subtracting the value of *integer*.

-p *priority*
Is the new absolute value for priority. The valid range is 0–100 (inclusive) where 0 is the lowest possible priority and 100 is highest.

joblist
Is a blank-delimited list of jobs. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

Description

You can adjust the priority of one or more job steps in the LoadLeveler queues by supplying a **+** (plus) or **-** (minus) immediately followed by an *integer* value. **llprio** does not affect a job step that is running, even if its priority is lower than other jobs steps, unless the job step goes into the Idle state.

The user priority of a job step ranges from 0 to 100 inclusively, with higher numbers corresponding to greater priority. The default priority is 50. Only the owner of a job step or the LoadLeveler administrator can change the priority of that job step. Note that the priority is not the UNIX *nice* priority.

Priority changes resulting in a value less than 0 become 0.

Priority changes resulting in a value greater than 100 become 100.

Any change to a job step's priority applied by a user is relative only to *that user's other job steps* in the same class. If you have three job steps enqueued, you can reorder those three job steps with **llprio** but the result does not affect job steps submitted by other users, regardless of their priority and position in the queue. For more information, see "Setting and changing the priority of a job" on page 230.

The **llprio** command can be issued for a scale-across step on the main cluster or from any other cluster that is being considered for running the step. The change in priority or queue position is applied to the scale-across step on the local cluster (the cluster from which the command is issued) and will not change the step on any other cluster.

Examples

1. This example raises the priority of job step **bronze.4.1** by a value of 25:

   ```
   llprio +25 bronze.4.1
   ```

2. This example sets the priority of job step **silver.18.4** to 100, the highest possible value:

   ```
   llprio -p 100 silver.18.4
   ```

   You should receive a response similar to the following:

   ```
   llprio: Priority command has been sent to the central manager.
   ```

Security

LoadLeveler administrators and users can issue this command.

llq - Query job status

Use the **llq** command to query information about jobs in the LoadLeveler queues.

Syntax

llq [**-?**] [**-H**] [**-v**] [**-W**] [**-x** [**-d**]] [**-s**] [**-l**] [**-b**] [**-w**] [**-X** {*cluster_list* | **all**}]
[**-j** *joblist* | *joblist*] [**-u** *userlist*] [**-h** *hostlist*] [**-c** *classlist*]
[**-R** *reservation_list*] [**-f** *category_list*] [**-r** *category_list*]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-W
Specifies that the width of columns in tabular output will be increased to fit the widest entry.

-x Provides extended information about the selected job. If the **-x** flag is used with the **-r**, **-s**, or **-f** flag, an error message is generated.

CPU usage and other resource consumption information on active jobs can only be reported using the **-x** flag if the LoadLeveler administrator has enabled it by specifying A_ON and A_DETAIL for the **ACCT** keyword in the LoadLeveler configuration file.

Normally, **llq** connects with the central manager to obtain job information. When you specify **-x**, **llq** connects to the Schedd machine that received the specified job to get extended job information. However, some statistics, including those corresponding to System Priority and q_sysprio, are available only from the central manager. Do not use the **-x** option if you need these statistics.

When specified without **-l**, CPU usage for active jobs is reported in the short format.

Note: Using both the **-l** and **-x** options without a *joblist* specification can produce a very long report and excessive network traffic.

-d Displays the user-specified unfiltered job command file keyword statements. Information is available only on jobs submitted in a multicluster environment. You must specify the **-d** flag in combination with the **-x** flag.

-s Provides information on why a selected list of jobs remain in the NotQueued, Idle, or Deferred state. Along with this flag, users must specify a list of jobs. The user can also optionally supply a list of machines to be considered when determining why the jobs cannot run. If a list of machines is not provided, the default is the list of machines in the LoadLeveler cluster. For each job, **llq** determines why the job remains in one of the given states instead of Running.

-l Specifies that a long listing be generated for each job for which status is requested.

-b Shows Blue Gene jobs in short form. This is the Blue Gene equivalent of the **llq** standard listing. Using this flag will display the following fields:

BG The state of the job on the Blue Gene system.

Id The LoadLeveler job step ID.

LL The LoadLeveler state of the job step.

Owner
The user ID of the job's owner.

Partition
The name of the Blue Gene partition assigned to the job.

PT The state of the Blue Gene partition assigned to the job.

Size The number of Blue Gene compute nodes allocated for the job.

Submitted
The time the job step was submitted to LoadLeveler.

-w Provides AIX Workload Manager (WLM) CPU, real memory, virtual memory, and large page statistics for jobs in the running state. This flag can be used with a joblist, steplist, or a single stepid. All other flags except **-h** will result in an error message.

When the **-w** flag is augmented with a single stepid, the **-h** flag can be used in conjunction with **-w** to specify a single hostname.

This flag can only be used when ENFORCE_RESOURCE_USAGE is enabled in the configuration file. Otherwise, an error message is produced.

-X {*cluster_list* | **all**}
Indicates that you can specify the **-X** flag with either:

cluster_list
Is a blank-delimited list of clusters where the command is to run.

all Is the reserved word indicating that the command is to run in all accessible clusters.

-j *joblist* |*joblist*
Is a blank-delimited list of job and step identifiers. When a job identifier is specified, the command action is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the command is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's hostname to construct the full job or step identifier.

The **-j** *joblist* flag is used to distinguish a *joblist* when specified in combination with the any flag that supports a list.

If the **-X** flag is specified in combination with a *joblist*, the **-j** flag must be specified. For example:

```
llq -X my_cluster1 my_cluster2 -j c94n13.2.1 c94n13.25.0
```

-u *userlist*
Is a blank-delimited list of users. Only job steps belonging to users in this list are queried.

-h *hostlist*
Is a blank-delimited list of machines. If the **-s** flag is not specified, only job steps managed by the Schedd on machines in this list are queried. If the **-s** flag is specified, the list of machines is considered when determining why a job remains in the Idle state.

When the **-h** flag is used with the **-w** flag, only a single machine name can be specified to obtain the WLM statistics for that machine.

-c *classlist*
Is a blank-delimited list of classes. Only job steps belonging to classes in this list are queried.

-f *category_list*
Is a blank-delimited list of categories you want to query. Each category you specify must be preceded by a percent sign. The *category_list* cannot contain duplicate entries. This flag allows you to create a customized version of the standard **llq** listing. You cannot use this flag with the **-l** flag. The output fields produced by this flag all have a fixed length. The output is displayed in the order in which you specify the categories. *category_list* can be one or more of the following:

%a	Account number
%BB	Name of the Blue Gene block/partition assigned to the job
%BG	State of the job on the Blue Gene system
%BS	Number of compute nodes in the Blue Gene partition assigned to the job
%c	Class
%cc	Completion code
%dc	Completion date
%dd	Dispatch Date
%dh	Hold date
%dq	Queue date (″Submitted″ date of ″standard″ **llq** output)
%fj	Favored Job
%gl	LoadLeveler group
%gu	UNIX group
%h	Hostname (first hostname if more than one machine is allocated to the job step)
%id	Step ID
%is	Virtual image size
%jn	Job name
%jt	Job type
%nh	Number of hosts allocated to the job step
%o	Job owner
%p	User priority
%PT	State of the Blue Gene partition assigned to the job
%R	Reservation ID
%sn	Step name
%st	Status
%X	Cluster name where the job is to be scheduled
%Xf	Cluster name from where the job was sent
%Xk	Cluster name the user requested
%Xs	Cluster name from where the job was submitted
%Xu	User name of the original submission

-r *category_list*
Is a blank-delimited list of formats (categories) you want to query. Each category you specify must be preceded by a percent sign. The *category_list* cannot contain duplicate entries. This flag allows you to create a customized

version of the standard **llq** listing. You cannot use this flag with the **-l** flag. The output produced by this flag is considered raw, in that the fields can be variable in length. Output fields are separated by an exclamation point (!). The output is displayed in the order in which you specify the formats. *category_list* can be one or more of the formats listed under the **-f** flag.

-R *reservation_list*
Is a blank-delimited list of reservation identifiers. Only job steps bound to reservations in this list are queried. The format of a full LoadLeveler reservation identifier is [*host*.]*rid*[.**r**].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional).

The reservation identifier can be specified in an abbreviated form, *rid*[.**r**], when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's hostname to construct the full reservation identifier.

Description

The **llq** command queries information about jobs in the LoadLeveler queues.

Note the following when using this command:

- If a job step is not specified and if **-u**, **-h**, **-c**, or **-R** is not specified, all jobs are queried.
- If a job step is specified, you cannot specify **-u**, **-h**, **-c**, or **-R**, except in the cases of **-w** and **-s**, for which the **-h** flag has special meaning.
- When **-u**, **-h**, **-c**, or **-R** are used in combination, the result is the intersection of the job steps selected by each flag.
- The **-b** flag can be used alone or with the **-u** flag and the *joblist* argument. If used in conjunction with any other flag, an error will occur.
- You cannot specify **-d**, **-x**, or **-w** in combination with the **-X** flag.
- In order to query all information about a scale-across job step, you must issue two **llq** commands. First issue **llq –l** on the main cluster to find out which clusters are scheduling or running the job step. Then issue **llq –X** where the list of clusters displayed by the first command are used as the values for the **–X** flag.
- For scale-across steps on the main cluster, the long form of the **llq** command will display a list of allocated machines only if the **-x** flag is also specified. Without specifying the **-x** flag, the long form of **llq** will display a list of clusters that have allocated machines. On the non-main cluster, the long form of the **llq** command will display a list of allocated machines from that cluster.
- For top-dog scale-across steps on the main cluster, the long form of the **llq** command will display a list of clusters that have reserved machines. On the non-main cluster, the long form of the **llq** command will display a list of reserved machines from that cluster.

Examples

1. This example generates the standard listing where the machine `mars` has two jobs running and one job waiting:

```
Id                 Owner      Submitted   ST PRI Class     Running On
---------------    ---------- ----------- -- --- --------  ----------
mars.498.0         brownap     5/20 11:31 R  100 silver    mars
mars.499.0         brownap     5/20 11:31 R  50  No_Class  mars
mars.501.0         brownap     5/20 11:31 I  50  silver

3 job step(s) in query, 1 waiting, 0 pending, 2 running, 0 held,
                        0 preempted
```

The standard listing includes the following fields:

Class Job class.

Id The format of a full LoadLeveler step identifier is *host.jobid.stepid*. If the **llq** command returns information about a job owned by a Schedd in the same domain, then the domain of the hostname will not appear in the output. However, when the **llq** command reports information about a job owned by a Schedd in a different domain, the fully qualified hostname is always included. Due to space limitations, the domain of the host may be truncated to fit in the space allocated to the Id field. If the domain is truncated, a dash (-) will appear at the end to indicate that characters have been left out. To see the full job ID, run **llq** with the **-l** flag.

Owner
User ID that the job will be run under.

PRI User priority of the job step, where the values are defined with the **user_priority** keyword in the job command file or changed by the **llprio** command, which is described in "llprio - Change the user priority of submitted job steps" on page 477.

Running On
If running, the name of the machine the job step is running on. This is blank when the job is not running. For a parallel job step, only the first machine is shown.

ST For more information, see "LoadLeveler job states" on page 19.

Submitted
Date and time of job submission.

2. To generate a standard listing containing a scale-across job step on the main cluster, issue:

   ```
   llq
   ```

   You should receive a response similar to the following:

   ```
   Id                 Owner      Submitted   ST PRI Class     Running On
   ---------------    ---------- ----------- -- --- --------  ------------
   sat.498.0          brownap     5/20 11:31 R  100 silver    sat
   sat.499.0          brownap     5/20 11:31 R  50  No_Class  sat
   sat.501.0          brownap     5/20 11:31 R  50  silver    scale_across

   3 job step(s) in query, 1 waiting, 0 pending, 2 running, 0 held,
                           0 preempted
   ```

   Note that for a scale-across step, instead of displaying a hostname for the running host, the text **scale_across** will be displayed.

3. This example generates the long listing. The long listing is generated when you specify the **-x -l** flags with the **llq** command:

   ```
   llq -l -x c271f2rp01.ppd.pok.ibm.com.16.0
   ```

   The **long listing** includes the following fields. See Appendix B, "Sample command output," on page 725 for sample output of long listings.

Account
The account number specified in the job command file.

Adapter Requirement
Reflects the settings of the **network** keyword in the job command file.

For more information on the **network** keyword, see "Job command file keyword descriptions" on page 359.

Allocated Hosts
The machines that have been allocated for this job step.

Args Arguments that were passed to the executable.

Blocking
Reflects the settings for the **blocking** keyword in the job command file.

Blue Gene Job ID
The ID of the Blue Gene job in the Blue Gene DB2® database. This field is displayed for Blue Gene jobs only.

Blue Gene Status
The state of the Blue Gene job in the Blue Gene DB2 database. This field is displayed for Blue Gene jobs only.

BG Requirements
The job step requirements on Blue Gene resources as specified at job submission. This field is displayed for Blue Gene jobs only.

Bulk Transfer
Indicates that the value will be Yes or No depending on whether the application requested that the communication subsystem use bulk transfer by specifying `bulkxfer=yes` in the job command file.

Checkpoint Directory
Value of the **ckpt_dir** keyword.

Checkpoint File
For AIX checkpointable job steps, the file name to be used for checkpoint data.

Checkpointable
Indicates if LoadLeveler considers the job step checkpointable (yes, no, or interval).

Ckpt Accum Time
Accumulated time, in seconds, the job step has spent checkpointing.

Ckpt Elapse Time
Amount of time taken to perform the last successful checkpoint.

Ckpt Execute Dir
The directory where the job step's executable will be saved for checkpointable jobs.

Ckpt Hard Limit
Checkpoint hard limit as specified at job step submission.

Ckpt Soft Limit
Checkpoint soft limit as specified at job step submission.

Ckpt Start Time
The start time of the current checkpoint in progress. Blank if no checkpoint running.

Class The class of the job step as specified at job submission.

class_sysprio
The class priority of the job step, where the value is defined in the administration file.

Cluster input file
The information format is *local_pathname*, *remote_pathname*.

where:
local_pathname
Is the full path name of the file to be copied from the local cluster.
remote_pathname
Is the full path name of the file that will be copied into the remote cluster.

Cluster List
A blank-delimited list of clusters used for scheduling or running a scale-across step.

Cluster Option
The value specified in the **cluster_option** job command file statement or modified by the **llmodify** command. The value of **scale_across** indicates that the step is eligible for scale-across scheduling.

Cluster output file
The information format is *local_pathname*, *remote_pathname*.

where:
local_pathname
Is the full path name of the file that will be copied into the local cluster.
remote_pathname
Is the full path name of the file to be copied from the remote cluster.

Cmd The name of the executable associated with the **executable** keyword (if specified) or the name of the job command file.

Comment
The comment specified by the **comment** keyword in the job command file.

Completion Code
The status returned by the wait3 UNIX system call.

Completion Date
Date and time job completed or exited.

Core Hard Limit
Core hard limit as specified at job submission.

Core Soft Limit
Core soft limit as specified at job submission.

Coschedule
Indicates whether the job step is required to be coscheduled (**yes** or **no**).

Cpu Hard Limit
CPU hard limit as specified at job submission.

Cpu Soft Limit
CPU soft limit as specified at job submission.

Cpus Per Core
The CPUs per processor core requested by the job.

Data Hard Limit
Data hard limit as specified at job submission.

Data Soft Limit
Data soft limit as specified at job submission.

Data Staging Script
The script that will be run for data staging in this job step.

Data Stg Dependency
An expression specifying how this step is dependent on other data staging steps in the job.

Dependency
Job step dependencies as specified at job submission.

Dispatch Time
The time that the job was dispatched.

Env Environment variables to be set before executable runs. Appears only when the **-x** option is specified.

Err The file to be used for stderr.

Error Text
The error text in the Blue Gene job record from the Blue Gene DB2 database. This field is displayed for Blue Gene jobs only.

Fail Ckpt Time/Date
Time and date stamp of the last failed checkpoint.

Favored Job
Indicates whether the job has been specified to have a higher system priority than all jobs that are not favored (**yes** or **no**).

File Hard Limit
File hard limits as specified at job submission.

File Soft Limit
File soft limit as specified at job submission.

Good Ckpt Time/Date
Time and date stamp of the last successful checkpoint.

group_sysprio
The group priority of the job step, where the value is defined in the administration file.

Hold Job Until
Job step is deferred until this date and time.

In The file to be used for stdin.

Initial Working Dir
The directory from which the job step is run. The relative directory from which the stdio files are accessed, if appropriate.

Job Accounting Key
The Job Accounting Key is a unique identifier for a LoadLeveler job step. The accounting key is stored in the AIX accounting record for

each process associated with a LoadLeveler job step. This field can be used to correlate AIX accounting records with LoadLeveler accounting records. The Job Accounting Key is stored in the history file and can be displayed using the **llsummary -l** command.

This keyword is not applicable on LoadLeveler for Linux platforms.

For more information on the Job Accounting Key, see "Correlating AIX and LoadLeveler accounting records" on page 66.

Job Name
The name of the job.

Job Step ID
The job step identifier.

Large Page
Indicates whether Large Page memory should be used to run this job step. Can be **Y** (use Large Page memory if available), **N** (No), or **M** (Mandatory).

LoadLeveler Group
The LoadLeveler group associated with the job step.

Machine Speed
For a serial job step, the value associated with the **speed** keyword of the machine that is running this job step. For a parallel job step, the value associated with the **speed** keyword of the first machine that has been allocated for this job step.

Max Processors
The maximum number of processors that can be used for this job step.

McmAffinityOptions
The MCM affinity options for the job.

Min Processors
The minimum number of processors needed for this job step.

Negotiator Messages
Informational messages for the job step if it is in the Idle or NotQueued state.

(Node) Allocated Hosts

- The machines of this Node type that have been allocated for this job step. The format is:

```
hostname:task status:adapter usage, ... ,adapter usage, \
         cpu usage, ... ,cpu usage + ... +,
hostname:task status:adapter usage, ... ,adapter usage, \
         cpu usage, ... ,cpu usage
```

- The adapter usage information has the format:

```
adapter name(adapter window ID, network protocol, mode, \
             adapter window memory)
```

  For information on the units used to report window memory, see the description of the "Adapter" field in "llstatus - Query machine status" on page 512.

- The CPU usage information has one of the following formats:

```
CPU <cpulist>
MCMnumber:CPU <cpulist>
```

The *cpulist* is a blank-delimited list of individual CPU IDs or CPU ranges, or a combination of both CPU IDs and CPU ranges. The CPU range is specified as the starting CPU ID and the ending CPU ID separated by a hyphen (-).

(Node) Name
Blank value. Reserved for future use.

(Node) Node actual
Actual number of machines of this Node type that are used in the running of this job step.

(Node) Node maximum
Maximum number of machines of this Node type that can be used to run this job step.

(Node) Node minimum
Minimum number of machines of this Node type required to run this job step.

(Node) Preferences
Job step preferences as specified at job submission.

(Node) Requirements
Job step requirements as specified at job submission.

(Node/Master Task) Exec Args
The arguments passed to the master task executable.

(Node/Master Task) Executable
The executable associated with the master task.

(Node/Master Task) Num Task Inst
The number of task instances of the master task.

(Node/Master Task) Task Instance

- Task instance information has the format:

  ```
  hostname:task ID:adapter usage, ... ,adapter usage
  ```

- Adapter usage information has the format:

  ```
  adapter name(adapter window ID, network protocol, mode, \
  adapter window memory)
  ```

  For information on the units used to report window memory, see the description of the "Adapter" field in "llstatus - Query machine status" on page 512.

(Node/Task) Num Task Inst
The number of task instances.

(Node/Task) Task Instance

- Task instance information has the format:

  ```
  hostname:task ID:adapter usage, ... ,adapter usage, cpu usage
  ```

- Adapter usage information has the format:

  ```
  adapter name(adapter window ID, network protocol, mode, \
  adapter window memory)
  ```

  For information on the units used to report window memory, see the description of the "Adapter" field in "llstatus - Query machine status" on page 512.

- The CPU usage information has one of the following formats:

  ```
  CPU <cpulist>
  MCMnumber:CPU <cpulist>
  ```

The *cpulist* is a blank-delimited list of individual CPU IDs or CPU ranges, or a combination of both CPU IDs and CPU ranges. The CPU range is specified as the starting CPU ID and the ending CPU ID separated by a hyphen (-).

Node Resources
Reflects the settings for the **node_resources** keyword in the job command file.

Node Usage
A request that a node be shared or not shared or that a time-slice is not shared. The user specifies this request while submitting the job.

Notifications
The notification status for the job step, where:

always
Indicates notification is sent through the mail for the complete, error, never, and start notification categories.

complete
Indicates notification is sent through the mail only when the job step completes.

error
Indicates notification is sent through the mail only when the job step terminates abnormally.

never
Indicates notification is never sent.

start
Indicates notification is sent through the mail only when starting or restarting the job step.

Notify User
The user to be notified by mail of a job's status.

Out The file to be used for stdout.

Outbound Schedds
The list of Schedds that have acted as the outbound Schedd for the job. The last Schedd in the list is the current outbound Schedd. This field only displays multicluster-specific information that was submitted or moved to a remote cluster.

Owner
The user ID that the job will be run under.

parallel_threads
Indicates whether the job requests thread binding and the number of parallel threads of an OpenMP job.

Partition ID
The ID of the Blue Gene partition allocated for the job. This field is displayed for Blue Gene jobs only.

Partition State
The state of the Blue Gene partition allocated for the job. This field is displayed for Blue Gene jobs only.

Port Number
The port number for InfiniBand resources used by the running job.

Preempt Wait Count
Specifies the number of job steps that an idle job step must preempt before it can be started.

Preemptable
Indicates whether a job step is preemptable (yes or no).

Preferences
Job step preferences as specified at job submission.

previous q_sysprio
The previous adjusted system priority of the job step. For more information, see "Example: How does a job's priority affect dispatching order?" on page 231.

q_sysprio
The adjusted system priority of the job step. For more information, see "Example: How does a job's priority affect dispatching order?" on page 231.

Queue Date
The date and time that LoadLeveler received the job.

Requested Cluster
The cluster the user specified at job submission.

Requested Res. ID
The reservation identifier that a job step is requested to be bound to, but has not yet been bound to. This field will be set when a job submitted with a request to bind has been successfully submitted, but the bind has not yet occurred. The bind might never occur if either the owner of the job step is not allowed to use the reservation, or if the reservation does not exist.

When soft binding is being used, the string "(soft)" will be appended to the reservation ID. If the reservation the step is bound to is a recurring reservation, the occurrence ID will be included as part of the reservation ID.

If a job command file is used to select nodes to reserve in a make or change reservation request and the request fails, all steps of the job, if submitted successfully, will have MAKERES as their Requested Res. ID and the steps will be in the **NQ** state.

Requirements
Job step requirements as specified at job submission.

Reservation ID
The reservation identifier that a job step is bound to. If a job step is not bound to any reservation, this field will be blank.

When soft binding is being used, the string "(soft)" will be appended to the reservation ID. If the reservation the step is bound to is a recurring reservation, the occurrence ID will be included as part of the reservation ID.

Resource
The resource being enforced by WLM. This is either **CPU**, **Real Memory**, **Virtual Memory**, or **Large Page Memory**.

Resources
Reflects the settings for the **resources** keyword in the job command file.

Restart
Restart status (**yes** or **no**).

Restart From Ckpt
Indicates if a job has been restarted from an existing checkpoint (**yes** or **no**).

Restart Same Nodes
Indicates if a job step should be restarted on the same nodes after vacate (**yes** or **no**).

Rotate Indicates whether the scheduler is free to rotate the requested Blue Gene partition shape in order to match an available partition (**TRUE** or **FALSE**). This field is displayed for Blue Gene jobs only.

RSet The RSet requirement of the job.

Rss Hard Limit
RSS hard limit as specified at job step submission.

Rss Soft Limit
RSS soft limit as specified at job step submission.

Running Host
For a serial job step, the machine that is running this job step. For a parallel job step, the first machine that has been allocated for this job step.

Schedd History
The list of Schedds that have acted as the Schedd host for the job. The last one in the list is the current Schedd host. This field only displays multicluster-specific information.

Scheduling Cluster
The cluster name where the job is to be scheduled. This field only displays multicluster-specific information.

Sending Cluster
The cluster name that the job was sent from when moved. This field only displays multicluster-specific information.

Shape Allocated
The allocated shape of the Blue Gene partition for the job. This field is defined only for running-like jobs. This field is displayed for Blue Gene jobs only.

Shape Requested
The requested shape of the Blue Gene partition for the job, if defined, in units of base partitions. This field is displayed for Blue Gene jobs only.

Shell The shell to be used when the job step runs.

Size Allocated
The size of the Blue Gene partition for the job in units of compute nodes. The size allocated is not always identical to the requested size. This field is displayed for Blue Gene jobs only.

Size Requested
The requested size of the Blue Gene partition for the job in units of compute nodes. The size must be equivalent to the size of the shape, if such is defined. This field is displayed for Blue Gene jobs only.

SMT requested
Indicates the required simultaneous multithreading (SMT) state, which is defined in the job command file, if the job step requires SMT to be turned on or off. Valid values are **yes** or **no**.

SMT required
Indicates the required simultaneous multithreading (SMT) state, if the job step requires SMT to be enabled, disabled, or kept as is. Valid values are **yes**, **no**, or **as_is**.

Stack Hard Limit
Stack hard limit as specified at job submission.

Stack Soft Limit
Stack soft limit as specified at job submission.

Starter idrss/Step Starter idrss
An integral value of the amount of unshared memory in the data segment of a process (expressed in units of kilobytes * seconds-of-execution).

Starter inblock/Step inblock
Number of times file system performed input. Cumulative total.

Starter isrss/Step isrss
Depending on the Operating System, this field may contain the integral value of unshared stack size.

Starter ixrss/Step ixrss
An integral value indicating the amount of memory used by the text segment that was also shared among other processes (expressed in units of kilobytes * seconds-of-execution).

Starter majflt/Step majflt
Number of page faults (I/O required). Cumulative total.

Starter maxrss/Step maxrss
Maximum resident set size utilized. Maximum value.

Starter minflt/Step minflt
Number of page faults (reclaimed). Cumulative total.

Starter msgrcv/Step msgrcv
Number of IPC messages received. Cumulative total.

Starter msgsnd/Step msgsnd
Number of IPC messages sent. Cumulative total.

Starter nivcsw/Step nivcsw
Number of involuntary context switches. Cumulative total.

Starter nsignals/Step nsignals
Number of signals delivered. Cumulative total.

Starter nswap/Step nswap
Number of times swapped out. Cumulative total.

Starter nvcsw/Step nvcsw
Number of context switches due to voluntarily giving up processor. Cumulative total.

Starter oublock/Step oublock
Number of times file system performed output. Cumulative total.

Starter System Time/Step System Time
CPU system time of Starter/Step processes. Cumulative total.

Starter Total Time/Step Total Time
CPU total time of Starter/Step processes. Cumulative total.

Starter User Time/Step User Time
CPU user time of Starter/Step processes. Cumulative total.

Status The status (state) of the job. For more information, see "LoadLeveler job states" on page 19.

Step Adapter Memory
The total adapter pinned memory for the job step.

Step Cpu Hard Limit
Job step CPU hard limit as specified at job submission.

Step Cpu Soft Limit
Job step CPU soft limit as specified at job submission.

Step Cpus
The total ConsumableCpus for the job step.

Step Large Page Memory
The total ConsumableLargePageMemory for the job step.

Step Name
The name of the job step.

Step rCxt Blocks
The number of rCxt blocks for High Performance Switch adapters.

Step Real Memory
The total ConsumableMemory for the job step.

Step Type
Type of job step:
- Serial
- General parallel
- Blue Gene
- MPICH parallel

Step Virtual Memory
The total ConsumableVirtualMemory for the job step.

Structure Version
An internal version identifier.

Submitting Cluster
The cluster name where the job was submitted from. This field only displays multicluster-specific information.

Submitting Host
The name of the machine to which the job is submitted.

Submitting User
The user name that the job was submitted under. This field only displays multicluster-specific information.

System Priority
The overall system priority of the job step, where the value is defined by the SYSPRIO expression in the configuration file.

Task Affinity
The task affinity requirements of the job.

Task_geometry
Reflects the settings for the **task_geometry** keyword in the job command file.

total Total CPU time consumed in milliseconds. CPU resource only.

Unix Group
The effective UNIX group name.

User Hold Time
The total time that a job step is in User Hold state.

User Priority
The priority of the job step, as specified by the user in the job command, or changed by the **llprio** command.

User Space Windows
The number of switch adapter windows assigned to the job step.

user_sysprio
The user system priority of the job step, where the value is defined in the administration file.

Virtual Image Size
The value of the **image_size** keyword (if specified) or the size of the executable associated with the **executable** keyword (if specified) or the size of the job command file.

Wall Clk Hard Limit
Wall clock hard limit as specified at job submission.

Wall Clk Soft Limit
Wall clock soft limit as specified at job submission.

Wiring Allocated
Allocated type of wiring for the Blue Gene partition. It is either `TORUS` or `MESH`. This field is displayed for Blue Gene jobs only.

Wiring Requested
Requested type of wiring for the Blue Gene partition. It is `TORUS`, `MESH`, or `PREFER_TORUS`. This field is displayed for Blue Gene jobs only.

4. Using the abbreviated form of *jobid*, this example generates a standard listing for all job steps with `jobid 12` assigned by the local machine:

   ```
   llq 12
   ```

5. This example generates a standard listing for all job steps owned by either rich or nathan and bound to reservation 6:

   ```
   llq -u rich nathan -R 6
   ```

6. This example generates an extended listing for all job steps of class batch or class highprio, managed by the Schedd daemon on either c94n07 or c94n09:

   ```
   llq -x -c batch highprio -h c94n07 c94n09
   ```

7. The following example generates a standard listing for all job steps bound to reservation c94n04.2.r:

   ```
   llq -R c94n04.2.r
   ```

   You should receive a response similar to the following:

```
Id                   Owner      Submitted   ST PRI Class     Running On
-------------------- ---------- ----------- -- --- --------- -----------
c94n04.5.0           zhong       2/8  08:17 I  50  classA

1 job step(s) in query, 1 waiting, 0 pending, 0 running, 0 held,
                        0 preempted
```

8. The following example generates a customized listing for all job steps:

   ```
   llq -f %id %o %R
   ```

   You should receive a response similar to the following:

   ```
   Step Id                  Owner       Reservation ID
   ------------------------ ----------- ------------------------
   c94n04.5.0               zhong       c94n04.2.r
   c94n04.4.0               zhong

   2 job step(s) in queue, 1 waiting, 0 pending, 0 running, 1 held,
                           0 preempted
   ```

9. The following is sample output for **llq -X cluster2**. The output representing a cluster is delineated with a cluster header, in this example it is cluster2.

   ```
   ================== Cluster cluster2 ======================================

   Id                     Owner      Submitted   ST PRI Class        Running On
   ---------------------- ---------- ----------- -- --- ----------- -----------
   c188f2n02.9.0          brownap    10/29 13:54 R  50  april        c188f2n08

   1 job step(s) in query, 0 waiting, 0 pending, 1 running, 0 held, 0 preempted
   ```

10. The following is sample output for **llq -X all** command where there are two clusters:

    ```
    ================== Cluster cluster1 ======================================

    Id                      Owner      Submitted   ST PRI Class       Running On
    ----------------------- ---------- ----------- -- --- ----------- ----------
    c193n13.283.0           rolf        8/4 10:58  R  50  No_Class    c193n13
    c193n13.283.0           rolf        8/4 10:58  R  50  No_Class    c193n13
    c193n13.289.0           rolf        8/4 10:58  R  50  No_Class    c193n13
    c193n13.291.0           rolf        8/4 10:59  R  50  No_Class    c193n13
    c193n13.293.0           rolf        8/4 10:59  R  50  No_Class    c193n13
    c193n13.295.0           rolf        8/4 10:59  R  50  No_Class    c193n13
    c193n13.297.0           rolf        8/4 11:01  R  50  No_Class    c193n13
    c193n13.299.0           brownap     8/4 11:02  R  50  No_Class    c193n13

    7 job step(s) in queue, 0 waiting, 0 pending, 7 running, 0 held, 0 preempted

    ================== Cluster cluster2 ======================================

    Id                   Owner      Submitted   ST PRI Class        Running On
    -------------------- ---------- ----------- -- --- ------------ -----------
    c193n13.265.0        llbld       8/2 13:42  R  50  No_Class     c197blade3b14
    c193n13.267.0        llbld       8/2 13:43  R  50  No_Class     c197blade3b14
    c193n13.271.0        llbld       8/2 13:55  I  50  No_Class
    c193n13.273.0        llbld       8/4 10:53  I  50  No_Class
    c193n13.275.0        llbld       8/4 10:53  I  50  No_Class
    c193n13.277.0        llbld       8/4 10:53  I  50  No_Class
    c193n13.279.0        llbld       8/4 10:58  I  50  No_Class

    7 job step(s) in queue, 5 waiting, 0 pending, 2 running, 0 held, 0 preempted
    ```

11. The following is sample output for **llq -b** for a standard Blue Gene listing:

```
Id                    Owner      Submitted   LL  BG  PT  Partition    Size
--------------------- ---------- ----------- --- --- --- ------------ -----
fen01.193.0           jdoe        2/21 22:52 R       C   part031      65536
fen02.1305.0          jfoe        2/20 02:36 R   R   B   part031       1024
fen01.194.0           jane        2/21 14:12 I                          512
```

12. This example generates a customized and formatted standard listing:

```
llq -f %id %c %dq %dd %gl %h
```

You should receive output similar to the following:

```
Step Id        Class      Queue Date  Disp. Date  LL Group   Running On
-------------- ---------- ----------- ----------- ---------- ---------------
ll6.2.0        No_Class   04/08 09:19 04/08 09:21 No_Group   ll6.pok.ibm.com
ll6.1.0        No_Class   04/08 09:19 04/08 09:21 No_Group   ll6.pok.ibm.com
ll6.3.0        No_Class   04/08 09:19 04/08 09:21 No_Group   ll5.pok.ibm.com

3 job step(s) in queue, 0 waiting, 0 pending, 3 running, 0 held, 0 preempted
```

13. This example generates a customized, unformatted (raw) standard listing. Output fields are separated by an exclamation point (!).

```
llq -r %id %c %dq %dd %gl %h
```

You should receive output similar to the following:

```
ll6.pok.ibm.com.2.0!No_Class!01/16/2008 09:19!01/16/2008 09:21!
                    No_Group!ll6.pok.ibm.com
ll6.pok.ibm.com.1.0!No_Class!01/16/2008 09:19!01/16/2008 09:21!
                    No_Group!ll6.pok.ibm.com
ll6.pok.ibm.com.3.0!No_Class!10/16/2008 09:19!01/16/2008 09:21!
                    No_Group!ll5.pok.ibm.com
```

14. This example generates a WLM CPU and memory statistics listing where c704f5sq06.55.0 is a parallel job step currently running on two nodes c704f5sq05 and c704f5sq06. If consumable resource enforcement is enabled, the **-w** option can be used to obtain CPU and memory statistics of job steps in the running state.

```
llq -w c704f5sq06.55.0
```

You should receive output similar to the following:

```
 =============== Job Step c704f5sq06.ppd.pok.ibm.com.55.0 ============
      c704f5sq05.ppd.pok.ibm.com:
              Resource: CPU
                      snapshot: 13
                      total: 14996
              Resource: Real Memory
                      snapshot: 0
                      high water: 718
              Resource: Virtual Memory
                      snapshot: 98
                      high water: 25284
              Resource: Large Page Memory
                      snapshot: 96

      c704f5sq06.ppd.pok.ibm.com:
              Resource: CPU
                      snapshot: 13
                      total: 14549
              Resource: Real Memory
                      snapshot: 0
                      high water: 382
```

```
                Resource: Virtual Memory
                        snapshot: 81
                        high water: 29109
                Resource: Large Page Memory
                        snapshot: 80
```

The standard listing includes the following fields:

high water
The highest number of memory pages used. **Real Memory** and **Virtual Memory** resources only.

snapshot
For **CPU** and **Real Memory** consumption, it is the current percentage of the total resources available. For **Virtual Memory** and **Large Page Memory**, it is the current usage in megabytes.

The following statistics are displayed for every node the job is running on:

- The current CPU resource consumption as a percentage of the total resources available
- The total CPU time consumed in milliseconds
- The current real memory consumption as a percentage of the total resources available
- The highest number of real memory pages used
- The current virtual memory usage in megabytes
- The highest number of virtual memory pages used
- The current large page memory usage in megabytes

15. The following is sample **llq -l** output for task instances and allocated hosts if the job requested MCM affinity:

```
Allocated Hosts: e189f4rp04.ppd.pok.ibm.com::
                    sn1(MPI,IP,-1,Shared,0 rCxt Blks),
                    sn1(MPI,IP,-1,Shared,0 rCxt Blks),
                    MCM0:CPU< 0-5 >,MCM0:CPU< 0-5 >
                 + e189f4rp03.ppd.pok.ibm.com::
                    sn1(MPI,IP,-1,Shared,0 rCxt Blks),
                    sn1(MPI,IP,-1,Shared,0 rCxt Blks),
                    MCM1:CPU< 4-5 >,MCM1:CPU< 4-5 >

Num Task Inst: 4
      Task Instance: e189f4rp04:0:sn1(MPI,IP,-1,Shared,0 rCxt Blks),
                     MCM0:CPU< 0-5 >
      Task Instance: e189f4rp04:1:sn1(MPI,IP,-1,Shared,0 rCxt Blks),
                     MCM0:CPU< 0-5 >
      Task Instance: e189f4rp03:2:sn1(MPI,IP,-1,Shared,0 rCxt Blks),
                     MCM1:CPU< 4-5 >
      Task Instance: e189f4rp03:3:sn1(MPI,IP,-1,Shared,0 rCxt Blks),
                     MCM1:CPU< 4-5 >
```

Note that the < > notation will be used to list individual CPU IDs instead of the CPU count ( ) notation when the **RSET_SUPPORT** configuration file keyword is set to **RSET_MCM_AFFINITY**.

16. The following example shows the Resource Set information in the **llq -l** listing when the consumable CPUs Resource Set requirement is requested:

```
Allocated Hosts : e189f4rp01.ppd.pok.ibm.com::
                     sn0(MPI,IP,-1,Shared,0 rCxt Blks),
                     sn0(MPI,IP,-1,Shared,0 rCxt Blks),
                     CPU< 0-5 >,CPU< 0-5>
                  + e189f4rp02.ppd.pok.ibm.com::
                     sn0(MPI,IP,-1,Shared,0 rCxt Blks),
                     sn0(MPI,IP,-1,Shared,0 rCxt Blks),
                     CPU< 0-5 >,CPU< 0-5 >
```

```
Num Task Inst: 4
      Task Instance: e189f4rp01:0:sn0(MPI,IP,-1,Shared,0 rCxt Blks),
                     CPU< 0-5 >
      Task Instance: e189f4rp01:1:sn0(MPI,IP,-1,Shared,0 rCxt Blks),
                     CPU< 0-5 >
      Task Instance: e189f4rp02:2:sn0(MPI,IP,-1,Shared,0 rCxt Blks),
                     CPU< 0-5 >
      Task Instance: e189f4rp02:3:sn0(MPI,IP,-1,Shared,0 rCxt Blks),
                     CPU< 0-5 >
```

17. The following example shows output for the **llq -l** command when rCxt blocks are present:

```
.
.
.
Adapter Requirement: (sn_single,MPI,US,shared,AVERAGE,instances=1,
                      rcxtblks=5)
.
.
.

Num Task Inst: 4
      Task Instance: c60f1rp02:0:sn1(MPI,US,10,Shared,5 rCxt Blks),
      Task Instance: c60f1rp02:1:sn0(MPI,US,10,Shared,5 rCxt Blks),
      Task Instance: c60f1rp02:2:sn1(MPI,US,11,Shared,5 rCxt Blks),
      Task Instance: c60f1rp02:3:sn0(MPI,US,11,Shared,5 rCxt Blks),
```

18. The following example shows output for the **llq -l** command when SMT is requested:

```
=============== Job Step blablahome.clusters.com.22.0 ===============
   Job Step Id: blablahome.clusters.com.22.0
      Job Name: blablahome.clusters.com.22
.
.
.
        Status: Running
.
.
.
    Large Page: N
    Coschedule: no
 SMT requested: yes
Checkpointable: no
.
.
.
```

19. The following example shows the port number for the InfiniBand resources used by the running job:

```
.
.
.
Task
----

   Num Task Inst: 2
   Task Instance: c171f6sq08:0:ib0(MPI,US,2,Shared,0 rCxt Blks,1),
      ib1(MPI,US,66,Shared,0 rCxt Blks,2),
   Task Instance: c171f6sq08:1:ib0(MPI,US,3,Shared,0 rCxt Blks,1),
       ib1(MPI,US,67,Shared,0 rCxt Blks,2),
.
.
.
```

20. The following example shows a job queue that contains one job comprising an inbound data staging, an application job step, and an outbound data staging job step:

    ```
    llq
    ```

    You should receive a response similar to the following:

    ```
    Id               Owner    Submitted    ST  PRI Class        Running On
    ---------------- -------- -----------  --  --- ------------ ----------
    r12f12n05.11.0   loadl     7/28 10:05  R   50  data_stage   r12f07n08
    r12f12n05.11.1   loadl     7/28 10:05  I   50  small
    r12f12n05.11.2   loadl     7/28 10:05  I   50  data_stage
    3 job step(s) in queue, 2 waiting, 0 pending, 1 running, 0 held, 0
    preempted
    ```

    Data staging job steps will always belong to the **data_stage** built-in class. If the first step of a job belongs to **data_stage**, it is an inbound data staging job step. If the last step of a job belongs to **data_stage**, it is an outbound data staging job step. Conversely, if the first job step does not belong to the **data_stage** class, the job has no inbound data staging job step. If the last step does not belong to the **data_stage** class, the job has no outbound data staging job step. A job can have a maximum of one inbound data staging job step and one outbound data staging job step.

21. The following example shows a job with data staging that does not use an inbound data staging job step:

    ```
    llq
    ```

    You should receive a response similar to the following:

    ```
    Id               Owner    Submitted    ST  PRI Class        Running On
    ---------------- -------- -----------  --  --- ------------ ----------
    r12f12n05.11.0   loadl     7/28 10:05  R   50  small        r12f07n08
    r12f12n05.11.1   loadl     7/28 10:05  I   50  data_stage
    2 job step(s) in queue, 1 waiting, 0 pending, 1 running, 0 held, 0
    preempted
    ```

22. The following example shows a job with data staging that does not use an outbound data staging job step:

    ```
    llq
    ```

    You should receive a response similar to the following:

    ```
    Id               Owner    Submitted    ST  PRI Class        Running On
    ---------------- -------- -----------  --  --- ------------ ----------
    r12f12n05.11.0   loadl     7/28 10:05  R   50  data_stage   r12f07n08
    r12f12n05.11.1   loadl     7/28 10:05  I   50  small
    2 job step(s) in queue, 1 waiting, 0 pending, 1 running, 0 held, 0
    preempted
    ```

Security

LoadLeveler administrators and users can issue this command.

llqres - Query a reservation

Use the **llqres** command to return information about reservations in LoadLeveler.

Syntax

llqres { **-?** | **-H** | **-v** | **-W** | [**-l** | **-r**] [**-s**] [[**-u** *user_list*] [**-g** *group_list*] [**-h** *host_list* | **-h all**] [**-B** *base_partition_list* | **-B all**] [**-b** *begin_time*] [**-e** *end_time*] | **-R** *reservation_list*] }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-W
Specifies that the width of columns in tabular output will be increased to fit the widest entry.

-l Specifies that a long listing be generated for each reservation to be queried.

-r Specifies raw mode for output. Each reservation will occupy one line with the output fields separated by an exclamation point (!).

-s Specifies that short host names will be used in the output of machine names.

-u *user_list*
Specifies a blank-delimited list of users. Reservations to be queried are owned by one of these users.

-g *group_list*
Specifies a blank-delimited list of LoadLeveler groups. Reservations to be queried are owned by one of these groups.

-h all
-h *host_list*
Specifies a blank-delimited list of machines or all machines. Reservations to be queried use one or more of these machines.

-B all
-B *base_partition_list*
Specifies all or a blank-delimited list of base partitions in the Blue Gene system. Reservations to be queried use one or more of these base partitions.

-b *begin_time*
Reservations to be queried are active at or after the specified begin time. The **-b** flag can be used together with the **-e** flag to query reservations expected to be active between the begin and end times. The *begin_time* must be specified using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*. Hours must be specified using a 24-hour clock.

-e *end_time*
Reservations to be queried are active at or before the specified end time. The **-e** flag can be used together with the **-b** flag to query reservations expected to be active between the begin and end times. The *end_time* must be specified using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*. Hours must be specified using a 24-hour clock.

-R *reservation_list*
Is a blank-delimited list of reservation identifiers to be queried. The format of a full LoadLeveler reservation identifier is [*host*.]*rid*[.**r**].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional).

The reservation identifier can be specified in an abbreviated form, *rid*[.**r**], when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

When **-R** is specified, **-u**, **-g**, and **-h** are ignored.

Description

All users can issue this command. Reservations satisfying all criteria specified by **-u**, **-g**, **-h** or **-B**, **-b**, and **-e** will be queried if more than one of these options are present. The **-h** and **-B** flags are mutually exclusive. No reservation information will be returned if both are specified at the same time. By default, the **llqres** command queries all existing reservations.

This command is for the BACKFILL scheduler only.

Examples

When the **BG_ENABLED** keyword is set to **false** in the configuration file, the following examples apply.

1. When issuing the **llqres** command, you should receive output similar to the following:

```
Id              Owner     ST  Start Time   Duration #Nodes
-----------     -----     --  -----------  -------- ------
c94n16.30.r     loadl     A   10/16  14:00    120      3
c94n16.31.r     dave      W   10/17  02:00    420      4
c94n16.35.r     carol     W   10/17  13:30    240      2
```

2. When issuing the **llqres -l** command, you should receive output similar to the following:

```
=============== Reservation c94n16.ppd.pok.ibm.com.64.r ===============
ID: c94n16.ppd.pok.ibm.com.64.r.0
    Creation Time: Mon 25 Feb 10:55:18 AM EST 2008
            Owner: nathan
            Group: No_Group
       Start Time: Sat 01 Mar 07:00:00 PM EST 2008
         Duration: 120 minutes
Expected End Time: Sat 01 Mar 09:00:00 PM EST 2008
           SHARED: no
   REMOVE_ON_IDLE: no
   Binding Method: firm
           Status: WAITING
      Modified By: nathan
Modification Time: Mon 25 Feb 10:55:18 AM EST 2008
            Users: 0
           Groups: 0
            Nodes: 4
                   c94n01.ppd.pok.ibm.com
                   c94n02.ppd.pok.ibm.com
                   c94n12.ppd.pok.ibm.com
```

```
                    c94n16.ppd.pok.ibm.com
         Job Steps: 1
                    c94n16.ppd.pok.ibm.com.25.0
------------------------ Future Occurrences -------------------------
       Expiration: Mon 31 Mar 11:59:00 PM EDT 2008
       Recurrence: 0 19 * * 5-6
                    07:00 PM
                    Friday, Saturday of each week
                    Every month
      Start Times: (1) Sat 01 Mar 07:00:00 PM EST 2008
                    (2) Fri 07 Mar 07:00:00 PM EST 2008
                    (3) Sat 08 Mar 07:00:00 PM EST 2008
                    (4) Fri 14 Mar 07:00:00 PM EDT 2008
                    (5) Sat 15 Mar 07:00:00 PM EDT 2008
                    (6) Fri 21 Mar 07:00:00 PM EDT 2008
                    (7) Sat 22 Mar 07:00:00 PM EDT 2008
                    (8) Fri 28 Mar 07:00:00 PM EDT 2008
                    (9) Sat 29 Mar 07:00:00 PM EDT 2008
    Canceled OIDs: (none)
         Duration: 120 minutes
           SHARED: no
   REMOVE_ON_IDLE: no
            Users: 0
           Groups: 0
        Job Steps: 1
                    c94n16.ppd.pok.ibm.com.25.0 (0)
```

3. To determine if any reservations will be active on the machine c94n01 before performing an hours worth of maintenance beginning at 8:00 on 02/18/2008, issue the following command:

   ```
   llqres -b 02/18/2008 8:00 -e 02/18/2008 9:00 -h c94n01
   ```

   You should receive output similar to the following:

   ```
   Id              Owner     ST  Start Time   Duration #Nodes
   -----------     -----     --  -----------  -------- ------
   c94n16.31.r     dave      W   02/18  02:00    420      4
   ```

4. There are no job steps associated with a reservation in the following example. The short form is used for host names:

   ```
   llqres -r -s -R c94n16.30.r
   ```

   You should receive output similar to the following:

   ```
   c94n16.30.r!Mon Feb 18 08:12:23 EST 2008!loadl!No_Group!
      Mon Feb 18 14:00:00 EST
   2008!120!Mon Feb 18 16:00:00 EST 2008!no!no!ACTIVE!loadl!
      Mon Feb 18 10:21:14 EST
   2008!0!!1!loadlusr!3!c94n01,c94n11,c94n12!0!
   ```

5. There are job steps associated with a reservation in the following example. The short form is used for host names:

   ```
   llqres -r -s -R c94n16.31.r
   ```

   You should receive output similar to the following:

   ```
   c94n16.31.r!Mon Feb 18 10:35:18 EST 2008!dave!No_Group!
      Mon Feb 18 02:00:00 EST
   2008!420!Mon Feb 18 09:00:00 EST 2008!no!yes!WAITING!dave!
      Mon Feb 18 10:55:18
   EST 2008!0!!0!!4!c94n01,c94n02,c94n12,c94n16!1!c94n16.25.0
   ```

6. To show all reservation occurrences from March 15th 00:01 until the reservation expires, issue the following command. Note that the first occurrence in this interval is occurrence 4. Of the six job steps bound to the reservation, only two of them are bound to occurrence 4 and are shown in the first section of the listing. All six are shown in the second part of the listing. Occurrence 7 has

been canceled. It is listed as a canceled occurrence under the ″Canceled OIDs:″ heading and is omitted from the list of start times.

```
llqres -l -b 03/15 00:01 -R c94n16.64
```

You should receive output similar to the following:

```
=============== Reservation c94n16.ppd.pok.ibm.com.64.r ===============
ID: c94n16.ppd.pok.ibm.com.64.r.4
    Creation Time: Mon 25 Feb 10:55:18 AM EST 2008
            Owner: nathan
            Group: No_Group
       Start Time: Fri 14 Mar 07:00:00 PM EDT 2008
         Duration: 120 minutes
Expected End Time: Fri 14 Mar 09:00:00 PM EDT 2008
           SHARED: no
   REMOVE_ON_IDLE: no
   Binding Method: firm
           Status: WAITING
      Modified By: nathan
Modification Time: Mon 25 Feb 10:55:18 AM EST 2008
            Users: 0
           Groups: 0
            Nodes: 4
                   c94n01.ppd.pok.ibm.com
                   c94n02.ppd.pok.ibm.com
                   c94n12.ppd.pok.ibm.com
                   c94n16.ppd.pok.ibm.com
        Job Steps: 2
                   c94n15.ppd.pok.ibm.com.28.0
                   c94n16.ppd.pok.ibm.com.29.0
------------------------ Future Occurrences -------------------------
       Expiration: Mon 31 Mar 11:59:00 PM EDT 2008
       Recurrence: 0 19 * * 5-6
                   07:00 PM
                   Friday, Saturday of each week
                   Every month
      Start Times: (5) Sat 15 Mar 07:00:00 PM EDT 2008
                   (6) Fri 21 Mar 07:00:00 PM EDT 2008
                   (8) Fri 28 Mar 07:00:00 PM EDT 2008
                   (9) Sat 29 Mar 07:00:00 PM EDT 2008
     Canceled OIDs: 7
          Duration: 120 minutes
            SHARED: no
    REMOVE_ON_IDLE: no
             Users: 0
            Groups: 0
         Job Steps: 6
                    c94n15.ppd.pok.ibm.com.28.0 (4)
                    c94n16.ppd.pok.ibm.com.29.0 (4)
                    c94n16.ppd.pok.ibm.com.30.0 (5)
                    c94n16.ppd.pok.ibm.com.30.1 (5)
                    c94n16.ppd.pok.ibm.com.30.2 (5)
                    c94n16.ppd.pok.ibm.com.32.0 (8)
```

When the **BG_ENABLED** keyword is set to **true** in the configuration file, the following examples apply.

1. When issuing the **llqres** command, you should receive output similar to the following:

   ```
   llqres

   ID                 Owner      ST  Start Time Duration #Nodes #BG C-nodes
   ------------------ ---------- -- ----------- -------- ------ -----------
   bgldd1.62.r        ezhong      W  6/13 18:40        5      1           0
   bgldd1.61.r        ezhong      W  6/13 18:40        5      0         128
   bgldd1.60.r        ezhong      W  6/13 18:30        5      0         512
   ```

2. The following example returns reservation information about all machines:

   ```
   llqres -h all
   ```

   You should receive output similar to the following:

   ```
   ID                 Owner      ST  Start Time Duration #Nodes #BG C-nodes
   ------------------ ---------- -- ----------- -------- ------ -----------
   bgldd1.62.r        ezhong      W  6/13 18:40        5      1           0
   ```

3. The following example generates a list of base partitions for R010:

   ```
   llqres -B R010
   ```

   You should receive output similar to the following:

   ```
   ID                 Owner      ST  Start Time Duration #Nodes #BG C-nodes
   ------------------ ---------- -- ----------- -------- ------ -----------
   bgldd1.60.r        ezhong      A  6/13 18:30        5      0         512
   ```

4. The following example generates a list of all base partitions in the Blue Gene system in raw mode:

   ```
   llqres -r -B all
   ```

   You should receive output similar to the following:

   ```
   bgldd1.rchland.ibm.com.61.r!Wed 13 Feb 2008 06:28:09 PM CDT!
      ezhong!No_Group!Wed 13 Feb 2008 06:40:00 PM
   CDT!5!Wed 13 Feb 2008 06:45:00 PM CDT!no!no!WAITING!ezhong!
      Wed 13 Feb 2008 06:28:09 PM
   CDT!0!!0!!0!!1!bgldd1.rchland.ibm.com.200.0!128!MESH!0x0x0!1!R011
      (J111;J113;J115;J117)!MYPARTITION
   bgldd1.rchland.ibm.com.60.r!Wed 13 Feb 2008 06:26:36 PM CDT!
      ezhong!No_Group!Wed 13 Feb 2008 06:30:00 PM
   CDT!5!Wed 13 Feb 2008 06:35:00 PM CDT!no!no!ACTIVE!ezhong!
      Wed 13 Feb 2008 06:26:36 PM
   CDT!0!!0!!0!!1!bgldd1.rchland.ibm.com.199.0!512!MESH!1x1x1!1!R010!
   ```

5. The following example shows a long listing of all reservations in a system where Blue Gene support is enabled:

   ```
   llqres -l
   ```

   You should receive output similar to the following:

   ```
   =============== Reservation bgldd1.rchland.ibm.com.62.r ===============
                   ID: bgldd1.rchland.ibm.com.62.r
        Creation Time: Wed 13 Feb 2008 06:28:25 PM CDT
                Owner: ezhong
                Group: No_Group
           Start Time: Wed 13 Feb 2008 06:40:00 PM CDT
             Duration: 5 minutes
     xpected End Time: Wed 13 Feb 2008 06:45:00 PM CDT
               SHARED: no
         MOVE_ON_IDLE: no
               Status: WAITING
          Modified By: ezhong
    Modification Time: Wed 13 Feb 2008 06:28:25 PM CDT
                Users: 0
               Groups: 0
                Nodes: 1
                       bgldd1.rchland.ibm.com
            Job Steps: 1
                       bgldd1.rchland.ibm.com.201.0
           BG C-nodes: 0
        BG Connection:
             BG Shape:
               BG BPs: 0
         BG Partition:
   =============== Reservation bgldd1.rchland.ibm.com.61.r ===============
                   ID: bgldd1.rchland.ibm.com.61.r
        Creation Time: Wed 13 Feb 2008 06:28:09 PM CDT
                Owner: ezhong
                Group: No_Group
   ```

```
        Start Time: Wed 13 Feb 2008 06:40:00 PM CDT
          Duration: 5 minutes
  Expected End Time: Wed 13 Feb 2008 06:45:00 PM CDT
            SHARED: no
     REMOVE_ON_IDLE: no
            Status: WAITING
       Modified By: ezhong
  Modification Time: Wed 13 Feb 2008 06:28:09 PM CDT
             Users: 0
            Groups: 0
             Nodes: 0
         Job Steps: 1
                    bgldd1.rchland.ibm.com.200.0
        BG C-nodes: 128
     BG Connection: MESH
          BG Shape: 0x0x0
            BG BPs: 1
                    R011(J111;J113;J115;J117)
      BG Partition: MYPARTITION
=============== Reservation bgldd1.rchland.ibm.com.60.r ===============
                ID: bgldd1.rchland.ibm.com.60.r
     Creation Time: Wed 13 Feb 2008 06:26:36 PM CDT
             Owner: ezhong
             Group: No_Group
        Start Time: Wed 13 Feb 2008 06:30:00 PM CDT
          Duration: 5 minutes
  Expected End Time: Wed 13 Feb 2008 06:35:00 PM CDT
            SHARED: no
     REMOVE_ON_IDLE: no
            Status: ACTIVE
       Modified By: ezhong
  Modification Time: Wed 13 Feb 2008 06:26:36 PM CDT
             Users: 0
            Groups: 0
             Nodes: 0
         Job Steps: 1
                    bgldd1.rchland.ibm.com.199.0
        BG C-nodes: 512
     BG Connection: MESH
          BG Shape: 1x1x1
            BG BPs: 1
                    R010
      BG Partition:
```

6. The following example shows reserving resources during the time period from 18:35 to 18:45:

   ```
   llqres -b 18:35 -e 18:45
   ```

   You should receive output similar to the following:

   ```
   ID                 Owner      ST  Start Time Duration #Nodes #BG C-nodes
   ------------------ ---------- -- ----------- -------- ------ -----------
   bgldd1.62.r        ezhong      W  6/13 18:40        5      1           0
   bgldd1.61.r        ezhong      W  6/13 18:40        5      0         128
   ```

7. The following example shows one reservation in raw mode. The short form is used for *hostnames*:

   ```
   llqres -r -s c94n16.30.r
   ```

   You should receive output similar to the following:

   ```
   c94n16.30.r!Fri Feb 22 08:12:23 EST 2008!loadl!No_Group!
      Fri Feb 22 14:00:00 EST
   2008!120!Fri Feb 22 16:00:00 EST 2008!no!no!ACTIVE!loadl!
      Fri Feb 22 10:21:14 EST
   2008!0!!1!loadlusr!3!c94n01,c94n11,c94n12!0!!0!0x0x0!
   ```

8. The following example shows that there are job steps associated with the reservation. The short form is used for *hostnames*:

```
llqres -r -s c94n16.31.r
```

You should receive output similar to the following:

```
c94n16.31.r!Fri Feb 22 10:35:18 EST 2008!dave!No_Group!
   Thu Feb 21 02:00:00 EST
2008!420!Thu Feb 21 09:00:00 EST 2008!no!yes!WAITING!dave!
   Fri Feb 22 10:55:18 EST
2008!0!!0!!4!c94n01,c94n02,c94n12,c94n16!1!c94n16.25.0!0!0x0x0!
```

9. To query a recurring reservation with no expiration on a Blue Gene system, issue:

```
llqres -l -R bgpdd2sys1.1.r
```

You should receive a response similar to the following:

```
============== Reservation bgpdd2sys1.rchland.ibm.com.1.r.0 ===========
               ID: bgpdd2sys1.rchland.ibm.com.1.r.0
    Creation Time: Tue 26 Aug 2008 03:30:44 AM CDT
            Owner: yanhy
            Group: yanhy
       Start Time: Mon 01 Sep 2008 08:00:00 AM CDT
         Duration: 10 minutes
Expected End Time: Mon 01 Sep 2008 08:10:00 AM CDT
           SHARED: no
   REMOVE_ON_IDLE: no
   Binding Method: firm
           Status: WAITING
      Modified By: yanhy
Modification Time: Tue 26 Aug 2008 03:30:44 AM CDT
            Users: 0
           Groups: 0
            Nodes: 0
        Job Steps: 0
       BG C-nodes: 512
    BG Connection: MESH
         BG Shape: 1x1x1
           BG BPs: 1
                   R20-M1
     BG Partition:
-------------------------- Future Occurrences --------------------------
       Expiration: none
       Recurrence: 0-40/20 8-10 1-15/14 * *
                   08:00 AM,08:20 AM,08:40 AM,09:00 AM,09:20 AM,09:40 AM,
     10:00 AM,10:20 AM,10:40 AM
                   day 01,15 of
                   every month
       Start Time: (0) (Mon 01 Sep 2008 08:00:00 AM CDT)
                   (1) (Mon 01 Sep 2008 08:20:00 AM CDT)
                   (2) (Mon 01 Sep 2008 08:40:00 AM CDT)
                   (3) (Mon 01 Sep 2008 09:00:00 AM CDT)
                   (4) (Mon 01 Sep 2008 09:20:00 AM CDT)
                   (5) (Mon 01 Sep 2008 09:40:00 AM CDT)
                   (6) (Mon 01 Sep 2008 10:00:00 AM CDT)
                   (7) (Mon 01 Sep 2008 10:20:00 AM CDT)
                   (8) (Mon 01 Sep 2008 10:40:00 AM CDT)
                   (9) (Mon 15 Sep 2008 08:00:00 AM CDT)
                   (10) (Mon 15 Sep 2008 08:20:00 AM CDT)
                   (11) (Mon 15 Sep 2008 08:40:00 AM CDT)
                   (12) (Mon 15 Sep 2008 09:00:00 AM CDT)
                   (13) (Mon 15 Sep 2008 09:20:00 AM CDT)
                   (14) (Mon 15 Sep 2008 09:40:00 AM CDT)
                   (15) (Mon 15 Sep 2008 10:00:00 AM CDT)
                   (16) (Mon 15 Sep 2008 10:20:00 AM CDT)
                   (17) (Mon 15 Sep 2008 10:40:00 AM CDT)
    Canceled OIDs: (none)
         Duration: 10 minutes
           SHARED: no
```

```
|                            REMOVE_ON_IDLE: no
|                                     Users: 0
|                                    Groups: 0
|                                 Job Steps: 0
```

llrmres - Cancel a reservation

Use the **llrmres** command to cancel a reservation in LoadLeveler.

Syntax

llrmres

{ **-?** | **-H** | **-v** | [**-q**] [**-b** *begin_time*] [**-e** *end_time*]
{ [**-u** *user_list*] [**-g** *group_list*] [**-h all** | **-h** *host_list*]
[**-B all** | **-B** *base_partition_list*] | [**-R all** | **-R** *reservation_list*] } }

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-b *begin_time*
Indicates that occurrences of a recurring reservation to be canceled are active at or after the specified begin time. The **-b** flag must be used together with the **-e** flag to cancel reservation occurrences expected to be active between the begin and end times. The *begin_time* must be specified using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*. Hours must be specified using a 24-hour clock.

-e *end_time*
Indicates that occurrences of a recurring reservation to be canceled are active at or before the specified end time. The **-e** flag can be used together with the **-b** flag to cancel reservation occurrences expected to be active between the begin and end times. The *end_time* must be specified using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*. Hours must be specified using a 24-hour clock.

-u *user_list*
Specifies a blank-delimited list of user IDs. Reservations to be canceled are owned by one of these users.

-g *group_list*
Specifies a blank-delimited list of LoadLeveler groups. Reservations to be canceled are owned by one of these groups.

-h all
-h *host_list*
Specifies a blank-delimited list of machines or all machines. Reservations to be canceled use one or more of these machines.

-B all
-B *base_partition_list*
Specifies a blank-delimited list of Blue Gene base partitions or all Blue Gene base partitions. Reservations to be canceled use one or more of these Blue Gene base partitions.

-R all
-R *reservation_list*
Is a blank-delimited list of reservation identifiers to be canceled. A LoadLeveler administrator can specify the reserved word **all** to cancel all reservations in the system. Nonadministrators can specify the reserved word **all** to cancel all of the reservations that they own. The format of a full LoadLeveler reservation identifier is [*host*.]*rid*[.**r**[*oid*]].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional if *oid* is not specified).
- *oid* is the occurrence ID of a recurring reservation (*oid* is optional).

The reservation identifier can be specified in an abbreviated form, *rid*[.**r**[*oid*]], when the command is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

Description

The **llrmres** command is for LoadLeveler administrators and owners of a reservation. Owners of reservations can cancel their own reservations. A LoadLeveler administrator can cancel any reservation. The state of a job step will not be changed directly by the cancellation of a reservation. Reservations satisfying all criteria specified by the **-u**, **-g**, **-h**, **-B**, **-b**, **-e**, or **-R** flag will be canceled if more than one of these options are present. The **-h** and **-B** flags are mutually exclusive. The **-R** flag cannot be used in conjunction with the **-u**, **-g**, **-h**, or **-B** flag. The **llqres** command can be used to determine the status of the reservation.

When the **-b** or **-e** flag is used, all occurrences of recurring reservations and all one-time reservations that will be active during the specified interval and that meet the other criteria specified by the **-u**, **-g**, **-h**, **-B**, and **-R** flags are canceled. If all occurrences of a recurring reservation fall within the specified interval, the entire reservation is removed.

When the **llrmres** command is issued against a recurring reservation, the entire reservation is canceled unless:

- The **-b** and **-e** flags are used to specify which specific occurrences are to be canceled
- The **-R** flag is used and the *oid* is specified

When the **-b** flag is used, the **-e** flag must also be used to specify an end to the interval. If the desired result is for all occurrences that begin after *start_time* to be removed, then the way to do this is to change the reservation's expiration using **llchres -e** *start_time*.

The **-e** flag can be used without the **-b** flag to remove all occurrences between now and the specified *end_time*.

This command is for the BACKFILL scheduler only.

Examples

1. To request to cancel all reservations owned by user ID iris that use machine c188f2n01, issue the following command. Note that this request can be made either by an administrator or the user iris.

   ```
   llrmres -u iris -h c188f2n01
   ```

   You should receive a response similar to the following:

   ```
   The request to remove reservations has been sent to the central manager.
   ```

2. To request that the LoadLeveler administrator cancel all reservations, issue:

```
llrmres -R all
```

You should receive a response similar to the following:

```
The request to remove reservations has been sent to the central manager.
```

3. To request that the LoadLeveler administrator cancel all reservations of Blue Gene resources, issue:

```
llrmres -B all
```

You should receive a response similar to the following:

```
The request to remove reservations has been sent to the central manager.
```

4. To request that the LoadLeveler administrator cancel all reservations on nodes that are not Blue Gene compute nodes (C-nodes), issue:

```
llrmres -h all
```

You should receive a response similar to the following:

```
The request to remove reservations has been sent to the central manager.
```

5. To cancel all occurrences of the recurring reservation **c94n16.64.r** between now (where now is February 23rd) and March 17th, issue:

```
llrmres -e 03/17 23:59 -R c94n16.64.r
```

6. To cancel all occurrences of all reservations owned by user ID **nathan** during the month of April, issue:

```
llrmres -b 04/01 00:00 -e 04/30 23:59 -u nathan
```

7. To cancel one specific occurrence of a recurring reservation, issue:

```
llrmres -R c197blade3b11.10.r.16
```

Security

LoadLeveler administrators and users can issue this command.

llrunscheduler - Run the central manager's scheduling algorithm

Use the **llrunscheduler** command to run the central manager's scheduling algorithm when the internal scheduling interval is disabled.

Syntax

llrunscheduler [**-?**] | [**-H**] | [**-v**] | [**-q**]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

Description

The **llrunscheduler** command is used to run the central manager's scheduling algorithm when the internal scheduling interval has been disabled so that an external program can control when the central manager attempts to schedule job steps. The **llrunscheduler** command sends a request to the central manager to run the scheduling algorithm. The central manager's scheduling algorithm will run only once each time the **llrunscheduler** command is invoked. Each time the scheduling algorithm runs, the central manager will schedule as many job steps as the current available resources allow.

The request to run the scheduling algorithm is ignored if the internal scheduling interval has not been disabled by setting the **NEGOTIATOR_INTERVAL** configuration keyword to 0. If **NEGOTIATOR_INTERVAL** is set to 0, the **llstatus** command will report that the scheduler interval is disabled.

Security

LoadLeveler administrators can issue this command.

llstatus - Query machine status

Use the **llstatus** command to return status information about machines in the LoadLeveler cluster.

Syntax

llstatus

[-?] [-H] [-v] [-W] [-R] [-F] [-M] [-l] [-a] [-C] [-b]
[-B {*base_partition_list* | **all**}**]** **[-P** {*partition_list* | **all**}**]**
[-X {*cluster_list* | **all**}**]** **[-f** *category_list***]** **[-r** *category_list***]**
[-h *hostlist* | *hostlist***]**

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-W
Specifies that the width of columns in tabular output will be increased to fit the widest entry.

-R Lists the machine consumable resources associated with each machine for which status is requested. The total number of RDMA resources for High Performance Switch adapters is limited to four and each RDMA job running on a node consumes one RDMA resource. Because there is no limit on RDMA resources for InfiniBand adapters, RDMA resources are not listed in the long listing when there are any InfiniBand adapters connected to the system.

This option should not be used with any other option.

-F Lists all of the floating consumable resources associated with the LoadLeveler cluster. This option should not be used with any other option.

-M
Lists the Multiple Chip Modules (MCMs) available on a machine, where:

Available CPUs
Are the CPU IDs of the CPUs available for LoadLeveler on this MCM.

Used CPUs
Are the CPU IDs of the CPUs used by LoadLeveler jobs on this MCM.

Adapters
Are the switch adapters connected to this MCM of the form:

```
[used windows/available windows, used rCxt blocks/available \
   rCxtBlocks]
```

where:

used windows
Is the number of windows used.

available windows
Is the total number of windows on the adapter.

used rCxt blocks
Is the number of rCxt blocks used.

available rCxt blocks
Is the total number of rCxt blocks on the adapter.

Total Tasks
Is the total number of tasks that are running using CPUs of this MCM.

Note that the < > notation will be used to list individual CPU IDs instead of the CPU count ( ) notation when the **RSET_SUPPORT** configuration file keyword is set to **RSET_MCM_AFFINITY**.

-l Specifies that a long listing be generated for each machine for which status is requested. If **-l** is *not* specified, the standard list is generated.

-a Displays information for each virtual adapter followed by information for each physical adapter it manages. This flag also displays the port number on each InfiniBand adapter port.

-C Displays cluster stanza information defined in the administration file. Only fields that contain data are displayed. If **-C** is specified without the **-X** flag, cluster stanza information will be reported from one outbound local Schedd. If the **-X** and **-C** flags are specified, cluster stanza information will be reported from an inbound Schedd in each available remote cluster specified with the **-X** flag. If the **-h** flag is specified, cluster stanza information will only be reported from the specified hosts.

-b Displays Blue Gene system information. It is valid only when specified as a single option or in combination with the **-l** flag. When used as single option, **llstatus** displays a short listing of information on the Blue Gene system. When used the **-l** flag, **llstatus** displays a detailed listing of the components of the Blue Gene system.

-P {*partition_list* | **all**}
Displays Blue Gene partition information. It is valid only when specified as a single option. When this flag is specified, **llstatus** displays information on all Blue Gene partitions in the *partition_list*.

partition_list
Is a blank-delimited list of Blue Gene partitions.

all Is the reserved word indicating that the command is to return information for all partitions.

-B {*base_partition_list* | **all**}
Displays Blue Gene base partition information. It is valid only when specified as a single option. When this flag is specified, **llstatus** displays information about **all** Blue Gene base partitions in the *base_partition_list*.

base_partition_list
Is a blank-delimited list of Blue Gene base partitions.

all Is the reserved word indicating that the command is to return information for all base partitions.

-X {*cluster_list* | **all**}
Indicates that you can specify the **-X** flag with either:

cluster_list
Specifies a blank-delimited list of clusters for which status is requested.

all Is a reserved word which specifies that status is requested for all accessible clusters.

-f *category_list*
Is a blank-delimited list of categories you want to query. Each category you specify must be preceded by a percent sign. The *category_list* cannot contain duplicate entries. This flag allows you to create a customized version of the standard **llstatus** listing. The output fields produced by this flag all have a fixed length. The output is displayed in the order in which you specify the categories. *category_list* can be one or more of the following:

%a Hardware architecture

%act Number of job steps dispatched by the Schedd daemon on this machine

%cm Custom Metric value

%cpu Number of CPUs on this machine

%d Available disk space in the LoadLeveler execute directory

%i Number of seconds since last keyboard or mouse activity

%inq Number of job steps in the job queue of this Schedd machine

%l Berkeley one-minute load average

%m Physical memory on this machine

%mt Maximum number of initiators that can be used simultaneously on this machine

%n Machine name

%o Operating system on this machine

%r Number of initiators used by the startd daemon on this machine

%sca Availability of the Schedd daemon

%scs State of the Schedd daemon

%sta Availability of the startd daemon

%sts State of the startd daemon

%v Available swap space (free paging space) of this machine

%X Local cluster name

-r *category_list*
Is a blank-delimited list of categories you want to query. Each category you specify must be preceded by a percent sign. The *category_list* cannot contain duplicate entries. This flag allows you to create a customized version of the standard **llstatus** listing. The output produced by this flag is considered raw, in that the fields can be variable in length. The output is displayed in the order in which you specify the formats. Output fields are separated by an exclamation point (!). *category_list* can be one or more of the categories listed under the **-f** flag.

-h *hostlist*
hostlist
Is a blank-delimited list of machines for which status is requested.

If the **-X** flag is specified in combination with a *hostlist*, the **-h** flag must be specified. For example:

```
llstatus -X my_cluster1 my_cluster2 -h c94n13 c94n14
```

Description

If you have more than a few machines configured for LoadLeveler, consider redirecting the output to a file when using the **-l** flag.

Each machine periodically updates the central manager with a snapshot of its situation. Since the information returned by using **llstatus** is a collection of such snapshots, all taken at varying times, the total picture may not be completely consistent.

In most cases, if a *hostlist* is not specified, all machines are queried. However, if the **-X** and **-C** flags are specified without a *hostlist*, the command will run on one inbound Schedd in the remote cluster. In this case, the Schedd version information from the inbound Schedd in the remote cluster will be displayed.

Certain resources such as remote direct-memory access (RDMA) have their available value always calculated by startd. Available **ConsumableCpus** resources are calculated by startd if the value is specified as **all** in the administration file. When the value of a resource is calculated by startd, the **llstatus** command appends a plus (+) sign to the resource name in the output reports. Resources that are automatically created, such as RDMA, have a less than (<) sign appended to them.

Examples

1. This example generates the standard listing where there are two nodes in the cluster. The standard listing is generated when you do *not* specify the **-l** option with the **llstatus** command.

   ```
   llstatus
   ```

   You should receive output similar to the following:

   ```
   Name                    Schedd InQ Act Startd Run LdAvg Idle Arch  OpSys
   k10n09.ppd.pok.ibm.com  Avail   3   1  Run      1 2.72     0 R6000 AIX53
   k10n12.ppd.pok.ibm.com  Avail   0   0  Idle     0 0.00   365 R6000 AIX53

   R6000/AIX53            2 machines   3 jobs   1 running tasks
   Total Machines         2 machines   3 jobs   1 running tasks

   The Central Manager is defined on k10n09.ppd.pok.ibm.com

   The BACKFILL scheduler is in use

   Cluster name is cluster2

   All machines on the machine_list are present.
   ```

   The **standard listing** includes the following fields:

   Act Number of job steps dispatched by the Schedd daemon on this machine.

   Arch The hardware architecture of the machine as listed in the configuration file.

   Idle The number of seconds since keyboard or mouse activity in a login session was detected. Highest number displayed is 9999.

   InQ Number of job steps in the job queue of this Schedd machine.

   LdAvg Berkeley one-minute load average on this machine.

   Name Hostname of the machine.

   OpSys
   The operating system on this machine.

   Run The number of initiators used by the startd daemon to run LoadLeveler jobs on this machine. One initiator is used for each serial job step and one initiator is used for each task of a parallel job step.

Schedd
State of the Schedd daemon, which can be one of the following:
- Down
- Drned (Drained)
- Drning (Draining)
- Avail (Available)

For more information, see "The Schedd daemon" on page 10.

Startd State of the startd daemon, which can be:
- Busy
- Down
- Drned (Drained)
- Drning (Draining)
- Flush
- Idle
- None
- Run (Running)
- Suspnd (Suspend)

For more information, see "The startd daemon" on page 11.

Total Machines
The standard listing includes the following summary fields:

jobs The number of job steps in LoadLeveler job queues.

machines
The number of machines in the cluster that have made a status report to the central manager.

running tasks
The number of initiators used by all the startd daemons in the LoadLeveler cluster. One initiator is used for each serial job step. One initiator is used for each task of a parallel job step.

The standard listing also contains summary information for the cluster such as the type of scheduler and the cluster name.

2. This example generates the long listing. The long listing is generated when you specify the **-l** flag with the **llstatus** command. See Appendix B, "Sample command output," on page 725 for sample output of long listings.

```
llstatus -l c271f2rp02
```

The **long listing** includes the following fields:

Adapter
Network adapter information associated with this machine.

- For a switch adapter, the information format is:

```
adapter_name(network_type, interface_name,
interface_address, multilink_address,
switch_node_number or
adapter_logical_id, available_adapter_windows/
total_adapter_windows, unused rCxt blocks/
total rCxt blocks, adapter_fabric_connectivity,
adapter_state)
```

For example:

```
Adapter = networks(striped,c60f1rp01ml0.ppd.pok.ibm.com,
10.10.10.1,,-1,32/32,1596/1596 rCxt Blks,1,READY)
en0(ethernet,c60f1rp01.ppd.pok.ibm.com,9.114.88.65,)
network1(aggregate,,,10.10.10.1,-1,32/32,1596/1596 rCxt Blks,1,
READY)ml0(multilink,c60f1rp01ml0.ppd.pok.ibm.com,10.10.10.1,)
```

Possible values for `adapter_state` are:

ErrAdapter
The adapter information is incorrect. More information might be available in the network table API log.

ErrDown
The adapter has been reported as down. This field is displayed as part of the command output when the protocol network services daemon (**PNSD**) returns **RSCT_NAM_CONNECT_DOWN** adapter status.

ErrInternal
An error occurred while accessing the adapter. More information might be available in the network table API log and if the **D_FULLDEBUG** and **D_ADAPTER** flags are specified for **STARTD_DEBUG**.

ErrNotConfigured
The adapter is not configured. This field is displayed as part of the command output when the **PNSD** daemon returns **RSCT_NAM_CONNECT_UNCONFIG** adapter status.

ErrNotConnected
The adapter is not connected to the network.

ErrNotInitialized
An error occurred initializing access to the adapter. More information might be available if the **D_FULLDEBUG** and **D_ADAPTER** flags are specified for **STARTD_DEBUG**.

ErrNTBL
An error occurred while accessing the network table API. More information might be available if the **D_FULLDEBUG** and **D_ADAPTER** flags are specified for **STARTD_DEBUG**.

ErrNTBLVersion
The version of the available network table API is not compatible with the version required by LoadLeveler.

ErrPerm
The network table API reported that LoadLeveler does not have permission to access the adapter. More information might be available in the network table API log.

ErrPNSD
An error occurred in the network table API. More information might be available in the network table API log.

ErrType
The network table API reported that the adapter is not a switch adapter. Check the adapter configuration.

MachineDown
The machine to which the adapter is attached could not be reached by LoadLeveler to query status.

NOT READY
An unspecified problem occurred when accessing the adapter state. More information might be available if the **D_FULLDEBUG** and **D_ADAPTER** flags are specified for **STARTD_DEBUG**.

READY
The adapter can be used for communication.

- For non-switch adapters, the format is:

  ```
  adapter_name(network_type, interface_name, interface_address,
  multilink_address)
  ```

Arch Hardware architecture of this machine.

AvailableClasses
List of available classes and the associated number of available initiators on this machine.

Completed
The number of job steps in this state on this Schedd machine.

Config Time Stamp
Date and time of last configuration or reconfiguration.

ConfiguredClasses
List of configured classes and the associated number of configured initiators on this machine.

ConsumableResources
List of consumable resources associated with this machine. Each element of this list has the format: `resource_name(available, total)`.

Note: The individual CPU ID < > notation will be used to list individual CPU IDs instead of the CPU count ( ) notation for machines where the **RSET_SUPPORT** configuration file keyword is set to **RSET_MCM_AFFINITY**. The CPU count ( ) notation will be used when the **RSET_SUPPORT** configuration file keyword is set to **RSET_USER_DEFINED** or **RSET_NONE**, or if this keyword is not specified in the configuration file.

CONTINUE
The expression, defined following C conventions in the configuration file, that evaluates to true or false (T or F). This determines whether suspended jobs are continued on this machine.

Cpus Number of CPUs on this machine.

CustomMetric
This value can be the number assigned to the **CUSTOM_METRIC** keyword or the exit code of the executable associated with the **CUSTOM_METRIC_COMMAND** keyword or the default value of 1.

Disk Available space, in kilobytes (less 512 KB) in LoadLeveler's execute directory on this machine.

DrainedClasses
List of classes which have been drained. If a job step is in a class named on this list, that job step will not start on this machine.

DrainingClasses
List of classes which are currently being drained on this machine. If a job step is in a class named on this list, that job step will not start on this machine.

Entered Current State
Date and time when machine state was set.

FabricConnectivity
Represents the current state of connectivity between the machine and the switch through the switch adapters. The format of the field is: `network_id: connectivity, network_id: connectivity...` where connectivity is either 1 or 0. A value of 1 indicates an active connection from the machine to a given network_id through one of the switch adapters.

If a machine does not have switch adapters, the **FabricConnectivity** field has no meaning and should be ignored by the user.

Feature
Set of all features on this machine.

FreeLargePageMemory
Free Large Page memory.

In LoadLeveler for Linux, the **FreeLargePageMemory** field has no meaning and should be ignored by the user.

FreeRealMemory
Free real memory, in megabytes, on this machine. This value should track closely with the ″fre″ value of the **vmstat** command and the ″free″ value of the **svmon -G** command whose units are 4 KB blocks.

Held The number of job steps in this state on this Schedd machine.

Idle The number of job steps in this state on this Schedd machine.

Keyboard Idle
Number of seconds since last keyboard or mouse activity.

KILL The expression, defined following C conventions in the configuration file, that evaluates to true or false (T or F). This determines whether jobs running on this machine should be sent the SIGKILL signal.

LargePageMemory
Configured Large Page physical memory.

In LoadLeveler for Linux, the **LargePageMemory** field has no meaning and should be ignored by the user.

LargePageSize
The size of a Large Page memory block.

In LoadLeveler for Linux, the **LargePageSize** field has no meaning and should be ignored by the user.

LoadAvg
Berkely one-minute load average on machine.

Machine
Fully qualified name of the machine.

Machine Mode
The type of job this machine can run. This can be: **batch**, **interactive**, or **general**.

MACHPRIO
Actual expression that determines machine priority, defined in the configuration file.

MasterMachPriority
The machine priority for the parallel master node.

Max_Dstg_Starters
A machine-specific limit on the number of data staging initiators. This is also the number of initiators available on that machine for the **data_stage** class.

Max_Starters
Maximum number of initiators that can be used simultaneously on this machine.

Mcms The MCMs information associated with this machine has the format:

mcm_info ... mcm_info

The format of *mcm_info* is:

```
MCMnumber Available Cpus: < cpulist > (Total Cpus)
Used Cpus: < cpulist > (Total Cpus)
Adapters: adapater_info .... adapter_info
Total Tasks: (Tasks)
```

where:

Available Cpus
Are the CPUs available for LoadLeveler on this MCM.

Used Cpus
Are the CPUs used by LoadLeveler jobs from this MCM.

Adapters
Are the switch adapters connected to this MCM.

Total tasks
Is the total number of tasks that are running using CPUs of this MCM.

where *number* is the MCM sequence number:

cpulist Is a blank-delimited list of individual CPU IDs or CPU ranges, or a combination of both CPU IDs and CPU ranges associated with the MCM.

adapter_info
Has the format:

```
[used windows/available windows, used
memory/available memory]
```

where:

used windows
Is the total number of windows used.

available windows
Is the total number of available windows.

used memory
Is the total memory used. It is the number of rCxt blocks for the High Performance Switch adapter.

available memory
Is the total available memory. It is the number of rCxt blocks for the High Performance Switch adapter.

Tasks Is the total number of tasks that are running using the CPUs of this MCM.

Memory
Regular physical memory, in megabytes, on this machine.

Name Hostname of the machine.

OpSys
Operating system on this machine.

PagesFreed
Pages freed per second. This value corresponds to the ″fr″ value of the **vmstat** command output.

In LoadLeveler for Linux, the **PagesFreed** field has no meaning and should be ignored by the user.

PagesPaged In
Pages paged in from paging space per second. This value corresponds to the ″pi″ value of the **vmstat** command output.

In LoadLeveler for Linux, the **PagesPagedIn** field has no meaning and should be ignored by the user.

PagesPagedOut
Pages paged out to paging space per second. This value corresponds to the ″po″ value of the **vmstat** command output.

In LoadLeveler for Linux, the **PagesPagedOut** field has no meaning and should be ignored by the user.

PagesScanned
Pages scanned by the page-replacement algorithm per second. This value corresponds to the ″sr″ value of the **vmstat** command output.

In LoadLeveler for Linux, the **PagesScanned** field has no meaning and should be ignored by the user.

Pending
The number of job steps in this state on this Schedd machine.

Pool The identifier of the pool where this startd machine is located.

Prestarted_Starters
The maximum number of Prestarted Starters that can be started on this machine at any time.

Remove Pending
The number of job steps in this state on this Schedd machine.

ReservationPermitted
Indicates whether or not the node can be reserved. It is displayed as T or F (true or false).

Reservations
The IDs of reservations that will use the node now or in the future.

RSetSupportType
Indicates the type of RSet support set up on a machine. Possible values are:
RSET_MCM_AFFINITY
Creates and attaches RSets for tasks to satisfy memory and affinity requests.
RSET_NONE
Indicates that LoadLeveler RSet support is not available.
RSET_USER_DEFINED
Attaches user-created RSets to Tasks.

Running Tasks
The number of initiators used by the startd daemon to run LoadLeveler jobs. One initiator is used for each serial job step. One initiator is used for each task of a parallel job step.

Running steps
The list of job steps currently running on this machine.

ScheddAvail
Flag indicating if machine is running a Schedd daemon (0=no, 1=yes).

ScheddRunning
The number of job steps submitted to this machine that are running somewhere in the LoadLeveler cluster.

ScheddState
The state of the Schedd daemon on this machine, which can be one of the following:
- Down
- Drned (Drained)
- Drning (Draining)
- Avail (Available)

Speed Speed associated with the machine.

SMT Indicates whether the simultaneous multithreading (SMT) function is turned on, off, or is not supported in the running machine. Valid values are **Enabled**, **Disabled**, or **Not Supported**.

START
The expression, defined following C conventions in the configuration file, that evaluates to true or false (T or F). This determines whether jobs can be started on this machine.

StartdAvail
Flag indicating if machine is running a startd daemon (0=no, 1=yes).

Starting
The number of job steps in this state on this Schedd machine.

State State of the startd daemon, which can be:
- Busy
- Down
- Drained
- Draining
- Flush
- Idle
- None
- Running
- Suspend

For more information, see "The startd daemon" on page 11.

Subnet
The TCP/IP subnet that this machine resides on.

SUSPEND
The expression, defined following C conventions in the configuration file, that evaluates to true or false (T or F). This determines whether running jobs should be suspended on this machine.

SYSPRIO
Actual expression that determines overall system priority of a job step. Defined in the configuration file.

TimeStamp
The date and time the central manager last received a status update from this Schedd machine.

Tmp Available space, in kilobytes (less than 512 KB) in the /tmp directory on this machine.

Total Jobs
The number of total job steps submitted to this Schedd machine.

TotalMemory
The sum of configured regular and Large Page memory.

Unexpanded
The number of job steps in this state on this Schedd machine.

VACATE
The expression, defined following C conventions in the

configuration file, that evaluates to true or false (T or F). This determines whether suspended jobs are vacated on this machine.

Virtual Memory
Available swap space (free paging space) in kilobytes, on this machine.

3. This example generates a listing of cluster information defined in the administration file and the Schedd version for **cluster2**. Only fields with data are displayed.

```
llstatus -X cluster2 -C
```

The output representing a cluster is delineated with a cluster header and the Schedd version information from a remote cluster similar to the following:

```
================== Cluster cluster2 ================================
llstatus: Sending request to Schedd "c188f2n08.ppd.pok.ibm.com" in
          cluster "cluster2"

cluster2: type = cluster
        Local = True
        inbound_schedd_port = 9605
        secure_schedd_port = 9607
        multicluster_security = NOT_SET
        ssl_cipher_list = ALL:eNULL:!aNULL
        inbound_hosts = c188f2n08.ppd.pok.ibm.com
        outbound_hosts = c188f2n08.ppd.pok.ibm.com
        exclude_classes = badtesters(cluster3) OKtesters(cluster1)
        main_scale_across_cluster = True
        allow_scale_across_jobs = True
cluster1: type = cluster
        Local = False
        inbound_schedd_port = 9605
        secure_schedd_port = 9607
        multicluster_security = NOT_SET
        ssl_cipher_list = ALL:eNULL:!aNULL
        inbound_hosts = c188f2n02.ppd.pok.ibm.com
        outbound_hosts = c188f2n02.ppd.pok.ibm.com
        exclude_users = loadl(cluster2)
        exclude_groups = april(cluster3)
        include_classes = No_Class
        main_scale_across_cluster = False
        allow_scale_across_jobs = True
cluster3: type = cluster
        Local = False
        inbound_schedd_port = 1966
        secure_schedd_port = 9607
        multicluster_security = NOT_SET
        ssl_cipher_list = ALL:eNULL:!aNULL
        inbound_hosts = c94n02.ppd.pok.ibm.com
        outbound_hosts = c94n02.ppd.pok.ibm.com(cluster1)
                         c94n06.ppd.pok.ibm.com(cluster2)
        main_scale_across_cluster = False
        allow_scale_across_jobs = True

        cluster2 schedd gateway Version:
        c188f2n08.ppd.pok.ibm.com   3.5.0.1  rsats001a  2008/01/25
             RHEL  4.0  132
```

4. This example generates a listing of all of the consumable resources associated with all of the machines in the LoadLeveler cluster.

```
llstatus -R
```

You should receive output similar to the following:

```
Machine                       Consumable Resource(Available, Total)
-------------------------     -------------------------------------
c209f1n01.ppd.pok.ibm.com     ConsumableCpus(4,4)+ ConsumableMemory
                               (1.000 gb,1.000 gb) n01_res(123,500)
c209f1n02.ppd.pok.ibm.com     ConsumableCpus< 0 1 2 3 4>< 0 1 2 3 4 >
                               n02_res(123,500) Frame5(10,10)
c209f1n05.ppd.pok.ibm.com     ConsumableCpus(4,4)+ ConsumableMemory
                               (1.000 gb,1.000 gb) spice2g6(250,360)

Resources with "+" appended to their names have the Total value reported
from Startd.
```

Note: The individual CPU ID < > notation will be used to list individual CPU IDs instead of the CPU count ( ) notation for machines where the **RSET_SUPPORT** configuration file keyword is set to **RSET_MCM_AFFINITY**. The CPU count ( ) notation will be used when the **RSET_SUPPORT** configuration file keyword is set to **RSET_USER_DEFINED** or **RSET_NONE**, or if this keyword is not specified in the configuration file.

5. This example generates a listing of information related to MCMs of machines in the LoadLeveler cluster.

   ```
   llstatus -M
   ```

   You should receive output similar to the following:

   ```
   Machine              MCM details
   -------------------- ------------------------------------------------
   c61f2sq01.ppd.pok.ibm.com
                MCM0
                   Available Cpus :< 0-15 >(16)
                   Used Cpus      :< >(0)
                   Adapters       :
                   Total Tasks    :(0)
                MCM1
                   Available Cpus :< 16-29 >(14)
                   Used Cpus      :< 16-27 >(12)
                   Adapters       :sn1[16/16,798/798 rCxt Blks]
                                   sn0[12/16,790/798 rCxt Blks]
                   Total Tasks    :(4)

   c61f2sq02.ppd.pok.ibm.com
                MCM0
                   Available Cpus :< 0-1 >(2)
                   Used Cpus      :< >(0)
                   Adapters       :
                   Total Tasks    :(0)
                MCM1
                   Available Cpus :< 2-3 >(2)
                   Used Cpus      :< >(0)
                   Adapters       :
                   Total Tasks    :(0)
   ```

   Note: The **-M** option will list the MCM information only when the **RSET_SUPPORT** configuration file keyword is set to **RSET_MCM_AFFINITY**.

6. This example generates a listing of all of the floating consumable resources associated with all of the machines in the LoadLeveler cluster. This option should not be specified with any other option.

   ```
   llstatus -F
   ```

   You should receive output similar to the following:

```
Floating Resource              Available     Total
------------------------------ ------------- ---------------
EDA_licenses                   20            29
Frame5                         15            20
WorkBench6                     5             7
XYZ_software                   6             6
```

7. This example generates a customized and formatted standard listing.

   ```
   llstatus -f %n %scs %inq %m %v %sts %l %o
   ```

   You should receive output similar to the following:

   ```
   Name             Schedd  InQ  Memory  FreeVMemory Startd LdAvg  OpSys
   ll5.pok.ibm.com  Avail   0    128     22708       Run    0.23   AIX53
   ll6.pok.ibm.com  Avail   3    224     16732       Run    0.51   AIX53

   R6000/AIX53             2 machines      3  jobs      3  running tasks
   Total Machines          2 machines      3  jobs      3  running tasks

   The Central Manager is defined on ll5.pok.ibm.com

   The BACKFILL scheduler is in use

   All machines on the machine_list are present.
   ```

8. This example generates a customized and unformatted (raw) standard listing.

   Customized, Unformatted Standard Listing: A customized Output fields are separated by an exclamation point (!).

   ```
   llstatus -r %n %scs %inq %m %v %sts %l %o
   ```

   You should receive output similar to the following:

   ```
   ll5.pok.ibm.com!Avail!0!128!22688!Running!0.14!AIX53
   ll6.pok.ibm.com!Avail!3!224!16668!Running!0.37!AIX53
   ```

9. This example generates a listing containing information about the status of adapters associated with all of the machines in the LoadLeveler cluster:

   ```
   llstatus -a
   ```

   You should receive output similar to the following:

   ```
   c271f2rp02.ppd.pok.ibm.com
   ml0(multilink,c271f2san02.ppd.pok.ibm.com,10.10.10.6,)
   networks(striped,c271f2san02.ppd.pok.ibm.com,10.10.10.6,,-1,500/512,
            1474/1596 rCxt Blks,1,READY)
   network1(aggregate,,,10.10.10.6,-1,500/512,500M/512M,1,READY)
     sn0(switch,c271f2s0n02.ppd.pok.ibm.com,192.168.0.6,10.10.10.6,2,250
         /256,737/798 rCxt Blks,1,READY,MCM0)
     sn1(switch,c271f2s1n02.ppd.pok.ibm.com,192.168.1.6,10.10.10.6,0,250
         /256,737/798 rCxt Blks,1,READY,MCM0)
   en0(ethernet,c271f2rp02.ppd.pok.ibm.com,9.114.175.82,)
   ```

   - For a switch adapter, the information format is:

     ```
     adapter_name(network_type, interface_name, interface_address,
     multilink_address, switch_node_number or
     adapter_logical_id, available_adapter_windows/total_adapter_windows,
     unused rCxt blocks/total rCxt blocks,
     adapter_fabric_connectivity, adapter_state[,adapter mcm id])
     ```

   - For non-switch adapters, the format is:

     ```
     adapter_name(network_type, interface_name, interface_address,
     multilink_address)
     ```

   - For InfiniBand, this example displays the port number on each InfiniBand adapter. The **llstatus** command does not show port information for adapters that are not InfiniBand adapters:

     ```
     llstatus -a
     ```

You should receive output similar to the following:

```
================================================================================
c171f6sq08.ppd.pok.ibm.com
ehca0(InfiniBand,,,,-1,0/0,0/0/0 rCxt Blks,101,READY)
eth0(ethernet,c171f6sq08.ppd.pok.ibm.com,9.114.136.59,)
network18338657682652659715(striped,,,,-1,64/64,0/0 rCxt Blks,101,
   READY)
network18338657682652659714(aggregate,,,,-1,64/64,0/0 rCxt Blks,1,
   READY)
ib1(InfiniBand,192.168.9.59,192.168.9.59,,2,64/64,0/0 rCxt Blks,1,
   READY,2)
network18338657682652659712(aggregate,,,,-1,64/64,0/0 rCxt Blks,1,
   READY)
ib0(InfiniBand,192.168.8.59,192.168.8.59,,2,64/64,0/0 rCxt Blks,1,
   READY,1)

================================================================================
c171f6sq07.ppd.pok.ibm.com
ehca0(InfiniBand,,,,-1,0/0,0/0/0 rCxt Blks,101,READY)
eth0(ethernet,c171f6sq07.ppd.pok.ibm.com,9.114.136.58,)
network18338657682652659715(striped,,,,-1,64/64,0/0 rCxt Blks,101,
   READY)
network18338657682652659714(aggregate,,,,-1,64/64,0/0 rCxt Blks,1,
   READY)
ib1(InfiniBand,192.168.9.58,192.168.9.58,,1,64/64,0/0 rCxt Blks,1,
   READY,2)
network18338657682652659712(aggregate,,,,-1,64/64,0/0 rCxt Blks,1,
   READY)
ib0(InfiniBand,192.168.8.58,192.168.8.58,,1,64/64,0/0 rCxt Blks,1,
   READY,1)
```

This following example displays information when the **PNSD** daemon returns **RSCT_NAM_CONNECT_UNCONFIG** adapter status:

```
c931f9ec09.ppd.pok.ibm.com
.
.
.
ib2(InfiniBand,c931f9ec09-ib2,10.0.3.97,,158484833,128/128,0/0
rCxtBlks,0,ErrNotConfigured,MCM1)
ib0(InfiniBand,c931f9ec09-ib0,10.0.1.97,,158484833,128/128,0/0
rCxtBlks,0,ErrNotConfigured,MCM0)
.
.
.
```

The Adapter error status **ErrDown** is displayed as part of the **llstatus –a** command output when the **PNSD** daemon returns **RSCT_NAM_CONNECT_DOWN** adapter status.

Note: The adapter MCM ID will be printed only for High Performance Switch adapters and only when the **RSET_SUPPORT** configuration file keyword is set to **RSET_MCM_AFFINITY**. A value of MCM-1 for this field means that none of the CPUs from the physical MCM, where that adapter is connected to, is part of the machine's partition.

10. This example generates a listing containing information about the status of the Blue Gene/L system in the LoadLeveler cluster.

    ```
    llstatus -b
    ```

    You should receive output similar to the following:

    ```
    Name          Base Partitions  c-nodes    InQ    Run
    BGL           1x2x4            8x16x32    4      1
    ```

11. This example generates information for base Blue Gene/L partition R010:

    ```
    llstatus -B R010
    ```

You should receive output similar to the following:

```
Base Partition Id: R010
  Base Partition State: UP
  Location: (0,1,0)
  C-node Memory: 1024 mb
  Number of IONodes: 64
  Sub Divided Busy: False
  PartitionState=READY Partition=GPFS_R010
```

12. This example generates information for Blue Gene/L partition GPFS_R010:

```
llstatus -P GPFS_R010
```

You should receive output similar to the following:

```
Partition Id: GPFS_R010
  Partition State: READY
  Description: Generated via BlockBuilder
  Owner: apeters
  Users:
  Connection: TORUS
  Size: 512
  Shape: 1x1x1
  Number of IONodes: 64
  Mode: VIRTUAL_NODE
  MloaderImage: /bgl/BlueLight/ppcfloor/bglsys/bin/mmcs-mloader.rts
  BlrtsImage: /bgl/BlueLight/ppcfloor/bglsys/bin/rts_hw.rts
  LinuxImage: /bgl/BlueLight/ppcfloor/bglsys/bin/zImage.elf
  RamDiskImage: /bgl/BlueLight/ppcfloor/bglsys/bin/ramdisk.elf
  Small Partitions: False
  Base Partition List: R010
  Switch ID: X_R010
    Switch State: UP
    Base Partition: R010
    Switch Dimension: X
    Switch Connections:
      FromPort=PORT_S0 ToPort=PORT_S1 PartitionState=READY Partition=GPFS_R010
  Switch ID: Y_R010
    Switch State: UP
    Base Partition: R010
    Switch Dimension: Y
    Switch Connections:
      FromPort=PORT_S0 ToPort=PORT_S1 PartitionState=READY Partition=GPFS_R010
  Switch ID: Z_R010
    Switch State: UP
    Base Partition: R010
    Switch Dimension: Z
    Switch Connections:
      FromPort=PORT_S0 ToPort=PORT_S1 PartitionState=READY Partition=GPFS_R010
```

13. The following example shows output for the **llstatus -l** command that displays the SMT state for the machine:

```
================================================================================
     Name = devf1n01.clusters.com
  Machine = devf1n01.clusters.com
     Arch = ppc64
    OpSys = Linux2
.
.
.
  Feature = SMT
.
.
.
      SMT = Enabled | Disabled | Not Supported
TimeStamp = Fri 25 Jan 2008 04:44:06 PM CST
.
.
.
```

14. This example generates a listing containing information about the status of the Blue Gene/P system in the LoadLeveler cluster.

    ```
    llstatus -b
    ```

    You should receive output similar to the following:

    ```
    Name          Base Partitions  c-nodes    InQ    Run
    BGP           4x1x2            32x8x16    0      0
    ```

15. This example generates information for base Blue Gene/P partition R001:

    ```
    llstatus -B R001
    ```

    You should receive output similar to the following:

    ```
    Base Partition Id: R00-M0
      Base Partition State: UP
      Location: (0,0,0)
      C-node Memory: 2048 mb
      Number of IONodes: 32
      Sub Divided Busy: True
      Node Card List:
        NodeCardId=N00      NodeCardState=UP    Quarter=Q1 PartitionState=NONE
           Partition=NONE
        NodeCardId=N01      NodeCardState=UP    Quarter=Q1 PartitionState=READY
           Partition=R00-M0-N01
        NodeCardId=N02      NodeCardState=UP    Quarter=Q1 SubDividedBusy=True
          IONodeId=J00      IPAddress=172.16.103.5    PartitionState=READY
             Partition=R00-M0-N02-J00
          IONodeId=J01      IPAddress=172.16.103.6    PartitionState=READY
             Partition=R00-M0-N02-J01
        NodeCardId=N03      NodeCardState=UP    Quarter=Q1 SubDividedBusy=True
          IONodeId=J00      IPAddress=172.16.103.7    PartitionState=NONE
             Partition=NONE
          IONodeId=J01      IPAddress=172.16.103.8    PartitionState=READY
             Partition=R00-M0-N03-J01
        NodeCardId=N04      NodeCardState=UP    Quarter=Q2 SubDividedBusy=True
          IONodeId=J00      IPAddress=172.16.103.9    PartitionState=READY
             Partition=R00-M0-N04-J00
          IONodeId=J01      IPAddress=172.16.103.10   PartitionState=NONE
             Partition=NONE
        NodeCardId=N05      NodeCardState=UP    Quarter=Q2 PartitionState=NONE
          Partition=NONE
        NodeCardId=N06      NodeCardState=UP    Quarter=Q2 SubDividedBusy=True
          IONodeId=J00      IPAddress=172.16.103.13   PartitionState=READY
             Partition=R00-M0-N06-J00
          IONodeId=J01      IPAddress=172.16.103.14   PartitionState=NONE
             Partition=NONE
        NodeCardId=N07      NodeCardState=UP    Quarter=Q2 PartitionState=NONE
          Partition=NONE
        NodeCardId=N08      NodeCardState=UP    Quarter=Q3 PartitionState=READY
          Partition=R00-M0-N08-32
        NodeCardId=N09      NodeCardState=UP    Quarter=Q3 PartitionState=READY
          Partition=R00-M0-N09
        NodeCardId=N10      NodeCardState=UP    Quarter=Q3 SubDividedBusy=True
          IONodeId=J00      IPAddress=172.16.103.21   PartitionState=READY
             Partition=R00-M0-N10-J00
          IONodeId=J01      IPAddress=172.16.103.22   PartitionState=READY
             Partition=R00-M0-N10-J01
        NodeCardId=N11      NodeCardState=UP    Quarter=Q3 PartitionState=NONE
          Partition=NONE
        NodeCardId=N12      NodeCardState=UP    Quarter=Q4 SubDividedBusy=True
          IONodeId=J00      IPAddress=172.16.103.25   PartitionState=READY
             Partition=R00-M0-N12-J00
          IONodeId=J01      IPAddress=172.16.103.26   PartitionState=READY
             Partition=R00-M0-N12-J01
        NodeCardId=N13      NodeCardState=UP    Quarter=Q4 PartitionState=READY
          Partition=R00-M0-N13
        NodeCardId=N14      NodeCardState=UP    Quarter=Q4 PartitionState=NONE
          Partition=NONE
    ```

```
   NodeCardId=N15      NodeCardState=UP    Quarter=Q4 SubDividedBusy=True
     IONodeId=J00      IPAddress=172.16.103.31   PartitionState=READY
        Partition=R00-M0-N15-J00
     IONodeId=J01      IPAddress=172.16.103.32   PartitionState=NONE
        Partition=NONE
```

16. This example generates information for Blue Gene/P partition R00-M0-N08-32:

    ```
    llstatus -P R00-M0-N08-32
    ```

    You should receive output similar to the following:

    ```
    Partition Id: R00-M0-N08-32
      Partition State: READY
      Description: Generated via BlockBuilder
      Owner: mmundy
      Users:
      Connection: MESH
      Size: 32
      Shape: 0x0x0
      Number of IONodes: 2
      IONodes / Base Partition: N08-J00 N08-J01
      MloaderImage: /bgsys/drivers/ppcfloor/boot/uloader
      CnLoadImage: /bgsys/drivers/ppcfloor/boot/cns,/bgsys/drivers/ppcfloor
        /boot/cnk
      IoLoadImage: /bgsys/drivers/ppcfloor/boot/cns,
        /bgsys/drivers/ppcfloor/boot/linux,/bgsys/drivers/ppcfloor/boot/ramdisk
      Small Partitions: True
      Base Partition List: R00-M0
      Node Card List: N08
    ```

17. This example displays information pertaining to data staging:

    ```
    llstatus -l c197blade1b05
    ```

    You should receive output similar to the following:

    ```
    ================================================================
    Name                = c197blade1b05.ppd.pok.ibm.com
    Machine             = c197blade1b05.ppd.pok.ibm.com
    Arch                = i386
    OpSys               = Linux2
    SYSPRIO             = (0 - QDate)
    MACHPRIO            = (0 - LoadAvg)
    .
    .
    .
    LoadAvg             = 0.000000
    ConfiguredClasses   = small(2) medium(2) large(2) data_stage(3)
    AvailableClasses    = small(2) medium(2) large(2) data_stage(1)
    DrainingClasses     =
    DrainedClasses      =
    Pool                =
    FabricConnectivity  =
    Adapter             = eth0(unknown,c197blade1b05.ppd.pok.ibm.com,
                          9.114.198.5,)
    Feature             =
    Max_Starters        = 1
    Max_Dstg_Starters   = 3
    Prestarted_Starters = 1
    Total Memory        = 502 mb
    Memory              = 502 mb
    ```

Security

LoadLeveler administrators and users can issue this command.

llsubmit - Submit a job

Use the **llsubmit** command to submit a job to LoadLeveler to be dispatched based upon job requirements in the job command file.

Syntax

llsubmit [**-H**] [**-?**] [**-v**] [**-q**] [**-s**] [**-S**] [**-X** {*cluster_list* | **any**}] [*cmdfile* | **–**]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-q Specifies quiet mode: print no messages other than error messages.

-s Specifies that the **llsubmit** command will not exit until all steps of the job have completed. You cannot specify **-s** in combination with the **-X** flag.

-S Specifies that the job is a scale-across job that should be scheduled to run on a set of resources from multiple clusters. If specified with the **-X** option, the job will be scheduled to run on a set of resources from clusters that are provided in the cluster list specified by the **-X** option.

-X {*cluster_list* | **any**}
Is a blank-delimited list of cluster names or the reserved word **any** where:
- A single cluster name indicates that the job is to be submitted to that cluster.
- A list of multiple cluster names indicates that the job is to be submitted to one of the clusters as determined by the installation exit **CLUSTER_METRIC**.
- The reserved word **any** indicates the job is to be submitted to any cluster defined by the installation exit **CLUSTER_METRIC**.

For scale-across jobs, *cluster_list* is used to limit which clusters will be used to schedule and run the scale-across job. The **CLUSTER_METRIC** installation exit is not used for scale-across jobs.

If a *cluster_list* is specified with the **-X** option on the **llsubmit** command, the specified *cluster_list* takes precedence over any *cluster_list* statements already specified in the job command file.

cmdfile
Is the name of the job command file containing LoadLeveler commands.

– Specifies that LoadLeveler commands that would normally be in the job command file are read from stdin. When entry is complete, press `Ctrl-D` to end the input.

Description

- Users with **uid** or **gid** equal to 0 are not allowed to issue the **llsubmit** command.
- When a LoadLeveler job ends, you may receive UNIX mail notification indicating the job exit status. For example, you could get the following mail message:

```
Your LoadLeveler job
myjob1
exited with status 139.
```

The return code 139 is from the user's job, and is not a LoadLeveler return code.

- For more information on writing a program to filter job scripts, see "Filtering a job script" on page 76.
- The **llsubmit** command will display an error and fail to submit the job if the **resources** keyword in the job command file does not match the resources to be enforced and LoadLeveler is set to check for the **resources** specification. For more information, see "Defining usage policies for consumable resources" on page 60.
- If the LL_RES_ID environment variable is set, the **llsubmit** command will set the requested reservation ID of the submitted job steps using the value of the LL_RES_ID environment variable. When the central manager receives the job steps from the Schedd, it will bind the job steps to a specified reservation. If the job steps cannot be bound to the reservation, they will be placed in the **NotQueued** state and the requested reservation ID will keep the same value. If the value of LL_RES_ID is set to blank, it will be treated as if it were unset. The value for the **ll_res_id job** command file keyword overrides the value for the LL_RES_ID environment variable.
- If you want to submit a job to run on a specific type of machine (for example, one with **Arch = i386** and **OpSys= Linux2**), you must specify a requirements statement that includes the **Arch** and **OpSys** requirements.
- In a multicluster environment, job identifiers are assigned by the local cluster and are retained by the job regardless of what cluster the job runs in.

  If the job was submitted as a remote job in a multicluster environment, the host represented in *host.jobid.stepid*, is the name of the local Schedd machine that assigned the *jobid*. To determine the managing Schedd machine, issue the **llq -l** command to obtain the Schedd Host field.

  If the administrator has not defined a **CLUSTER_METRIC** for the local cluster, the **llsubmit** command will display an error and fail to submit the job if the user specifies the **-X** flag with a *cluster_list* or the reserved word **any**. The **llsubmit** command will also display an error and fail to submit the job if the user specifies the **-X** *cluster_name* in the following instances:
  - The local cluster is not in the multicluster environment
  - The specified cluster name is not configured
  - The specified cluster name does not have *inbound_hosts* specified

  The **CLUSTER_METRIC** installation exit is not used for scale-across jobs. If a scale-across job is submitted with a *cluster_list*, the command will *not* fail even if **CLUSTER_METRIC** is not defined.
- If the **-S** flag is specified with certain job command file statements, the job submission will fail and an error message will be displayed. For more information, see the **cluster_option** keyword in "Job command file keyword descriptions" on page 359.

Examples

1. This example shows a job command file named **qtrlyrun.cmd** is submitted:

   ```
   llsubmit qtrlyrun.cmd
   ```

   You should receive a response similar to the following when issued from the machine **earth**:

   ```
   llsubmit: The job "earth.505" has been submitted.
   ```

2. This example shows a job being submitted to a remote cluster:

   ```
   llsubmit -X cluster1 jcf.cmd
   ```

   You should receive a response similar to the following:

```
Job c188f2n08.ppd.pok.ibm.com.21 assigned to local outbound
                              Schedd c188f2n08.ppd.pok.ibm.com.
Job c188f2n08.ppd.pok.ibm.com.21 assigned to remote inbound
                              Schedd c188f2n02.ppd.pok.ibm.com.
Job c188f2n08.ppd.pok.ibm.com.21 has been submitted to cluster "cluster1"
llsubmit: The job "c188f2n08.ppd.pok.ibm.com.21" has been submitted.
```

3. This example shows a job command file specifying an inbound data staging step, an application job step, and an outbound data staging job step:

   ```
   llsubmit 3step.cmd
   ```

   You should receive output similar to the following:

   ```
   llsubmit: The job "c197blade1b05.ppd.pok.ibm.com.11" with 3 job steps
   has been submitted.
   ```

4. The following example may result in an error when a submitted job requires a higher number of consumable resources for one of its steps than what is allowed in the corresponding class stanza:

   ```
   llsubmit badconsres.cmd
   ```

   The following error messages are displayed:

   ```
   llsubmit: 2512-058 The consumable resources requested exceed the
   maximum allowed for the class.

   llsubmit: 2512-051 This job has not been submitted to LoadLeveler.
   ```

5. This example shows how to bind the steps contained in **jcf.cmd** to occurrence 21 of the **c197blade3b11.10.r** recurring reservation:

   ```
   LL_RES_ID=c197blade3b11.10.r.21 llsubmit jcf.cmd
   ```

   You should receive a response similar to the following:

   ```
   llsubmit: The job "c197blade3b11.ppd.pok.ibm.com.77" has been submitted.
   ```

6. This example shows the submission of a scale-across job. The job command file in this example does not contain the **cluster_option** or **cluster_list** job command file statement.

   ```
   llsubmit -S sa.cmd
   ```

   The following messages are displayed:

   ```
   Job devf1n02v4.clusters.com.1 assigned to local outbound Schedd
      devf1n02v4.clusters.com.
   Job devf1n02v4.clusters.com.1 assigned to remote inbound Schedd
      devf1n02v2.clusters.com.
   Job devf1n02v4.clusters.com.1 has been submitted to cluster "clusterA"
   llsubmit: The job "devf1n02v4.clusters.com.1" has been submitted.
   ```

   Note: The cluster, **clusterA**, referred to in the third message, is the main scale-across cluster.

   A subsequent query of the job from the main scale-across cluster will include the following display:

   ```
   llq -l devf1n02v4.clusters.com.1.0
   =============== Job Step devf1n02v4.clusters.com.1.0 ===============
           Job Step Id: devf1n02v4.clusters.com.1.0
           ...
     Requested Cluster:
           ...
        Cluster Option: scale_across
          Cluster List: clusterB clusterC clusterD clusterE
   ```

7. This example shows the submission of a scale-across job using the **-S** and **-X** flags. The job command file in this example does not contain the **cluster_option** or **cluster_list** job command file statement.

```
llsubmit -S -X clusterC clusterD sa.cmd
```

The following messages are displayed:

```
Job devf1n02v4.clusters.com.2 assigned to local outbound Schedd
   devf1n02v4.clusters.com.
Job devf1n02v4.clusters.com.2 assigned to remote inbound Schedd
   devf1n02v2.clusters.com.
Job devf1n02v4.clusters.com.2 has been submitted to cluster "clusterA"
llsubmit: The job "devf1n02v4.clusters.com.2" has been submitted.
```

Note: The cluster, **clusterA**, referred to in the third message, is the main scale-across cluster.

A subsequent query of the job from the main scale-across cluster will include the following display:

```
llq -l devf1n02v4.clusters.com.2.0
=============== Job Step devf1n02v4.clusters.com.2.0 ===============
        Job Step Id: devf1n02v4.clusters.com.1.0
        ...
  Requested Cluster: clusterC clusterD
        ...
     Cluster Option: scale_across
       Cluster List: clusterC clusterD
```

Note: The **Requested Cluster** output line contains only the clusters specified in the **-X** flag of the **llsubmit** command.

8. To submit **job1.cmd** and wait for the job's completion, issue:

   ```
   llsubmit -s job1.cmd
   ```

   The **llsubmit** command will not exit until all steps of the job have completed.

Related Information

Subroutines: **llsubmit**

Security

LoadLeveler administrators and users can issue this command.

llsummary - Return job resource information for accounting

Use the **llsummary** command to return job resource information on completed jobs for accounting purposes.

Syntax

llsummary

[**-?**] [**-H**] [**-v**] [**-x**] [**-l**] [**-s** *MM/DD/YYYY* **to** *MM/DD/YYYY*]
[**-e** *MM/DD/YYYY* **to** *MM/DD/YYYY*] [**-g** *group*]
[**-G** *unixgroup*] [**-a** *allocated*] [**-r** *report*] [**-j** *jobname*]
[**-d** *section*] [**-c** *class*] [**-u** *user*] [*filelist*]

Flags

-? Provides a short usage message.

-H Provides extended help information.

-v Displays the name of the command, release number, service level, service level date, and lowest level of the operating system to run this release.

-x Provides extended information. Using **-x** can produce a very long report. This option is meaningful only when used with the **-l** option. You must enable the recording of accounting data in order to collect information with the **-x** flag. To do this, specify **ACCT=A_ON A_DETAIL** in your **LoadL_config** file.

-l Specifies that the long form of output is displayed.

-s Specifies a range for the start date (queue date) for accounting data to be included in this report. The format for entering the date is either *MM/DD/YYYY* (where *MM* is month, *DD* is day, and *YYYY* is year), *MM/DD/YY* (where *YY* is a two-digit year value), or a string of digits representing the number of seconds since 1970. If a two-digit year value is used, then 69-99 maps to 1969-1999, and 00-68 maps to 2000-2068. The default is to include all the data in the report.

-e Specifies a range for the end date (completion date) for accounting data to be included in this report. The format for entering the date is either *MM/DD/YYYY* (where *MM* is month, *DD* is day, and *YYYY* is year), *MM/DD/YY* (where *YY* is a two-digit year value), or a string of digits representing the number of seconds since 1970. The default is to include all the data in the report.

-u *user*
Specifies the user ID for whom accounting data is reported.

-c *class*
Specifies the class for which accounting data is reported. For reports of all formats (short, long and extended), **llsummary** will report information about every job which contains at least one step of the specified class. For the short format, **llsummary** also reports a job count and step count for each class; for these counts, a job's class is determined by the class of its first step.

-g *group*
Specifies the LoadLeveler group for which accounting data is reported. For reports of all formats (short, long and extended), **llsummary** reports information about every job which contains at least one step of the specified group. For the short format, **llsummary** also reports a job count and step count for each group; for these counts, a job's group is determined by the group of its first step.

-G *unixgroup*
Specifies the UNIX group for which accounting data is reported.

-a *allocated*
Specifies the hostname that was allocated to run the job. You can specify the allocated host in short or long form.

-r *report*
Specifies the report type. You must enable the recording of accounting data in order to collect information with the **-r** flag. To do this, specify **ACCT=A_ON A_DETAIL** in your **LoadL_config** file. You can choose one or more of the following reports:

avgthroughput
Provides average queue time, run time, and CPU time for jobs that ran for at least some period of time.

maxthroughput
Provides maximum queue time, run time, and CPU time for jobs that ran for at least some period of time.

minthroughput
Provides minimum queue time, run time, and CPU time for jobs that ran for at least some period of time.

numeric
Reports CPU times in seconds rather than hours, minutes, and seconds.

resource
Provides CPU usage for all submitted jobs, including those that did not run. This is the default.

throughput
Selects all throughput reports.

-d *section*
Specifies the category (data section) for which you want to generate a report. You can specify one or more of the following: **user**, **group**, **unixgroup**, **class**, **account**, **day**, **week**, **month**, **jobid**, **jobname**, **allocated**.

-j *host.jobid*
Specifies the job for which accounting data is reported.

The format of a full LoadLeveler job identifier is *host.jobid*.

where:

- *host* is the name of the machine that assigned the job identifiers.
- *jobid* is the job number assigned to the job when it was submitted.

The entire *host.jobid* string is required.

filelist
Is a blank-delimited list of files containing the accounting data. If not specified, the default is the local history file on the machine from which the command was issued. You can use the **llacctmrg** command to combine history files on different Schedd machines into a single history file.

Description

You must enable the recording of accounting data in order to generate any of the four throughput reports. To do this, specify **ACCT=A_ON** in your **LoadL_config** file. For detailed usage of the **ACCT** keyword, see "Gathering job accounting data" on page 61.

In order to create an accounting report with the **llsummary** command, you must have read access to a history file. If a history file name is not specified as an argument, **llsummary** uses the history file in the LoadLeveler spool directory of the local machine as input. By default, the permissions of the spool directory are set by the **llinit** command to 700 at installation time. However, these permissions may be changed by a system administrators with root privileges.

The file permissions of the history file created by a **LoadL_schedd** daemon are controlled by the **HISTORY_PERMISSION** configuration keyword. A specification such as **HISTORY_PERMISSION = rw-rw-r--** will result in permission settings of 664. The default settings are 660.

Notes on recurring reservations:

For recurring jobs, an accounting record will be written each the job completes, meaning that all steps of the job have completed. In the standard listing, the result is that the accounting data from every occurrence of the job that is present in the history file used is included in the summary totals. In the long and extended listings, each occurrence of each step will be displayed under a single job heading. Multiple occurrences of the same step can be distinguished by the **Reservation ID** field, which will include the occurrence ID as part of the reservation ID.

Examples

1. The following example requests summary reports (standard listing) of all the jobs submitted on your machine between the days of January 15, 2008 and March 15, 2008:

   ```
   llsummary -s 01/15/2008 to 03/15/2008
   ```

2. This example generates the standard listing when you do not specify **-l**, **-r**, or **-d** with **llsummary**.

   This sample report includes summaries of the following data:
   - Number of jobs, Total CPU usage, per user.
   - Number of jobs, Total CPU usage, per class.
   - Number of jobs, Total CPU usage, per group.
   - Number of jobs, Total CPU usage, per account number.

   ```
   llsummary
   ```

   You should receive output similar to the following:

```
     Name   Jobs   Steps        Job Cpu    Starter Cpu     Leverage
  krystal     15      36     0+00:09:50     0+00:00:10         59.0
   lixin3     18      54     0+00:08:28     0+00:00:16         31.8
    TOTAL     33      90     0+00:18:18     0+00:00:27         40.7

    Class   Jobs   Steps        Job Cpu    Starter Cpu     Leverage
    small      9      21     0+00:01:03     0+00:00:06         10.5
    large     12      36     0+00:13:45     0+00:00:11         75.0
     osl2      3       9     0+00:00:27     0+00:00:02         13.5
 No_Class      9      24     0+00:03:01     0+00:00:06         30.2
    TOTAL     33      90     0+00:18:18     0+00:00:27         40.7
```

```
      Group   Jobs   Steps        Job Cpu    Starter Cpu     Leverage
   No_Group     12      30     0+00:09:32     0+00:00:09         63.6
  chemistry      7      18     0+00:04:50     0+00:00:05         58.0
engineering     14      42     0+00:03:56     0+00:00:12         19.7
  TOTAL         33      90     0+00:18:18     0+00:00:27         40.7

    Account   Jobs   Steps        Job Cpu    Starter Cpu     Leverage
      33333     16      39     0+00:05:54     0+00:00:11         32.2
      22222     15      45     0+00:12:05     0+00:00:13         55.8
      99999      2       6     0+00:00:18     0+00:00:01         18.0
      TOTAL     33      90     0+00:18:18     0+00:00:27         40.7
```

The **standard listing** includes the following fields:

Account
: Account number specified for the jobs.

Class Class specified or defaulted for the jobs.

Group User's login group.

Job CPU
: Total CPU time consumed by user's jobs.

Jobs Count of the total number of jobs submitted by this user, class, group, or account.

Leverage
: Ratio of job CPU to starter CPU.

Name User ID submitting jobs.

Starter CPU
: Total CPU time consumed by LoadLeveler starter processes on behalf of the user jobs.

Steps Count of the total number of job steps submitted by this user, class, group, or account.

3. To generate a throughput report, issue:

```
llsummary -r throughput
```

You should receive output similar to the following. Note that only the user output is shown, the class, group, and account lines are not shown.

```
  Name   Jobs   Steps   AvgQueueTime    AvgRealTime     AvgCPUTime
 loadl      1       4     0+00:00:03     0+00:05:27     0+00:05:17
 user1      2       6     0+00:03:05     0+00:03:45     0+00:03:04
   ALL      3      10     0+00:01:52     0+00:04:26     0+00:03:58

  Name   Jobs   Steps   MinQueueTime    MinRealTime     MinCPUTime
 loadl      1       4     0+00:00:01     0+00:02:49     0+00:02:44
 user1      2       6     0+00:02:02     0+00:03:43     0+00:03:02
   ALL      3      10     0+00:00:01     0+00:02:49     0+00:02:44

  Name   Jobs   Steps   MaxQueueTime    MaxRealTime     MaxCPUTime
 loadl      1       4     0+00:00:06     0+00:12:58     0+00:12:37
 user1      2       6     0+00:06:21     0+00:03:48     0+00:03:07
   ALL      3      10     0+00:06:21     0+00:12:58     0+00:12:37
```

The **-r** listing includes the following fields:

AvgCPUTime
: Average amount of accumulated CPU time for jobs associated with this user, class, group, or account.

AvgQueueTime
: Average amount of time the job spent queued before running for this user, class, group, or account.

AvgRealTime
Average amount of accumulated wall clock time for jobs associated with this user, class, group, or account.

MaxCPUTime
Time of the job with the greatest amount of CPU time for this user, class, group, or account.

MaxQueueTime
Time of the job that spent the greatest amount of time in queue before running for this user, class, group, or account.

MaxRealTime
Time of the job with the greatest amount of wall clock time for this user, class, group, or account.

MinCPUTime
Time of the job with the least amount of CPU time for this user, class, group, or account.

MinQueueTime
Time of the job that spent the least amount of time in queue before running for this user, class, group, or account.

MinRealTime
Time of the job with the least amount of wall clock time for this user, class, group, or account.

The ALL line for the Average listing displays the average time for all users, classes, groups, and accounts. The ALL line for the Minimum listing displays the time of the job with the least amount of time for all users, classes, groups, and accounts. The ALL line for the Maximum listing displays the time of the job with the greatest amount of time for all users, classes, groups, and accounts.

4. The following example generates the long listing that contains Blue Gene-specific information:

```
llsummary -l -j job_name
```

You should receive output similar to the following:

```
.
.
.
           Step Type: bluegene
      Min Processors: 1
      Max Processors: 1
      Size Requested: 2048
      Size Allocated: 2048
     Shape Requested:
     Shape Allocated: 32x8x8
    Wiring Requested: PREFER_TORUS
    Wiring Allocated: TORUS
              Rotate: TRUE
 Partition Requested:
 Partition Allocated: part130
     BG Requirements: (Memory == 1024)
          Error Text:
   Alloc. Host Count: 1
.
.
.
```

5. The following example generates the long listing that contains multicluster-specific information submitted or moved to a remote cluster:

```
llsummary -l
```

You should receive output similar to the following:

```
.
.
.
 Scheduling Cluster: cluster1
 Submitting Cluster: cluster2
    Sending Cluster: cluster2
    Submitting User: brownap
     Schedd History: c188f2n08.ppd.pok.ibm.com
   Outbound Schedds: c188f2n08.ppd.pok.ibm.com
 .
 .
 .
 Cluster input file: /u/brownap/copyfile_input, /tmp/copyfile_input1
 Cluster input file: /u/brownap/copyfile_input, /tmp/copyfile_input2
 Cluster input file: /u/brownap/copyfile_input, /tmp/copyfile_input3
Cluster output file: /tmp/copyfile_output, /u/brownap/copyfile_output
 .
 .
 .
```

For an explanation of the fields in the long listing, see "llq - Query job status" on page 479. See Appendix B, "Sample command output," on page 725 for sample output of long listings.

6. For InfiniBand support, the following example includes the port number for the allocated hosts and task instances:

   ```
   llsummary -l -x
   ```

   You should receive output similar to the following:

   ```
      .
      .
      .

     Task
     ----

        Num Task Inst: 4
        Task Instance: c171f6sq07:0:ib0(MPI,IP,-1,Shared,0 rCxt Blks,1),
           ib1(MPI,IP,-1,Shared,0 rCxt Blks,2)
        Task Instance: c171f6sq07:1:ib0(MPI,IP,-1,Shared,0 rCxt Blks,1),
           ib1(MPI,IP,-1,Shared,0 rCxt Blks,2)
        Task Instance: c171f6sq08:2:ib0(MPI,IP,-1,Shared,0 rCxt Blks,1),
           ib1(MPI,IP,-1,Shared,0 rCxt Blks,2)
        Task Instance: c171f6sq08:3:ib0(MPI,IP,-1,Shared,0 rCxt Blks,1),
           ib1(MPI,IP,-1,Shared,0 rCxt Blks,2)

      .
      .
      .
   ```

Security

LoadLeveler administrators and users can issue this command.

Chapter 17. Application programming interfaces (APIs)

The LoadLeveler application programming interfaces (APIs) allow application programs written by customers to interact with the LoadLeveler environment using specific data and functions that are a part of LoadLeveler.

These interfaces can be subroutines within a library or installation exits.

The header file **llapi.h** defines all of the API data structures and subroutines. This file is located in the **include** subdirectory of the LoadLeveler release directory. You must include this file when you call any API subroutine.

The library **libllapi.a** (AIX) or **libllapi.so** (Linux) is a shared library containing all of the LoadLeveler API subroutines. This library is located in the **lib** subdirectory of the LoadLeveler release directory.

Attention: These APIs are not *thread safe*; they should not be linked to by a threaded application. On AIX, xlC must be used to link a C object with the **libllapi.a** library.

Table 86 lists all of the LoadLeveler APIs, along with the intended users and supported operating systems for each, and a reference to the full descriptions of each interface.

Table 86. LoadLeveler API summary

Task / API category	Interface name	Intended users	Supported operating systems
Generate accounting reports "Accounting API" on page 544	**"GetHistory subroutine" on page 545**	Both administrators and general users	AIX and Linux
	"llacctval user exit" on page 547	Administrators only	AIX and Linux
Checkpoint LoadLeveler jobs "Checkpointing API" on page 548	**"ckpt subroutine" on page 549**	Provided for backward compatibility only. Use **ll_init_ckpt** and **ll_ckpt** instead.	AIX only
	"ll_ckpt subroutine" on page 550	Both administrators and general users	AIX and Linux[1]
	"ll_init_ckpt subroutine" on page 553	Both administrators and general users	AIX only
	"ll_set_ckpt_callbacks subroutine" on page 555	Both administrators and general users	AIX only
	"ll_unset_ckpt_callbacks subroutine" on page 556	Both administrators and general users	AIX only
Process configuration files "Configuration API" on page 557	**"ll_config_changed subroutine" on page 558**	Both administrators and general users	AIX and Linux
	"ll_read_config subroutine" on page 559	Both administrators and general users	AIX and Linux

Table 86. LoadLeveler API summary (continued)

Task / API category	Interface name	Intended users	Supported operating systems
Access LoadLeveler objects and retrieve data from objects "Data access API" on page 560	**"ll_deallocate subroutine" on page 568**	Both administrators and general users	AIX and Linux
	"ll_free_objs subroutine" on page 569	Both administrators and general users	AIX and Linux
	"ll_get_data subroutine" on page 570	Both administrators and general users	AIX and Linux
	"ll_get_objs subroutine" on page 624	Both administrators and general users	AIX and Linux
	"ll_next_obj subroutine" on page 627	Both administrators and general users	AIX and Linux
	"ll_query subroutine" on page 628	Both administrators and general users	AIX and Linux
	"ll_reset_request subroutine" on page 629	Both administrators and general users	AIX and Linux
	"ll_set_request subroutine" on page 630	Both administrators and general users	AIX and Linux
Convert an error object into an error message "Error handling API" on page 639	**"ll_error subroutine" on page 640**	Both administrators and general users	AIX and Linux
Fair share scheduling API "Fair share scheduling API" on page 641	**"ll_fair_share subroutine" on page 642**	Administrators only	AIX and Linux
Reservation APIs "Reservation API" on page 643	**"ll_bind subroutine" on page 645**	Both administrators and general users	AIX and Linux
	"ll_change_reservation subroutine" on page 648	Both administrators and general users	AIX and Linux
	"ll_init_reservation_param subroutine" on page 652	Both administrators and general users	AIX and Linux
	"ll_make_reservation subroutine" on page 653	Both administrators and general users	AIX and Linux
	"ll_remove_reservation subroutine" on page 658	Both administrators and general users	AIX and Linux
	"ll_remove_reservation_xtnd subroutine" on page 660	Both administrators and general users	AIX and Linux
Submit jobs to LoadLeveler "Submit API" on page 663	**"llfree_job_info subroutine" on page 664**	Both administrators and general users	AIX and Linux
	"llsubmit subroutine" on page 665	Both administrators and general users	AIX and Linux
	"monitor_program user exit" on page 667	Both administrators and general users	AIX and Linux

Table 86. LoadLeveler API summary (continued)

Task / API category	Interface name	Intended users	Supported operating systems
Perform LoadLeveler control operations and work with an external scheduler "Workload management API" on page 668	**"ll_cluster subroutine" on page 669**	Both administrators and general users	AIX and Linux
	"ll_cluster_auth subroutine" on page 671	Administrators only	AIX and Linux
	"ll_control subroutine" on page 673	Both administrators and general users can specify the following control operations: • LL_CONTROL_HOLD_USER • LL_CONTROL_PRIO_ABS • LL_CONTROL_PRIO_ADJ • LL_CONTROL_START • LL_CONTROL_START_DRAINED All other control operations defined in the **llapi.h** header file are intended for use by administrators only.	AIX and Linux
	"ll_modify subroutine" on page 677	Both administrators and general users	AIX and Linux
	"ll_move_job subroutine" on page 681	Administrators only	AIX and Linux
	"ll_move_spool subroutine" on page 683	Administrators only	AIX and Linux
	"ll_preempt subroutine" on page 686	Administrators only	AIX only
	"ll_preempt_jobs subroutine" on page 688	Administrators only	AIX and Linux
	"ll_run_scheduler subroutine" on page 691	Administrators only	AIX and Linux
	"ll_start_job_ext subroutine" on page 692	Administrators only	AIX and Linux
	"ll_terminate_job subroutine" on page 696	Administrators only	AIX and Linux

[1] This subroutine will run on LoadLeveler for Linux platforms, but it can only checkpoint jobs on AIX.

64-bit support for the LoadLeveler APIs

LoadLeveler for AIX APIs support both 32-bit and 64-bit applications. LoadLeveler for Linux APIs support 32-bit applications on 32-bit platforms and 64-bit applications on 64-bit platforms.

LoadLeveler for AIX APIs

In LoadLeveler 3.2 or later releases, the LoadLeveler API library (**libllapi.a**) consists of two sets of objects: 32-bit and 64-bit.

Both sets of objects and interfaces are provided since the AIX linker cannot create an executable from a mixture of 32-bit and 64-bit objects. They must be all of the same type. Developers attempting to exploit the 64-bit capabilities of the LoadLeveler API library should take into consideration that all interfaces of the

LoadLeveler API library are available in both 32-bit and 64-bit formats. Interfaces with the same names are functionally equivalent.

LoadLeveler for Linux APIs

On Linux, the LoadLeveler 3.5 API library (**libllapi.so**) is a 32-bit library on 32-bit platforms and a 64-bit library on 64-bit platforms.

The library **libllapi.so** is a 32-bit library on the following platforms:
- RHEL 4 and RHEL 5 on IBM IA-32 xSeries servers
- SLES 9 and SLES 10 on IBM IA-32 xSeries servers

libllapi.so is a 64-bit library on the following platforms:
- RHEL 4 and RHEL 5 on IBM System servers with AMD Opteron or Intel EM64T processors
- RHEL 4 and RHEL 5 on IBM Power Systems servers
- SLES 9 and SLES 10 on IBM System servers with AMD Opteron or Intel EM64T processors
- SLES 9 and SLES 10 on IBM Power Systems servers

For users running Parallel Operating Environment, there are 32-bit LoadLeveler library RPMs available for installing on the following 64-bit platforms:
- RHEL 4 on IBM System servers with AMD Opteron or Intel EM64T processors
- RHEL 4 on IBM Power Systems servers
- SLES 9 and SLES 10 on IBM System servers with AMD Opteron or Intel EM64T processors
- SLES 9 and SLES 10 on IBM Power Systems servers

Accounting API

Use the accounting API to extract accounting data and for account validation.

This API consists of the following subroutine and user exit:
- "GetHistory subroutine" on page 545
- "llacctval user exit" on page 547

Job accounting information saved in a history file can also be queried by using the data access API.

GetHistory subroutine

Use the **GetHistory** subroutine to process local or global LoadLeveler history files.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int GetHistory(char *filename, int (*func) (LL_job *), int version);
```

Parameters

filename
Specifies the name of the history file.

(*func*) (LL_job *)
Specifies the user-supplied function you want to call to process each history record. The function must return an integer and must accept as input a pointer to the LL_job structure. The LL_job structure is defined in the **llapi.h** file.

version
Specifies the version of the history record you want to create. LL_JOB_VERSION in the **llapi.h** file creates an LL_job history record.

Description

GetHistory opens the history file you specify, reads one LL_job accounting record, and calls a user-supplied routine, passing to the routine the address of an LL_job structure. **GetHistory** processes all history records one at a time and then closes the file. Any user can call this subroutine.

The user-supplied function must include the following files:

```
#include <sys/resource.h>
#include <sys/types.h>
#include <sys/time.h>
```

The ll_event_usage structure is part of the LL_job structure and contains the following LoadLeveler defined data:

int *event*
Specifies the event identifier. This is an integer whose value is one of the following:
1 Represents a LoadLeveler-generated event.
2 Represents an installation-generated event.

char **name*
Specifies a character string identifying the event. This can be one of the following:

- An installation generated string that uses the command **llctl capture** *eventname*.
- LoadLeveler-generated strings, which can be the following:
  - started
  - checkpoint
  - vacated
  - completed
  - rejected

– removed

Return Values

GetHistory returns a zero when successful.

Error Values

GetHistory returns -1 to indicate that the version is not supported or that an error occurred opening the history file.

Examples

Makefiles and examples which use this API are located in the **samples/llphist** subdirectory of the release directory. The examples include the executable **llpjob**, which invokes **GetHistory** to print every record in the history file. In order to compile **llpjob**, the sample Makefile must update the RELEASE_DIR field to represent the current LoadLeveler release directory. The syntax for **llpjob** is:

```
llpjob history_file
```

Where *history_file* is a local or global history file.

llacctval user exit

Use the **llacctval** executable to perform account validation.

Syntax

```
program user_name user_group user_acct# acct1 acct2 ...
```

Parameters

program
Is the name of the program that performs the account validation. The default is **llacctval**. The name you specify here must match the value specified on the **ACCT_VALIDATION** keyword in the configuration file.

user_name
Is the name of the user whose account number you want to validate.

user_group
Is the login group name of the user.

user_acct#
Is the account number specified by the user in the job command file.

acct1 acct2 ...
Are the account numbers obtained from the user stanza in the LoadLeveler administration file.

Description

The **llacctval** user exit compares the account number a user specifies in a job command file with the account numbers defined for that user in the LoadLeveler administration file. If the account numbers match, **llacctval** returns a value of zero. Otherwise, it returns a nonzero value.

The **llacctval** user exit is invoked from within the **llsubmit** command. If the return code is nonzero, **llsubmit** does not submit the job.

You can replace **llacctval** with your own accounting user exit.

To enable account validation, you must specify the following keyword in the configuration file:

```
ACCT = A_VALIDATE
```

To use your own accounting exit, specify the following keyword in the configuration file:

```
ACCT_VALIDATION = pathname
```

where *pathname* is the name of your accounting exit.

Return Values

If the validation succeeds, the exit status must be zero. If it does not succeed, the exit status must be a nonzero number.

Checkpointing API

Use the checkpointing API to checkpoint jobs running under LoadLeveler.

This API consists of the following subroutines:
- **"ckpt subroutine" on page 549**
- **"ll_ckpt subroutine" on page 550**
- **"ll_init_ckpt subroutine" on page 553**
- **"ll_set_ckpt_callbacks subroutine" on page 555**
- **"ll_unset_ckpt_callbacks subroutine" on page 556**

The **ll_ckpt** subroutine will run on LoadLeveler for Linux platforms, but it can only checkpoint jobs on AIX. All other checkpoint API functions are not supported on Linux.

For more information, see "LoadLeveler support for checkpointing jobs" on page 139. For information on checkpointing parallel jobs, see *IBM Parallel Environment for AIX and Linux: Operation and Use, Volume 1*.

ckpt subroutine

Use the **ckpt** subroutine in a FORTRAN, C, or C++ program to activate checkpointing from within the application. Whenever this subroutine is invoked, a checkpoint of the program is taken.

C++ syntax

```
extern "C"{void ckpt();}
```

C syntax

```
void ckpt();
```

FORTRAN syntax

```
call ckpt()
```

Description

Note: This API is obsolete and is supported for backward compatibility only. It calls **ll_init_ckpt**.

ll_ckpt subroutine

Use the **ll_ckpt** subroutine to initiate a checkpoint on a specific job step.

Library

LoadLeveler API library **libllapi.a** or **libllapi.so** (Linux)

Syntax

#include ″**llapi.h**″

int ll_ckpt (LL_ckpt_info ****ckpt_info*****);**

Parameters

ckpt_info
A pointer to a **LL_ckpt_info** structure, which has the following fields:

int *version*
The version of the API that the program was compiled with (from **llapi.h**).

char* *step_id*
A job or step identifier. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's host name to construct the full job or step identifier.

enum ckpt_type *ckptType*
The action to be taken after the checkpoint successfully completes. The values for **enum ckpt_type** are:

CKPT_AND_CONTINUE
Allows the job to continue after the checkpoint.

CKPT_AND_TERMINATE
Terminates the job after the checkpoint.

CKPT_AND_HOLD
Puts the job on user hold after the checkpoint. A coschedule job step can be specified with the **CKPT_AND_HOLD** option.

Note: If checkpoint is not successful, the job continues on return regardless of these settings.

enum wait_option *waitType*
The flag used to identify blocking action during checkpoint. By default, **ll_ckpt()** will block until the checkpoint completes. The values for the **enum wait_option** are:

CKPT_NO_WAIT
Disables blocking while the job is being checkpointed.

CKPT_WAIT
The job is blocked while being checkpointed. This is the default.

int *abort_sig*
Identifies the signal to be used to interrupt a checkpoint initiated by the API. Upon receipt of this signal the checkpoint will be aborted. Default is SIGINT.

cr_error_t **cp_error_data*
The structure containing error information from the checkpoint operation.

int *ckpt_rc*
The return code from checkpoint.

int *soft_limit*
The time, in seconds, indicating the maximum time allocated for a checkpoint operation to complete before the checkpoint operation is aborted. The job is allowed to continue. The value for soft_limit specified here will override any soft limit value specified in the job command file. If the value for soft limit specified by the administration file is less than the value specified here, the administration file value takes precedence.

Values are:

-1 Indicates there is no limit.

0 Indicates the existing soft limit for the job step should be enforced.

Positive integer
Indicates the number of seconds allocated for the limit.

int *hard_limit*
The time, in seconds, indicating the maximum time allocated for a checkpoint operation to complete before the job is terminated. The value for hard-limit specified here will override any hard limit value specified in the job command file. If the value for hard limit specified by the administration file is less than the value specified here, the administration file value will take precedence.

Values are:

-1 Indicates there is no limit.

0 Indicates the existing hard limit for the job step should be enforced.

Positive integer
Indicates the number of seconds allocated for the limit.

Description

This function initiates a checkpoint for the specified job step. **ll_ckpt()** will, by default, block until the checkpoint operation completes. To disable blocking, the flag *waitType* must be set to **NO_WAIT**. This function is allowed to be executed by the owner of the job step or a LoadLeveler administrator.

Return Values

0 Checkpoint completed successfully.

1 Checkpoint event did not receive status and the success or failure of the checkpoint is unclear.

Error Values

-1 Error occurred attempting to checkpoint.

-2 Format not valid for job step, not in the form *host.jobid.stepid*.

-3 Cannot allocate memory.

-4 API cannot create listen socket.

-6 Configuration file errors.

ll_init_ckpt subroutine

Use the **ll_init_ckpt** subroutine to initiate a checkpoint from within a serial application.

Library

LoadLeveler API library **libllapi.a**.

Syntax

```
#include "llapi.h"

int ll_init_ckpt (LL_ckpt_info *ckpt_info);
```

Parameters

ckpt_info
A pointer to a LL_ckpt_info structure, which has the following fields:

int *version*
The version of the API that the program was compiled with (from **llapi.h**).

char* *step_id*
NULL, not used.

enum ckpt_type *ckptType*
NULL, not used.

enum wait_option *waitType*
NULL, not used.

int *abort_sig*
NULL, not used.

cr_error_t **cp_error_data*
AIX structure containing error info from **ll_init_ckpt**. When the return code indicates the checkpoint was attempted but failed (-7), detailed information is returned in this structure.

int *ckpt_rc*
Return code from checkpoint.

int *soft_limit*
This field is ignored.

int *hard_limit*
This field is ignored.

Description

This subroutine is only available if you have enabled checkpointing. **ll_init_ckpt** initiates a checkpoint from within a serial application. The checkpoint file name will consist of a base name with a suffix of a numeric checkpoint tag to differentiate from an earlier checkpoint file. LoadLeveler sets the LOADL_CKPT_FILE environment variable which identifies the directory and file name for checkpoint files.

Return Values

0 The checkpoint completed successfully.

1 Indicates **ll_init_ckpt()** returned as a result of a restart operation.

Error Values

-1 Cannot retrieve the job step ID from the LOADL_STEP_ID environment variable.

-2 Cannot retrieve the checkpoint file name from the LOADL_CKPT_FILE environment variable, checkpoint has not been enabled for the job step (checkpoint not set to yes or interval).

-3 Cannot allocate memory.

-4 Checkpoint/restart ID is not valid, checkpointing is not enabled for the job step.

-5 Request to take checkpoint denied by starter.

-6 Request to take checkpoint failed, no response from starter, possible communication problem.

-7 Checkpoint attempted but failed. Details of error can be found in the **LL_ckpt_info** structure.

-8 Cannot install SIGINT signal handler.

ll_set_ckpt_callbacks subroutine

Use the **ll_set_ckpt_callbacks** subroutine to register callbacks, which will be invoked, when a job step is checkpointed, resumed, and restarted.

Library

LoadLeveler API library **libllapi.a**

Syntax

#include ″**llapi.h**″

int ll_set_ckpt_callbacks (callbacks_t *cbs**);**

Parameters

cbs

A pointer to a **callbacks_t** structure, which is defined as:

```
typedef struct  {
  void (*checkpoint_callback) (void) ;
  void (*restart_callback) (void) ;
  void (*resume_callback) (void) ;
} callbacks_t;
```

Where:

checkpoint_callback
Pointer to the function to be invoked at checkpoint time.

restart_callback
Pointer to the function to be invoked at restart time.

resume_callback
Pointer to the function to be called when an application is resumed after taking a checkpoint.

Description

This function is called to register functions to be invoked when a job step is checkpointed, resumed, and restarted.

Return Values

If successful, a nonnegative integer is returned which is a handle used to identify the particular set of callback functions. The handle can be used as input to the **ll_unset_ckpt_callbacks** function. If an error occurs, a negative number is returned.

Error Values

-1 Process is not enabled for checkpointing.

-2 Unable to allocate storage to store callback structure.

-3 Cannot allocate memory.

ll_unset_ckpt_callbacks subroutine

Use the **ll_unset_ckpt_callbacks** subroutine to unregister previously registered checkpoint, resume, and restart callbacks.

Library

LoadLeveler API library **libllapi.a**

Syntax

#include ″**llapi.h**″

int ll_unset_ckpt_callbacks(int *handle***);**

Parameters

handle
An integer indicating the set of callback functions to be unregistered. This integer is the value returned by the **ll_set_ckpt_callbacks** function which was used to register the callbacks.

Description

This API is called to unregister checkpoint, resume, and restart application callback functions which were previously registered with the **ll_set_ckpt_callbacks** function.

Return Values

0 Success.

Error Values

-1 Unable to unregister callback. Argument not valid, specified handle does not reference a valid callback structure.

Configuration API

Use the configuration API to operate on LoadLeveler configuration files.

This API consists of the following subroutines:

- **"ll_config_changed subroutine" on page 558**
- **"ll_read_config subroutine" on page 559**

ll_config_changed subroutine

Use the **ll_config_changed** subroutine to allow users to determine if the LoadLeveler configuration files were changed since the last time they were read.

Library

LoadLeveler API library **libllapi.a**

Syntax

```
#include "llapi.h"
int ll_config_changed(void);
```

Description

This subroutine is used in conjunction with the **ll_read_config** subroutine to reread the configuration files.

Return Values

An integer value will be returned which indicates whether the configuration files were changed since the last time that they were read.

0 The configuration files were not changed.

1 At least one of the configuration files was changed.

Related Information

Subroutine: **ll_read_config**

ll_read_config subroutine

Use the **ll_read_config** subroutine to allow users to read or reread the LoadLeveler configuration files.

Library

LoadLeveler API library **libllapi.a**

Syntax

```
#include "llapi.h"
int ll_read_config(LL_element **errObj);
```

Parameters

errObj
This is the address of a pointer to a LoadLeveler error object. The pointer to the **LL_element** should be set to NULL before calling this function. If this function fails, the pointer will point to an error object. The error messages stored in the error object can be displayed through the **ll_error** function. The caller should free the error object storage before reusing the pointer.

Description

This subroutine is used in conjunction with the **ll_config_changed** subroutine to determine whether the configuration files were changed since the last time they were read.

Return Values

API_OK
The configuration files was successfully read.

API_CONFIG_ERR
Errors were encountered while reading the configuration files.

Related Information

Subroutines: **ll_config_changed**, **ll_error**

Data access API

Use the data access API to access LoadLeveler data objects and to retrieve specific data from those objects.

You can use this API to query LoadLeveler daemons for information about:
- BLUE_GENE (Blue Gene system)
- CLASSES (job classes)
- CLUSTER (cluster information)
- FAIRSHARE (fair share scheduling information)
- JOBS (job information)
- MACHINES (machine information)
- MCLUSTERS (multicluster objects)
- RESERVATIONS (reservation information)
- WLMSTAT (AIX Workload Manager)

This API can also be used to query a LoadLeveler history file for accounting information about JOBS.

The data access API consists of the following subroutines:
- **"ll_deallocate subroutine" on page 568**
- **"ll_free_objs subroutine" on page 569**
- **"ll_get_data subroutine" on page 570**
- **"ll_get_objs subroutine" on page 624**
- **"ll_next_obj subroutine" on page 627**
- **"ll_query subroutine" on page 628**
- **"ll_reset_request subroutine" on page 629**
- **"ll_set_request subroutine" on page 630**

Using the data access API

The data access API makes use of a query object to facilitate each request for LoadLeveler data.

The query object is used to specify the details of each query request and to manage the list of LoadLeveler objects retrieved. It is initialized by the **ll_query** subroutine to specify the kind of LoadLeveler objects requested and is modified by the **ll_set_request** and **ll_reset_request** subroutines to specify filtering of those objects. It is then passed to the **ll_get_objs** and **ll_next_obj** subroutines to use in traversing the list of objects. To use this API, you need to call the subroutines in the following order:

- Call **ll_query** to initialize the query object and define the type of objects you want to query. See "ll_query subroutine" on page 628 for more information.
- Call **ll_set_request** to filter the objects you want to query. See "ll_set_request subroutine" on page 630 for more information.
- Call **ll_reset_request** to reset the filter on the objects you want to query. See "ll_reset_request subroutine" on page 629 for more information.
- Call **ll_get_objs** to retrieve a list of objects from a LoadLeveler daemon or history file. See "ll_get_objs subroutine" on page 624 for more information.
- Call **ll_get_data** to retrieve specific data from an object. See "ll_get_data subroutine" on page 570 for more information.
- Call **ll_next_obj** to retrieve the next object in the list. See "ll_next_obj subroutine" on page 627 for more information.
- Call **ll_free_objs** to free the list of objects you received. See "ll_free_objs subroutine" on page 569 for more information.

- Call **ll_deallocate** to end the query. See "ll_deallocate subroutine" on page 568 for more information.

In a multicluster configuration, you need to use the "ll_cluster subroutine" on page 669 to access data from a remote cluster. The **ll_cluster** subroutine is used to define the cluster prior to any data access API calls.

To see code that uses these subroutines, refer to "Examples of using the data access API" on page 633. For more information on LoadLeveler objects, see "Understanding the LoadLeveler data access object model."

Understanding the LoadLeveler data access object model

The **ll_get_data** subroutine of the data access API allows you to access the LoadLeveler object model.

A LoadLeveler object model consists of a root object with zero or more associated objects that have attributes and associations to other objects. An attribute is a characteristic of the object and generally has a primitive data type (such as integer, float, or character). Attributes and related objects are retrieved from an object using the "ll_get_data subroutine" on page 570. One of the arguments to the **ll_get_data** subroutine is the specification. Specifications are used to identify which attribute or related object to retrieve. The job name, submission time, and job priority are examples of attributes.

Objects are associated with one or more other objects through relationships. An object can be associated with other objects through more than one relationship, or through the same relationship. For example, A Job object is associated with a Credential object and to Step objects through two different relationships. A Job object can be associated with more than one Step object through the same relationship of "having a Step." When an object is associated through different relationships, different specifications are used to retrieve the appropriate object.

When an object is associated with more than one object through the same relationship, there are GetFirst and GetNext specifications associated with the relationship. You must use the GetFirst specification to initialize access to the first such associated object. You must use the GetNext specification to get the remaining objects in succession. After the last object has been retrieved, GetNext will return NULL.

The specification tables for the **ll_get_data** subroutine ("ll_get_data subroutine" on page 570) in the data access API describe the specifications and elements available when you use the **ll_get_data** subroutine. Each specification name describes the object you need to specify and the attribute returned. For example, the specification **LL_JobGetFirstStep** includes the object you need to specify (**Job**) and the value returned (**LL_element* Step**). The tables are sorted alphabetically by object.

You can use the **ll_get_data** subroutine to access both attributes and associated objects. See the "ll_get_data subroutine" on page 570 for more information.

It is important to keep in mind how the list of objects returned by the **ll_get_objs** subroutine have been defined by the previous data access API calls when getting specific pieces of data using the **ll_get_data** subroutine.

Several factors can affect what and when data attributes are available or relevant:

- Data related to certain LoadLeveler features (such as Blue Gene or multicluster) either will not be available, or the data will not be relevant unless the feature is configured
- What source returned the data object
- What type of job is being queried
- What is the state of the job being queried

Understanding the Blue Gene object model

To access the Blue Gene model, initialize the query object using ll_query with the BLUE_GENE query_type.

The root of the Blue Gene model is the BgMachine object. The BgMachine is associated with one or more BgBP objects, one or more BgSwitch objects, one or more BgWire objects, and one or more BgPartition objects. These objects show how the Blue Gene system is configured.

Each BgBP object is associated with one or more BgNodeCard objects.

Each BgPartition object is associated with one or more BgSwitch objects.

Each BgSwitch object is associated with one or more BgPortConn objects.

BgMachine objects can only be obtained from the LL_CM query daemon.

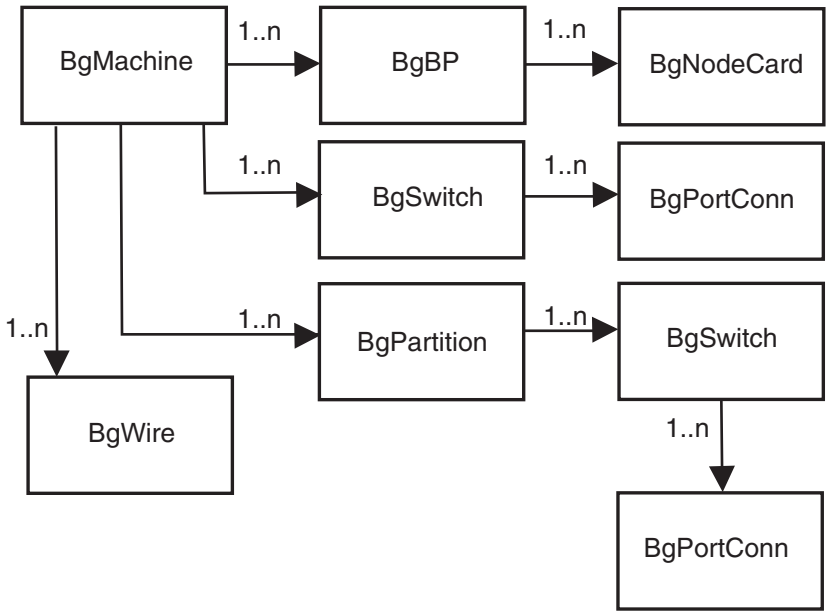

Figure 44. TWS LoadLeveler Blue Gene object model

See Table 87 on page 571 for a listing of BLUE_GENE specifications.

Understanding the Class object model

To access the Class model, initialize the query object using ll_query with the CLASSES query_type.

The root of the class model is the Class object. The class is associated with zero or more ResourceReq objects and one or more ClassUser objects depending on the configuration of the class that the Class object represents.

Class objects can only be obtained from the LL_CM query daemon.

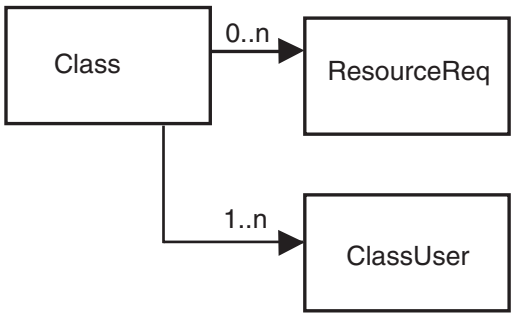

Figure 45. TWS LoadLeveler Class object model

See Table 88 on page 576 for a listing of CLASS specifications.

Understanding the Cluster object model

To access the Cluster model, initialize the query object using ll_query with the CLUSTERS query_type.

The root of the cluster model is the Cluster object. The Cluster is associated with one or more Resource objects.

Cluster objects can only be obtained from the LL_CM query daemon.

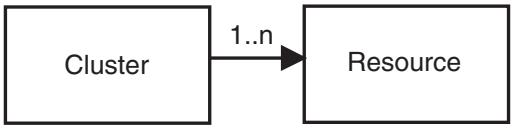

Figure 46. TWS LoadLeveler Cluster object model

See Table 89 on page 580 for a listing of CLUSTERS specifications.

Understanding the Fairshare object model

To access the Fairshare model, initialize the query object using ll_query with the FAIRSHARE query_type.

The Fairshare object model consists of Fairshare objects only. These objects represent fair share scheduling information.

Fairshare objects can only be obtained from the LL_CM query daemon.

Figure 47. TWS LoadLeveler Fairshare object model

See Table 90 on page 582 for a listing of FAIRSHARE specifications.

Understanding the Job object model

To access the Job model, initialize the query object using ll_query with the JOBS query_type.

The root of the job model is the Job object. The Job is associated with a single Credential object, one or more Step objects, and zero or more ClusterFile objects.

The Step object represents one executable unit of the Job (all the tasks that are executed together). The Step is associated with one or more Machine objects, one or more Node objects, one or more MachUsage objects, and one or more AdapterReq objects. The only relevant data within the Machine object when linked to a Step is the machine name. The list of Machines represents all of the hosts assigned to a step that is in a running-like state. If two or more nodes are running on the same host, the Machine object for the host occurs only once in the Step's Machine list.

The MachUsage object is associated with one or more DispUsage objects. The DispUsage object is associated with one or more EventUsage objects. The MachUsage, DispUsage, and EventUsage objects contain accounting information available from the history file only.

Each Node object manages a set of executables that share common requirements and preferences. The Node object is associated with one or more Task objects.

The Task object represents one or more copies of the same executable. The Task object is associated with one or more ResourceReq objects and one or more TaskInstance objects.

The TaskInstance object is associated with one or more AdapterUsage objects and one or more Adapter objects. The only relevant data within the Adapter objects associated with each TaskInstance is the adapter name. The list of Machines represents all of the hosts where one or more nodes of the step are running.

Job objects can only be obtained from the LL_CM, LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE query daemon.

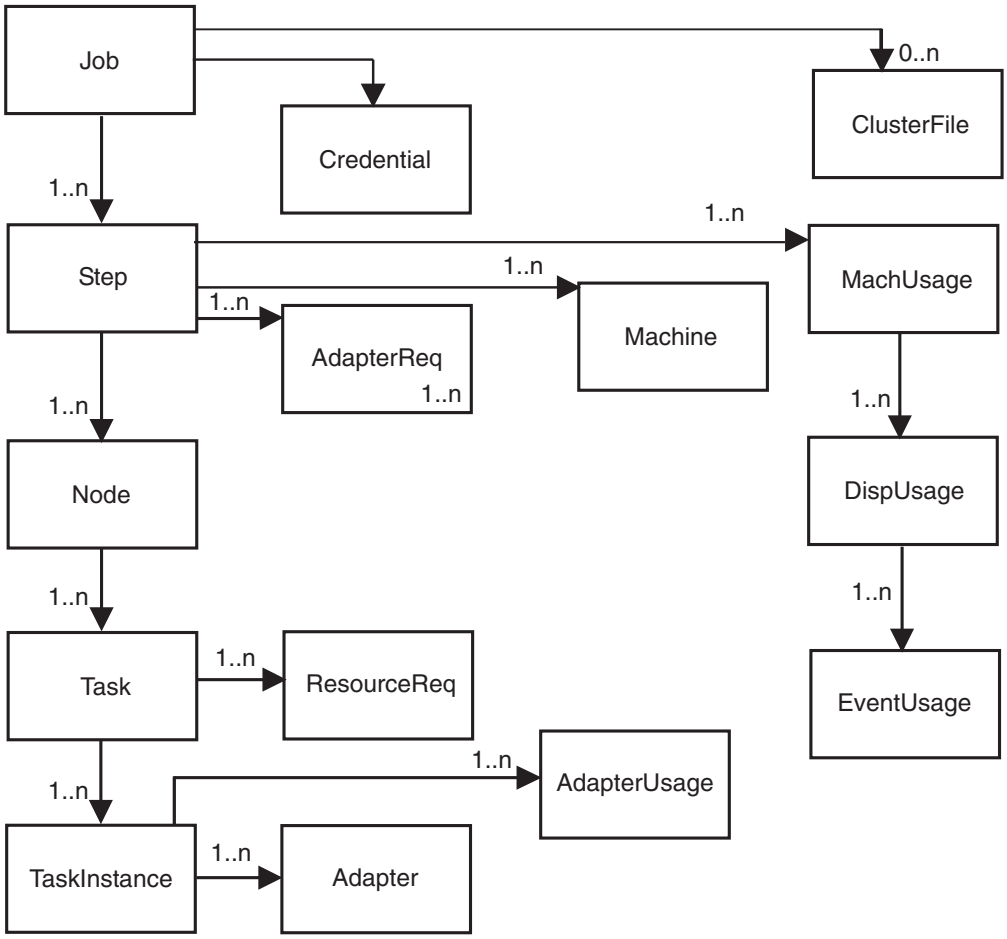

Figure 48. TWS LoadLeveler Job object model

See Table 91 on page 583 for a listing of JOB specifications.

Understanding the Machine object model

To access the Machine model, initialize the query object using ll_query with the MACHINES query_type.

The root of the machine model is the Machine object. The machine is associated with one or more Resource objects, one or more Adapter objects, and one or more MCM objects depending on the configuration of the machine that the Machine object represents.

Machine objects can only be obtained from the LL_CM query daemon.

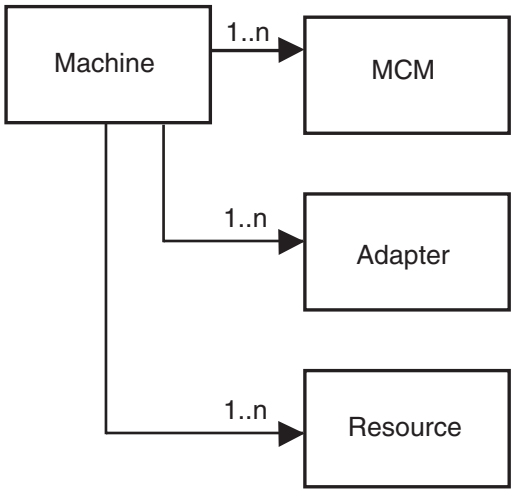

Figure 49. TWS LoadLeveler Machine object model

See Table 92 on page 614 for a listing of MACHINE specifications.

Understanding the MCluster object model

To access the MCluster model, initialize the query object using ll_query with the MCLUSTERS query_type.

The MCluster object model consists of MCluster objects only. These objects represent configuration information for multicluster clusters.

MCluster objects can only be obtained from the LL_SCHEDD query daemon.

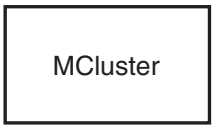

Figure 50. TWS LoadLeveler MCluster object model

See Table 93 on page 619 for a listing of MCLUSTER specifications.

Understanding the Reservations object model

To access the Reservations model, initialize the query object using ll_query with the RESERVATIONS query_type.

The Reservations object model consists of Reservations objects only. These objects represent reservation information.

Reservations objects can only be obtained from the LL_CM query daemon.

Figure 51. TWS LoadLeveler Reservations object model

See Table 94 on page 620 for a listing of RESERVATIONS specifications.

Understanding the Wlmstat object model

To access the Wlmstat model, initialize the query object using ll_query with the WLMSTAT query_type.

The Wlmstat object model consists of Wlmstat objects only. These objects return WLM statistics about running steps. Wlmstat objects must be queried for a specific step.

WlmStat objects can only be obtained from the LL_STARTD query daemon.

Figure 52. TWS LoadLeveler Wlmstat object model

See Table 95 on page 622 for a listing of WLMSTAT specifications.

ll_deallocate subroutine

Use the **ll_deallocate** subroutine to deallocate the *query_element* allocated by the **ll_query** subroutine.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_deallocate (LL_element *query_element);
```

Parameters

query_element
Is a pointer to the **LL_element** returned by the **ll_query** function.

Description

query_element is the input field for this subroutine.

Return Values

This subroutine returns a zero to indicate success.

Error Values

-1 You specified a *query_element* that is not valid.

Related Information

Subroutines: **ll_free_objs**, **ll_get_data**, **ll_get_objs**, **ll_next_obj**, **ll_query**, **ll_reset_request**, **ll_set_request**

ll_free_objs subroutine

Use the **ll_free_objs** subroutine to free all of the **LL_element** objects in the *query_element* list that were obtained by the **ll_get_objs** subroutine. You must free the *query_element* by using the **ll_deallocate** subroutine.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_free_objs (LL_element *query_element);
```

Parameters

query_element
Is a pointer to the **LL_element** returned by the **ll_query** function.

Description

query_element is the input field for this subroutine.

Return Values

This subroutine returns a zero to indicate success.

Error Values

-1 You specified a *query_element* that is not valid.

Related Information

Subroutines: **ll_free_objs**, **ll_get_data**, **ll_get_objs**, **ll_query**, **ll_reset_request**, **ll_set_request**

ll_get_data subroutine

Use the **ll_get_data** subroutine to return data from a valid **LL_element**.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_get_data (LL_element *element, enum LLAPI_Specification specification,
                 void* resulting_data_type);
```

Parameters

element
Is a pointer to the **LL_element** returned by the **ll_get_objs** subroutine.

specification
Specifies the data field within the data object you want to read.

resulting_data_type
Is a pointer to the location where you want the data stored. If the call returns a nonzero value, an error has occurred and the contents of the location are undefined.

Description

Note: Before you use this subroutine, make sure you are familiar with the concepts discussed in "Understanding the Job object model" on page 564 .

object and *specification* are input fields, while *resulting_data_type* is an output field.

The **ll_get_data** subroutine of the data access API allows you to access LoadLeveler objects. The parameters of **ll_get_data** are a LoadLeveler object (**LL_element**), a specification that indicates what information about the object is being requested, and a pointer to the area where the information being requested should be stored.

If the specification indicates an attribute of the element that is passed in, the result pointer must be the address of a variable of the appropriate type, and must be initialized to NULL. The type returned by each specification is found in the specification tables. If the specification queries the connection to another object, the returned value is of type **LL_element**. You can use a subsequent **ll_get_data** call to query information about the new object.

The data type **char*** and any arrays of type **int** or **char** must be freed by the caller.

LL_element pointers cannot be freed by the caller.

For the specifications, **LL_MachineOperatingSystem** and **LL_MachineArchitecture**, *resulting_data_type* returns the string "???" if a query is made before the associated records are updated with their actual values by the appropriate startd daemons.

Return Values

This subroutine returns a zero to indicate success.

Error Values

-1 You specified an *object* that is not valid.
-2 You specified an LLAPI_Specification that is not valid.

Related Information

Subroutines: **ll_deallocate**, **ll_free_objs**, **ll_get_objs**, **ll_next_obj**, **ll_query**, **ll_reset_request**, **ll_set_request**

See "Understanding the Blue Gene object model" on page 562 for more information on the Blue Gene object model.

Table 87. BLUE_GENE specifications for ll_get_data subroutine

Object	Specification	type of resulting data parameter	Description
BgBP	LL_BgBPCnodeMemory	int*	A pointer to an integer indicating the compute node (C-node) memory of the Blue Gene base partition (`BgBPComputenodeMemory_t;`).
BgBP	LL_BgBPCurrentPartition	char**	A pointer to a string containing the ID of the partition to which the Blue Gene base partition is part of.
BgBP	LL_BgBPCurrentPartitionState	int*	A pointer to an integer indicating the state of the current Blue Gene partition (`BgPartitionState_t`).
BgBP	LL_BgBPGetFirstNodeCard	LL_element* (BgNodeCard)	A pointer to the element associated with the first node card in the Blue Gene base partition.
BgBP	LL_BgBPGetNextNodeCard	LL_element* (BgNodeCard)	A pointer to the element associated with the next node card in the Blue Gene base partition.
BgBP	LL_BgBPId	char**	A pointer to a string containing the ID of the base partition in the Blue Gene system.
BgBP	LL_BgBPIONodeCount	int*	A pointer to an integer indicating the number of I/O nodes in the base partition.
BgBP	LL_BgBPLocation	int**	A pointer to an array indicating the location of the base partition in the Blue Gene system in each dimension.
BgBP	LL_BgBPNodeCardCount	int*	A pointer to an integer indicating the number of node cards in the Blue Gene base partition.
BgBP	LL_BgBPState	int*	A pointer to an integer indicating the state of the Blue Gene base partition (`BgBPState_t`).

Table 87. BLUE_GENE specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
BgBP	LL_BgBPSubDividedBusy	int*	A pointer to an integer indicating that small partitions are active in the Blue Gene base partition.
BgIONode	LL_BgIONodeCurrentPartition	char**	A pointer to a string containing the ID of the partition to which the I/O node belongs (not for Blue Gene/L).
BgIONode	LL_BgIONodeCurrentPartitionState	int*	A pointer to an integer indicating the state of the current partition (`BgPartitionState_t`) (not for Blue Gene/L).
BgIONode	LL_BgIONodeId	char**	A pointer to a string containing the ID of the I/O node (not for Blue Gene/L).
BgIONode	LL_BgIONodeIPAddr	char**	A pointer to a string containing the IP address of the I/O node (not for Blue Gene/L).
BgMachine	LL_BgMachineBPSize	int**	A pointer to an array indicating the size of a Blue Gene base partition in compute nodes in each dimension.
BgMachine	LL_BgMachineGetFirstBP	LL_element* (BgBP)	A pointer to the element associated with the first base partition in the Blue Gene base partition list.
BgMachine	LL_BgMachineGetFirstPartition	LL_element* (BgPartition)	A pointer to the element associated with the first partition in the Blue Gene partition list.
BgMachine	LL_BgMachineGetFirstSwitch	LL_element* (BgSwitch)	A pointer to the element associated with the first switch in the Blue Gene switch list.
BgMachine	LL_BgMachineGetFirstWire	LL_element* (BgWire)	A pointer to the element associated with the first wire in the Blue Gene wire list.
BgMachine	LL_BgMachineGetNextBP	LL_element* (BgBP)	A pointer to the element associated with the next base partition in the Blue Gene base partition list.
BgMachine	LL_BgMachineGetNextPartition	LL_element* (BgPartition)	A pointer to the element associated with the next partition in the Blue Gene partition list.
BgMachine	LL_BgMachineGetNextSwitch	LL_element* (BgSwitch)	A pointer to the element associated with the next switch in the Blue Gene switch list.
BgMachine	LL_BgMachineGetNextWire	LL_element* (BgWire)	A pointer to the element associated with the next wire in the Blue Gene wire list.
BgMachine	LL_BgMachinePartitionCount	int*	A pointer to an integer indicating the number of defined partitions in the Blue Gene system.

Table 87. BLUE_GENE specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
BgMachine	LL_BgMachineSize	int**	A pointer to an array indicating the size of the Blue Gene system in number of base partitions in each dimension.
BgMachine	LL_BgMachineSwitchCount	int*	A pointer to an integer indicating the number of switches in the Blue Gene system.
BgMachine	LL_BgMachineWireCount	int*	A pointer to an integer indicating the number of wires in the Blue Gene system.
BgNodeCard	LL_BgNodeCardCurrentPartition	char**	A pointer to a string containing the ID of the Blue Gene partition that the node card is assigned to.
BgNodeCard	LL_BgNodeCardCurrentPartitionState	int*	A pointer to an integer indicating the state of the current Blue Gene partition (`BgPartitionState_t`).
BgNodeCard	LL_BgNodeCardGetFirstIONode	LL_element* (BgIONode)	The element associated with the first I/O node in the node card (not for Blue Gene/L).
BgNodeCard	LL_BgNodeCardGetNextIONode	LL_element* (BgIONode)	The element associated with the next I/O node in the node card (not for Blue Gene/L).
BgNodeCard	LL_BgNodeCardId	char**	A pointer to a string containing the ID of the Blue Gene node card.
BgNodeCard	LL_BgNodeCardIONodeCount	int*	A pointer to an integer indicating the total number of I/O nodes in the node card.
BgNodeCard	LL_BgNodeCardQuarter	int*	A pointer to an integer indicating the quarter of the Blue Gene base partition the node card is in (`BgQuarter_t`).
BgNodeCard	LL_BgNodeCardState	int*	A pointer to an integer indicating the state of the Blue Gene node card (`BgNodeCardState_t`).
BgNodeCard	LL_BgNodeCardSubDividedBusy	int*	A pointer to an integer indicating a partition is using a portion of the node card (not for Blue Gene/L).
BgPartition	LL_BgPartitionBLRTSImage	char**	A pointer to a string containing the file name of the Blue Gene compute node's kernel image (for Blue Gene/L only).
BgPartition	LL_BgPartitionBPCount	int*	A pointer to an integer indicating the number of Blue Gene base partitions in the partition.
BgPartition	LL_BgPartitionBPList	char***	A pointer to an array containing the list of Blue Gene base partition IDs assigned to the partition.

Table 87. BLUE_GENE specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
BgPartition	LL_BgPartitionCnLoadImage	char**	A pointer to a string containing a comma-separated list of images to load on the compute nodes of the partition (not for Blue Gene/L).
BgPartition	LL_BgPartitionConnection	int*	A pointer to an integer indicating the connection type of the Blue Gene partition (`BgConnection_t`).
BgPartition	LL_BgPartitionDescription	char**	A pointer to a string containing the Blue Gene partition description.
BgPartition	LL_BgPartitionGetFirstSwitch	LL_element* (BgSwitch)	A pointer to the element associated with the first switch in the Blue Gene partition.
BgPartition	LL_BgPartitionGetNextSwitch	LL_element* (BgSwitch)	A pointer to the element associated with the next switch in the Blue Gene partition.
BgPartition	LL_BgPartitionId	char**	A pointer to a string containing the ID of the Blue Gene partition.
BgPartition	LL_BgPartitionIoLoadImage	char**	A pointer to a string containing a comma-separated list of images to load on the I/O nodes of the partition (not for Blue Gene/L).
BgPartition	LL_BgPartitionIONodeCount	int*	A pointer to an integer indicating the total number of I/O nodes in the partition.
BgPartition	LL_BgPartitionIONodeList	char***	A pointer to an array of strings containing Blue Gene I/O nodes used by each base partition of the partition. The array ends with a NULL string (not for Blue Gene/L).
BgPartition	LL_BgPartitionLinuxImage	char**	A pointer to a string containing the file name of the I/O nodes' Linux image (for Blue Gene/L only).
BgPartition	LL_BgPartitionMLoaderImage	char**	A pointer to a string containing the file name of the machine loader image.
BgPartition	LL_BgPartitionMode	int*	A pointer to an integer indicating the node mode of the Blue Gene partition (for Blue Gene/L only).
BgPartition	LL_BgPartitionNodeCardList	char***	A pointer to an array containing the list of node card IDs assigned to the Blue Gene partition.
BgPartition	LL_BgPartitionOwner	char**	A pointer to a string containing the user name of the owner of the Blue Gene partition.
BgPartition	LL_BgPartitionRamDiskImage	char**	A pointer to a string containing the file name of the ram disk image (for Blue Gene/L only).

Table 87. BLUE_GENE specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
BgPartition	LL_BgPartitionShape	int**	A pointer to an array indicating the shape of the Blue Gene partition.
BgPartition	LL_BgPartitionSize	int*	A pointer to an integer indicating the size (number of C-nodes) of the Blue Gene partition.
BgPartition	LL_BgPartitionSmall	int*	A pointer to an integer indicating if the partition is smaller than a Blue Gene base partition.
BgPartition	LL_BgPartitionState	int*	A pointer to an integer indicating the state of the Blue Gene partition (`BgPartitionState_t`).
BgPartition	LL_BgPartitionSwitchCount	int*	A pointer to an integer indicating the number of switches in the Blue Gene partition.
BgPartition	LL_BgPartitionUserList	char***	A pointer to an array containing the users of the partition.
BgPortConn	LL_BgPortConnCurrentPartition	char**	A pointer to a string containing the ID of the Blue Gene partition to which the connection is assigned.
BgPortConn	LL_BgPortConnCurrentPartitionState	int*	A pointer to an integer indicating the state of the current Blue Gene partition (`BgPartitionState_t`).
BgPortConn	LL_BgPortConnFromSwitchPort	int*	A pointer to an integer indicating the from switch port ID (`BgPort_t`).
BgPortConn	LL_BgPortConnToSwitchPort	int*	A pointer to an integer indicating the to switch port ID (`BgPort_t`).
BgSwitch	LL_BgSwitchBasePartitionId	char**	A pointer to a string containing the ID of the base Blue Gene partition connected to the switch.
BgSwitch	LL_BgSwitchConnCount	int*	A pointer to an integer indicating the number of connections in the Blue Gene switch.
BgSwitch	LL_BgSwitchDimension	int*	A pointer to an integer indicating the dimension the Blue Gene switch is associated with (`BgSwitchDimension_t`).
BgSwitch	LL_BgSwitchGetFirstConn	LL_element* (BgPortConn)	A pointer to the element associated with the first connection in the Blue Gene switch connection list.
BgSwitch	LL_BgSwitchGetNextConn	LL_element* (BgPortConn)	A pointer to the element associated with the next connection in the Blue Gene switch connection list.
BgSwitch	LL_BgSwitchId	char**	A pointer to a string containing the ID of the Blue Gene switch.

Table 87. BLUE_GENE specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
BgSwitch	LL_BgSwitchState	int*	A pointer to an integer indicating the state of the Blue Gene switch (`BgSwitchState_t`).
BgWire	LL_BgWireCurrentPartition	char**	A pointer to a string containing the ID of the Blue Gene partition which the wire is assigned.
BgWire	LL_BgWireCurrentPartitionState	int*	A pointer to an integer indicating the state of the current Blue Gene partition (`BgPartitionState_t`).
BgWire	LL_BgWireFromPortCompId	char**	A pointer to a string containing the Blue Gene base partition or the switch the wire source port is part of.
BgWire	LL_BgWireFromPortId	int*	A pointer to an integer indicating the ID of the Blue Gene wire source port (`BgPort_t`).
BgWire	LL_BgWireId	char**	A pointer to a string containing the ID of the Blue Gene wire.
BgWire	LL_BgWireToPortCompId	char**	A pointer to a string containing the Blue Gene base partition or the switch the wire destination port is part of.
BgWire	LL_BgWireToPortID	int*	A pointer to an integer indicating the ID of the Blue Gene wire destination port (`BgPort_t`).
BgWire	LL_BgWireState	int*	A pointer to an integer indicating the state of the Blue Gene wire (`BgWireState_t`).

See "Understanding the Class object model" on page 562 for more information on the Class object model.

Table 88. CLASSES specifications for ll_get_data subroutine

Object	Specification	type of resulting data parameter	Description
Class	LL_ClassAdmin	char***	A pointer to an array of strings containing administrators for the class. The array ends with a NULL string.
Class	LL_ClassAllowScaleAcrossJobs	int*	A pointer to a Boolean integer indicating if this class allows scale-across jobs.
Class	LL_ClassCkptDir	char**	A pointer to a string containing the directory for checkpoint files.
Class	LL_ClassCkptTimeHardLimit	int64_t*	A pointer to a 64-bit integer indicating the checkpoint time hard limit.

Table 88. CLASSES specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Class	LL_ClassCkptTimeSoftLimit	int64_t*	A pointer to a 64-bit integer indicating the checkpoint time soft limit.
Class	LL_ClassComment	char**	A pointer to a string containing the class comment.
Class	LL_ClassConstraints	int*	A pointer to an integer indicating whether the values of Maximum and Free Slots are constrained by MAX_STARTERS and MAXJOBS.
Class	LL_ClassCoreLimitHard	int64_t*	A pointer to a 64-bit integer indicating the core file hard limit.
Class	LL_ClassCoreLimitSoft	int64_t*	A pointer to a 64-bit integer indicating the core file soft limit.
Class	LL_ClassCpuLimitHard	int64_t*	A pointer to a 64-bit integer indicating the CPU hard limit.
Class	LL_ClassCpuLimitSoft	int64_t*	A pointer to a 64-bit integer indicating the CPU soft limit.
Class	LL_ClassCpuStepLimitHard	int64_t*	A pointer to a 64-bit integer indicating the CPU hard limit.
Class	LL_ClassCpuStepLimitSoft	int64_t*	A pointer to a 64-bit integer indicating the CPU soft limit.
Class	LL_ClassDataLimitHard	int64_t*	A pointer to a 64-bit integer indicating the data hard limit.
Class	LL_ClassDataLimitSoft	int64_t*	A pointer to a 64-bit integer indicating the data soft limit.
Class	LL_ClassDefWallClockLimitHard	int64_t*	A pointer to a 64-bit integer indicating the default wall clock hard limit.
Class	LL_ClassDefWallClockLimitSoft	int64_t*	A pointer to a 64-bit integer indicating the default wall clock soft limit.
Class	LL_ClassExcludeBg	char***	A pointer to an array of strings containing Blue Gene resources that cannot be used by jobs in the class. The array ends with a NULL string.
Class	LL_ClassExcludeGroups	char***	A pointer to an array of strings containing groups not permitted to use the class. The array ends with a NULL string.
Class	LL_ClassExcludeUsers	char***	A pointer to an array of strings containing users not permitted to use the class. The array ends with a NULL string.
Class	LL_ClassFileLimitHard	int64_t*	A pointer to a 64-bit integer indicating the file size hard limit.

Table 88. CLASSES specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Class	LL_ClassFileLimitSoft	int64_t*	A pointer to a 64-bit integer indicating the file size soft limit.
Class	LL_ClassFreeSlots	int*	A pointer to an integer indicating the number of available initiators.
Class	LL_ClassGetFirstMaxNodeResourceRequirement	LL_element* (ResourceReq)	A pointer to the element associated with the first max consumable resource per node.
Class	LL_ClassGetFirstMaxResourceRequirement	LL_element* (ResourceReq)	A pointer to the element associated with the first max consumable resource per task.
Class	LL_ClassGetFirstNodeResource Requirement	LL_element* (ResourceReq)	A pointer to the element associated with the first node resource requirement.
Class	LL_ClassGetFirstResourceRequirement	LL_element* (ResourceReq)	A pointer to the element associated with the first resource requirement.
Class	LL_ClassGetFirstUser	LL_element* (ClassUser)	A pointer to the element associated with the first user defined in the class.
Class	LL_ClassGetNextMaxNodeResourceRequirement	LL_element* (ResourceReq)	A pointer to the element associated with the next max consumable resource per node.
Class	LL_ClassGetNextMaxResourceRequirement	LL_element* (ResourceReq)	A pointer to the element associated with the next max consumable resource per task.
Class	LL_ClassGetNextNodeResource Requirement	LL_element* (ResourceReq)	A pointer to the element associated with the next node resource requirement.
Class	LL_ClassGetNextResourceRequirement	LL_element* (ResourceReq)	A pointer to the element associated with the next resource requirement.
Class	LL_ClassGetNextUser	LL_element* (ClassUser)	A pointer to the element associated with the next user defined in the class.
Class	LL_ClassIncludeBg	char***	A pointer to an array of strings containing Blue Gene resources that can be used by jobs in the class. The array ends with a NULL string.
Class	LL_ClassIncludeGroups	char***	A pointer to an array of strings containing groups permitted to use the class. The array ends with a NULL string.
Class	LL_ClassIncludeUsers	char***	A pointer to an array of strings containing users permitted to use the class. The array ends with a NULL string.

Table 88. CLASSES specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Class	LL_ClassMaximumSlots	int*	A pointer to an integer indicating the total number of configured initiators.
Class	LL_ClassMaxJobs	int*	A pointer to an integer indicating the maximum number of job steps that can run at any time.
Class	LL_ClassMaxProcessors	int*	A pointer to an integer indicating the maximum number of processors for a parallel job step.
Class	LL_ClassMaxProtocolInstances	int*	A pointer to an integer indicating the maximum number of adapter windows per protocol per task.
Class	LL_ClassMaxTotalTasks	int*	A pointer to an integer indicating the value for Max_total_tasks.
Class	LL_ClassName	char**	A pointer to a string containing the name of the class.
Class	LL_ClassNice	int*	A pointer to an integer indicating the nice value.
Class	LL_ClassPreemptClass	char**	A pointer to a string containing the PREEMPT_CLASS rule.
Class	LL_ClassPriority	int*	A pointer to an integer indicating the class system priority.
Class	LL_ClassRssLimitHard	int64_t*	A pointer to a 64-bit integer indicating the resident set size hard limit.
Class	LL_ClassRssLimitSoft	int64_t*	A pointer to a 64-bit integer indicating the resident set size soft limit.
Class	LL_ClassStackLimitHard	int64_t*	A pointer to a 64-bit integer indicating the stack size hard limit.
Class	LL_ClassStackLimitSoft	int64_t*	A pointer to a 64-bit integer indicating the stack size soft limit.
Class	LL_ClassStartClass	char**	A pointer to a string containing the START_CLASS rule.
Class	LL_ClassStripingWithMinimumNetworks	int*	A pointer to a Boolean integer indicating that striping is allowed on nodes with more than half of the networks in the READY state.
Class	LL_ClassWallClockLimitHard	int64_t*	A pointer to a 64-bit integer indicating the wall clock hard limit.

Table 88. CLASSES specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Class	LL_ClassWallClockLimitSoft	int64_t*	A pointer to a 64-bit integer indicating the wall clock soft limit.
ClassUser	LL_ClassUserMaxIdle	int*	A pointer to an integer indicating the maximum number of idle job steps.
ClassUser	LL_ClassUserMaxJobs	int*	A pointer to an integer indicating the maximum number of running job steps.
ClassUser	LL_ClassUserMaxQueued	int*	A pointer to an integer indicating the maximum number of total job steps in the queue.
ClassUser	LL_ClassUserMaxTotalTasks	int*	A pointer to an integer indicating the maximum number of running tasks.
ClassUser	LL_ClassUserName	char**	A pointer to a string containing the user name.
ResourceReq	LL_ResourceRequirementName	char**	A pointer to a string containing the resource requirement name.
ResourceReq	LL_ResourceRequirementValue	int*	A pointer to an integer indicating the value of the resource requirement.
ResourceReq	LL_ResourceRequirementValue64	int64_t*	A pointer to a 64-bit integer indicating the value of the resource requirement.

See "Understanding the Cluster object model" on page 563 for more information on the Cluster object model.

Table 89. CLUSTERS specifications for ll_get_data subroutine

Object	Specification	type of resulting data parameter	Description
Cluster	LL_ClusterClusterMetric	char**	A pointer to a string containing the CLUSTER_METRIC string.
Cluster	LL_ClusterClusterRemoteJobFilter	char**	A pointer to a string containing the CLUSTER_REMOTE_JOB_FILTER string.
Cluster	LL_ClusterClusterUserMapper	char**	A pointer to a string containing the CLUSTER_USER_MAPPER string.
Cluster	LL_ClusterDefinedResourceCount	int*	A pointer to an integer indicating the number of consumable resources defined in the cluster.

Table 89. CLUSTERS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Cluster	LL_ClusterDefinedResources	char***	A pointer to an array containing the names of consumable resources defined in the cluster. The array ends with a NULL string.
Cluster	LL_ClusterEnforcedResourceCount	int*	A pointer to an integer indicating the number of enforced resources
Cluster	LL_ClusterEnforcedResources	char***	A pointer to an array of characters indicating the number of enforced resources
Cluster	LL_ClusterEnforceMemory	int*	A pointer to a Boolean integer indicating absolute memory limit.
Cluster	LL_ClusterEnforceSubmission	int*	A pointer to a Boolean integer indicating resources required at time of submission.
Cluster	LL_ClusterGetFirstResource	LL_element* (Resource)	A pointer to the element associated with the first resource.
Cluster	LL_ClusterGetNextResource	LL_element* (Resource)	A pointer to the element associated with the next resource.
Cluster	LL_ClusterMusterEnvironment	int*	A pointer to an integer indicating that the multicluster environment is enabled.
Cluster	LL_ClusterScaleAcrossEnv	int*	A pointer to a Boolean integer indicating if the cluster is in a scale-across environment.
Cluster	LL_ClusterSchedulerType	char**	A pointer to a string containing the scheduler type.
Cluster	LL_ClusterSchedulingResourceCount	int*	A pointer to an integer indicating the number of consumable resources considered by the scheduler for the cluster.
Cluster	LL_ClusterSchedulingResources	char***	A pointer to an array containing the names of consumable resources considered by the scheduler for the cluster. The array ends with a NULL string.
Resource	LL_ResourceAvailableValue	int*	A pointer to an integer indicating the value of available resources.
Resource	LL_ResourceAvailableValue64	int64_t*	A pointer to a 64-bit integer indicating the value of available resources.
Resource	LL_ResourceInitialValue	int*	A pointer to an integer indicating the initial resource value.
Resource	LL_ResourceInitialValue64	int64_t*	A pointer to a 64-bit integer indicating the initial resource value.
Resource	LL_ResourceName	char**	A pointer to a string containing the resource name.

See "Understanding the Fairshare object model" on page 563 for more information on the Fairshare object model.

Table 90. FAIRSHARE specifications for ll_get_data subroutine

Object	Specification	type of resulting data parameter	Description
FairShare	LL_FairShareAllocatedShares	int**	A pointer to an array indicating the number of allocated shares for each user or group. **LL_FairShareNumberOfEntries** indicates the size of this array.
FairShare	LL_FairShareCurrentTime	time_t*	A pointer to a **time_t** structure indicating the time that the information is obtained.
FairShare	LL_FairShareEntryNames	char***	A pointer to an array containing the names of users or groups whose fair share information has been returned. **LL_FairShareNumberOfEntries** indicates the size of this array.
FairShare	LL_FairShareEntryTypes	int**	A pointer to an array indicating the types of names: 0 for users, 1 for groups. **LL_FairShareNumberOfEntries** indicates the size of this array.
FairShare	LL_FairShareInterval	int*	A pointer to an integer indicating the time interval that is most important to fair share scheduling.
FairShare	LL_FairShareNumberOfEntries	int*	A pointer to an integer indicating the number of users or groups for which the fair share information has been returned.
FairShare	LL_FairShareTotalShares	int*	A pointer to an integer indicating the total number of shares in the cluster.
FairShare	LL_FairShareUsedBgShares	int**	A pointer to an array indicating the number of Blue Gene shares used by each user or group.
FairShare	LL_FairShareUsedShares	int**	A pointer to an array indicating the number of shares used by each user or group. **LL_FairShareNumberOfEntries** indicates the size of this array.

See "Understanding the Job object model" on page 564 for more information on the Job object model.

Note the following in Table 91 on page 583:

- Any specifications that are only available from a specific query_daemon will have that described in the "Description" column.
- Any specification that does not have any detailed query_daemon in the "Description" column is available from the LL_CM, LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE query_daemon.

Table 91. JOBS specifications for ll_get_data subroutine

Object	Specification	type of resulting data parameter	Description
Adapter	LL_AdapterName	char**	A pointer to a string containing the adapter name. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterReq	LL_AdapterReqCommLevel	int*	A pointer to the integer indicating the adapter's communication level. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterReq	LL_AdapterReqInstances	int*	A pointer to an integer containing the requested adapter instances. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterReq	LL_AdapterReqMode	char**	A pointer to a string containing the requested adapter mode (IP or US). Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterReq	LL_AdapterReqProtocol	char**	A pointer to a string containing the requested adapter protocol. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterReq	LL_AdapterReqRcxtBlocks	int*	A pointer to the integer indicating the number of rCxt blocks requested for the adapter usage. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterReq	LL_AdapterReqTypeName	char**	A pointer to a string containing the requested adapter type. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterReq	LL_AdapterReqUsage	int*	A pointer to the integer indicating the requested adapter usage. This integer will be one of the values defined in the Usage enum. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterUsage	LL_AdapterUsageDeviceDriver	char**	A pointer to a string containing the name of the adapter device being used. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
AdapterUsage	LL_AdapterUsageLmc	int*	A pointer to an integer indicating the logical mask on an InfiniBand adapter port. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterUsage	LL_AdapterUsageMode	char**	A pointer to a string containing the adapter usage mode of IP or US. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterUsage	LL_AdapterUsageNetmask	char**	A pointer to a string containing the netmask of the adapter in the AdapterUsage object. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterUsage	LL_AdapterUsagePortNumber	int*	A pointer to an integer indicating the port number on an InfiniBand adapter port. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterUsage	LL_AdapterUsageProtocol	char**	A pointer to a string containing the task's protocol. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterUsage	LL_AdapterUsageRcxtBlocks	int*	A pointer to the integer indicating the number of rCxt blocks associated with the adapter usage. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterUsage	LL_AdapterUsageTag	char**	A pointer to a character string that indicates which switch table the adapter usage is in. Adapter usages with the same tag are in the same switch table. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterUsage	LL_AdapterUsageWindow	int*	Contains the adapter window assigned to the task. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
AdapterUsage	LL_AdapterUsageWindowMemory64	uint64_t*	A pointer to an unsigned 64-bit integer indicating the number of bytes used by the adapter window. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
ClusterFile	LL_ClusterFileLocalPath	char**	A pointer to a string containing the expanded local file path name. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
ClusterFile	LL_ClusterFileRemotePath	char**	A pointer to a string containing the expanded remote file path name. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Credential	LL_CredentialGid	int*	A pointer to an integer containing the UNIX gid of the user submitting the job.
Credential	LL_CredentialGroupName	char**	A pointer to a string containing the UNIX group name of the user submitting the job.
Credential	LL_CredentialUid	int*	A pointer to an integer containing the UNIX uid of the person submitting the job.
Credential	LL_CredentialUserName	char**	A pointer to a string containing the user ID of the user submitting the job.
DispUsage	LL_DispUsageEventUsageCount	int*	A pointer to an integer indicating the count of event usages. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageGetFirstEventUsage	LL_element* (EventUsage)	A pointer to the element associated with the first event usage. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageGetNextEventUsage	LL_element* (EventUsage)	A pointer to the element associated with the next event usage. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterIdrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of unshared memory in the data segment of a process. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterInblock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed input. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterIsrss64	int64_t*	A pointer to a 64-bit integer indicating the unshared stack size. Data is available from the LL_HISTORY_FILE only.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
DispUsage	LL_DispUsageStarterIxrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of memory used by the text segment that was also shared among other processes. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterMajflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterMaxrss64	int64_t*	A pointer to a 64-bit integer indicating the maximum resident set size utilized. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterMinflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterMsgrcv64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages received. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterMsgsnd64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages sent. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterNivcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of involuntary context switches. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterNsignals64	int64_t*	A pointer to a 64-bit integer indicating the number of signals delivered. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterNswap64	int64_t*	A pointer to a 64-bit integer indicating the number of times swapped out. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterNvcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of context switches due to voluntarily giving up processor. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterOublock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed output. Data is available from the LL_HISTORY_FILE only.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
DispUsage	LL_DispUsageStarterSystemTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU system time. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStarterUserTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU user time. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepIdrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of unshared memory in the data segment of a process. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepInblock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed input. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepIsrss64	int64_t*	A pointer to a 64-bit integer indicating the unshared stack size. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepIxrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of memory used by the text segment that was also shared among other processes. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepMajflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepMaxrss64	int64_t*	A pointer to a 64-bit integer indicating the maximum resident set size utilized. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepMinflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepMsgrcv64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages received. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepMsgsnd64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages sent. Data is available from the LL_HISTORY_FILE only.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
DispUsage	LL_DispUsageStepNivcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of involuntary context switches. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepNsignals64	int64_t*	A pointer to a 64-bit integer indicating the number of signals delivered. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepNswap64	int64_t*	A pointer to a 64-bit integer indicating the number of times swapped out. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepNvcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of context switches due to voluntarily giving up processor. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepOublock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed output. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepSystemTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU system time. Data is available from the LL_HISTORY_FILE only.
DispUsage	LL_DispUsageStepUserTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU user time. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageEventID	int*	A pointer to an integer indicating the event ID. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageEventName	char**	A pointer to a string containing the event name. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageEventTimestamp	int*	A pointer to an integer indicating the event timestamp. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterIdrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of unshared memory in the data segment of a process. Data is available from the LL_HISTORY_FILE only.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
EventUsage	LL_EventUsageStarterInblock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed input. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterIsrss64	int64_t*	A pointer to a 64-bit integer indicating the unshared stack size. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterIxrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of memory used by the text segment that was also shared among other processes. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterMajflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterMaxrss64	int64_t*	A pointer to a 64-bit integer indicating the maximum resident set size utilized. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterMinflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterMsgrcv64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages received. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterMsgsnd64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages sent. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterNivcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of involuntary context switches. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterNsignals64	int64_t*	A pointer to a 64-bit integer indicating the number of signals delivered. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterNswap64	int64_t*	A pointer to a 64-bit integer indicating the number of times swapped out. Data is available from the LL_HISTORY_FILE only.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
EventUsage	LL_EventUsageStarterNvcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of context switches due to voluntarily giving up processor. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterOublock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed output. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterSystemTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU system time. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStarterUserTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU user time. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepIdrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of unshared memory in the data segment of a process. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepInblock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed input. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepIsrss64	int64_t*	A pointer to a 64-bit integer indicating the unshared stack size. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepIxrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of memory used by the text segment that was also shared among other processes. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepMajflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepMaxrss64	int64_t*	A pointer to a 64-bit integer indicating the maximum resident set size utilized. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepMinflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_HISTORY_FILE only.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
EventUsage	LL_EventUsageStepMsgrcv64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages received. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepMsgsnd64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages sent. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepNivcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of involuntary context switches. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepNsignals64	int64_t*	A pointer to a 64-bit integer indicating the number of signals delivered. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepNswap64	int64_t*	A pointer to a 64-bit integer indicating the number of times swapped out. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepNvcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of context switches due to voluntarily giving up processor. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepOublock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed output. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepSystemTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU system time. Data is available from the LL_HISTORY_FILE only.
EventUsage	LL_EventUsageStepUserTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU user time. Data is available from the LL_HISTORY_FILE only.
Job	LL_JobCredential	LL_element* (Credential)	A pointer to the element associated with the job credential. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobGetFirstClusterInputFile	LL_element* (ClusterFile)	A pointer to the element associated with the first input ClusterFile.
Job	LL_JobGetFirstClusterOutputFile	LL_element* (ClusterFile)	A pointer to the element associated with the first output ClusterFile.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Job	LL_JobGetFirstStep	LL_element* (Step)	A pointer to the element associated with the first step of the job, to be used in subsequent **ll_get_data** calls. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobGetNextClusterInputFile	LL_element* (ClusterFile)	A pointer to the element associated with the next input ClusterFile.
Job	LL_JobGetNextClusterOutputFile	LL_element* (ClusterFile)	A pointer to the element associated with the next output ClusterFile.
Job	LL_JobGetNextStep	LL_element* (Step)	A pointer to the element associated with the next step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobIsRemote	int*	A pointer to an integer. If the integer contains the value 1, the job is remote. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobJobQueueKey	int*	A pointer to an integer indicating the key used to write the job to the spool. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobLocalOutboundSchedds	char***	A pointer to an array containing a list of local outbound Schedds. The last Schedd in the list is the current outbound Schedd. Data is available when the multicluster environment is configured. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobName	char**	A pointer to a character string containing the job name.
Job	LL_JobRequestedCluster	char***	A pointer to an array containing the list of user-requested clusters. Data is available when the multicluster environment is configured. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobSchedd	char**	A pointer to a string containing the Schedd managing the job.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Job	LL_JobScheddHistory	char***	A pointer to an array containing a list of managing Schedds. The last Schedd in the list is the current managing Schedd. Data is available when the multicluster environment is configured. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobSchedulingCluster	char**	A pointer to a string containing the name of the cluster where the job is scheduled. Data is available when the multicluster environment is configured. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobSendingCluster	char**	A pointer to a string containing the name of the sending cluster. Data is available when the multicluster environment is configured. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobStepCount	int*	A pointer to an integer indicating the number of steps connected to the job.
Job	LL_JobStepType	int*	A pointer to an integer indicating the type of job, which can be INTERACTIVE_JOB or BATCH_JOB.
Job	LL_JobSubmitHost	char**	A pointer to a character string containing the name of the host machine from which the job was submitted.
Job	LL_JobSubmitTime	time_t*	A pointer to the **time_t** structure indicating when the job was submitted.
Job	LL_JobSubmittingCluster	char**	A pointer to a string containing the name of the submitting cluster. Data is available when the multicluster environment is configured. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Job	LL_JobSubmittingUser	char**	A pointer to a string containing the name of the submitting user. Data is available when the multicluster environment is configured. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Job	LL_JobUsersJCF	char**	A pointer to a single string containing all of the user's job command file keyword statements. Data is available from the LL_SCHEDD only. Data is available when the multicluster environment is configured.
Job	LL_JobVersionNum	int*	A pointer to an integer indicating the job's version number.
Machine	LL_MachineName	char**	A pointer to a string containing the machine name.
MachUsage	LL_MachUsageDispUsageCount	int*	A pointer to an integer indicating the count of dispatch usages. Data is available from the LL_HISTORY_FILE only.
MachUsage	LL_MachUsageGetFirstDispUsage	LL_element* (DispUsage)	A pointer to the element associated with the first dispatch usage. Data is available from the LL_HISTORY_FILE only.
MachUsage	LL_MachUsageGetNextDispUsage	LL_element* (DispUsage)	A pointer to the element associated with the next dispatch usage. Data is available from the LL_HISTORY_FILE only.
MachUsage	LL_MachUsageMachineName	char**	A pointer to a string containing the machine name. Data is available from the LL_HISTORY_FILE only.
MachUsage	LL_MachUsageMachineSpeed	double*	A pointer to a double containing the machine speed. Data is available from the LL_HISTORY_FILE only.
Node	LL_NodeGetFirstResourceRequirement	LL_element* (ResourceReq)	A pointer to the element associated with the first resource requirement.
Node	LL_NodeGetFirstTask	LL_element* (Task)	A pointer to the element associated with the first task for this node.
Node	LL_NodeGetNextResourceRequirement	LL_element* (ResourceReq)	A pointer to the element associated with the next resource requirement.
Node	LL_NodeGetNextTask	LL_element* (Task)	A pointer to the element associated with the next task for this node.
Node	LL_NodeInitiatorCount	int*	A pointer to an integer indicating the number of tasks running on the node.
Node	LL_NodeMaxInstances	int*	A pointer to an integer indicating the maximum number of machines requested.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Node	LL_NodeMinInstances	int*	A pointer to an integer indicating the minimum number of machines requested.
Node	LL_NodeRequirements	char**	A pointer to a string containing the node requirements.
Node	LL_NodeTaskCount	int*	A pointer to an integer indicating the different types of tasks running on the node.
ResourceReq	LL_ResourceRequirementName	char**	A pointer to a string containing the resource requirement name. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
ResourceReq	LL_ResourceRequirementValue	int*	A pointer to an integer indicating the value of the resource requirement. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
ResourceReq	LL_ResourceRequirementValue64	int64_t*	A pointer to a 64-bit integer indicating the value of the resource requirement. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepAccountNumber	char**	A pointer to a string containing the account number specified by the user submitting the job.
Step	LL_StepAcctKey	int64_t*	A pointer to a 64-bit integer that can be used to identify all of the AIX accounting records for the job step. Data is available from the LL_HISTORY_FILE only.
Step	LL_StepAsLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the **as** hard limit set by the user in the **as_limit** keyword.
Step	LL_StepAsLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the **as** soft limit set by the user in the **as_limit** keyword.
Step	LL_StepBgErrorText	char**	A pointer to a string containing the error text for the Blue Gene job record in the Blue Gene database. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBgJobId	char**	A pointer to a string containing the ID of the Blue Gene job in the Blue Gene database. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepBgJobState	int*	A pointer to an integer indicating the state of the Blue Gene job in the Blue Gene database (`BgJobState_t`). Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBgPartitionAllocated	char**	A pointer to a string containing the ID of the Blue Gene partition allocated for the job. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBgPartitionRequested	char**	A pointer to a string containing the ID of the Blue Gene partition requested for the job step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBgPartitionState	int*	A pointer to an integer indicating the state of the Blue Gene partition allocated for the job step (`BgPartitionState_t`). Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBgShapeAllocated	int**	A pointer to an array indicating the shape of the Blue Gene compute nodes allocated for the job step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBgShapeRequested	int**	A pointer to an array indicating the shape of Blue Gene compute nodes requested for the job step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBgSizeAllocated	int*	A pointer to an integer indicating the number of Blue Gene compute nodes allocated for the job step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBgSizeRequested	int*	A pointer to an integer indicating the number of Blue Gene compute nodes requested for the job step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepBgWiringAllocated	int*	A pointer to an integer indicating the allocated type of wiring for the Blue Gene job (`BgConnection_t`). Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBgWiringRequested	int*	A pointer to an integer indicating the requested type of wiring for the Blue Gene job (`BgConnection_t`). Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBlocking	int*	A pointer to an integer representing blocking as specified by the user in the job command file. • Returns -1 if unlimited is specified • Returns 0 if blocking is unspecified Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepBulkXfer	int*	A pointer to an integer that is set to 1 if the step requested bulk transfer and 0 if it did not. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepCheckpointable	int*	A pointer to an integer indicating if checkpointing was enabled via the **checkpoint** keyword (0=disabled, 1=enabled). Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepCheckpointing	int*	A pointer to an integer indicating that a checkpoint is currently being taken for the step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepCkptAccumTime	int*	A pointer to an integer indicating the amount of accumulated time, in seconds, that the job step has spent checkpointing. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepCkptExecuteDirectory	char**	A pointer to a string containing the directory where the job step's executable will be saved. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepCkptFailStartTime	time_t*	A pointer to a **time_t** structure indicating the start time of the last unsuccessful checkpoint. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepCkptFile	char**	A pointer to a string containing the directory and file name which contain checkpoint information for the last successful checkpoint.
Step	LL_StepCkptGoodElapseTime	int*	A pointer to an integer indicating the amount of time, in seconds, it took for the last successful checkpoint to complete. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepCkptGoodStartTime	time_t*	A pointer to a **time_t** structure indicating the start time of the last successful checkpoint. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepCkptRestart	int*	A pointer to an integer indicating the value specified by the user for the **restart_from_ckpt** keyword (0= no, 1= yes). Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepCkptRestartSameNodes	int*	A pointer to a string indicating the value specified by the user for the **restart_on_same_nodes** keyword (0= no, 1= yes). Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepCkptTimeHardLimit	int*	A pointer to an integer indicating the hard limit set by the user in the **ckpt_time_limit** keyword.
Step	LL_StepCkptTimeHardLimit64	int64_t*	A pointer to a 64-bit integer indicating the hard limit set by the user in the **ckpt_time_limit** keyword.
Step	LL_StepCkptTimeSoftLimit	int*	A pointer to an integer indicating the soft limit set by the user in **ckpt_time_limit** keyword.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepCkptTimeSoftLimit64	int64_t*	A pointer to a 64-bit integer indicating the soft limit set by the user in **ckpt_time_limit** keyword.
Step	LL_StepClassSystemPriority	int*	A pointer to an integer indicating the class priority of the job step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepClusterOption	char**	A pointer to a string indicating the cluster option of this step.
Step	LL_StepComment	char**	A pointer to a string indicating the comment specified by the user submitting the job.
Step	LL_StepCompletionCode	int*	A pointer to an integer indicating the completion code of the step.
Step	LL_StepCompletionDate	time_t*	A pointer to a **time_t** structure indicating the completion date of the step.
Step	LL_StepConsideredAt	time_t*	A pointer to an **time_t** structure indicating the time at which the top dog step is last considered for scheduling.
Step	LL_StepCoreLimitHard	int*	A pointer to an integer indicating the core hard limit set by the user in the **core_limit** keyword.
Step	LL_StepCoreLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the core hard limit set by the user in the **core_limit** keyword.
Step	LL_StepCoreLimitSoft	int*	A pointer to an integer indicating the core soft limit set by the user in the **core_limit** keyword.
Step	LL_StepCoreLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the core soft limit set by the user in the **core_limit** keyword.
Step	LL_StepCoschedule	int*	A pointer to an integer indicating if a job step is coscheduled set by the user in the **coschedule** keyword.
Step	LL_StepCpuLimitHard	int*	A pointer to an integer indicating the CPU hard limit set by the user in the **cpu_limit** keyword.
Step	LL_StepCpuLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the CPU hard limit set by the user in the **cpu_limit** keyword.
Step	LL_StepCpuLimitSoft	int*	A pointer to an integer indicating the CPU soft limit set by the user in the **cpu_limit** keyword.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepCpuLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the CPU soft limit set by the user in the **cpu_limit** keyword.
Step	LL_StepCpusPerCore	int*	A pointer to an integer indicating the CPUs per processor core requested by the job using the **cpus_per_core** keyword.
Step	LL_StepCpuStepLimitHard	int*	A pointer to an integer indicating the CPU step hard limit set by the user in the **job_cpu_limit** keyword.
Step	LL_StepCpuStepLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the CPU step hard limit set by the user in the **job_cpu_limit** keyword.
Step	LL_StepCpuStepLimitSoft	int*	A pointer to an integer indicating the CPU step soft limit set by the user in the **job_cpu_limit** keyword.
Step	LL_StepCpuStepLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the CPU step soft limit set by the user in the **job_cpu_limit** keyword.
Step	LL_StepDataLimitHard	int*	A pointer to an integer indicating the data hard limit set by the user in the **data_limit** keyword.
Step	LL_StepDataLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the data hard limit set by the user in the **data_limit** keyword.
Step	LL_StepDataLimitSoft	int*	A pointer to an integer indicating the data soft limit set by the user in the **data_limit** keyword.
Step	LL_StepDataLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the data soft limit set by the user in the **data_limit** keyword.
Step	LL_StepDependency	char**	A pointer to a string containing the step dependency value. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepDispatchTime	time_t*	A pointer to a **time_t** structure indicating the time the negotiator dispatched the job. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepEnvironment	char**	A pointer to a string containing the environment variables set by the user in the executable. Data is available from LL_SCHEDD and LL_HISTORY_FILE.
Step	LL_StepErrorFile	char**	A pointer to a string containing the standard error file name used by the executable.
Step	LL_StepEstimatedStartTime	time_t*	A pointer to an **time_t** structure indicating the estimated start time of the top dog step.
Step	LL_StepExecSize	int*	A pointer to an integer indicating the executable size.
Step	LL_StepFavoredJob	int*	A pointer to an integer that specifies whether the step is favored using the **llfavorjob** command. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepFileLimitHard	int*	A pointer to an integer indicating the file hard limit set by the user in the **file_limit** keyword.
Step	LL_StepFileLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the file hard limit set by the user in the **file_limit** keyword.
Step	LL_StepFileLimitSoft	int*	A pointer to an integer indicating the file soft limit set by the user in the **file_limit** keyword.
Step	LL_StepFileLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the file soft limit set by the user in the **file_limit** keyword.
Step	LL_StepGetFirstAdapterReq	LL_element* (AdapterReq)	A pointer to the element associated with the first adapter requirement. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepGetFirstMachine	LL_element* (Machine)	A pointer to the element associated with the first machine in the step. Data is available from LL_CM, LL_SCHEDD, and LL_STARTD.
Step	LL_StepGetFirstMachUsage	LL_element* (MachUsage)	A pointer to the element associated with the first machine usage in the list of machine usages where a single machine usage corresponds to any machine that was ever assigned to the step. Data is available from the LL_HISTORY_FILE only.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepGetFirstNode	LL_element* (Node)	A pointer to the element associated with the first node of the step.
Step	LL_StepGetFirstScaleAcrossCluster	LL_element* (MCluster)	A pointer to the element associated with the first cluster where the step is being scheduled or dispatched to.
Step	LL_StepGetMasterTask	LL_element* (Task)	A pointer to the element associated with the master task of the step.
Step	LL_StepGetNextAdapterReq	LL_element* (AdapterReq)	A pointer to the element associated with the next adapter requirement. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepGetNextMachine	LL_element* (Machine)	A pointer to the element associated with the next machine of the step. Data is available from LL_CM, LL_SCHEDD, and LL_STARTD.
Step	LL_StepGetNextMachUsage	LL_element* (MachUsage)	A pointer to the element associated with the next machine usage in the list of machine usages where a single machine usage corresponds to any machine that was ever assigned to the step. Data is available from the LL_HISTORY_FILE only.
Step	LL_StepGetNextNode	LL_element* (Node)	A pointer to the element associated with the next node of the step.
Step	LL_StepGetNextScaleAcrossCluster	LL_element* (MCluster)	A pointer to the element associated with the next cluster where the step is being scheduled or dispatched to.
Step	LL_StepGroupSystemPriority	int*	A pointer to an integer indicating the group priority of a job step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepHoldType	int*	A pointer to an integer indicating the hold state of the step (user, system, and so on). The value returned is in the HoldType enum. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepHostList	char***	A pointer to an array containing the list of hosts in the **host.list** file associated with the step. The array ends with a null string. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepID	char**	A pointer to a string containing the ID of the step.
Step	LL_StepImageSize	int*	A pointer to an integer indicating the image size of the executable. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepImageSize64	int64_t*	A pointer to a 64-bit integer indicating the image size of the executable. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepInputFile	char**	A pointer to a string containing the standard input file name used by the executable.
Step	LL_StepIsTopDog	int*	A pointer to an integer indicating that the step is a top dog in the last complete dispatching cycle. It is updated at the end of the dispatching cycle.
Step	LL_StepIwd	char**	A pointer to a string containing the initial working directory name used by the executable.
Step	LL_StepJobClass	char**	A pointer to a string containing the class of the step.
Step	LL_StepLargePage	char**	A pointer to a string containing the Large Page level of support associated with the job step.
Step	LL_StepLoadLevelerGroup	char**	A pointer to a string containing the name of the LoadLeveler group specified by the step.
Step	LL_StepLocksLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the **locks** hard limit set by the user in the **locks_limit** keyword.
Step	LL_StepLocksLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the **locks** soft limit set by the user in the **locks_limit** keyword.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepMachineCount	int*	A pointer to an integer indicating the number of machines assigned to the step when it is in a running-like state. Data is available from LL_CM, LL_SCHEDD, and LL_STARTD.
Step	LL_StepMachUsageCount	int*	A pointer to an integer indicating the number of machine usage objects corresponding to the set of machines that were ever assigned to the step. Data is available from the LL_HISTORY_FILE only.
Step	LL_StepMemlockLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the **memlock** hard limit set by the user in the **memlock_limit** keyword.
Step	LL_StepMemlockLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the **memlock** soft limit set by the user in the **memlock_limit** keyword.
Step	LL_StepMessages	char**	A pointer to a string containing a list of messages from LoadLeveler. The messages are updated right after the step is considered for scheduling by LoadLeveler. The data is available from the LL_CM only.
Step	LL_StepName	char**	A pointer to a string containing the name of the step.
Step	LL_StepNodeCount	int*	A pointer to an integer indicating the number of node objects associated with the step.
Step	LL_StepNodeUsage	int*	A pointer to an integer indicating the node usage specified by the user (SHARED or NOT_SHARED). The value returned is in the enum Usage.
Step	LL_StepNofileLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the **nofile** hard limit set by the user in the **nofile_limit** keyword.
Step	LL_StepNofileLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the **nofile** soft limit set by the user in the **nofile_limit** keyword.
Step	LL_StepNprocLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the **nproc** hard limit set by the user in the **nproc_limit** keyword.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepNprocLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the **nproc** soft limit set by the user in the **nproc_limit** keyword.
Step	LL_StepOutputFile	char**	A pointer to a character string containing the standard output file name used by the executable.
Step	LL_StepParallelMode	int*	A pointer to an integer indicating the mode of the step.
Step	LL_StepPreemptable	int*	A pointer to an integer indicating whether the job step is preemptable. The integer is set to 0 if the job step is not preemptable and is set to 1 if the job step is preemptable.
Step	LL_StepPreemptWaitList	char***	A pointer to an array containing the job steps that an idle job must preempt. The array ends with a NULL string. This data is available from the LL_CM only.
Step	LL_StepPriority	int*	A pointer to an integer indicating the priority of the step.
Step	LL_StepQueueSystemPriority	int*	A pointer to an integer indicating the adjusted system priority of the job step. This data is available from the LL_CM only.
Step	LL_StepRequestedReservationID	char**	A pointer to a string containing the step's requested reservation ID.
Step	LL_StepReservationBindingMethod	int*	A pointer to an integer indicating the method used to bind the step to its reservation. The value is 0 if the step is not bound to any reservation, or **RESERVATION_BIND_SOFT** or **RESERVATION_BIND_FIRM** from Reservation_mode_t.
Step	LL_StepReservationID	char**	A pointer to a string containing the step's reservation ID.
Step	LL_StepRestart	int*	A pointer to an integer representing whether restart is specified as yes (default value) or no by the user in the job command file. • 1 indicates yes • 0 indicates no
Job	LL_StepRsetName	char**	A pointer to a character string containing the RSet name used by the step. If no RSet name was used, the value is NULL.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepRssLimitHard	int*	A pointer to an integer indicating the RSS hard limit set by the user in the **rss_limit** keyword.
Step	LL_StepRssLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the RSS hard limit set by the user in the **rss_limit** keyword.
Step	LL_StepRssLimitSoft	int*	A pointer to an integer indicating the RSS soft limit set by the user in the **rss_limit** keyword.
Step	LL_StepRssLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the RSS soft limit set by the user in the **rss_limit** keyword.
Step	LL_StepScaleAcrossClusterCount	int*	A pointer to an integer indicating the number of scale-across clusters where this step is being scheduled or dispatched to.
Step	LL_StepShell	char**	A pointer to a character string containing the shell name used by the executable.
Step	LL_StepSMTRequired	int*	A pointer to an integer indicating the required SMT state. The value returned is in the enum SMTRequiredState.
Step	LL_StepStackLimitHard	int*	A pointer to an integer indicating the stack hard limit set by the user in the **stack_limit** keyword.
Step	LL_StepStackLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the stack hard limit set by the user in the **stack_limit** keyword.
Step	LL_StepStackLimitSoft	int*	A pointer to an integer indicating the stack soft limit set by the user in the **stack_limit** keyword.
Step	LL_StepStackLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the stack soft limit set by the user in the **stack_limit** keyword.
Step	LL_StepStartCount	int*	A pointer to an integer indicating the number of times the step has been started. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepStartDate	time_t*	A pointer to a **time_t** structure indicating the value the user specified in the **startdate** keyword. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepStarterIdrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of unshared memory in the data segment of a process. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterInblock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed input. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterIsrss64	int64_t*	A pointer to a 64-bit integer indicating the unshared stack size. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterIxrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of memory used by the text segment that was also shared among other processes. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterMajflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterMaxrss64	int64_t*	A pointer to a 64-bit integer indicating the maximum resident set size utilized. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterMinflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterMsgrcv64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages received. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterMsgsnd64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages sent. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepStarterNivcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of involuntary context switches. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterNsignals64	int64_t*	A pointer to a 64-bit integer indicating the number of signals delivered. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterNswap64	int64_t*	A pointer to a 64-bit integer indicating the number of times swapped out. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterNvcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of context switches due to voluntarily giving up processor. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterOublock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed output. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterSystemTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU system time. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStarterUserTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU user time. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStartTime	time_t*	A pointer to a **time_t** structure indicating the time at which the starter process for the job started. Data is available from the LL_SCHEDD and LL_HISTORY_FILE.
Step	LL_StepState	int*	A pointer to an integer indicating the state of the Step (Idle, Pending, Starting, and so on). The value returned is in the StepState enum. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepStepIdrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of unshared memory in the data segment of a process. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepInblock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed input. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepIsrss64	int64_t*	A pointer to a 64-bit integer indicating the unshared stack size. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepIxrss64	int64_t*	A pointer to a 64-bit integer indicating the amount of memory used by the text segment that was also shared among other processes. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepMajflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepMaxrss64	int64_t*	A pointer to a 64-bit integer indicating the maximum resident set size utilized. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepMinflt64	int64_t*	A pointer to a 64-bit integer indicating the number of page faults. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepMsgrcv64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages received. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepMsgsnd64	int64_t*	A pointer to a 64-bit integer indicating the number of IPC messages sent. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepStepNivcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of involuntary context switches. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepNsignals64	int64_t*	A pointer to a 64-bit integer indicating the number of signals delivered. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepNswap64	int64_t*	A pointer to a 64-bit integer indicating the number of times swapped out. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepNvcsw64	int64_t*	A pointer to a 64-bit integer indicating the number of context switches due to voluntarily giving up processor. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepOublock64	int64_t*	A pointer to a 64-bit integer indicating the number of times the file system performed output. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepSystemTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU system time. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepStepUserTime64	int64_t*	A pointer to a 64-bit integer indicating the CPU user time. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepSystemPriority	int*	A pointer to an integer indicating the overall system priority of the job step. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepTaskAffinity	char**	A pointer to a string containing the task affinity requirement of the job requested with the **task_affinity** keyword.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepTaskGeometry	char**	A pointer to a string containing the values specified in the task_geometry statement by the user in the job command file. The syntax is the same as specified in the statement , {(task id, task id, ...) (task id, task id, ...) ...}. If unspecified, a null string is returned. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepTaskInstanceCount	int*	A pointer to an integer indicating the number of task instances in the step. Data is available from the LL_SCHEDD, LL_STARTD, and LL_HISTORY_FILE.
Step	LL_StepTasksPerNodeRequested	int*	A pointer to an integer representing the tasks per node specified by the user in the job command file. If unspecified, the integer will contain a 0. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepTotalNodesRequested	char**	A pointer to a string containing the values specified by the user in the job command file node statement. The syntax is the same as specified in the statement, [min],[max], where min contains the minimum number of nodes requested and max contains the maximum nodes requested. If unspecified, a null string is returned. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepTotalTasksRequested	int*	A pointer to an integer representing the total tasks specified by the user in the job command file. If unspecified, the integer will contain a 0. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
Step	LL_StepUserHoldTime	int*	A pointer to an integer indicating the total time of a job step in User Hold state.
Step	LL_StepUserSystemPriority	int*	A pointer to an integer indicating the user system priority of the job step. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Step	LL_StepWallClockLimitHard	int*	A pointer to an integer indicating the wall clock hard limit set by the user in the **wall_clock_limit** keyword.
Step	LL_StepWallClockLimitHard64	int64_t*	A pointer to a 64-bit integer indicating the wall clock hard limit set by the user in the **wall_clock_limit** keyword.
Step	LL_StepWallClockLimitSoft	int*	A pointer to an integer indicating the wall clock soft limit set by the user in the **wall_clock_limit** keyword.
Step	LL_StepWallClockLimitSoft64	int64_t*	A pointer to a 64-bit integer indicating the wall clock soft limit set by the user in the **wall_clock_limit** keyword.
Step	LL_StepWallClockUsed	int*	A pointer to an integer that is the number of seconds of elapsed time for this step. This specification is valid only when **SCHEDULER_TYPE = API**, otherwise a value of zero is returned. The value does not include any time that a job step has spent in a preempted by suspend state or doing a checkpoint. Data is available from the LL_STARTD only.
Task	LL_TaskExecutable	char**	A pointer to a string containing the name of the executable.
Task	LL_TaskExecutableArguments	char**	A pointer to a string containing the arguments passed by the user in the executable.
Task	LL_TaskGetFirstResourceRequirement	LL_element (ResourceReq)	A pointer to the element associated with the first resource requirement.
Task	LL_TaskGetFirstTaskInstance	LL_element* (TaskInstance)	A pointer to the element associated with the first task instance.
Task	LL_TaskGetNextResourceRequirement	LL_element* (ResourceReq)	A pointer to the element associated with the next resource requirement.
Task	LL_TaskGetNextTaskInstance	LL_element* (TaskInstance)	A pointer to the element associated with the next task instance.
Task	LL_TaskIsMaster	int*	A pointer to an integer, where 1 indicates master task.
Task	LL_TaskTaskInstanceCount	int*	A pointer to an integer indicating the number of task instances.

Table 91. JOBS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
TaskInstance	LL_TaskInstanceAdapterCount	int*	A pointer to the integer indicating the number of adapters. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
TaskInstance	LL_TaskInstanceCpuList	int*	A pointer to the integer indicating the number of CPUs used by a given task instance object. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
TaskInstance	LL_TaskInstanceGetFirstAdapter	LL_element* (Adapter)	A pointer to the element associated with the first adapter. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
TaskInstance	LL_TaskInstanceGetFirstAdapterUsage	LL_element* (AdapterUsage)	A pointer to the element associated with the first adapter usage. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
TaskInstance	LL_TaskInstanceGetNextAdapter	LL_element* (Adapter)	A pointer to the element associated with the next adapter. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
TaskInstance	LL_TaskInstanceGetNextAdapterUsage	LL_element* (AdapterUsage)	A pointer to the element associated with the next adapter usage. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
TaskInstance	LL_TaskInstanceMachineAddress	char**	A pointer to a string containing the IP address of the machine assigned to a task. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.
TaskInstance	LL_TaskInstanceMachineName	char**	A pointer to the string indicating the machine assigned to a task.
TaskInstance	LL_TaskInstanceTaskID	int*	A pointer to the integer indicating the task ID. Data is available from LL_CM, LL_SCHEDD, and LL_HISTORY_FILE.

See "Understanding the Machine object model" on page 565 for more information on the Machine object model.

Table 92. MACHINES specifications for ll_get_data subroutine

Object	Specification	type of resulting data parameter	Description
Adapter	LL_AdapterAvailWindowCount	int*	A pointer to an integer indicating the number of adapter windows not in use.
Adapter	LL_AdapterCommInterface	int*	Contains the adapter's communication interface.
Adapter	LL_AdapterInterfaceAddress	char**	A pointer to a string containing the adapter's interface IP address.
Adapter	LL_AdapterInterfaceNetmask	char**	A pointer to a string containing the netmask of an adapter.
Adapter	LL_AdapterMaxWindowSize64	uint64_t*	A pointer to an unsigned 64-bit integer indicating the maximum allocatable adapter window memory.
Adapter	LL_AdapterMCMId	int*	A pointer to an integer indicating the MCM ID for the adapter.
Adapter	LL_AdapterMemory64	uint64_t*	A pointer to an unsigned 64-bit integer indicating the amount of total adapter memory.
Adapter	LL_AdapterMinWindowSize64	int*	A pointer to the integer indicating the minimum allocatable adapter window memory.
Adapter	LL_AdapterName	char**	A pointer to a string containing the adapter name.
Adapter	LL_AdapterRcxtBlocks	int*	A pointer to the integer indicating the number of rCxt blocks available on an adapter.
Adapter	LL_AdapterTotalWindowCount	int*	A pointer to the integer indicating the number of windows on the adapter.
Adapter	LL_AdapterWindowList	int**	A pointer to an array indicating window numbers for the adapter. LL_AdapterTotalWindowCount indicates the size of this array. If the adapter has no windows, LL_AdapterTotalWindowCount is zero and LL_AdapterWindowList is null.
Machine	LL_MachineAdapterList	char***	A pointer to an array containing a list of the types of adapters associated with the machine. The array ends with a NULL string.
Machine	LL_MachineArchitecture	char**	A pointer to a string containing the machine architecture. The string may result in "???" if a query is made before the associated records are updated with their actual values by the appropriate startd daemons.

Table 92. MACHINES specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Machine	LL_MachineAvailableClassList	char***	A pointer to an array containing the currently available job classes defined on the machine. The array ends with a NULL string.
Machine	LL_MachineConfigTimeStamp	int*	A pointer to an integer containing the date and time value of the last configuration or reconfiguration.
Machine	LL_MachineConfiguredClassList	char***	A pointer to an array containing the initiators on the machine. The array ends with a NULL string.
Machine	LL_MachineContinueExpr	char**	A pointer to a string containing the machine's continue control expression.
Machine	LL_MachineCpuList	int*	A pointer to an integer containing the list of CPUs on the machine.
Machine	LL_MachineCPUs	int*	A pointer to an integer containing the number of CPUs on the machine.
Machine	LL_MachineDisk	int*	A pointer to an integer indicating the disk space in KBs in the machine's execute directory.
Machine	LL_MachineDisk64	int64_t*	A pointer to a 64-bit integer indicating the disk space in KBs in the machine's execute directory.
Machine	LL_MachineDrainClassList	char***	A pointer to an array containing the drain class list on the machine. The array ends with a NULL string.
Machine	LL_MachineDrainingClassList	char***	A pointer to an array containing the draining class list on the machine. The array ends with a NULL string.
Machine	LL_MachineFeatureList	char***	A pointer to an array containing the features defined on the machine. The array ends with a NULL string.
Machine	LL_MachineFreeRealMemory	int*	A pointer to an integer indicating the amount of free real memory in MBs on the machine.
Machine	LL_MachineFreeRealMemory64	int64_t*	A pointer to a 64-bit integer indicating the amount of free real memory in MBs on the machine.
Machine	LL_MachineGetFirstAdapter	LL_element* (Adapter)	A pointer to the element associated with the machine's first adapter.
Machine	LL_MachineGetFirstMCM	LL_element* (MCM)	A pointer to the element associated with the machine's first MCM.

Table 92. MACHINES specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Machine	LL_MachineGetFirstResource	LL_element* (Resource)	A pointer to the element associated with the machine's first resource.
Machine	LL_MachineGetNextAdapter	LL_element* (Adapter)	A pointer to the element associated with the machine's next adapter.
Machine	LL_MachineGetNextMCM	LL_element* (MCM)	A pointer to the element associated with the machine's next MCM.
Machine	LL_MachineGetNextResource	LL_element* (Resource)	A pointer to the element associated with the machine's next resource.
Machine	LL_MachineKbddIdle	int*	A pointer to an integer indicating the number of seconds since the kbdd daemon detected keyboard mouse activity.
Machine	LL_MachineKillExpr	char**	A pointer to a string containing the machine's kill control expression.
Machine	LL_MachineLargePageCount64	int64_t*	A pointer to a 64–bit integer indicating the number of Large Pages defined on the machine.
Machine	LL_MachineLargePageFree64	int64_t*	A pointer to a 64–bit integer indicating the number of Large Pages free.
Machine	LL_MachineLargePageSize64	int64_t*	A pointer to a 64–bit integer indicating the size of the machine's Large Page.
Machine	LL_MachineLoadAverage	double*	A pointer to a double containing the load average on the machine.
Machine	LL_MachineMachineMode	char**	A pointer to a string containing the configured machine mode.
Machine	LL_MachineMaxTasks	int*	A pointer to an integer indicating the maximum number of tasks this machine can run at one time.
Machine	LL_MachineName	char**	A pointer to a string containing the machine name.
Machine	LL_MachineOperatingSystem	char**	A pointer to a string containing the operating system on the machine. The string may result in ″???″ if a query is made before the associated records are updated with their actual values by the appropriate startd daemons.
Machine	LL_MachinePagesFreed	int*	A pointer to an integer indicating the number of pages freed per second by the page replacement algorithm.

Table 92. MACHINES specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Machine	LL_MachinePagesFreed64	int64_t*	A pointer to a 64-bit integer indicating the number of pages freed per second by the page replacement algorithm.
Machine	LL_MachinePagesPagedIn	int*	A pointer to an integer indicating the number of pages paged in per second from paging space.
Machine	LL_MachinePagesPagedIn64	int64_t*	A pointer to a 64-bit integer indicating the number of pages paged in per second from paging space.
Machine	LL_MachinePagesPagedOut	int*	A pointer to an integer indicating the number of pages paged out per second to paging space.
Machine	LL_MachinePagesPagedOut64	int64_t*	A pointer to a 64-bit integer indicating the number of pages paged out per second to paging space.
Machine	LL_MachinePagesScanned	int*	A pointer to an integer indicating the number of pages scanned per second by the page replacement algorithm.
Machine	LL_MachinePagesScanned64	int64_t*	A pointer to a 64-bit integer indicating the number of pages scanned per second by the page replacement algorithm.
Machine	LL_MachinePoolList	int**	A pointer to an array indicating the pool numbers to which this machine belongs. The size of the array can be determined by using LL_MachinePoolListSize.
Machine	LL_MachinePoolListSize	int*	A pointer to an integer indicating the number of pools configured for the machine.
Machine	LL_MachinePrestartedStarters	int*	A pointer to an integer indicating the number of prestarted Starters on a machine.
Machine	LL_MachineRealMemory	int*	A pointer to an integer indicating the physical memory in MBs on the machine.
Machine	LL_MachineRealMemory64	int64_t*	A pointer to a 64-bit integer indicating the physical memory in MBs on the machine.
Machine	LL_MachineReservationList	char***	A pointer to an array containing the list of reservation IDs using this machine. The array ends with a NULL string.
Machine	LL_MachineReservationPermitted	int*	A pointer to an integer to determine if this machine can be reserved.

Table 92. MACHINES specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Machine	LL_MachineRSetSupport	int*	A pointer to an integer indicating the type of AffinitySupport. Valid values are: **MCM_AFFINITY** Indicates that the machine is configured to support MCM/CORE/CPU affinity. **USER_DEFINED_RSET** Indicates that the machine is configured to support user-defined RSets. **Note:** User-defined RSets are not supported on Linux. **NO_AFFINITY** Indicates that no specific affinity is configured on the machine.
Machine	LL_MachineScheddRunningJobs	int*	A pointer to an integer indicating a list of the running jobs assigned to Schedd.
Machine	LL_MachineScheddState	int*	A pointer to an integer indicating the machine's Schedd state.
Machine	LL_MachineScheddTotalJobs	int*	A pointer to an integer indicating the total number of jobs assigned to the Schedd.
Machine	LL_MachineSMTState	int*	A pointer to an integer indicating the SMT state of a node. Valid values are: **SMT_ENABLED** and **SMT_DISABLED**.
Machine	LL_MachineSpeed	double*	A pointer to a double containing the configured speed of the machine.
Machine	LL_MachineStartdRunningJobs	int*	A pointer to an integer containing the number of running jobs known by the startd daemon.
Machine	LL_MachineStartdState	char**	A pointer to a string containing the state of the startd daemon.
Machine	LL_MachineStartExpr	char**	A pointer to a string containing the machine's start control expression.
Machine	LL_MachineStepList	char***	A pointer to an array containing the steps running on the machine. The array ends with a NULL string.
Machine	LL_MachineSuspendExpr	char**	A pointer to a string containing the machine's suspend control expression.
Machine	LL_MachineTimeStamp	time_t*	A pointer to a **time_t** structure indicating the time the machine last reported to the negotiator.

Table 92. MACHINES specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Machine	LL_MachineUsedCpuList	int*	A pointer to an integer containing the list of CPUs being used on the machine.
Machine	LL_MachineVacateExpr	char**	A pointer to a string containing the machine's vacate control expression.
Machine	LL_MachineVirtualMemory	int*	A pointer to an integer indicating the free swap space in KBs on the machine.
Machine	LL_MachineVirtualMemory64	int64_t*	A pointer to a 64-bit integer indicating the free swap space in KBs on the machine.
MCM	LL_MCMCPUList	int**	A pointer to an array indicating the list of CPUs on the MCM.
MCM	LL_MCMCPUs	int*	A pointer to an integer containing the number of CPUs within the MCM.
MCM	LL_MCMID	int*	A pointer to an integer containing the ID of the MCM.
Resource	LL_ResourceAvailableValue	int*	A pointer to an integer indicating the value of available resources.
Resource	LL_ResourceAvailableValue64	int64_t*	A pointer to a 64-bit integer indicating the value of available resources.
Resource	LL_ResourceInitialValue	int*	A pointer to an integer indicating the initial resource value.
Resource	LL_ResourceInitialValue64	int64_t*	A pointer to a 64-bit integer indicating the initial resource value.
Resource	LL_ResourceName	char**	A pointer to a string containing the resource name.

See "Understanding the MCluster object model" on page 566 for more information on the MCluster object model.

Table 93. MCLUSTERS specifications for ll_get_data subroutine

Object	Specification	type of resulting data parameter	Description
MCluster	LL_MClusterAllowScaleAcrossJobs	int*	A pointer to a Boolean integer indicating if this cluster allows scale-across jobs.
MCluster	LL_MClusterExcludeClasses	char***	A pointer to an array containing a list of exclude classes.
MCluster	LL_MClusterExcludeGroups	char***	A pointer to an array containing a list of exclude groups.
MCluster	LL_MClusterExcludeUsers	char***	A pointer to an array containing a list of exclude users.

Table 93. MCLUSTERS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
MCluster	LL_MClusterInboundHosts	char***	A pointer to an array containing a list of inbound machines.
MCluster	LL_MClusterInboundScheddPort	int*	A pointer to an integer containing the cluster Schedd port number.
MCluster	LL_MClusterIncludeClasses	char***	A pointer to an array containing a list of include classes.
MCluster	LL_MClusterIncludeGroups	char***	A pointer to an array containing a list of include groups.
MCluster	LL_MClusterIncludeUsers	char***	A pointer to an array containing a list of include users.
MCluster	LL_MClusterLocal	int*	A pointer to an integer. If the integer contains the value 1, the cluster is local. If the integer contains the value 0, the cluster is remote.
MCluster	LL_MClusterMainScaleAcrossCluster	int*	A pointer to a Boolean integer indicating when a cluster serves as the main cluster for scale-across jobs.
MCluster	LL_MClusterMulticlusterSecurity	char**	A pointer to a string containing the security method for the multicluster.
MCluster	LL_MClusterName	char*	A pointer to a string containing the cluster name.
MCluster	LL_MClusterOutboundHosts	char***	A pointer to an array containing a list of outbound machines.
MCluster	LL_MClusterSecureScheddPort	int*	A pointer to an integer containing the secure Schedd port for the cluster.
MCluster	LL_MClusterSslCipherList	char**	A pointer to a string containing the list of cipher for SSL.

See "Understanding the Reservations object model" on page 566 for more information on the Reservations object model.

Table 94. RESERVATIONS specifications for ll_get_data subroutine

Object	Specification	type of resulting data parameter	Description
Reservation	LL_ReservationBgBPs	char***	A pointer to an array containing the Blue Gene base partitions reserved by the reservation. For a partially reserved base partition, the node cards reserved will be listed in parenthesis after the BP name.
Reservation	LL_ReservationBgCNodes	int*	A pointer to an integer indicating the number of Blue Gene C-nodes that are reserved.

Table 94. RESERVATIONS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Reservation	LL_ReservationBgConnection	char**	A pointer to a string containing the Blue Gene connection.
Reservation	LL_ReservationBgShape	int**	A pointer to an array indicating the Blue Gene shape.
Reservation	LL_ReservationBindingMethod	int*	A pointer to an integer containing the binding method for the reservation; either **RESERVATION_BIND_FIRM** or **RESERVATION_BIND_SOFT**.
Reservation	LL_ReservationCanceledOccurrences	int**	A pointer to an array indicating which occurrences of a recurring reservation have been canceled.
Reservation	LL_ReservationCanceledOccurrencesCount	int*	A pointer to an integer containing the number of canceled occurrences corresponding to the length of the array returned by LL_ReservationCanceled Occurrences.
Reservation	LL_ReservationCreateTime	time_t*	A pointer to the **time_t** structure indicating the creation time of the reservation.
Reservation	LL_ReservationDuration	int*	A pointer to an integer containing the reservation duration in the unit of minutes.
Reservation	LL_ReservationExpiration	time_t*	A pointer to the **time_t** structure indicating the expiration date and time of the recurring reservation.
Reservation	LL_ReservationGetNextOccurrence	LL_element* (Reservation)	A pointer to the element associated with the next occurrence of the reservation.
Reservation	LL_ReservationGroup	char**	A pointer to a string containing the LoadLeveler group that owns the reservation.
Reservation	LL_ReservationGroups	char***	A pointer to an array containing the LoadLeveler groups whose users may run jobs in the reservation. The array ends with a NULL string.
Reservation	LL_ReservationID	char**	A pointer to a string containing the ID of the reservation.
Reservation	LL_ReservationJobs	char***	A pointer to an array containing the job steps bound to the reservation. The array ends with a NULL string.
Reservation	LL_ReservationMachines	char***	A pointer to an array containing the machines reserved by the reservation. The array ends with a NULL string.

Table 94. RESERVATIONS specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
Reservation	LL_ReservationModeRemoveOnIdle	int*	A pointer to an integer indicating that RESERVATION_REMOVE_ON_IDLE mode is on if 1; off if 0.
Reservation	LL_ReservationModeShared	int*	A pointer to an integer indicating that RESERVATION_SHARED mode is on if 1; off if 0.
Reservation	LL_ReservationModifiedBy	char**	A pointer to a string containing the user ID who last modified the reservation.
Reservation	LL_ReservationModifyTime	time_t*	A pointer to the **time_t** structure indicating the last modification time.
Reservation	LL_ReservationOccurrenceID	int*	A pointer to an integer containing the occurrence ID (always 0 for a one-time reservation).
Reservation	LL_ReservationOwner	char**	A pointer to a string containing the owner of the reservation.
Reservation	LL_ReservationRecurrenceString	char**	A pointer to a string containing the reservation's recurrences.
Reservation	LL_ReservationRecurrenceStructure	LL_crontab_time*	An array of integers containing the reservation's recurrences as a structure (**LL_crontab_time** structure defined in **llapi.h**).
Reservation	LL_ReservationStartTime	time_t*	A pointer to the **time_t** structure indicating the beginning time of the reservation.
Reservation	LL_ReservationStatus	int*	A pointer to an integer containing the state of the reservation that takes one of the **Reservation_State_t** values in **llapi.h**.
Reservation	LL_ReservationUsers	char***	A pointer to an array containing the users who may run jobs in the reservation. The array ends with a NULL string.

See "Understanding the Wlmstat object model" on page 567 for more information on the Wlmstat object model.

Table 95. WLMSTAT specifications for ll_get_data subroutine

Object	Specification	type of resulting data parameter	Description
WlmStat	LL_WlmStatCpuSnapshotUsage	int*	A pointer to CPU usage obtained from the AIX Workload Manager.
WlmStat	LL_WlmStatCpuTotalUsage	int64_t*	A pointer to total CPU usage obtained from the AIX Workload Manager.

Table 95. WLMSTAT specifications for ll_get_data subroutine (continued)

Object	Specification	type of resulting data parameter	Description
WlmStat	LL_WlmStatLargePageMemorySnapshotUsage	int*	A pointer to large page memory usage obtained from the AIX Workload Manager.
WlmStat	LL_WlmStatMemoryHighWater	int64_t*	A pointer to real memory high water mark obtained from the AIX Workload Manager.
WlmStat	LL_WlmStatMemorySnapshotUsage	int*	A pointer to real memory usage obtained from the AIX Workload Manager.
WlmStat	LL_WlmStatVMemoryHighWater	int64_t*	A pointer to the virtual memory high-water mark obtained from the AIX Workload Manager.
WlmStat	LL_WlmStatVMemorySnapshotUsage	int64_t*	A pointer to virtual memory usage obtained from the AIX Workload Manager.

ll_get_objs subroutine

Use the **ll_get_objs** subroutine to send a query request to the daemon you specify along with the request data you specified in the **ll_set_request** subroutine. **ll_get_objs** receives a list of objects matching the request.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

LL_element * ll_get_objs (LL_element *query_element, LL_Daemon query_daemon,
                          char *hostname,int * number_of_objs,
                          int * error_code);
```

Parameters

query_element
Is a pointer to the **LL_element** returned by the **ll_query** function.

query_daemon
Specifies the LoadLeveler daemon you want to query or whether you want to query job information stored in a history file. The enum **LL_Daemon** is defined in **llapi.h** as:

```
enum LL_Daemon {LL_STARTD, LL_SCHEDD, LL_CM, LL_MASTER, LL_STARTER,
                LL_HISTORY_FILE};
```

Table 96 indicates which daemons respond to which query flags:

Table 96. query_daemon summary

When query_type (in ll_query) is:	query_flags (in ll_set_request) can be:	Responded to by these daemons:
BLUE_GENE	**QUERY_ALL**	negotiator (LL_CM)
	QUERY_BG_BASE_PARTITION	negotiator (LL_CM)
	QUERY_BG_PARTITION	negotiator (LL_CM)
CLASSES	**QUERY_ALL**	negotiator (LL_CM)
	QUERY_CLASS	negotiator (LL_CM)
CLUSTER	**QUERY_ALL**	negotiator (LL_CM)
FAIRSHARE	**QUERY_ALL**	negotiator (LL_CM)
	QUERY_GROUP	negotiator (LL_CM)
	QUERY_USER	negotiator (LL_CM)

Table 96. query_daemon summary (continued)

When query_type (in ll_query) is:	query_flags (in ll_set_request) can be:	Responded to by these daemons:
JOBS	**QUERY_ALL**	negotiator (LL_CM), Schedd (LL_SCHEDD), or history file (LL_HISTORY_FILE)
	QUERY_BG_JOB	negotiator (LL_CM)
	QUERY_CLASS	negotiator (LL_CM) or Schedd (LL_SCHEDD)
	QUERY_ENDDATE	history file (LL_HISTORY_FILE)
	QUERY_GROUP	negotiator (LL_CM)
	QUERY_HOST	negotiator (LL_CM)
	QUERY_JOBID	negotiator (LL_CM) or Schedd (LL_SCHEDD)
	QUERY_PROCID	startd (LL_STARTD)
	QUERY_RESERVATION_ID	negotiator (LL_CM) or Schedd (LL_SCHEDD)
	QUERY_STARTDATE	history file (LL_HISTORY_FILE)
	QUERY_STEPID	negotiator (LL_CM), Schedd (LL_SCHEDD), or startd (LL_STARTD)
	QUERY_TOP_DOG	negotiator (LL_CM)
	QUERY_USER	negotiator (LL_CM) or Schedd (LL_SCHEDD)
MACHINES	**QUERY_ALL**	negotiator (LL_CM)
	QUERY_HOST	negotiator (LL_CM)
MCLUSTERS	**QUERY_ALL**	Schedd (LL_SCHEDD)
RESERVATIONS	**QUERY_ALL**	negotiator (LL_CM)
	QUERY_BG_BASE_PARTITION	negotiator (LL_CM)
	QUERY_GROUP	negotiator (LL_CM)
	QUERY_HOST	negotiator (LL_CM)
	QUERY_RESERVATION_ID	negotiator (LL_CM)
	QUERY_USER	negotiator (LL_CM)
WLMSTAT	**QUERY_STEPID**	startd (LL_STARTD)

hostname
Specifies the *hostname* of the daemon or the history file name to be queried.

When *query_type* is **JOBS**, if *query_daemon* is:

LL_SCHEDD or LL_STARTD
The local machine is queried if the *hostname* is NULL.

LL_CM
The *hostname* is ignored.

LL_HISTORY_FILE
The *hostname* represents the history file to obtain data from. If the *hostname* is NULL, an error is returned.

When *query_type* is **MCLUSTER**, the *query_daemon* must be **LL_SCHEDD**. If you specify NULL for the *hostname*:

- The cluster specified by the **ll_cluster** API is the local cluster, a configured outbound Schedd daemon for the local cluster is queried.
- The cluster specified by the **ll_cluster** API is a remote cluster, a configured inbound Schedd daemon for the remote cluster is queried.

number_of_objs
Is a pointer to an integer representing the number of objects received from the daemon.

error_code
Is a pointer to an integer representing the error code issued when the function returns a NULL value. For more information, see ″Error values.″

Description

query_element, *query_daemon*, and *hostname* are the input fields for this subroutine. *number_of_objs* and *error_code* are output fields.

Each LoadLeveler daemon returns only the objects that it knows about.

Return Values

This subroutine returns a pointer to the first object in the list. You must use the **ll_next_obj** subroutine to access the next object in the list.

Error Values

This subroutine returns a NULL to indicate failure. The *error_code* parameter is set to one of the following:

-1 *query_element* not valid.
-2 *query_daemon* not valid.
-3 Cannot resolve *hostname*.
-4 Request type for specified daemon not valid.
-5 System error.
-6 No valid objects meet the request.
-7 Configuration error.
-9 Connection to daemon failed.
-10 Error processing history file (LL_HISTORY_FILE query only).
-11 History file must be specified in the hostname argument (LL_HISTORY_FILE query only).
-12 Unable to access the history file (LL_HISTORY_FILE query only).

Related Information

Subroutines: **ll_cluster**, **ll_deallocate**, **ll_free_objs**, **ll_get_data**, **ll_next_obj**, **ll_query**, **ll_set_request**

ll_next_obj subroutine

Use the **ll_next_obj** subroutine to return the next object in the *query_element* list you specify.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

LL_element * ll_next_obj (LL_element *query_element);
```

Parameters

query_element
Is a pointer to the **LL_element** returned by the **ll_query** function.

Description

query_element is the input field for this subroutine.

Use this subroutine in conjunction with the **ll_get_objs** subroutine to "loop" through the list of objects queried.

Return Values

This subroutine returns a pointer to the next object in the list.

Error Values

NULL Indicates an error or the end of the list of objects.

Related Information

Subroutines: **ll_cluster**, **ll_deallocate**, **ll_free_objs**, **ll_get_data**, **ll_get_objs**, **ll_query**, **ll_set_request**

ll_query subroutine

Use the **ll_query** subroutine to initialize the query object and define the type of query you want to perform. The **LL_element** created and the corresponding data returned by this function is determined by the *query_type* you select.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

LL_element * ll_query (enum QueryType query_type);
```

Parameters

query_type
Can be:

- **BLUE_GENE** (to query information about the Blue Gene system)
- **CLASSES** (to query information about job classes)
- **CLUSTER** (to query cluster information)
- **FAIRSHARE** (to query fair share scheduling information)
- **JOBS** (to query job information)
- **MACHINES** (to query machine information)
- **MCLUSTERS** (to query multicluster objects)

  Multicluster objects only exist when LoadLeveler has a multicluster configuration.
- **RESERVATIONS** (to query reservation information)
- **WLMSTAT** (to query AIX Workload Manager)

Description

query_type is the input field for this subroutine.

This subroutine is used in conjunction with other data access subroutines to query information about job and machine objects. You must call **ll_query** prior to using the other data access subroutines.

Return Values

This subroutine returns a pointer to an **LL_element** object. The pointer is used by subsequent data access subroutine calls.

Error Values

NULL The subroutine was unable to create the appropriate pointer.

Related Information

Subroutines: **ll_cluster**, **ll_deallocate**, **ll_free_objs**, **ll_get_data**, **ll_get_objs**, **ll_next_obj**, **ll_reset_request**, **ll_set_request**

ll_reset_request subroutine

Use the **ll_reset_request** subroutine to reset the request data to NULL for the *query_element* you specify.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_reset_request (LL_element *query_element);
```

Parameters

query_element
Is a pointer to the **LL_element** returned by the **ll_query** function.

Description

query_element is the input field for this subroutine.

This subroutine is used in conjunction with **ll_set_request** to change the data requested with the **ll_get_objs** subroutine.

Return Values

This subroutine returns a zero to indicate success.

Error Values

-1 The subroutine was unable to reset the appropriate data.

Related Information

Subroutines: **ll_deallocate**, **ll_free_objs**, **ll_get_data**, **ll_get_objs**, **ll_next_obj**, **ll_query**, **ll_set_request**

ll_set_request subroutine

Use the **ll_set_request** subroutine to determine the data requested during a subsequent **ll_get_objs** call to query specific objects. You can filter your queries based on the *query_type*, *object_filter*, and *data_filter* you select.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_set_request (LL_element *query_element, QueryFlags query_flags,
                    char **object_filter, DataFilter data_filter);
```

Parameters

query_element
Is a pointer to the **LL_element** returned by the **ll_query** subroutine.

query_flags
Table 97 provides information on *query_type* (in **ll_query**) and related *query_flags*:

Table 97. query_flags summary

When query_type (in ll_query) is:	query_flags can be:	Flag description:
BLUE_GENE	**QUERY_ALL**	Query Blue Gene base partitions, switches, and wires.
	QUERY_BG_BASE_PARTITION	Query Blue Gene base partitions, including any small partitions allocated on the base partition.
	QUERY_BG_PARTITION	Query partitions defined on the Blue Gene system.
CLASSES	**QUERY_ALL**	Query all classes.
	QUERY_CLASS	Query by LoadLeveler class.
CLUSTER	**QUERY_ALL**	Query cluster information from central manager.
FAIRSHARE	**QUERY_ALL**	Query returns all available information.
	QUERY_GROUP	Query by LoadLeveler group.
	QUERY_USER	Query by user ID.

Table 97. query_flags summary (continued)

When query_type (in ll_query) is:	query_flags can be:	Flag description:
JOBS	**QUERY_ALL**	Query all jobs.
	QUERY_BG_JOB	Query by **bluegene** type jobs only.
	QUERY_CLASS	Query by LoadLeveler class.
	QUERY_ENDDATE	Query by job end dates. History file query only.
	QUERY_GROUP	Query by LoadLeveler group.
	QUERY_HOST	Query by machine name.
	QUERY_JOBID	Query by job ID.
	QUERY_PROCID	Query by process ID of a task of a job step.
	QUERY_RESERVATION_ID	Query job steps bound to a particular reservation.
	QUERY_STARTDATE	Query by job start dates. History file query only.
	QUERY_STEPID	Query by step ID.
	QUERY_TOP_DOG	Query by job steps that are top dogs.
	QUERY_USER	Query by user ID.
MACHINES	**QUERY_ALL**	Query all machines.
	QUERY_HOST	Query by machine names.
MCLUSTERS	**QUERY_ALL**	Query all multiclusters.
RESERVATIONS	**QUERY_ALL**	Query all reservations.
	QUERY_BG_BASE_PARTITION	Query by Blue Gene base partitions or **all** for all base partitions.
	QUERY_GROUP	Query by LoadLeveler group that owns the reservations.
	QUERY_HOST	Query by machine name.
	QUERY_RESERVATION_ID	Query by reservation ID.
	QUERY_USER	Query by user ID that owns the reservations.
WLMSTAT	**QUERY_STEPID**	Query by step ID.

object_filter
Specifies search criteria. The value you specify for *object_filter* is related to the value you specify for *query_flags* as shown in Table 98:

Table 98. object_filter value related to the query flags value

If you specify:	Note:
QUERY_ALL	You do not need an *object_filter*.
QUERY_BG_BASE_PARTITION	The *object_filter* must contain a list of base partition IDs. For all base partitions, the first entry in the list must contain the string ″all″.
QUERY_BG_PARTITION	The *object_filter* must contain a list of partition IDs. For all partitions, the first entry in the list must contain the string ″all″.

Table 98. object_filter value related to the query flags value (continued)

If you specify:	Note:
QUERY_CLASS	The *object_filter* must contain a list of LoadLeveler class names.
QUERY_GROUP	The *object_filter* must contain a list of LoadLeveler group names.
QUERY_HOST	The *object_filter* must contain a list of LoadLeveler machine names. When the query type is **JOBS**, the machine names must be the names of machines to which the jobs are submitted.
QUERY_JOBID	The *object_filter* must contain a list of job IDs (in the form *host.jobid*).
QUERY_PROCID	The *object_filter* must contain a list with a single process ID of a task of a job step.
QUERY_RESERVATION_ID	The *object_filter* must contain a list of reservation IDs.
QUERY_STARTDATE or **QUERY_ENDDATE**	The *object_filter* must contain a list of two start dates or two end dates having the format *MM/DD/YYYY*.
QUERY_STEPID	The *object_filter* must contain a list of step IDs (in the form *host.jobid.stepid*).
QUERY_TOP_DOG	You do not need an *object_filter* for **QUERY_TOP_DOG**.
QUERY_USER	The *object_filter* must contain a list of user IDs.

The last entry in the *object_filter* array must be NULL.

data_filter
Filters the data returned from the object you query. The value you specify for *data_filter* is related to the value you specify for *query_type*. The *data_filter* must be **ALL_DATA** (the default) when:

- You query a history file for job information
- You specify **JOBS** and *query_flags* **QUERY_PROCID**
- You specify **BLUE_GENE**, **CLASSES**, **CLUSTER**, **MACHINES**, **MCLUSTERS**, **RESERVATIONS**, or **WLMSTAT**

Description

query_element, *query_flags*, *object_filter*, and *data_filter* are the input fields for this subroutine.

The **QUERY_PROCID** and **QUERY_TOP_DOG** flags should not be used in combination with any other *query_flags*.

Do not use the **QUERY_BG_BASE_PARTITION** flag in combination with the **QUERY_HOST** flag.

You can request certain combinations of object filters by calling **ll_set_request** more than once. When you do this, the query flags you specify are or-ed together. The following are valid combinations of object filters:

- **QUERY_JOBID** and **QUERY_STEPID**: the result is the union of both queries and any other query flags (such as, **QUERY_HOST**) will be ignored
- **QUERY_STARTDATE** and **QUERY_ENDDATE**: the result is the intersection of both queries
- **QUERY_HOST**, **QUERY_USER**, **QUERY_GROUP**, **QUERY_CLASS**, and **QUERY_RESERVATION_ID**: the result is the intersections of all of the queries
- When the *query_type* is **RESERVATIONS**, **QUERY_RESERVATION_ID** takes precedence and any other query flags are ignored (with the exception of **QUERY_ALL**, which always replaces any other query flags). **QUERY_HOST** and **QUERY_BG_BASE_PARTITION** are mutually exclusive and setting one will clear the other.

To query jobs owned by certain users and on specific machines, issue **ll_set_request** first with **QUERY_USER** and the appropriate user IDs, and then issue it again with **QUERY_HOST** and the appropriate host names.

For example, suppose you issue **ll_set_request** with a user ID list of anton and meg, and then issue it again with a host list of k10n10 and k10n11. The objects returned are all of the jobs on k10n10 and k10n11 which belong to anton or meg.

Note that if you use two consecutive calls with the same flag, the second call will replace the previous call.

Also, you should not use the **QUERY_ALL** flag in combination with any other flag, since **QUERY_ALL** will replace any existing requests.

For history file queries, ***query_flags*** is restricted to the following: **QUERY_ALL**, **QUERY_STARTDATE**, **QUERY_ENDDATE**.

Return Values

This subroutine returns a zero to indicate success.

Error Values

-1 You specified a *query_element* that is not valid.
-2 You specified a *query_flag* that is not valid.
-3 You specified an *object_filter* that is not valid.
-4 You specified a *data_filter* that is not valid.
-5 A system error occurred.

Related Information

Subroutines: **ll_cluster**, **ll_deallocate**, **ll_free_objs**, **ll_get_data**, **ll_get_objs**, **ll_next_obj**, **ll_query**, **ll_reset_request**

Examples of using the data access API

These examples are provided in the **samples/lldata_access** subdirectory of the release directory (usually **/usr/lpp/LoadL/full**).

Example 1: The following example shows how LoadLeveler's data access API can be used to obtain machine, job, and cluster information. The program consists of three steps:

1. Getting information about selected hosts in the LoadLeveler cluster
2. Getting information about jobs of selected classes

3. Getting floating consumable resource information in the LoadLeveler cluster

```
#include <stdio.h>
#include "llapi.h"

main(int argc, char *argv[])
{
   LL_element *queryObject, *machine, *resource, *cluster;
   LL_element *job, *step, *node, *task, *credential, *resource_req;
   int rc, obj_count, err_code, value;
   double load_avg;
   enum StepState step_state;
   char **host_list, **class_list;
   char *name, *res_name, *step_id, *job_class, *node_req;
   char *task_exec, *ex_args, *startd_state;

   /* Step 1: Display information of selected machines in the LL cluster */

   /* Initialize the query: Machine query */
   queryObject = ll_query(MACHINES);
   if (!queryObject) {
      printf("Query MACHINES: ll_query() returns NULL.\n"); exit(1);
   }

   /* Set query parameters: query specific machines by name */
   host_list = (char **)malloc(3*sizeof(char *));
   host_list[0] = "c163n12.ppd.pok.ibm.com";
   host_list[1] = "c163n11.ppd.pok.ibm.com";
   host_list[2] = NULL;
   rc = ll_set_request(queryObject, QUERY_HOST, host_list, ALL_DATA);
   if (rc) {
      printf("Query MACHINES: ll_set_request() return code is non-zero.\n"); exit(1);
   }

   /* Get the machine objects from the LoadL_negotiator (central manager) daemon */
   machine = ll_get_objs(queryObject, LL_CM, NULL, obj_count, err_code);
   if (machine == NULL) {
      printf("Query MACHINES: ll_get_objs() returns NULL. Error code =
   }
   printf("Number of machines objects returned =

   /* Process the machine objects */
   while(machine) {
      rc = ll_get_data(machine, LL_MachineName, name);
      if (!rc) {
         printf("Machine name:  free(name);
      }
      rc = ll_get_data(machine, LL_MachineStartdState, stard_state);
      if (rc) {
         printf("Query MACHINES: ll_get_data() return code is non-zero.\n"); exit(1);
      }

      printf("Startd State:
      if (strcmp(startd_state, "Down") != 0) {
         rc = ll_get_data(machine, LL_MachineRealMemory, value);
         if (!rc) printf("Total Real Memory:
         rc = ll_get_data(machine, LL_MachineVirtualMemory, value);
         if (!rc) printf("Free Swap Space:
         rc = ll_get_data(machine, LL_MachineLoadAverage, load_avg);
         if (!rc) printf("Load Average:
      }
      free(startd_state);
     /* Consumable Resources associated with this machine */
      resource = NULL;
      ll_get_data(machine, LL_MachineGetFirstResource, resource);
      while(resource) {
         rc = ll_get_data(resource, LL_ResourceName, res_name);
         if (!rc) {printf("Resource Name =  free (res_name);}
         rc = ll_get_data(resource, LL_ResourceInitialValue, value);
         if (!rc) printf("   Total:
         rc = ll_get_data(resource, LL_ResourceAvailableValue, value);
         if (!rc) printf("   Available:
         resource = NULL;
         ll_get_data(machine, LL_MachineGetNextResource, resource);
      }
      machine = ll_next_obj(queryObject);
   }

   /* Free objects obtained from Negotiator */
   ll_free_objs(queryObject);
   /* Free query element */
```

```
ll_deallocate(queryObject);

/* Step 2: Display information of selected jobs */

/* Initialize the query: Job query  */
queryObject = ll_query(JOBS);
if (!queryObject) {
   printf("Query JOBS: ll_query() returns NULL.\n");
   exit(1);
}

/* Query all class "Parallel" and "No_Class"  jobs submitted to c163n11, c163n12 */
class_list = (char **)malloc(3*sizeof(char *));
class_list[0] = "Parallel";
class_list[1] = "No_Class";
class_list[2] = NULL;
rc = ll_set_request(queryObject, QUERY_HOST, host_list, ALL_DATA);
if (rc) {printf("Query JOBS: ll_set_request() return code is  non-zero.\n"); exit(1);}
rc = ll_set_request(queryObject, QUERY_CLASS, class_list, ALL_DATA);
if (rc) {printf("Query JOBS: ll_set_request() return code is  non-zero.\n"); exit(1);}

/* Get the requested job objects from the Central Manager */
job = ll_get_objs(queryObject, LL_CM, NULL, obj_count, err_code);
if (job == NULL) {
   printf("Query JOBS: ll_get_objs() returns NULL. Error code =
}
printf("Number of job objects returned =

/*  Process the job objects and display selected information of each job step.
 *
 *  Notes:
 *    1. Since LL_element is defined as "void" in llapi.h, when using
 *       ll_get_data it is important that a valid "specification"
 *       parameter be used for a given "element" argument.
 *    2. Checking of return code is not always made in the following
 *        loop to minimize the length of the listing.
 */

while(job) {
   rc = ll_get_data(job, LL_JobName, name);
   if (!rc) {printf("Job name:  free(name);}

   rc = ll_get_data(job, LL_JobCredential, credential);
   if (!rc) {
      rc = ll_get_data(credential, LL_CredentialUserName, name);
      if (!rc) {printf("Job owner:  free(name);}
      rc = ll_get_data(credential, LL_CredentialGroupName, name);
      if (!rc) {printf("Unix Group:  free(name);}
   }
   step = NULL;
   ll_get_data(job, LL_JobGetFirstStep, step);
   while(step) {
      rc = ll_get_data(step, LL_StepID, step_id);
      if (!rc) {printf("  Step ID:  free(step_id);}
      rc = ll_get_data(step, LL_StepJobClass, job_class);
      if (!rc) {printf("  Step Job Class:  free(job_class);}
      rc = ll_get_data(step, LL_StepState, step_state);
      if (!rc) {
         if (step_state == STATE_RUNNING) {
            printf("  Step Status: Running\n");
            printf("  Allocated Hosts:\n");
            machine = NULL;
            ll_get_data(step, LL_StepGetFirstMachine, machine);
            while(machine) {
               rc = ll_get_data(machine, LL_MachineName, name);
               if (!rc) { printf("     free(name); }
               machine = NULL;
               ll_get_data(step, LL_StepGetNextMachine, machine);
            }
         }else {
            printf("  Step Status: Not Running\n");
         }
      }
      node = NULL;
      ll_get_data(step, LL_StepGetFirstNode, node);
      while(node) {
         rc = ll_get_data(node, LL_NodeRequirements, node_req);
```

```
            if (!rc) {printf("    Node Requirements:  free(node_req);}
            task = NULL;
            ll_get_data(node, LL_NodeGetFirstTask, task);
            while(task) {
               rc = ll_get_data(task, LL_TaskExecutable, task_exec);
               if (!rc) {printf("      Task Executable:  free(task_exec);}
               rc = ll_get_data(task, LL_TaskExecutableArguments, ex_args);
               if (!rc) {printf("      Task Executable Arguments:
               free(ex_args);}
               resource_req = NULL;
               ll_get_data(task, LL_TaskGetFirstResourceRequirement, resource_req);
               while(resource_req) {
                  rc = ll_get_data(resource_req, LL_ResourceRequirementName, name);
                  if (!rc) {printf("        Resource Req Name:  free(name);}
                  rc = ll_get_data(resource_req, LL_ResourceRequirementValue, value);
                  if (!rc) {printf("        Resource Req Value: }
                  resource_req = NULL;
                  ll_get_data(task, LL_TaskGetNextResourceRequirement, resource_req);
               }
               task = NULL;
               ll_get_data(node, LL_NodeGetNextTask, task);
            }
            node = NULL;
            ll_get_data(step, LL_StepGetNextNode, node);
         }
         step = NULL;
         ll_get_data(job, LL_JobGetNextStep, step);
      }
      job = ll_next_obj(queryObject);
   }
   ll_free_objs(queryObject);
   ll_deallocate(queryObject);

   /* Step 3: Display Floating Consumable Resources information of LL cluster. */

   /* Initialize the query: Cluster query  */
   queryObject = ll_query(CLUSTERS);
   if (!queryObject) {
      printf("Query CLUSTERS: ll_query() returns NULL.\n");
      exit(1);
   }
   ll_set_request(queryObject, QUERY_ALL, NULL, ALL_DATA);
   cluster = ll_get_objs(queryObject, LL_CM, NULL, obj_count, err_code);
   if (!cluster) {
      printf("Query CLUSTERS: ll_get_objs() returns NULL. Error code =
   }
   printf("Number of Cluster objects =
   while(cluster) {
      resource = NULL;
      ll_get_data(cluster, LL_ClusterGetFirstResource, resource);
      while(resource) {
         rc = ll_get_data(resource, LL_ResourceName, res_name);
         if (!rc) {printf("Resource Name =  free(res_name);}
         rc = ll_get_data(resource, LL_ResourceInitialValue, value);
         if (!rc) {printf("Resource Initial Value = }
         rc = ll_get_data(resource, LL_ResourceAvailableValue, value);
         if (!rc) {printf("Resource Available Value = }
         resource = NULL;
         ll_get_data(cluster, LL_ClusterGetNextResource, resource);
      }
      cluster = ll_next_obj(queryObject);
   }
   ll_free_objs(queryObject);
   ll_deallocate(queryObject);
}
```

Example 2: The following example shows how LoadLeveler's data access API can be used to extract job accounting information saved in a history file.

```
#include <stdio.h>
#include "llapi.h"
#define  STR_NULL(ptr) (ptr ? ptr : "")

main(int argc, char *argv[])
{
   LL_element *queryObject, *job = NULL, *step = NULL;
   LL_element *mach_usage = NULL, *disp_usage = NULL, *event_usage = NULL;
   int64_t int64_data;
   int rc, obj_count, err_code, job_count, step_count, int_data;
```

```
char *str_data;
char *start_dates[] = { "01/23/2008", "01/25/2008", NULL };
char *end_dates[]   = { "01/23/2008", "02/01/2008", NULL };
int mach_usage_count, disp_usage_count, event_usage_count;

/* Initialize the query: Job query  */
queryObject = ll_query(JOBS);
if (!queryObject) { printf("Query JOBS: ll_query() returns NULL.\n"); exit(1); }

/* Request information of job steps started/ended between certain dates. */
rc = ll_set_request(queryObject, QUERY_STARTDATE, start_dates, ALL_DATA);
if (rc) { printf("ll_set_request() - QUERY_STARTDATE -  RC =  exit(1); }
rc = ll_set_request(queryObject, QUERY_ENDDATE, end_dates, ALL_DATA);
if (rc) { printf("ll_set_request() - QUERY_ENDDATE -  RC =  exit(1); }

/* Get the requested job objects from the specified history file. */
job = ll_get_objs(queryObject, LL_HISTORY_FILE,
   "/tmp/spool/c209f1n05/history", &obj_count, &err_code);
if (!job) { printf("ll_get_objs() returns NULL. Error code =  exit(1); }

printf("************************************************\n");
printf("Number of job objects returned =
printf("************************************************\n");

/* Loop through the job objects. */
job_count = 0;
while (job) {
   job_count++;
   printf("============================================================\n");
   printf("Job number =

   /* Loop through the job step objects. */

   ll_get_data(job, LL_JobGetFirstStep, &step);
   step_count = 0;
   while (step) {
      step_count++;
      printf("     ====================================================\n");
      printf("     Step number =
      ll_get_data(step, LL_StepID, &str_data);
      printf("     LL_StepID                  =
      ll_get_data(step, LL_StepImageSize, &int_data);
      printf("     LL_StepImageSize           =
      ll_get_data(step, LL_StepImageSize64, &int64_data);
      printf("     LL_StepImageSize64         =

      /* Process CPU limit */
      ll_get_data(step, LL_StepCpuLimitHard, &int_data);
      printf("     LL_StepCpuLimitHard        =
      ll_get_data(step, LL_StepCpuLimitHard64, &int64_data);
      printf("     LL_StepCpuLimitHard64      =
      ll_get_data(step, LL_StepCpuLimitSoft, &int_data);
      printf("     LL_StepCpuLimitSoft        =
      ll_get_data(step, LL_StepCpuLimitSoft64, &int64_data);
      printf("     LL_StepCpuLimitSoft64      =

      /* Job Step CPU limit */
      ll_get_data(step, LL_StepCpuStepLimitHard64, &int64_data);
      printf("     LL_StepCpuStepLimitHard64  =
      ll_get_data(step, LL_StepCpuStepLimitSoft64, &int64_data);
      printf("     LL_StepCpuStepLimitSoft64  =

      /* Process Data Limit */
      ll_get_data(step, LL_StepDataLimitHard64, &int64_data);
      printf("     LL_StepDataLimitHard64     =
      ll_get_data(step, LL_StepDataLimitSoft64, &int64_data);
      printf("     LL_StepDataLimitSoft64     =

      /* CPU time used by the job step. */
      ll_get_data(step, LL_StepStepUserTime64, &int64_data);
      printf("     LL_StepStepUserTime64      =
      ll_get_data(step, LL_StepStepSystemTime64, &int64_data);
      printf("     LL_StepStepSystemTime64    =

      /* Loop through the machine usage objects. */
      /* A parallel job step run on 3 machines typically has 3 machine usage objects. */
      mach_usage_count = 0;
      rc = ll_get_data(step, LL_StepGetFirstMachUsage, &mach_usage);
      while (mach_usage) {
         mach_usage_count++;
```

```
            printf("     ------------------------------------------------------\n");
            printf("     Machine Usage number       =
            ll_get_data(mach_usage, LL_MachUsageMachineName, &str_data);
            printf("     Machine name               =

            /* Loop through the dispatch usage objects. */
            disp_usage_count = 0;
            ll_get_data(mach_usage, LL_MachUsageGetFirstDispUsage, &disp_usage);
            while (disp_usage) {
               disp_usage_count++;
               printf("        ---------------------------------------------------\n");
               printf("        Dispatch Usage number        =

               ll_get_data(disp_usage, LL_DispUsageStepUserTime64, &int64_data);
               printf("        LL_DispUsageStepUserTime64   =
               ll_get_data(disp_usage, LL_DispUsageStepSystemTime64, &int64_data);
               printf("        LL_DispUsageStepSystemTime64 =

               /* Loop through the event usage objects. */
               /* Each dispatch typically has 2 events: "started" and "completed". */
               /* There may be other events if the LL administrator executes the command */
               /* "llctl -g capture <user event name>" while the job is running.         */
               event_usage_count = 0;
               ll_get_data(disp_usage, LL_DispUsageGetFirstEventUsage, &event_usage);
               while (event_usage) {
                  event_usage_count++;
                  printf("           ------------------------------------------------\n");
                  printf("           Event Usage number           =
                  ll_get_data(event_usage, LL_EventUsageEventName, &str_data);
                  printf("           LL_EventUsageEventName       =
                  ll_get_data(event_usage, LL_EventUsageStepUserTime64, &int64_data);
                  printf("           LL_EventUsageStepUserTime64   =
                  ll_get_data(event_usage, LL_EventUsageStepSystemTime64, &int64_data);
                  printf("           LL_EventUsageStepSystemTime64 =
                  ll_get_data(disp_usage, LL_DispUsageGetNextEventUsage, &event_usage);
               }
               ll_get_data(mach_usage, LL_MachUsageGetNextDispUsage, &disp_usage);
            }
            rc = ll_get_data(step, LL_StepGetNextMachUsage, &mach_usage);
         }
         ll_get_data(job, LL_JobGetNextStep, &step);
      }
      job = ll_next_obj(queryObject);
   }
   exit(0);
}
```

Error handling API

Use the error handling API to gather information contained in the LoadLeveler error object and output that information as an error message.

This API consists of the "ll_error subroutine" on page 640.

ll_error subroutine

Use the **ll_error** subroutine to convert a LoadLeveler error object to an error message string. As an option, you can print the error message string to stdout or stderr.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

char *ll_error (LL_element **errObj, int print_to);
```

Parameters

errObj
: This is the address of a pointer to a LoadLeveler error object. A NULL *errObj* pointer indicates that any internal error objects will be printed.

print_to
- 1 - print error message to stdout
- 2 - print error message to stderr
- Any other value - no error message printed

Description

This subroutine also prints any error messages generated by APIs that do not support an error object as a parameter. When called with a NULL *errObj*, any error messages previously stored by such APIs, will be printed as directed by the *print_to* parameter and then deleted.

It is the caller's responsibility to free the storage associated with the error message string.

The LoadLeveler error object pointed to by **errObj* is deleted upon exit and NULL is assigned to **errObj*.

Return Values

The **ll_error** API returns a NULL return code if there is no error object to print.

Fair share scheduling API

Use the fair share scheduling API to perform fair share scheduling operations.

This API consists of the "ll_fair_share subroutine" on page 642.

ll_fair_share subroutine

Use the **ll_fair_share** subroutine to allow LoadLeveler administrators to perform certain fair share scheduling operations.

Library

LoadLeveler API library **libllapi.a**

Syntax

```
#include "llapi.h"

int ll_fair_share (int version, LL_element **errOBJ,
                   LL_fair_share_param *param);
```

Parameters

version
Is an input parameter that indicates the LoadLeveler API version (this should be **LL_API_VERSION**).

errObj
Is the address of a pointer to an **LL_element**. The pointer to **LL_element** must be set to NULL before calling this function. If this function fails, the pointer will point to an error object. The error messages stored in the error object can be displayed through the **ll_error** function. The caller must free the error object storage before reusing the pointer.

param
Is an input parameter of the address of a **LL_fair_share_param** structure defined in **llapi.h**.

In the **LL_fair_share_param** structure, the fields are defined as follows:

int *operation*
Specifies an intended operation on fair share scheduling with one of the following values:

FAIR_SHARE_RESET
Indicates that fair share scheduling will be reset either to start from scratch again by erasing all previous historic fair share data, or to start from a previously saved point by reading from a saved data file.

FAIR_SHARE_SAVE
Indicates that a snapshot of the historic fair share data for fair share scheduling will be saved to a file in a specified directory.

char **savedir*
Specifies the directory for saving a snapshot of the historic fair share data for fair share scheduling. The directory should be initialized to NULL if not used. A valid directory writable by the central manager must be specified for the **FAIR_SHARE_SAVE** operation.

char **saved_file*
Indicates that the previously saved file will be used in the **FAIR_SHARE_RESET** operation, if specified, to reset fair share scheduling to a known point. The file should be initialized to NULL if not used.

Description

The **ll_fair_share( )** subroutine is the API for the **llfs** command used to perform certain fair share scheduling operations.

The **ll_fair_share** subroutine can be used to reset fair share scheduling or to save a snapshot of the historic fair share data to a file.

This function is for LoadLeveler administrators and the BACKFILL scheduler only.

Return Values

API_OK
Request successfully sent to LoadLeveler.
API_CANT_CONNECT
Failed to connect to a LoadLeveler daemon.
API_SCHEDD_DOWN
One or more of the LoadLeveler Schedd daemons are down.
API_INPUT_NOT_VALID
Input data is not valid.
API_NOT_SUPPORTED
Fair share scheduling is not supported by the scheduler.
API_NO_PERMISSION
The user does not have permission to perform this operation.
API_CANT_READ_FILE
The specified file cannot be read.
API_CANT_WRITE_FILE
Failed to write data to a file.
API_NOT_ENABLED
Fair share scheduling is not enabled.
API_CANT_TRANSMIT
A data transmission failure occurred.
API_CONFIG_ERR
Errors were encountered while processing configuration files.

Related Information

Commands: **llfs**

Subroutines: **ll_error**

Reservation API

Use the reservation API to make, change, and remove reservations. In addition, it provides the ability to bind job steps to a reservation and unbind job steps from a reservation.

General users should refer to “Working with reservations” on page 213 for additional information. Additional information for LoadLeveler administrators is in “Configuring LoadLeveler to support reservations” on page 131.

This API consists of the following subroutines:
- **“ll_bind subroutine” on page 645**
- **“ll_change_reservation subroutine” on page 648**
- **“ll_init_reservation_param subroutine” on page 652**
- **“ll_make_reservation subroutine” on page 653**
- **“ll_remove_reservation subroutine” on page 658**

- **"ll_remove_reservation_xtnd subroutine" on page 660**

ll_bind subroutine

Use the **ll_bind** subroutine to bind job steps to a reservation. This subroutine can also be used to unbind a list of job steps from the reservations to which they are currently bound to, or whichever reservation they have requested to bind to in the event that the bind has not yet occurred.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_bind (int version, LL_element **errOBJ, LL_bind_param **param);
```

Parameters

version
Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to an **LL_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll_error** subroutine to display error messages stored in the error object. If you are going to use the **ll_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll_error** subroutine.

param
Provides the address of a pointer to a **LL_bind_param** structure as defined in **llapi.h**.

In the **LL_bind_param** structure, the fields are defined as follows:

char ***jobsteplist*
A NULL-terminated array of job or step identifiers. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's *hostname* to construct the full job or step identifier.

Note: For coscheduled jobs, even if all coscheduled job steps are not in the list of targeted job steps, the requested operation is performed on all coscheduled job steps.

char **ID*

The reservation identifier. The format of a full LoadLeveler reservation identifier is [*host*.]*rid*[.**r**].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional).

The reservation identifier can be specified in an abbreviated form, *rid*[.**r**], when the API is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

int unbind

Indicates that a value of 1 means that the job steps in *jobsteplist* are to be unbound from the reservations to which they are currently bound. A value of 0 indicates that the job steps in the job step list are to be bound to the reservation specified by the ID.

int binding_method

A value of **RESERVATION_BIND_FIRM** or **RESERVATION_BIND_SOFT** indicates which method to use to bind the steps in *jobsteplist*. A value of 0 indicates that the reservation's default binding method should be used. If **unbind** has a value of 1, the value of *binding_method* is ignored.

Description

The **ll_bind( )** subroutine is the API for the **llbind** command.

This function is for the BACKFILL scheduler only and only jobs in an idle-like state can be bound to a reservation.

LoadLeveler administrators can bind any job step to a reservation. If a job step is already bound to a reservation, it will first be unbound from the current reservation before being bound to the requested reservation. Nonadministrators must be the owner of the job steps to be bound or unbound, and either be the owner of the reservation or one of the users specified by the owner as having permission to use the reservation.

Return Values

RESERVATION_OK

Request successfully sent to LoadLeveler.

RESERVATION_REQUEST_DATA_NOT_VALID

Input is not valid.

RESERVATION_CONFIG_ERR

Errors were encountered while processing configuration files.

RESERVATION_NO_STORAGE

The system cannot allocate memory.

RESERVATION_CANT_TRANSMIT

A data transmission failure occurred.

RESERVATION_API_CANT_CONNECT
The subroutine cannot connect to the Schedd or central manager.
RESERVATION_NOT_SUPPORTED
The scheduler in use does not support reservations.
RESERVATION_NOT_EXIST
The reservation does not exist.
RESERVATION_NO_PERMISSION
Permission cannot be granted.
RESERVATION_WRONG_STATE
The reservation is not in the correct state.

Related Information

Commands: **llbind**

Subroutines: **ll_error**, **ll_make_reservation**

ll_change_reservation subroutine

Use the **ll_change_reservation** subroutine to change the attributes of a reservation.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_change_reservation (int version, LL_element **errOBJ, char **ID,
                           LL_reservation_change_param **param);
```

Parameters

version
Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to an **LL_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll_error** subroutine to display error messages stored in the error object. If you are going to use the **ll_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll_error** subroutine.

When using a job command file to change a reservation once the job is successfully submitted, an informational message will be returned in *errObj* that contains the name of the job.

ID Provides the reservation identifier. The format of a full LoadLeveler reservation identifier is [*host*.]*rid*[.**r**].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional).

The reservation identifier can be specified in an abbreviated form, *rid*[.**r**], when the API is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

param
Provides the address of a pointer to a NULL-terminated array of **LL_reservation_change_param** structures as defined in **llapi.h**. The caller must allocate and free storage for the **LL_reservation_change** structures.

In the **LL_reservation_change_param** structure, the fields are defined as follows:

enum LL_reservation_data *type*
Contains the type of the data to modify as shown in Table 99 on page 649.

Table 99. enum LL_reservation_data type

To modify	Specify	Type of new data
binding_method	RESERVATION_BINDING_METHOD	int *, use the Reservation_mode_t binding options to select the binding method
duration	RESERVATION_ADD_DURATION	int *
duration	RESERVATION_DURATION	int *
expiration	RESERVATION_EXPIRATION	char *
group	RESERVATION_GROUP	char *
grouplist	RESERVATION_ADD_GROUPS	char **, NULL terminated
grouplist	RESERVATION_DEL_GROUPS	char **, NULL terminated
grouplist	RESERVATION_GROUPLIST	char **, NULL terminated
hostfile	RESERVATION_BY_HOSTFILE	char *
hostlist	RESERVATION_ADD_HOSTS	char **, NULL terminated
hostlist	RESERVATION_BY_HOSTLIST	char **, NULL terminated
hostlist	RESERVATION_DEL_HOSTS	char **, NULL terminated
job_command_file	RESERVATION_BY_JCF	char *
jobstep	RESERVATION_BY_JOBSTEP	char *
number_of_bg_cnodes	RESERVATION_BY_BG_CNODE	int *
number_of_nodes	RESERVATION_ADD_NUM_NODE	int *
number_of_nodes	RESERVATION_BY_NODE	int *
occurrence	RESERVATION_OCCURRENCE	int *, if 0, modify all occurrences; if 1, modify only the first occurrence
owner	RESERVATION_OWNER	char *
recurrence	RESERVATION_RECURRENCE	LL_crontab_time* structure defined in **llapi.h**
remove on idle mode	RESERVATION_MODE_REMOVE_ON_IDLE	int *; *data = 0: Do not remove on Idle *data = 1: Remove on Idle
shared mode	RESERVATION_MODE_SHARED	int *; *data = 0: Not Shared *data = 1: Share
start_time	RESERVATION_ADD_START_TIME	int *
start_time	RESERVATION_START_TIME	char *
userlist	RESERVATION_ADD_USERS	char **, NULL terminated

Table 99. enum LL_reservation_data type (continued)

To modify	Specify	Type of new data
userlist	RESERVATION_DEL_USERS	char **, NULL terminated
userlist	RESERVATION_USERLIST	char **, NULL terminated

If several options are available to modify the same type of data, only one is allowed. For example, RESERVATION_DURATION and RESERVATION_ADD_DURATION are mutually exclusive. *number_of_nodes*, *hostlist*, *jobstep*, *job_command_file*, *number_bg_cnodes*, and *host_file* are all used to modify the reserved nodes and, therefore, the associated enums are all mutually exclusive.

The duration of a reservation can be decreased (corresponding to the **-d** *-nn* option on **llchres**) by specifying the data type RESERVATION_ADD_DURATION and providing a negative value. The same is true for RESERVATION_ADD_NUM_NODE and RESERVATION_ADD_START_TIME.

Note that as with the **ll_make_reservation** and the **LL_reservation_param** structure, the recurrence can be changed by setting the start time to a **crontab** format. For a description of the fields in **LL_crontab_time**, see "ll_make_reservation subroutine" on page 653. For **ll_change_reservation**, the type field of the **LL_reservation_change_param** is **RESERVATION_START_TIME**.

void **data*
Specifies the new data for the modification corresponding to *type*.

Description

The **ll_change_reservation( )** subroutine is the API for the **llchres** command. The "Notes on changing a reservation" listed in the **llchres** command also apply to the **ll_change_reservation** subroutine.

More than one attribute of a reservation can be changed with a single call. Either all of the changes can and will be made, or none of the changes will be made. If the changes cannot be made, *errObj* will contain a message indicating a reason for the failure. The message may not contain all of the reasons the request cannot be satisfied.

A coscheduled job step cannot be used for changing a reservation.

This function is for the BACKFILL scheduler only.

Only LoadLeveler administrators and the owner of the reservation can use this function.

Return Values

RESERVATION_OK
Request successfully sent to LoadLeveler.

RESERVATION_TOO_CLOSE
Reservation is being made within the minimum advance time.

RESERVATION_NO_STORAGE
The system cannot allocate memory.

RESERVATION_CONFIG_ERR
Errors were encountered while processing configuration files.
RESERVATION_USER_LIMIT_EXCEEDED
Exceeds the maximum number of reservations for the user.
RESERVATION_GROUP_LIMIT_EXCEEDED
Exceeds the maximum number of reservations for the group.
RESERVATION_NO_PERMISSION
Permission cannot be granted.
RESERVATION_WRONG_STATE
The reservation is not in the correct state.
RESERVATION_API_CANT_CONNECT
The subroutine cannot connect to the Schedd or central manager.
RESERVATION_JOB_SUBMIT_FAILED
Submit of the job command file failed.
RESERVATION_NO_MACHINE
One or more machines in the host list are not in the LoadLeveler cluster.
RESERVATION_WRONG_MACHINE
Reservations are not permitted on one or more machines in the host list.
RESERVATION_NO_RESOURCE
Insufficient resources in the LoadLeveler cluster.
RESERVATION_NO_JOBSTEP
The job step used for node selection does not exist.
RESERVATION_WRONG_JOBSTEP
The job step used for node selection is not in the right state.
RESERVATION_NOT_SUPPORTED
The scheduler in use does not support reservations.
RESERVATION_NOT_EXIST
The reservation does not exist.
RESERVATION_REQUEST_DATA_NOT_VALID
Input is not valid.
RESERVATION_CANT_TRANSMIT
A data transmission failure occurred.
RESERVATION_TOO_LONG
The duration exceeds the maximum reservation duration.
RESERVATION_HOSTFILE_ERR
Errors were encountered while processing the host file.
RESERVATION_SCALE_ACROSS_NOT_ALLOWED
A scale-across step cannot be used to change a reservation.

Related Information

Commands: **llchres**

Subroutines: **ll_error**, **ll_make_reservation**

ll_init_reservation_param subroutine

Use the **ll_init_reservation_param** subroutine to initialize the optional fields in the **LL_reservation_param** structure to default values prior to passing that structure to the **ll_make_reservation** subroutine.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_init_reservation_param (int version, LL_element **errOBJ,
                               LL_reservation_param **param);
```

Parameters

version
Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to an **LL_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll_error** subroutine to display error messages stored in the error object. If you are going to use the **ll_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll_error** subroutine.

param
Provides the address of a pointer to a **LL_reservation_param** structure. The **LL_reservation_param** structure will be initialized.

Description

The **ll_init_reservation_param( )** subroutine is used in conjunction with the **ll_make_reservation** subroutine. A program using this function would only have to set the required fields and any optional fields where the default value is not applicable.

Return Values

This subroutine returns a zero to indicate success.

Related Information

Subroutines: **ll_make_reservation**

ll_make_reservation subroutine

Use the **ll_make_reservation** subroutine to create a LoadLeveler reservation.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_make_reservation (int version, LL_element **errOBJ,
                         LL_reservation_param **param);
```

Parameters

version
Is an input parameter that indicates the LoadLeveler API version (this should be **LL_API_VERSION**).

errObj
Provides the address of a pointer to an **LL_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll_error** subroutine to display error messages stored in the error object. If you are going to use the **ll_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll_error** subroutine.

If a job command file is used to create a reservation and the job is successfully submitted, an informational message will be returned.

param
Provides the address of a pointer to a **LL_reservation_param** structure defined in **llapi.h**. The caller must allocate and free storage for this structure. It is suggested that the caller use the **ll_init_reservation_param** call to initialize the structure.

```
typedef struct {
   char **ID;
   char *start_time;
   int duration;
   enum LL_reservation_data data_type;
   void *data;
   int mode;
   char **users;
   char **groups;
   char *group;
   char *expiration;
   LL_crontab_time *recurrence;
} LL_reservation_param;
```

In the **LL_reservation_param** structure, the fields are defined as follows:

**char *****ID*
Contains the address where the reservation ID is to be returned.

**char ****start_time*
Specifies the *start_time* for a one-time reservation using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*. Hours must be specified using a 24-hour clock.

For a recurring reservation, *start_time* is a string that specifies when the reservation is to recur. The format of the string is *'minute hour day_of_month month day_of_week* [[*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*]' where the first part, '*minute hour day_of_month month day_of_week*' is the same as the format used by **crontab**. For each field, lists (for example, 1,3,5) and ranges (for example, 1-10) can be specified.

The second, optional part, '[*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*', is the start of the first occurrence and must be consistent with the **crontab** portion of the string. For example, if a reservation is needed at 4 p.m. every day, but not starting until December 1st, you would specify: `'0 16 * * * 12/01 16:00'`.

Specifying the recurrence using a **crontab** format in **start_time** while also setting the **recurrence** field will result in an error. However, the start time of the first occurrence of a recurring reservation can be specified using **start_time** while the recurrence can be specified in the **recurrence** field.

int *duration*
Specifies how long the reservation lasts in the unit of minutes.

enum LL_reservation_data *data_type*
Indicates how the nodes should be reserved. The valid values are:

```
RESERVATION_BY_NODE           by number of nodes
RESERVATION_BY_HOSTLIST       by specifying a hostlist
RESERVATION_BY_JOBSTEP        by specifying a jobstep
RESERVATION_BY_JCF            by job command file
RESERVATION_BY_BG_CNODE       by number of Blue Gene c-nodes
RESERVATION_BY_HOSTFILE       by specifying a host file
```

void **data*
Contains the pointer to the actual data specifying what nodes to reserve:

```
data_type                     data is a pointer of the type
RESERVATION_BY_NODE           int *
RESERVATION_BY_HOSTLIST       char **, a NULL terminated array of
                              machine names
RESERVATION_BY_JOBSTEP        char *, a jobstep name in the format
                              of host.jobid.stepid
RESERVATION_BY_JCF            char *, the full pathname
                              to a LoadLeveler Job Command File
RESERVATION_BY_BG_CNODE       int * for number of Blue Gene c-nodes
RESERVATION_BY_HOSTFILE       char *, name of a file containing a
                              list of machine names
```

int *mode*
Specifies options that control characteristics of the reservation. The **Reservation_mode_t** values can be OR'ed together to set this parameter:

RESERVATION_SHARED
Selects the SHARED option for the reservation. For a SHARED reservation, after all bound job steps that can run on the reserved nodes are scheduled to run, the remaining resources can be used to run job steps not bound to the reservation. Only bound job steps can be scheduled to run on a reservation that is not shared.

RESERVATION_REMOVE_ON_IDLE
Selects the REMOVE_ON_IDLE option for the reservation. For a REMOVE_ON_IDLE reservation, if all bound job steps are

finished or if all bound job steps are Idle and none can run on the reserved nodes, the reservation will be removed (canceled) automatically by LoadLeveler. If this option is not set, the reservation will remain, regardless of whether or not it is being used.

RESERVATION_BIND_FIRM
Selects firm binding as the default binding mode for the reservation.

RESERVATION_BIND_SOFT
Selects soft binding as the default binding mode for the reservation.

**char *****users*
Contains the list of users who can use the reservation. This pointer should be set to NULL so only the reservation owner and the LoadLeveler administrator can use the reservation.

**char *****groups*
Contains the list of LoadLeveler groups whose users can use the reservation. This pointer should be set to NULL so only the list of LoadLeveler groups and the LoadLeveler administrator can use the reservation.

**char ****group*
Contains a string of a LoadLeveler group that will own the reservation.

**char ****expiration*
Specifies the expiration date for a recurring reservation using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*.

**LL_crontab_time ****recurrence*
Specifies when the reservation is to recur using a series of integer arrays in the **LL_crontab_time** structure.

where:
minutes
0-59
hours 0-23
dom Days of month (1-31)
months
1 (January) through 12 (December)
dow Days of the week: 0 (Sunday) through 6 (Saturday)

A value of NULL is equivalent to a '*' in the corresponding **crontab** string. If **recurrence** is non-NULL, *start_time* can be used to specify when the first occurrence will start. The last element in the array (for example, **int * minutes**) is the value -1, a marker to indicate the end of the array.

Description

The **ll_make_reservation( )** subroutine is the API for the **llmkres** command used to create a new reservation.

The **ll_init_reservation_param** subroutine can be used to initialize the **LL_reservation_param** structure.

A coscheduled job step cannot be used for making a reservation.

This function is for the BACKFILL scheduler only.

The "ll_init_reservation_param subroutine" on page 652 is a convenience function that can be used to initialize the **LL_reservation_param** structure. You must set the ID, start_time, duration, data_type, and data fields of the **LL_reservation_param** structure. If any of these fields are NULL or 0 (as appropriate), the call will fail.

Only users authorized by LoadLeveler administrators to make reservations can use this function.

Return Values

RESERVATION_OK
Request successfully sent to LoadLeveler.

RESERVATION_LIMIT_EXCEEDED
Exceeds the maximum number of reservations allowed for the cluster.

RESERVATION_TOO_CLOSE
Reservation is being made within the minimum advance time.

RESERVATION_NO_STORAGE
The system cannot allocate memory.

RESERVATION_CONFIG_ERR
Errors were encountered while processing configuration files.

RESERVATION_USER_LIMIT_EXCEEDED
Exceeds the maximum number of reservations for the user.

RESERVATION_GROUP_LIMIT_EXCEEDED
Exceeds the maximum number of reservations for the group.

RESERVATION_NO_PERMISSION
Permission cannot be granted.

RESERVATION_SCHEDD_CANT_CONNECT
The Schedd cannot connect to the central manager.

RESERVATION_API_CANT_CONNECT
The subroutine cannot connect to the Schedd or central manager.

RESERVATION_JOB_SUBMIT_FAILED
Submit of the job command file failed.

RESERVATION_NO_MACHINE
One or more machines in the host list are not in the LoadLeveler cluster.

RESERVATION_WRONG_MACHINE
Reservations are not permitted on one or more machines in the host list.

RESERVATION_NO_RESOURCE
Insufficient resources in the LoadLeveler cluster.

RESERVATION_NO_JOBSTEP
The job step used for node selection does not exist.

RESERVATION_WRONG_JOBSTEP
The job step used for node selection is not in the right state.

RESERVATION_NOT_SUPPORTED
The scheduler in use does not support reservations.

RESERVATION_REQUEST_DATA_NOT_VALID
Input is not valid.

RESERVATION_CANT_TRANSMIT
A data transmission failure occurred.

RESERVATION_TOO_LONG
The duration exceeds the maximum reservation duration.

RESERVATION_HOSTFILE_ERR
Errors were encountered while processing the host file.

RESERVATION_SCALE_ACROSS_NOT_ALLOWED
A scale-across step cannot be used to make a reservation.

Related Information

Commands: **llmkres**

Subroutines: **ll_error**

A sample program called **res.c** is provided in the **samples/llres** subdirectory of the release directory.

ll_remove_reservation subroutine

Use the **ll_remove_reservation** subroutine to cancel one or more reservations.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_remove_reservation (int version, LL_element **errOBJ, char **IDs,
                           char **user_list, char **host_list, char **group_list,
                           char **base_partition_list = NULL);
```

Parameters

version
Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to an **LL_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll_error** subroutine to display error messages stored in the error object. If you are going to use the **ll_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll_error** subroutine.

IDs
Specifies a NULL-terminated array of reservation identifiers. The format of a full LoadLeveler reservation identifier is [*host*.]*rid*[.**r**].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional).

The reservation identifier can be specified in an abbreviated form, *rid*[.**r**], when the API is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

user_list
Specifies a NULL-terminated array of user IDs that own reservations.

host_list
Specifies a NULL-terminated array of machine names. One member of **all** indicates all Blue Gene base partitions.

group_list
Specifies a NULL-terminated array of LoadLeveler groups.

base_partition_list
Specifies a NULL-terminated array of Blue Gene base partitions. One member of **all** indicates all Blue Gene base partitions.

Description

The **ll_remove_reservation()** subroutine is the API for the **llrmres** command.

In LoadLeveler 3.5, the **ll_remove_reservation** subroutine was replaced with the **ll_remove_reservation_xtnd** subroutine.

A list of reservation IDs cannot be specified when *user_list*, *host_list*, *base_partition_list*, or *group_list* is specified. If reservation IDs is non-NULL when *user_list*, *host_list*, *base_partition_list*, or *group_list* is also non-NULL, the return value will be **RESERVATION_REQUEST_DATA_NOT_VALID**. Input for the *user_list*, *host_list*, *group_list*, or *base_partition_list* parameters can be provided in any combination. The *host_list* and *base_partition_list* parameters are mutually exclusive.

This function is for the BACKFILL scheduler only.

Only LoadLeveler administrators and the owner of the reservation can use this function.

Return Values

RESERVATION_OK
Request successfully sent to LoadLeveler.

RESERVATION_REQUEST_DATA_NOT_VALID
Input is not valid.

RESERVATION_CONFIG_ERR
Errors were encountered while processing configuration files.

RESERVATION_NO_STORAGE
The system cannot allocate memory.

RESERVATION_CANT_TRANSMIT
A data transmission failure occurred.

RESERVATION_API_CANT_CONNECT
The subroutine cannot connect to the Schedd or central manager.

RESERVATION_NOT_SUPPORTED
The scheduler in use does not support reservations.

Related Information

Commands: **llrmres**

Subroutines: **ll_error**, **ll_make_reservation**

ll_remove_reservation_xtnd subroutine

Use the **ll_remove_reservation_xtnd** subroutine in place of the **ll_remove_reservation** subroutine to cancel one or more reservations.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_remove_reservation_xtnd (int version, LL_element **errOBJ,
                                LL_remove_reservation_param *param);
```

Parameters

version
Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to an **LL_element** that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the **ll_error** subroutine to display error messages stored in the error object. If you are going to use the **ll_error** subroutine, the pointer must be initialized to NULL to ensure that a valid pointer is passed to the **ll_error** subroutine.

param
Provides the address of a pointer to a **LL_remove_reservation_param** structure defined in **llapi.h**.

In the **LL_remove_reservation_param** structure, the fields are defined as follows:

char ***IDs*
Specifies a NULL-terminated array of reservation identifiers.

The format of a full LoadLeveler reservation identifier is [*host*.]*rid*[.*r*[.*oid*]].

where:

- *host* is the name of the machine that assigned the reservation identifier.
- *rid* is the number assigned to the reservation when it was created. An *rid* is required.
- **r** indicates that this is a reservation ID (**r** is optional if *oid* is not specified).
- *oid* is the occurrence ID of a recurring reservation (*oid* is optional).

The reservation identifier can be specified in an abbreviated form, *rid*[.**r**[.*oid*]], when the API is invoked on the same machine that assigned the reservation identifier. In this case, LoadLeveler will use the local machine's host name to construct the full reservation identifier.

char ***user_list*
Specifies a NULL-terminated array of user IDs that own reservations.

char ***group_list**
Specifies a NULL-terminated array of LoadLeveler groups.

char ***host_list**
Specifies a NULL-terminated array of machine names. One member of **all** indicates all nodes in the cluster.

char ***base_partition_list**
Specifies a NULL-terminated array of machine names. One member of **all** indicates all Blue Gene base partitions.

char ***begin**
Specifies the beginning of an interval for partial cancellation of occurrences of a recurring reservation using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*.

char ***end**
Specifies the end of an interval for partial cancellation of occurrences of a recurring reservation using the format [*mm*/*dd*[/[*cc*]*yy*]] *HH:MM*.

Description

The **ll_remove_reservation_xtnd()** subroutine is the API for the **llrmres** command. Calls to the **ll_remove_reservation()** subroutine should be replaced with calls to **ll_remove_reservation_xtnd()**.

A list of reservation IDs cannot be specified when *user_list*, *group_list*, *host_list*, or *base_partition_list* is specified. If IDs are non-NULL when *user_list*, *group_list*, *host_list*, or *base_partition_list* is also non-NULL, the return value will be **RESERVATION_REQUEST_DATA_NOT_VALID**. Input for the *user_list*, *group_list*, *host_list*, *base_partition_list begin* or *end* parameters can be provided in any combination. The *host_list* and *base_partition_list* parameters are mutually exclusive.

This function is for the BACKFILL scheduler only.

Only LoadLeveler administrators and the owner of the reservation can use this function.

Return Values

RESERVATION_OK
Request successfully sent to LoadLeveler.

RESERVATION_REQUEST_DATA_NOT_VALID
Input is not valid.

RESERVATION_CONFIG_ERR
Errors were encountered while processing configuration files.

RESERVATION_NO_STORAGE
The system cannot allocate memory.

RESERVATION_CANT_TRANSMIT
A data transmission failure occurred.

RESERVATION_API_CANT_CONNECT
The subroutine cannot connect to the Schedd or central manager.

RESERVATION_NOT_SUPPORTED
The scheduler in use does not support reservations.

Related Information

Commands: **llrmres**

Subroutines: **ll_error, ll_make_reservation**

Submit API

Use the submit API to submit jobs to LoadLeveler.

This API consists of the following subroutines and a user exit for monitoring programs:

- **"llfree_job_info subroutine" on page 664**
- **"llsubmit subroutine" on page 665**
- **"monitor_program user exit" on page 667**

In LoadLeveler for Linux only, **llsubmit** returns an error value of –1 and writes the error messages to stderr when **SEC_ENABLEMENT** is **CTSEC.**

llfree_job_info subroutine

Use the **llfree_job_info** subroutine to free space for the array and the job step information used by **llsubmit**.

Syntax

```
void llfree_job_info (LL_job *job_info, int job_version);
```

Parameters

job_info
Is a pointer to a **LL_job** structure. Upon return, the space pointed to by the **step_list** variable and the space associated with the **LL_job** step structures pointed to by the **step_list** array are freed. All fields in the **LL_job** structure are set to zero.

job_version
Is an integer indicating the version of **llfree_job_info** being used. This argument should be set to **LL_JOB_VERSION** which is defined in the **llapi.h** header file.

llsubmit subroutine

Use the **llsubmit** subroutine to submit jobs to LoadLeveler for scheduling. It is both the name of a LoadLeveler command used to submit jobs as well as the subroutine described here.

Syntax

```
int llsubmit (char *job_cmd_file, char *monitor_program, char *monitor_arg,
              LL_job *job_info, int job_version);
```

Parameters

job_cmd_file
Is a pointer to a string containing the name of the job command file.

monitor_program
Is a pointer to a string containing the name of the monitor program to be invoked when the state of the job is changed. Set to NULL if a monitoring program is not provided.

monitor_arg
Is a pointer to a string which is stored in the job object and is passed to the monitor program. The maximum length of the string is 1023 bytes. If the length exceeds this value, it is truncated to 1023 bytes. Set to NULL if an argument is not provided.

job_info
Is a pointer to a structure defined in the **llapi.h** header file. No fields are required to be filled in. Upon return, the structure will contain the number of job steps in the job command file and a pointer to an array of pointers to information about each job step. Space for the array and the job step information is allocated by **llsubmit**. The caller should free this space using the **llfree_job_info** subroutine.

job_version
Is an integer indicating the version of **llsubmit** being used. This argument should be set to **LL_JOB_VERSION** which is defined in the **llapi.h** include file.

Description

LoadLeveler must be installed and configured correctly on the machine on which the submit application is run.

The uid and gid in effect when **llsubmit** is invoked are the uid and gid used when the job is run.

To submit a job to a remote cluster, call the **ll_cluster** API to define the cluster prior to calling the **llsubmit** API. If the job being submitted has the **cluster_list** keyword defined in the job command file, the cluster specified by the **ll_cluster** API takes precedence over the **cluster_list** keyword.

Return Values

0 The job was submitted successfully.

Error Values

-1 Error, error messages written to stderr.

Related Information

Subroutines: **ll_cluster**

monitor_program user exit

Use the **monitor_program** user exit to create a program that monitors jobs submitted using the **llsubmit** subroutine. The Schedd daemon invokes this monitor program if the **monitor_program** argument to **llsubmit** is not null.

Syntax

monitor_program job_id user_arg state exit_status

Parameters

monitor_program
Is the name of the program supplied in the `monitor_program` argument passed to the **llsubmit** function.

job_id
Is the full ID for the job step.

user_arg
The string supplied to the `monitor_arg` argument that is passed to the **llsubmit** function.

state
Is the current state of the job step. Possible values for the state are:

JOB_STARTED
The job step has started.

JOB_COMPLETED
The job step has completed.

JOB_VACATED
The job step has been vacated. The job step will be rescheduled if the job step is restartable or if it is checkpointable.

JOB_REJECTED
A **startd** daemon has rejected the job. The job will be rescheduled to another machine if possible.

JOB_REMOVED
The job step was canceled or could not be started.

JOB_NOTRUN
The job step cannot be run because a dependency cannot be met.

exit_status
Is the exit status from the job step. The argument is meaningful only if the state is JOB_COMPLETED.

Description

The monitor program is invoked each time a job step changes state. This means that the monitor program will be informed when the job step is started, completed, vacated, removed, or rejected. If you suspect the monitor program encountered problems or did not run, you should check the listing in the Schedd log. In the event of a monitor program failure, the job is still run.

Workload management API

Use the workload management API to perform LoadLeveler control operations and to work with an external scheduler.

This API consists of the following subroutines:
- **"ll_cluster subroutine" on page 669**
- **"ll_cluster_auth subroutine" on page 671**
- **"ll_control subroutine" on page 673**
- **"ll_modify subroutine" on page 677**
- **"ll_move_job subroutine" on page 681**
- **"ll_move_spool subroutine" on page 683**
- **"ll_preempt subroutine" on page 686**
- **"ll_preempt_jobs subroutine" on page 688**
- **"ll_run_scheduler subroutine" on page 691**
- **"ll_start_job_ext subroutine" on page 692**
- **"ll_terminate_job subroutine" on page 696**

The **ll_control** subroutine can be used to perform most of the LoadLeveler control operations and is designed for general use.

The **ll_cluster**, **ll_cluster_auth**, and **ll_move_job** subroutines are for use in the multicluster environment.

The **ll_preempt** subroutine was replaced with the **ll_preempt_jobs** subroutine in LoadLeveler 3.3.

The **ll_start_job_ext** and **ll_terminate_job** subroutines are intended to be used together with an external scheduler.

Note that the **ll_start_job_ext** and **ll_terminate_job** subroutines automatically connect to an alternate central manager if they cannot contact the primary central manager.

Note: The AIX Workload Manager (WLM) and the LoadLeveler workload management API are two distinct and unrelated components.

ll_cluster subroutine

Use the **ll_cluster** subroutine to enable other APIs to operate on a remote cluster.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_cluster (int version, LL_element **errObj, LL_cluster_param *param);
```

Parameters

version
Input parameter that indicates the LoadLeveler API version (should have the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to **LL_element** that points to an error object if this function fails.

param
Provides a pointer to an **LL_cluster_param** structure.

```
typedef enum LL_cluster_op {
        CLUSTER_SET,
        CLUSTER_UNSET
} ClusterOp_t;

typedef struct {
        ClusterOp_t action;
        char **cluster_list;
}
LL_cluster_param;
```

In the **enum LL_Cluster_op** structure, valid values are:

CLUSTER_SET
Sets the multicluster environment to *cluster_list*.

CLUSTER_UNSET
Unsets the multicluster environment.

In the **LL_cluster_param** structure, the fields are defined as follows:

action
Determines whether the cluster environment should be set or unset. The set action must have a corresponding *cluster_list* The unset action ignores the *cluster_list* data.

cluster_list
Is a NULL-terminated array of cluster stanza names. Only one cluster name is allowed. The reserved words **any** and **all** are not allowed.

Description

This API is called to enable other APIs to run on remote clusters in a multicluster environment and can be invoked by all users. To issue an API multiple times for different clusters, the **ll_cluster** and corresponding APIs must be issued for each cluster.

Return Values

CLUSTER_SUCCESS
Cluster name successfully set.

CLUSTER_SYSTEM_ERROR
LoadLeveler internal system error.

CLUSTER_INVALID_CLUSTER_PARAM
An input parameter that is not valid was specified. Possible causes are that the *cluster_list* parameter is NULL or that the reserved words **any** or **all** were specified.

CLUSTER_INVALID_ACTION_PARAM
An *action* parameter that is not valid was specified. Valid values are **CLUSTER_UNSET** and **CLUSTER_SET**.

Related Information

Subroutines: **ll_ckpt**, **ll_deallocate**, **ll_free_objs**, **ll_get_data**, **ll_get_objs**, **ll_modify**, **ll_next_obj**, **ll_query**, **ll_reset_request**, **ll_set_request**, **llsubmit**

ll_cluster_auth subroutine

Use the **ll_cluster_auth** subroutine to create a public key, a private key, and a security certificate.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_cluster_auth (int version, LL_cluster_auth_param **param);
```

Parameters

version
Input parameter that indicates the LoadLeveler API version (should have the same value as **LL_API_VERSION** in **llapi.h**).

param
Provides the address of a pointer to an array of pointers to **LL_cluster_auth_param** structures. The last element of the array must be NULL.

```
typedef enum LL_cluster_auth_op {
        CLUSTER_AUTH_GENKEY
} ClusterAuthOp_t;

typedef struct {
      ClusterAuthOp_t type;
}
LL_cluster_auth_param;
```

In the **enum LL_cluster_auth_op** structure, valid values are:

CLUSTER_AUTH_GENKEY
Generates required keys.

In the **enum LL_cluster_auth_op** structure, the fields are defined as follows:

type
Indicates the requested operation.

Description

The **ll_cluster_auth( )** subroutine is the API for the **llclusterauth** command. Refer to the **llclusterauth** command for information about other available command options.

This function must be run from a process with **root** authority.

The **ll_cluster_auth( )** subroutine creates a public key, a private key, a security certificate, and a directory for authorized keys. The keys and certificate are created in the **/var/LoadL/ssl** directory for AIX and in the **/var/opt/LoadL/ssl** directory for Linux.

- The private key is stored in **id_rsa**
- The public key is stored in **id_rsa.pub**
- The security certificate is stored in **id_rsa.cert**
- The authorized keys are stored in **authorized_keys**

In order for a connection to be accepted, the public key for the node requesting the connection must be stored in the authorized keys file on the node being connected to. Only a process with **root** authority can run this subroutine.

Return Values

The following return values are defined in **llapi.h**:

API_OK
Request successfully sent to LoadLeveler.

API_INVALID_INPUT
An input parameter that is not valid was specified.

API_CONFIG_ERR
Errors encountered while processing configuration files.

API_CANT_AUTH
Caller not authorized.

API_CANT_LISTEN
API cannot create listen socket.

API_CANT_CONNECT
Failed to connect to LoadLeveler.

API_TIMEOUT
Timed out waiting for a response.

API_SSL_ERR
Timed out waiting for a response.

API_STEP_NOT_IDLE
Request failed, the job step is not in the IDLE state.

Related Information

Commands: **llclusterauth**

ll_control subroutine

Use the **ll_control** subroutine to allow an application program to perform most of the functions that are currently available through the standalone commands: **llctl**, **llfavorjob**, **llfavoruser**, **llhold**, and **llprio**.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_control (int control_version, enum LL_control_op control_op,
                char **host_list, char ** user_list, char **job_list,
                char **class_list, int priority);
```

Parameters

int *control_version*
An integer indicating the version of **ll_control** being used. This argument should be set to **LL_CONTROL_VERSION**.

enum *LL_control_op*
The control operation to be performed. The enum **LL_control_op** is defined in **llapi.h** as:

```
enum LL_control_op {
LL_CONTROL_RECYCLE, LL_CONTROL_RECONFIG, LL_CONTROL_START,
LL_CONTROL_STOP, LL_CONTROL_DRAIN, LL_CONTROL_DRAIN_STARTD,
LL_CONTROL_DRAIN_SCHEDD, LL_CONTROL_FLUSH, LL_CONTROL_SUSPEND,
LL_CONTROL_RESUME, LL_CONTROL_RESUME_STARTD, LL_CONTROL_RESUME_SCHEDD,
LL_CONTROL_FAVOR_JOB, LL_CONTROL_UNFAVOR_JOB, LL_CONTROL_FAVOR_USER,
LL_CONTROL_UNFAVOR_USER, LL_CONTROL_HOLD_USER, LL_CONTROL_HOLD_SYSTEM,
LL_CONTROL_HOLD_RELEASE, LL_CONTROL_PRIO_ABS, LL_CONTROL_PRIO_ADJ,
LL_CONTROL_START_DRAINED, LL_CONTROL_DUMP_LOGS};
```

char ***host_list*
A NULL-terminated array of host names.

char ***user_list*
A NULL-terminated array of user names.

char ***job_list*
A NULL-terminated array of job or step identifiers. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.
- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's host name to construct the full job or step identifier.

Note: For coscheduled jobs, even if all coscheduled job steps are not in the list of targeted job steps, the requested operation is performed on all coscheduled job steps only when holding or releasing jobs.

char ***class_list*
A NULL-terminated array of class names.

int *priority*
An integer representing the new absolute value of user priority or adjustment to the current user priority of job steps.

Description

The **ll_control** subroutine performs operations that are essentially equivalent to those performed by the standalone commands: **llctl**, **llfavorjob**, **llfavoruser**, **llhold**, and **llprio**. Because of this similarity, descriptions of the **ll_control** operations are grouped according to the standalone command they resemble.

In LoadLeveler for Linux only, **ll_control** returns an error condition when **SEC_ENABLEMENT** is **CTSEC**.

llctl type of operations: These are the ll_control operations which mirror operations performed by the **llctl** command. This summary includes a brief description of each of the allowed **llctl** types of operations. For more information about the **llctl** command, see "llctl - Control LoadLeveler daemons" on page 439.

LL_CONTROL_START:
Starts the LoadLeveler daemons on the specified machines. The calling program must have rsh privileges to start LoadLeveler daemons on remote machines.

Note: LoadLeveler will fail to start if any value has been set for the MALLOCTYPE environment variable.

LL_CONTROL_START_DRAINED:
Starts the LoadLeveler in the drained state.

LL_CONTROL_STOP:
Stops the LoadLeveler daemons on the specified machines.

LL_CONTROL_RECYCLE:
Stops, and then restarts, all of the LoadLeveler daemons on the specified machines.

LL_CONTROL_RECONFIG:
Forces all of the LoadLeveler daemons on the specified machines to reread the configuration files.

LL_CONTROL_DRAIN:
When this operation is selected, the following happens: (1) No LoadLeveler jobs can start running on the specified machines, and (2) No LoadLeveler jobs can be submitted to the specified machines.

LL_CONTROL_DRAIN_SCHEDD:
No LoadLeveler jobs can be submitted to the specified machines.

LL_CONTROL_DRAIN_STARTD:
Keeps LoadLeveler jobs from starting on the specified machines. If a *class_list* is specified, then the classes specified will be drained (made unavailable). The literal string "**allclasses**" can be used as an abbreviation for all of the classes.

LL_CONTROL_FLUSH:
Terminates running jobs on the specified machines and send them back to the negotiator to await redispatch (if restart=yes).

LL_CONTROL_SUSPEND:
Suspends all jobs on the specified machines. This operation is not supported for parallel jobs.

LL_CONTROL_RESUME:
Resumes job submission to, and job execution on, the specified machines.

LL_CONTROL_RESUME_STARTD:
Resumes job execution on the specified machines; if a *class_list* is specified, then execution of jobs associated with these classes is resumed.

LL_CONTROL_RESUME_SCHEDD:
Resumes job submission to the specified machines.

LL_CONTROL_DUMP_LOGS:
Allows the request to dump the logging buffer.

For these **llctl** type of operations, the *user_list*, *job_list*, and *priority* arguments are not used and should be set to **NULL** or zero. The *class_list* argument is meaningful only if the operation is LL_CONTROL_DRAIN_STARTD, or LL_CONTROL_RESUME_STARTD. If *class_list* is not being used, then it should be set to **NULL**. If *host_list* is NULL, then the scope of the operation is all machines in the LoadLeveler cluster. Unlike the standalone **llctl** command, where the scope of the operation is either global or one host, **ll_control** operations allow the user to specify a list of hosts (through the *host_list* argument). To perform these operations, the calling program must have LoadLeveler administrator authority. The only exception to this rule is the **LL_CONTROL_START** operation.

llfavorjob type of operations: The **llfavorjob** type of control operations are: **LL_CONTROL_FAVOR_JOB**, and **LL_CONTROL_UNFAVOR_JOB**. For these operations, the *user_list*, *host_list*, *class_list*, and *priority* arguments are not used and should be set to **NULL** or zero. LL_CONTROL_FAVOR_JOB is used to set specified job steps to a higher system priority than all job steps that are not favored. LL_CONTROL_UNFAVOR_JOB is used to unfavor previously favored job steps, restoring the original priorities. The calling program must have LoadLeveler administrator authority to perform these operations.

llfavoruser type of operations: The **llfavoruser** type of control operations are: **LL_CONTROL_FAVOR_USER**, and **LL_CONTROL_UNFAVOR_USER**. For these operations, the *host_list*, *job_list*, *class_list*, and *priority* arguments are not used and should be set to **NULL** or zero. LL_CONTROL_FAVOR_USER sets jobs of one or more users to the highest priority in the system, regardless of the current setting. Jobs already running are not affected. LL_CONTROL_UNFAVOR_USER is used to unfavor previously favored user's jobs, restoring the original priorities. The calling program must have LoadLeveler administrator authority to perform these operations.

llhold type of operations: The **llhold** type of control operations are: **LL_CONTROL_HOLD_USER**, **LL_CONTROL_HOLD_SYSTEM**, and **LL_CONTROL_HOLD_RELEASE**. For these operations, the *class_list* and *priority* arguments are not used, and should be set to **NULL** or zero. LL_CONTROL_HOLD_USER and LL_CONTROL_HOLD_SYSTEM place jobs in user hold and system hold, respectively. LL_CONTROL_HOLD_RELEASE is used to release jobs from both types of hold. The calling program must have

LoadLeveler administrator authority to put jobs into system hold, and to release jobs from system hold. If a job is in both user and system holds then the LL_CONTROL_HOLD_RELEASE operation must be performed twice to release the job from both types of hold. If the user is not a LoadLeveler administrator then the **llhold** types of operations have no effect on jobs that do not belong to that user.

llprio type of operations: The **llprio** type of control operations are: **LL_CONTROL_PRIO_ABS**, and **LL_CONTROL_PRIO_ADJ**. For these operations, the *user_list*, *host_list*, and *class_list* arguments are not used, and should be set to **NULL**. **llprio** type of operations change the user priority of one or more job steps in the LoadLeveler queue. LL_CONTROL_PRIO_ABS specifies a new absolute value of the user priority, and LL_CONTROL_PRIO_ADJ specifies an adjustment to the current user priority. The valid range of LoadLeveler user priorities is 0–100 (inclusive); 0 is the lowest possible priority, and 100 is the highest. The **llprio** type of operations have no effect on a running job step unless this job step returns to **Idle** state. If the user is not a LoadLeveler administrator, then an **llprio** type of operation has no effect on jobs that do not belong to that user.

Return Values

0 The specified command has been sent to the appropriate LoadLeveler daemon.
-2 The specified command cannot be sent to the central manager.
-3 The specified command cannot be sent to one of the **LoadL_master** daemons.
-4 ll_control encountered an error while processing the administration or configuration file.
-6 A data transmission failure has occurred.
-7 The calling program does not have LoadLeveler administrator authority.
-19 An incorrect **ll_control** version has been specified.
-20 A system error has occurred.
-21 The system cannot allocate memory.
-22 A **control_op** operation that is not valid has been specified.
-23 The **job_list** argument contains one or more errors.
-24 The **host_list** argument contains one or more errors.
-25 The **user_list** argument contains one or more errors.
-26 Incompatible arguments have been specified for **HOLD** operation.
-27 Incompatible arguments have been specified for **PRIORITY** operation.
-28 Incompatible arguments have been specified for **FAVORJOB** operation.
-29 Incompatible arguments have been specified for **FAVORUSER** operation.
-30 An error occurred while ll_control tried to start a child process.
-31 An error occurred while ll_control tried to start the **LoadL_master** daemon.
-33 The **class_list** argument contains incompatible information.
-34 ll_control cannot create a file in the **/tmp** directory.
-35 LoadLeveler has encountered miscellaneous incompatible input specifications.
-41 This release of LoadLeveler for Linux does not support CTSEC.

Related Information

Commands: **llctl**, **llfavorjob**, **llfavoruser**, **llhold**, **llprio**

ll_modify subroutine

Use the **ll_modify** subroutine to modify the attributes of a submitted job step.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_modify (int version, void *errObj, LL_modify_param **param,
               char **steplist);
```

Parameters

version
Input parameter that indicates the LoadLeveler API version (should have the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to LL_element that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the ll_error subroutine to display error messages stored in the error object. If you are going to do so, the pointer should be initialized to NULL to avoid a segmentation fault when the pointer is passed to the ll_error subroutine.

param
Provides the address of an array of 2 pointers to the **LL_modify_param** structure defined in **llapi.h**. The first pointer should point to an **LL_modify_param** structure already filled out by the caller. The second pointer should be assigned NULL.

In the **LL_modify_param** structure:

type Describes the attribute to be modified.

data Is a pointer to the new attribute value.

All job step attributes types that can be modified through **ll_modify( )** are listed in **enum LL_modify_op** in **llapi.h**.

The **LL_modify_op** structure stores user inputs to the function, where:

type Is the type of the command option.

data Is a pointer to the data value associated with the command option.

name Is a NULL terminated array of job step names. Only a single job step is allowed in the current implementation.

steplist
A NULL terminated array of job or step identifiers. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

where:

- *host* is the name of the machine that assigned the job and step identifiers.

- *jobid* is the job number assigned to the job when it was submitted.
- *stepid* is the job step number assigned to the job step when it was submitted.

The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's host name to construct the full job or step identifier.

Description

ll_modify( ) is the API for the **llmodify** command. Refer to the **llmodify** command for information about other available command options.

In LoadLeveler for Linux only, **ll_modify** returns an error condition when **SEC_ENABLEMENT** is **CTSEC**.

In **enum LL_modify_op**:

- The system priority option will be ignored for any job step not in an idle state. The data field for the SYSPRIO option is an integer. The system priority for a job step set with the SYSPRIO option will not be changed when LoadLeveler recalculates system priorities.
- The **keyword** value is to be used to specify a string in the form, **keyword**=*value*, where keyword is the attribute of the job step to modify and *value* is the new value for the attribute. For a list of supported keywords and their descriptions, see "llmodify - Change attributes of a submitted job step" on page 464.
- The attributes that can be modified by the **enums** are described in "llmodify - Change attributes of a submitted job step" on page 464.

Return Values

The following return values are defined in **llapi.h**:

MODIFY_BAD_BG_CONNECTION
The Blue Gene connection request was not recognized.

MODIFY_BAD_BG_SHAPE
The Blue Gene partition shape is bad.

MODIFY_BAD_BG_SIZE
The Blue Gene partition size request was not positive.

MODIFY__CANT_MODIFY
The Blue Gene partition exists, but you cannot modify this value.

MODIFY__EMPTY_BG_PARTITION
The Blue Gene requested partition name was blank.

MODIFY_SUCCESS
Request successfully sent to LoadLeveler.

MODIFY_INVALID_PARAM
An input parameter that is not valid was specified.

MODIFY_CONFIG_ERROR
Errors encountered while processing config files.

MODIFY_NOT_IDLE
Request failed, job step not in IDLE state.

MODIFY_WRONG_JOB_TYPE
The modify operation is not valid for the job type.

MODIFY_WRONG_STATE
Request failed, job step in wrong state.

MODIFY_NOT_AUTH
Caller not authorized.

MODIFY_SYSTEM_ERROR
LoadLeveler internal system error.

MODIFY_CANT_TRANSMIT
Communication error while sending request.

MODIFY_CANT_CONNECT
Failed to connect to LoadLeveler.

MODIFY_INVALID_PARAM
The specified keyword is not supported.

MODIFY_NO_CTSEC_SUPPORT_ERR
SEC_ENABLEMENT was set to **CTSEC**. LoadLeveler for Linux does not support CTSEC.

MODIFY_OVERLAP_RESERVATION
Request failed. The requested change would cause the job step to overlap with a reservation.

MODIFY_CLUSTER_OPTION_ERROR
A **cluster_option** keyword modification error.

Related Information

Commands: **llmodify**

Subroutines: **ll_cluster**, **ll_error**

Examples

```
/* mymodify.c - make a job step non-preemptable */
#include <stdio.h>
#include <string.h>
#include "llapi.h"

int main(int argc, char *argv[])
{
   int rc, preempt = 0;
   LL_modify_param mycmd, *cmdp[2];
   char *step_list[2];
   LL_element *errObj = NULL;
 char *errmsg;

if (argc < 2) {
   printf("Usage:  exit(1);
}

step_list[0] = argv[1];
step_list[1] = NULL;
printf("\n*** Make Job Step %s non-preemptable ***\n\n",
        step_list[0]);

/* Initialize the LL_modify_param structure */
mycmd.type = STEP_PREEMPTABLE;
mycmd.data = &preempt;
```

```
cmdp[0] = &mycmd
cmdp[1] = NULL;

/* Modify job step to be non preemptable */
printf("Modify job step to be non-preemptable\n");;
rc = ll_modify(LL_API_VERSION, &errObj, cmdp, step_list);
if (rc) {
errmsg = ll_error(&errObj, 0);
printf("ll_modify() return code:
free(errmsg);
      exit(1);
   }
   return 0;
}
```

ll_move_job subroutine

Use the **ll_move_job** subroutine to move an idle job from one cluster to another.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_move_job (int version, LL_element **errObj, LL_move_job_param **param);
```

Parameters

version
Input parameter that indicates the LoadLeveler API version (should have the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to **LL_element** that points to an error object if this function fails.

param
Provides the address of a pointer to an **LL_move_job_param** structure.

```
typedef struct {
        char *cluster_name;
        char *job_id;
}
LL_move_job_param;
```

In the **LL_move_job_param** structure, the fields are defined as follows:

cluster_name
The name of the cluster to which the job will be moved.

job_id
The job ID of the job to be moved.

Description

The **ll_move_job( )** subroutine is the API for the **llmovejob** command. Refer to the **llmovejob** command for information about other available command options.

The **ll_move_job** API moves a single idle job from one cluster to another. If any steps within the job are not idle, the transfer request is rejected and the API returns API_STEP_NOT_IDLE. The remote job retains the original *job_ID* from the local cluster. Upon transfer, the remote cluster performs any user mapping and remote job filtering necessary for the job.

Any changes made to the idle job in the local cluster by the **llmodify** command will not be carried forward to the remote cluster. Any jobs submitted when the local cluster was not configured as a part of a multicluster cannot be moved if the cluster's configuration is changed to a multicluster environment.

Only administrators can issue the **ll_move_job( )** subroutine. In a mixed operating multicluster environment, administrators must ensure the binary compatibility of the job being transferred.

Return Values

The following return values are defined in **llapi.h**:

API_OK
Request successfully sent to LoadLeveler.

API_INVALID_INPUT
An input parameter that is not valid was specified.

API_CONFIG_ERR
Errors encountered while processing configuration files.

API_CANT_AUTH
Caller not authorized.

API_CANT_LISTEN
API cannot create listen socket.

API_CANT_CONNECT
Failed to connect to LoadLeveler.

API_TIMEOUT
Timed out waiting for a response.

API_STEP_NOT_IDLE
Request failed, the job step is not in the IDLE state.

Related Information

Commands: **llmovejob**

ll_move_spool subroutine

Use the **ll_move_spool** subroutine to move the job records from the spool directory of one managing Schedd to another managing Schedd in the local cluster.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_move_spool (int version, LL_move_spool_param ** param,
                   int (*func) (char *jobid,
                   int rc, LL_element **messageObj),
                   LL_element **errObj);
```

Parameters

version
Input parameter that indicates the LoadLeveler API version (should have the same value as **LL_API_VERSION** in **llapi.h**).

param
Provides the address of a pointer to an **LL_move_spool_param** structure.

```
typedef struct {
        char **schedd_host;
        char *spool_directory;
        SpoolData_t data;
        } LL_move_spool_param;

        typedef enum move_spool_data {
                LL_MOVE_SPOOL_JOBS
        } SpoolData_t;
```

(*func***)(char** ***jobid*, **int** *rc*, **LL_element** ****messageObj*)**
Specifies the user-supplied function to be called after every job is processed. The function must return an integer and must accept as input:

- A char pointer representing the job ID processed
- An integer representing the return code of the job processing
- The address to a pointer of an **LL_element** data type representing any messages generated

The **LL_element** data type is defined in the **llapi.h** file. If a callback is not desired, the function pointer should be set to NULL.

errObj
Provides the address of a pointer to **LL_element** that points to an error object if this subroutine returns an unsuccessful return code.

Description

The **ll_move_spool( )** subroutine is the API for the **llmovespool** command.

The **ll_move_spool** subroutine is intended for recovery purposes only. This subroutine moves the job records from the *spool_directory* of one managing *schedd_host* to another managing *schedd_host* in the local cluster. The **ll_move_spool** subroutine must be run from a machine that has read and write access to the specified *spool_directory* containing the job records being moved. This machine

must also have network connectivity to the machine running the Schedd daemon that will receive the job records. Jobs to be moved can be in any state.

The *schedd_host* that created the job records to be moved must not be running during the move operation. Jobs within the job queue database will be unrecoverable if the job queue is updated during the move by any process other than the **ll_move_spool** subroutine. The *schedd_host* that created the job records to be moved must have the **schedd_fenced** machine stanza keyword set to **true** prior to the **ll_move_spool** subroutine being issued.

All moved jobs retain their original job identifiers. The **ll_move_spool** subroutine invokes the function specified by the (**func*) parameter after each job is processed. When the job records for a job are successfully transferred, the *schedd_host* of the job is updated to represent the new managing *schedd_host* and the job records in the specified *spool_directory* are deleted. If the transfer for any step within a job fails, the job records for that step remain in the specified *spool_directory*. If for some reason a job fails, the **ll_move_spool** subroutine should be reissued against the specified *spool_directory* to reprocess the job.

The user-supplied function enables messages to be displayed as each job is processed without having to wait for all of the jobs to be completed. If a callback is not desired, the function pointer should be set to NULL. The callback function must call the **ll_error** API passing in the *messageObj* in order to free the memory allocated to it.

The **ll_move_spool** subroutine does not move the reservation queue or fair share scheduling data found within the specified *spool_directory*.

Only administrators can issue the **ll_move_spool** subroutine.

A sample is available in:

{$RELEASEDIR}/samples/llmovespool

Return Values

The following return values are defined in **llapi.h** and can be returned by the **ll_move_spool** API:

API_OK
Request successfully sent to LoadLeveler.

API_INPUT_NOT_VALID
An input parameter that is not valid was specified.

API_CONFIG_ERR
Errors encountered while processing configuration files.

API_CANT_AUTH
Caller not authorized.

API_CANT_LISTEN
API cannot create listen socket.

API_CANT_CONNECT
Failed to connect to LoadLeveler.

API_TIMEOUT
Timed out waiting for a response.

API_JOBQ_ERR
Error occurred reading source job queue or writing to destination job queue.

API_SCHEDD_DOWN
The *schedd_host* is not accepting jobs.

API_SCHEDD_NOT_FENCED
The original Schedd machine stanza does not have the **schedd_fenced** keyword set to **true**.

The following return values are defined in **llapi.h** and can be passed to the user-specified function:

API_CANT_TRANSMIT
schedd_host encountered an error while processing the executable or job command file job records.

API_OK
Request successfully sent to LoadLeveler.

API_CANT_CONNECT
Failed to connect to LoadLeveler.

API_TIMEOUT
Timed out waiting for a response.

API_JOBQ_ERR
Error occurred reading source job queue or writing to destination job queue.

API_JOB_NOT_FOUND
schedd_host encountered an error while processing the received job.

Related Information

Commands: **llmovespool**

ll_preempt subroutine

Use the **ll_preempt** subroutine to preempt a running job step or to resume a job step that has already been preempted through the **llpreempt** command or the **ll_preempt** subroutine (user-initiated). The **ll_preempt** subroutine cannot resume a job step preempted through PREEMPT_CLASS rules (system-initiated).

Library

LoadLeveler API library, **libllapi.a**

Syntax

```
#include "llapi.h"

int ll_preempt (int version, LL_element **errObj, char *job_step,
                enum LL_preempt_op type);
```

Parameters

version
Input parameter that indicates the LoadLeveler API version (should have the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to LL_element that points to an error object if this function fails.

The caller must free the error object storage before reusing the pointer. You can also use the ll_error subroutine to display error messages stored in the error object. If you are going to do so, the pointer should be initialized to NULL to avoid a segmentation fault when the pointer is passed to the ll_error subroutine.

jobstep
A string used to specify the name of a job step.

type
- Preempts job step if *type* equals PREEMPT_STEP
- Resumes job step if *type* equals RESUME_STEP

Description

ll_preempt( ) is the API for the **llpreempt** command.
- This function is for external schedulers
- Only LoadLeveler administrators have authority to use this function

In LoadLeveler 3.3, the **ll_preempt** subroutine was replaced with the **ll_preempt_jobs** subroutine.

Return Values

API_OK
Request successfully sent to LoadLeveler.

API_INVALID_INPUT
An input parameter that is not valid was specified.

API_CONFIG_ERR
Errors encountered while processing configuration files.

API_CANT_AUTH
Caller not authorized.

API_CANT_CONNECT
Failed to connect to LoadLeveler.

ll_preempt_jobs subroutine

Use the **ll_preempt_jobs** subroutine to preempt a set of running job steps using the specified preempt method or to resume job steps that have already been preempted with the preempt method of suspend through the **llpreempt** command or the **ll_preempt_jobs** subroutine. The **ll_preempt_jobs** subroutine cannot resume a job step that was preempted through the **PREEMPT_CLASS** rules or a job step that was preempted with a preempt method other than suspend.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_preempt_jobs (int version, void *errObj, LL_preempt_param **param);
```

Parameters

version
Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL_API_VERSION** in **llapi.h**).

errObj
Provides the address of a pointer to an **LL_element** that points to an error object if this function fails.

param
Is a pointer to an array of structures. The structure specifies the parameters for a preempt operation.

```
typedef struct LL_preempt_param {
     enum LL_preempt_op type;
     enum LL_preempt_method method;
     char ** user_list;
     char ** host_list;
     char ** jobstep_list;
} LL_preempt_param;

enum LL_preempt_op {PREEMPT_STEP, RESUME_STEP};

enum LL_preempt_method {LL_PREEMPT_SUSPEND, LL_PREEMPT_VACATE,
     LL_PREEMPT_REMOVE, LL_PREEMPT_SYS_HOLD, LL_PREEMPT_USER_HOLD}
```

In the **LL_preempt_param** structure, the fields are defined as follows:

type Is the type of operation on the job steps, **preempt** or **resume**.

method Is the method to be used to preempt the specified job steps. This argument is ignored if the type argument is not set to **PREEMPT_STEP**. Valid values for this argument are:
- LL_PREEMPT_SUSPEND
- LL_PREEMPT_VACATE
- LL_PREEMPT_REMOVE
- LL_PREEMPT_SYS_HOLD
- LL_PREEMPT_USER_HOLD

In the **enum LL_preempt_op** structure, valid values are:
- PREEMPT_STEP
- RESUME_STEP

In the **enum LL_preempt_method** structure, valid values are:

- LL_PREEMPT_SUSPEND
- LL_PREEMPT_VACATE
- LL_PREEMPT_REMOVE
- LL_PREEMPT_SYS_HOLD
- LL_PREEMPT_USER_HOLD

user_list
: Is a pointer to a NULL-terminated array of pointers to strings containing user names. All running job steps belonging to all users in the list and monitored by the machine the subroutine is running on will be preempted or resumed. If a *host_list* is also specified, only the user's job steps monitored on the specified hosts will be preempted or resumed.

host_list
: Is a pointer to a NULL-terminated array of pointers to strings containing host names. All job steps monitored by the hosts will be preempted or resumed. If a *user_list* is also provided, only the running job steps monitored by the hosts and owned by the specified users will be preempted or resumed.

jobstep_list
: Is a pointer to a NULL-terminated array of job or step identifiers. When a job identifier is specified, the action of the API is taken for all steps of the job. At least one job or step identifier must be specified.

  The format of a job identifier is *host.jobid*. The format of a step identifier is *host.jobid.stepid*.

  where:

  - *host* is the name of the machine that assigned the job and step identifiers.
  - *jobid* is the job number assigned to the job when it was submitted.
  - *stepid* is the job step number assigned to the job step when it was submitted.

  The job or step identifier can be specified in an abbreviated form, *jobid* or *jobid.stepid*, when the API is invoked on the same machine that assigned the job and step identifiers. In this case, LoadLeveler will use the local machine's host name to construct the full job or step identifier.

  Note: For coscheduled jobs, even if all coscheduled job steps are not in the list of targeted job steps, the requested operation is performed on all coscheduled job steps.

Description

The **ll_preempt_jobs( )** subroutine is the API for the **llpreempt** command. See the **llpreempt** command for information about the available command options. In order to provide source code compatibility for applications using the current version of the **preempt** function, the **ll_preempt()** subroutine will not be modified to support the new preemption options. The **ll_preempt()** subroutine will continue to be supported as is.

Return Values

0 Request successfully sent to the central manager.
-1 An *LL_preempt_op* that is not valid was specified.

-2 Cannot send request to central manager.
-3 An incorrect version was specified.
-4 Errors encountered while processing the LoadLeveler administration or configuration files.
-5 A system error occurred.
-6 A data transmission failure occurred.
-7 The calling program does not have LoadLeveler administrator authority.

ll_run_scheduler subroutine

Use the **ll_run_scheduler** subroutine to send a request to the central manager to run the scheduling algorithm. It is used when the internal scheduling interval has been disabled so that an external program can control when the central manager attempts to schedule job steps.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_run_scheduler (int version);
```

Parameters

version
Is an input parameter that indicates the LoadLeveler API version (this should be the same value as **LL_API_VERSION** in **llapi.h**).

Description

The **ll_run_scheduler( )** subroutine sends a request to the central manager to run the LoadLeveler scheduling algorithm. The central manager's scheduling algorithm will run only once each time the **llrunscheduler** command is invoked. Each time the scheduling algorithm runs, the central manager will schedule as many job steps as the current available resources allow. The LoadLeveler scheduling interval must be disabled, that is the configuration keyword **NEGOTIATOR_INTERVAL** must be set to zero in order to use this algorithm. Only LoadLeveler administrators have authority to use this algorithm.

Return Values

RUN_SCHED_SUCCESS
Request successfully sent to the central manager.

RUN_SCHED_CONFIG_ERROR
Errors were encountered while processing configuration files.

RUN_SCHED_NOT_AUTH
Calling program does not have LoadLeveler administrator authority.

RUN_SCHED_NOT_AUTH
An internal system error occurred.

RUN_SCHED_CANT_TRANSMIT
A data transmission failure occurred.

RUN_SCHED_CANT_CONNECT
The Schedd cannot connect to the central manager.

ll_start_job_ext subroutine

Use the **ll_start_job_ext** subroutine to inform the LoadLeveler negotiator to start a job on the specified nodes, indicating which adapter and adapter resources to use.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_start_job_ext (LL_start_job_info_ext *ptr);
```

Parameters

ptr Specifies the pointer to the **LL_start_job_info_ext** structure that was allocated and populated by the caller. The **LL_start_job_info_ext** members are:

int *version_num*
Represents the version number of the **LL_start_job_info_ext** structure. Should be set to LL_PROC_VERSION.

LL_STEP_ID *StepId*
Represents the step ID of the job step to be started.

char ** *nodelist*
A pointer to an array of node names where the job will be started. The first member of the array is the parallel master node. The array must be ended with a NULL.

int *adapterUsageCount*
This is the size of the adapterUsage list. To determine what this number should be, add all the adapter usages for all protocols needed by one task and multiply the result by the number of tasks in the job.

LL_ADAPTER_USAGE * *adapterUsage*
This is a list of adapter information. The size of this list is given by adapterUsageCount. The members of this structure are:

char * *dev_name*
The device name of the adapter to be used.

char * *protocol*
A character string representing the communication protocol this usage supports. Valid values are **MPI**, **LAPI**, and **MPI_LAPI**.

char * *subsystem*
The communication subsystem this usage supports. Valid values are **IP** or **US**.

int *wid*
For **US** subsystem usages, this indicates which adapter window ID to use. For **IP** subsystem usages, this field is ignored.

uint64_t *mem*
For **US** subsystem usages, this is the amount of adapter memory to dedicate to the adapter usage. For **IP** subsystem usages, this field is ignored.

uint64_t *api_rcxtblocks*
For **US** subsystem usages, this is the number of user rCxt blocks to allocate for each adapter window. For **IP** subsystem usages, this field is ignored.

Note:

1. This field should only be used on systems which contain Switch_Network_Interface_For_HPS adapters. When using this field, the *mem* field should not be used.
2. Previously existing applications which use **ll_start_job_ext** can be used unchanged to start jobs on systems with Switch_Network_Interface_For_HPS adapters, the value previously specified for the memory request will be ignored.

Each element in the adapterUsage list represents one communication channel for a task. If the subsystem is US (User Space), a communication channel will require a switch adapter window. Adapter windows, and User Space usages, must be specified on actual switch adapters that are only accessible if AGGREGATE_ADAPTERS=False is specified in the configuration file.

Description

In LoadLeveler for Linux only, **ll_start_job_ext** returns an error condition when **SEC_ENABLEMENT** is **CTSEC**.

You must set **SCHEDULER_TYPE = API** in the global configuration file to use this subroutine. In order to have access to the physical switch adapters in the LoadLeveler cluster (as opposed to virtual adapters representing all of the adapters on a network or adapters striping across multiple networks) you must specify **AGGREGATE_ADAPTERS = False** in the global configuration file.

Only jobs steps currently in the Idle state are started.

Only processes having the LoadLeveler administrator user ID can invoke this subroutine.

An external scheduler uses this subroutine in conjunction with the **ll_query** and **ll_get_data** subroutines of the data access API to start jobs that are in idle state. The data access API returns information about which machines are available for scheduling and which jobs are currently in the job queue waiting to be scheduled. The list of jobs that are currently in the system is retrieved with the **ll_get_objs** API function, passing in a query element with type **JOBS**. The list of machines available to run jobs on is obtained with the **ll_get_objs** and a query element with type **MACHINES**. Additional data about both jobs and machines is obtained with the **ll_get_data** function call.

When this function is used to start a step, the external scheduler specifies the adapter resources that are assigned to the step and network statements in the job command file, if they are present, are ignored. It is the responsibility of the external scheduler to manage the availability of adapter resources and LoadLeveler does not prevent or detect the over commitment of adapter resources.

The node list that is passed to the external scheduler API specifies the node on which each task of the job being started is to run. The distribution of tasks to nodes in the node list must be consistent with the node allocation specified by the

job command file of the job being started. If it is not, the results are undefined and the job may fail to start or may start with incorrect node assignments. Except when **BLOCKING** is specified, the entries for tasks that are running on the same node must all be specified sequentially in the node list. Table 100 describes how nodes should be arranged in the node list for the possible combinations of node and task specification in the job command file. In the table, '/' denotes integer division and (N mod M) is the remainder of the integer division of N by M.

Table 100. How nodes should be arranged in the node list

Job command file specification	Required nodelist structure
`node=N` `tasks_per_node=T`	There must be N different machine names specified, each specified T times.
`node=N,M` `tasks_per_node=T`	There must be between N and M different machine names specified, each specified T times.

`node=N`
`total_tasks=TT`
`TT evenly divisible by N`
	There must be N different machine names specified, each specified TT/N times.

`node=N`
`total_tasks=TT`
`TT not evenly divisible by N`
	There must be N different machine names specified. The first (TT mod N) unique machine names must each be specified (TT/N +1) times and the remaining machine names are each specified TT/N times.

`total_tasks=TT`
`BLOCKING=B`
 	
`TT evenly divisible by B`
	There must be TT/B sets of machine names specified, each set specifies a machine name B times. It is permissible for a machine name to be specified in more than one set.

`total_tasks=TT`
`BLOCKING=B`
`TT not evenly divisible by B`
	There must be TT/B+1 sets of machine names specified. The first TT/B sets specify a machine name B times. The last set specifies a machine name (TT mod B) times. It is permissible for a machine name to be specified in more than one set.

`total_tasks=TT` `BLOCKING=UNLIMITED`	There must be TT entries in the node list. It is permissible for a machine name to be specified in the list more than once and it is not required that the specifications be contiguous.
`task_geometry`	There is a 1:1 correspondence between entries in the nodelist and task ids specified in the task geometry statement. Entries in the node list that correspond to task IDs in the same set must specify the same machine. Entries in the node list that correspond to task IDs in different sets must specify different machines.

Return Values

This routine returns a nonzero value to indicate the start request was not delivered to the negotiator. These values are defined in the **llapi.h** file and explained in "Error values." A return code of zero indicates the request was successfully delivered to the negotiator, but constraints on the negotiator may stop the job from starting. You can use the **llq** command to verify the job started.

Error Values

-1 There is an error in the input parameter.
-2 The subroutine cannot connect to the central manager.

-4 An error occurred reading parameters from the administration or the configuration file.
-5 The negotiator cannot find the specified StepId in the negotiator job queue.
-6 A data transmission failure occurred.
-7 The subroutine cannot authorize the action because you are not a LoadLeveler administrator.
-8 The job object version number is incorrect.
-9 The StepId is not in the Idle state.
-10 One of the nodes specified is not available to run the job.
-11 One of the nodes specified does not have an available initiator for the class of the job.
-12 For one of the nodes specified, the requirements statement does not satisfy the job requirements.
-13 The number of nodes specified was less than the minimum or more than the maximum requested by the job.
-14 The LoadLeveler default scheduler is enabled.
-20 The adapter usage information does not match job structure.
-21 The adapter usage requested an adapter not on the machine.
-22 A wrong number of entries on the adapter usage list.
-23 The adapter usage information did not specify the same protocol usage on each task.
-24 A protocol string that was not valid was specified on an adapter usage.
-25 The adapter usages specified incompatible protocols.
-26 An adapter usage specified a communication subsystem that was not **IP** or **US**.

Examples

Makefiles and examples that use this subroutine are located in the **samples/llsch** subdirectory of the release directory. The examples include the executable **sch_api_ext**, which invokes the data access API and the job control API to start the first job in the list received from **ll_query** on one node and uses **ll_terminate_job** to cancel the second job. You should submit at least two jobs prior to running the sample. To compile **sch_api_ext**, copy the sample to a writeable directory and update the RELEASE_DIR field to represent the current LoadLeveler release directory.

Related Information

Subroutines: **ll_get_data**, **ll_query**, **ll_terminate_job**

ll_terminate_job subroutine

Use the **ll_terminate_job** subroutine to inform the negotiator to cancel the specified job step.

Library

LoadLeveler API library **libllapi.a** (AIX) or **libllapi.so** (Linux)

Syntax

```
#include "llapi.h"

int ll_terminate_job (LL_terminate_job_info *ptr);
```

Parameters

ptr Specifies the pointer to the **LL_terminate_info** structure that was allocated by the caller. The **LL_terminate_job_info** members are:

int *version_num*
Represents the version number of the **LL_terminate_job_info** structure. Should be set to LL_PROC_VERSION.

LL_STEP_ID *StepId*
Represents the step ID of the job step to be terminated.

Note: For coscheduled jobs, even if all coscheduled job steps are not in the list of targeted job steps, the requested operation is performed on all coscheduled job steps.

char **msg*
A pointer to a null terminated array of characters. If this pointer is null or points to a null string, a default message is used. This message will be available through **ll_get_data** to tell the process why a program was terminated.

Description

Only processes having the LoadLeveler administrator user ID can invoke this subroutine.

In LoadLeveler for Linux only, **ll_terminate_job** returns an error condition when **SEC_ENABLEMENT** is **CTSEC**.

An external scheduler uses this subroutine in conjunction with the **ll_query** and **ll_get_data** subroutines of the data access API. The external scheduler must use this subroutine to terminate interactive parallel jobs that cannot be run.

Return Values

This subroutine returns a value of zero when successful, to indicate the terminate job request was accepted by the negotiator. However, a return code of zero does not necessarily imply the negotiator canceled the job. Use the **llq** command to verify the job was canceled. Otherwise, this subroutine returns an integer value defined in the **llapi.h** file.

Error Values

-1 There is an error in the input parameter.

-4 An error occurred reading parameters from the administration or the configuration file.
-6 A data transmission failure occurred.
-7 The subroutine cannot authorize the action because you are not a LoadLeveler administrator or you are not the user who submitted the job.
-8 The job object version number is incorrect.

Examples

Makefiles and examples that use this subroutine are located in the **samples/llsch** subdirectory of the release directory. The examples include the executable **sch_api_ext**, which invokes the data access API and the job control API to start the first job in the list received from **ll_query** on one node and uses **ll_terminate_job** to cancel the second job. You should submit at least two jobs prior to running the sample. To compile **sch_api_ext**, copy the sample to a writeable directory and update the RELEASE_DIR field to represent the current LoadLeveler release directory.

Related Information

Subroutines: **ll_query**, **ll_start_job_ext**

Appendix A. Troubleshooting LoadLeveler

LoadLeveler offers troubleshooting information to help you resolve problems.

This topic is divided into the following subtopics:

- "Frequently asked questions," which contains answers to questions frequently asked by LoadLeveler customers. This topic focuses on answers that may help you get out of problem situations. The questions and answers are organized into the following categories:
  - **LoadLeveler won't start.** See "Why won't LoadLeveler start?" on page 700 for more information.
  - **Jobs submitted to LoadLeveler do not run.** See "Why won't my job run?" on page 700 for more information.
  - **One or more of your machines goes down.** See "What happens to running jobs when a machine goes down?" on page 706 for more information.
  - **The central manager is not operating.** See "What happens if the central manager isn't operating?" on page 708 for more information.
  - **Resources need to be recovered from the Schedd machine**. See "How do I recover resources allocated by a Schedd machine?" on page 710 for more information.
  - **A core file needs to be found on Linux.** See "Why can't I find a core file on Linux?" on page 710 for more information.
  - **Inconsistencies are found in llfs output.** See "Why am I seeing inconsistencies in my llfs output?" on page 711 for more information.
  - **Configuration or administration file errors.** See "What happens if errors are found in my configuration or administration file?" on page 711 for more information.
  - **Miscellaneous questions.** See "Other questions" on page 712 for more information.
- "Troubleshooting in a multicluster environment" on page 714, which contains common questions and answers pertaining to operations within a multicluster environment.
- "Troubleshooting in a Blue Gene environment" on page 717, which contains common questions and answers pertaining to operations within a Blue Gene environment.
- "Helpful hints" on page 719, which contains tips on running LoadLeveler, including some productivity aids.
- "Getting help from IBM" on page 724, which tells you how to contact IBM for assistance.

It is helpful to create error logs when you are diagnosing a problem. See to "Configuring recording activity and log files" on page 48 for information on setting up error logs.

Frequently asked questions

This topic contains answers to questions frequently asked by LoadLeveler customers.

Why won't LoadLeveler start?

Follow these instructions if the **master** daemon will not run.

If the **master** daemon will not run, go to the node where **LoadL_master** will not start and issue the following at the command line:

```
LoadL_master -t
```

This generates messages that might help to diagnose the problem. In addition, ensure the following are true:

1. The **Release** and **bin** directories are properly specified in the configuration files.
2. The administration file exists and is properly defined in the configuration file.
3. The central manager is correctly defined in the administration file.
4. The **log** directories are correctly defined in the configuration file.
5. The **spool**, **execute**, and **log** directories exist and permissions are set as follows:
   - The **spool** subdirectory is set to 700
   - The **execute** subdirectory is set to 1777
   - The **log** subdirectory is set to 775
6. The **LoadL_master** binary, in **/usr/lpp/LoadL/full/bin** for AIX or **/opt/ibmll/LoadL/full/bin** for Linux, is owned by **root** and has the setuid bit set.
7. The daemons are not already running. If they are already running, use the **ps** command to identify the processes, and then use the **kill** command to kill the daemons.
8. When cluster security services is enabled, all machines in the LoadLeveler cluster must list each other in their trusted hosts list for authentication.
9. When cluster security services is enabled, the **loadl** ID must be a member of the UNIX group identified by the SEC_SERVICES_GROUP configuration file keyword.

Note: LoadLeveler for Linux does not support cluster security services.

Why won't my job run?

If you submitted your job but it has not run, issue **llq -s** first to help diagnose the problem.

If you need more help diagnosing the problem, refer to Table 101:

Table 101. Why your job might not be running

Why your job might not be running:	**Possible solution**
Job requires specific machine, operating system, or other resource.	Does the resource exist in the LoadLeveler cluster? If yes, wait until it becomes available. Check the GUI to compare the job requirements to the machine details, especially **Arch**, **OpSys**, and **Class**. Ensure that the spelling and capitalization matches.
Job requires specific job class	• Is the class defined in the administration file? Use **llclass** to determine this. If yes, • Is there a machine in the cluster that supports that class? If yes, you need to wait until the machine becomes available to run your job.

Table 101. Why your job might not be running (continued)

Why your job might not be running:	**Possible solution**
The maximum number of jobs are already running on all the eligible machines	Wait until one of the machines finishes a job before scheduling your job.

The start expression evaluates to false.	Examine the configuration files (both **LoadL_config** and **LoadL_config.local**) to determine the **START** control function expression used by LoadLeveler to start a job. As a problem determination measure, set the START and SUSPEND values, as shown in this example:
	`START: T`
	`SUSPEND: F`

A job step is running on the node that your job requires, and that job step's preemption rules list your job's class as one that cannot share the node	The running job step is in a job class for which an administrator has defined preemption rules through the PREEMPT_CLASS keyword. When your job step's class is listed in the ALL clause of that keyword, your job step must wait until the running job step finishes.
The priority of your job is lower than the priority of other jobs.	You cannot affect the system priority given to this job by the negotiator daemon but you can try to change your user priority to move this job ahead of other jobs you previously submitted using the **llprio** command or the GUI.
The information the central manager has about machines and jobs may not be current.	Wait a few minutes for the central manager to be updated and then the job may be dispatched. This time limit (a few minutes) depends upon the polling frequency and polls per update set in the **LoadL_config** file. The default polling frequency is five seconds.
You do not have the same user ID on all the machines in the cluster.	To run jobs on any machine in the cluster, you have to have the same user ID and the same uid number on every machine in the pool. If you do not have a userid on one machine, your jobs will not be scheduled to that machine.
CtSec is enabled and the **.rhosts** file was not updated.	The **.rhosts** file should contain entries which specify all the host and user combinations allowed to submit jobs which will run as the local user. See "Steps for enabling CtSec services" on page 58 for more details.

Table 101. Why your job might not be running (continued)

Why your job might not be running:	Possible solution
Your job is not bound to a reservation under which nodes that your job requires to run are reserved	When an unbound job requires nodes that are reserved under a reservation, LoadLeveler will not start the job unless one of the following conditions is true: • The reservation was created with SHARED mode specified. If the reservation is using SHARED mode, your job will remain idle until the reservation state becomes Active_Shared. • The job's expected end time (current time plus the hard wall clock limit) indicates that the job will complete before the reservation starts. If neither condition is true, but you have the authority to use the reservation, you may use the **llbind** command to bind your job to the reservation. Otherwise, your unbound job will remain idle until the reservation completes or is canceled. To check the reservation's status and attributes, use the **llqres** command. To find out which reservations you may use, check with your LoadLeveler administrator, or enter the command **llqres -l** and check the names in the Users or Groups fields (under the Modification time field) in the output listing. If your user name or a group name to which you belong appears in these output fields, you are authorized to use the reservation.
Your job is bound to a reservation but the reservation is not active yet	LoadLeveler schedules bound job steps to run only when a reservation becomes active. Use the command **llq -l** to find the ID of the reservation to which the job is bound. Use the command **llqres -l** to find the start time of the reservation, and wait until that time to check the job status again.
Your job is bound to a reservation that does not reserve all of the resources that your job requires to run	If a bound job requires specific resources that are not available during the reservation period, LoadLeveler will not dispatch the job to run under the reservation. This situation can occur if the job requires one or more of the following: • Specific nodes that were not selected for the reservation. • More than the total number of reserved nodes. • Floating consumable resources, which cannot be reserved under a reservation. If the LoadLeveler cluster has the resources that the job requires, use the command **llbind -r**, which unbinds the job from the reservation.
Your job is bound to a reservation but the maximum number of jobs you may run has been reached already	If LoadLeveler detects that you currently are running the maximum number of jobs that you are allowed to run, it will not start your bound job even if the reservation is active.

Table 101. Why your job might not be running (continued)

Why your job might not be running:	Possible solution
Your job is bound to a reservation but the job's expected end time exceeds the reservation's end time	LoadLeveler will dispatch your job only if its expected end time (current time plus the hard wall clock limit) does not exceed the end time of the reservation, or if both of the following conditions are true: • This reservation is configured to allow jobs to continue running even when their expected end time exceeds the end of the reservation, and • The resources required to run your job are available. Otherwise, this bound job will remain idle until either: • The reservation completes or is canceled, or • You use the command **llbind -r**, which unbinds the job from the reservation.
Your job is bound to a reservation that does not exist	LoadLeveler puts your job in NotQueued state until the reservation is created. In that case, LoadLeveler will bind your job to the reservation. Otherwise, use the command **llbind -r** to unbind the job from the reservation.
Your job is being rejected because a communication error is occurring while attempting to start the job. (Hic_Comm_Error occurred during job start.)	Check for mail sent by LoadLeveler when a job is rejected. If the job is being rejected because of a communication error (Hic_Comm_Error), verify that you can connect to the node for which the error occurred over the interface (generally Ethernet adapter) configured for LoadLeveler. Also verify that the **Loadl_startd** daemon is running on that node.

You can use the **llq** command to query the status of your job or the **llstatus** command to query the status of machines in the cluster. Refer to Chapter 16, "Commands," on page 411 for information on these commands.

Why won't my parallel job run?

If you submitted your parallel job but it has not run, issue **llq -s** first to help diagnose the problem.

If issuing this command does not help, refer to Table 101 on page 700 and to Table 102 for more information:

Table 102. Why your job might not be running

Why your job might not be running:	Possible solution
The minimum number of processors requested by your job is not available.	Sufficient resources must be available. Specifying a smaller number of processors may help if your job can run with fewer resources.
The pool in your **requirements** statement specifies a pool that is either not valid or not available.	The specified pool must be valid and available.

Table 102. Why your job might not be running (continued)

Why your job might not be running:	Possible solution
The adapter specified in the **requirements** statement or the **network** statement identifies an adapter that is either not valid or not available.	The specified adapter must be valid and available. Use **llstatus -a** to check the status of the adapters in the system. Switch adapters that show a state of 'NOT READY' or '-1' should be reported to the LoadLeveler administrator. Switch adapters with a state of '-1' indicate that the machine those adapters are on could not be queried for status. If the network statement specifies **rcxtblocks**, only Switch Network Interface for HPS adapters can be used for the step.
Your user space job is requesting stripping (**sn_all**) and the nodes allocated to the job do not have the same number of networks.	A user space job requesting striping will be rejected if the allocated nodes do not have the same number of networks. If notification is enabled for the job, mail will be sent to the user indicating that the job was rejected because the network table for the job could not be loaded. Use the **llstatus –a** command to verify that all the nodes in the cluster have same number of networks configured. The system administrator must take appropriate actions to insure the number of networks is the same on all nodes that will run user space jobs.

Common set-up problems with parallel jobs

This topic presents a list of common set-up problems.

This topic presents a list of common problems found in setting up parallel jobs:

- If jobs appear to remain in a Pending or Starting state: check that the nameserver is consistent. Compare results of **host** *machine_name* and **host** *IP_address*
- For POE:
  - Specify the POE partition manager as the executable. Do *not* specify the parallel job as the executable.
  - Pass the parallel job as an argument to POE.
  - The parallel job must exist and must be specified as a full path name.
  - If the job runs in user space, specify the flag **-euilib us**.
  - Specify the correct adapter (when needed).
  - Specify a POE job only once in the job command file.
  - Compile only with the supported level of POE.
  - Specify only **parallel** as the *job_type*.

Why won't my checkpointed job restart?

If the job you submitted has the keyword **restart_from_ckpt = yes** and if the checkpoint file specified does not exist, the job will move to the Starting state and will then be removed from the queue.

A mail message will be generated indicating the checkpoint file does not exist and a message will also appear in the StarterLog. Verify the values of the **ckpt_file**

keyword in the Job Command File and the value of the **ckpt_dir** keyword in the Job Command or Administration File to ensure they resolve to the directory and file name of the desired checkpoint file.

Note: When a job is enabled for checkpoint, it is important to ensure the name of the checkpoint file is unique.

Why won't my submit-only job run?

If a job you submitted from a *submit-only* machine does not run, verify that you have defined the following statements.

If a job you submitted from a *submit-only* machine does not run, verify that you have defined the following statements in the machine stanza of the administration file of the submit-only machine:

```
submit_only = true
schedd_host = false
central_manager = false
```

Verify that another machine has set **schedd_host = true** and **schedd_runs_here = true**.

Why won't my job run on a cluster with both AIX and Linux machines?

The default shell on Linux (in both Red Hat Enterprise Linux and SUSE Linux Enterprise Server) is **bash** and **bash** may not be available on AIX.

If a job step contains a **bash** script it will be rejected if it is run on an AIX node. The **ksh** is available on both AIX and Linux. You can specify which shell to use in the keyword **shell** in your job command file:

```
# @shell = /bin/ksh
```

Also, AIX and Linux are not binary compatible so jobs written in compiled languages such as C or FORTRAN must be compiled for the environment they will run on.

Why won't my job run when scheduling affinity is enabled on x86 and x86_64 systems?

When the **ALLOC_EXCLUSIVE_CPU_PER_JOB** configuration file keyword is set to **LOGICAL** or **PHYSICAL** on Linux x86 and x86_64 platforms, a job will be rejected if the job requests more CPUs than are available. If a job is rejected for this reason and notification is enabled for the job, you will receive mail which indicates that there are no available CPUs on the machine to run the job.

To resolve this problem, the LoadLeveler administrator must limit the number of initiators available on a node to the maximum available CPUs so that the number of jobs or parallel tasks scheduled to a node never exceeds the available CPUs. This can be done by setting the **MAX_STARTERS** configuration keyword as follows:

```
MAX_STARTERS = number_of_available_CPUs
```

Typically, **MAX_STARTERS** should be the same as the number of processors available on a compute node.

To get Linux kernel information about how many processors your node has, issue the following command to get a listing of available **LOGICAL** processors:

```
root@c197blade4b07# cat /proc/cpuinfo
```

Use the parameters provided by this listing, such as physical ID and siblings, to find the number of **PHYSICAL** processors available.

Note: If you are running LoadLeveler for Linux on POWER, it is suggested that you use task affinity instead of CPU affinity. For additional information on task affinity, see "Submitting jobs requesting scheduling affinity" on page 222.

Why does a job stay in the Pending (or Starting) state?

If a job appears to stay in the Pending or Starting state, it is possible the job is continually being dispatched and rejected.

Check the setting of the **MAX_JOB_REJECT** keyword. If it is set to -1 the job will be rejected an unlimited number of times. Try resetting this keyword to a small number, such as 10. Also, check the setting of the **ACTION_ON_MAX_REJECT** keyword. These keywords are described in Chapter 12, "Configuration file reference," on page 263. The reason for rejecting a job is sent to the user in mail if notification is enabled for the job.

Run **llq –lx** command on the job which is stuck in starting (ST) or pending (VP, RP). At the bottom of the **llq –lx** output the nodes allocated to the job and status of the job on those nodes is displayed. Look for the first node whose status is either starting or pending. Generally the first node whose state is starting or pending failed to report status and caused the job to be stuck in starting or pending state. Verify the node whose state is starting or pending is up and the **LoadL_startd** daemon on that node is running.

What happens to running jobs when a machine goes down?

Both the startd daemon and the Schedd daemon maintain persistent states of all jobs.

Both daemons use a specific protocol to ensure that the state of all jobs is consistent across LoadLeveler. In the event of a failure, the state can be recovered. Neither the Schedd nor the startd daemon discard the job state information until it is passed onto and accepted by another daemon in the process. Refer to Table 103 for more information.

Table 103. Troubleshooting running jobs when a machine goes down

If	Then
The network goes down but the machines are still running	If the network goes down but the machines are still running, when LoadLeveler is restarted, it looks for all jobs that were marked running when it went down. On the machine where the job is running, the startd daemon searches for the job and if it can verify that the job is still running, it continues to manage the job through completion. On the machine where Schedd is running, Schedd queues a transaction to the startd to reestablish the state of the job. This transaction stays queued until the state is established. Until that time, LoadLeveler assumes the state is the same as when the system went down.

Table 103. Troubleshooting running jobs when a machine goes down (continued)

If	Then
The network partitions or goes down.	All transactions are left queued until the recipient has acknowledged them. Critical transactions such as those between the Schedd and startd are recorded on disk. This ensures complete delivery of messages and prevents incorrect decisions based on incomplete state information.
The machine with startd goes down.	Because job state is maintained on disk in startd, when LoadLeveler is restarted it can forward correct status to the rest of LoadLeveler. In the case of total machine failure, this is usually ″JOB VACATED″, which causes the job to be restarted elsewhere. In the case that only LoadLeveler failed, it is often possible to ″find″ the job if it is still running and resume management of it. In this case LoadLeveler sends JOB RUNNING to the Schedd and central manager, thereby permitting the job to run to completion.
The central manager machine goes down.	All machines in the cluster send current status to the central manager on a regular basis. When the central manager restarts, it queries each machine that checks in, requesting the entire queue from each machine. Over the period of a few minutes the central manager restores itself to the state it was in before the failure. Each Schedd is responsible for maintaining the correct state of each job as it progressed while the central manager is down. Therefore, it is guaranteed that the central manager will correctly rebuild itself. All jobs started when the central manager was down will continue to run and complete normally with no loss of information. Users may continue to submit jobs. These new jobs will be forwarded correctly when the central manager is restarted.
The Schedd machine goes down	When Schedd starts up again, it reads the queue of jobs and for every job which was in some sort of active state (i.e. PENDING, STARTING, RUNNING), it queries the machine where it is marked active. The running machine is required to return current status of the job. If the job completed while Schedd was down, JOB COMPLETE is returned with exit status and accounting information. If the job is running, JOB RUNNING is returned. If the job was vacated, JOB VACATED is returned. Because these messages are left queued until delivery is confirmed, no job will be lost or incorrectly dispatched due to Schedd failure. During the time the Schedd is down, the central manager will not be able to start new jobs that were submitted to that Schedd. To recover the resources allocated to jobs scheduled by a Schedd machine, see “How do I recover resources allocated by a Schedd machine?” on page 710.
The **llsubmit** machine goes down	Schedd gets its own copy of the executable so it does not matter if the **llsubmit** machine goes down.

Why does llstatus indicate that a machine is down when llq indicates a job is running on the machine?

If a machine fails while a job is running on the machine, the central manager does not change the status of any job on the machine. When the machine comes back up the central manager will be updated.

Why won't my job run on a cluster with both AIX and Linux machines?

The default shell on Linux (in both Red Hat Enterprise Linux and SUSE Linux Enterprise Server) is **bash** and **bash** may not be available on AIX.

If a job step contains a **bash** script it will be rejected if it is run on an AIX node. The **ksh** is available on both AIX and Linux. You can specify which shell to use in the keyword **shell** in your job command file:

```
# @shell = /bin/ksh
```

Also, AIX and Linux are not binary compatible so jobs written in compiled languages such as C or FORTRAN must be compiled for the environment they will run on.

Why won't my jobs run that were directed to an idle pool?

To determine why a job that was directed to an idle pool, but did not run, first check the total number of jobs in the LoadLeveler queue. LoadLeveler can only process a specific number of jobs in the queue within a given amount of time. Some jobs are not considered for scheduling if they do not have the appropriate priority. In this case, despite the fact that a different pool is a requirement from the jobs, it is not a factor in LoadLeveler's scheduling consideration.

To direct LoadLeveler's attention to scheduling jobs based on a priority, a job priority must be set or LoadLeveler's system priority must be defined.

A job's priority can be set by the system administrator with the class it is associated with. See the class stanza in the **LoadL_admin** file. The stanza keyword for setting the job class priority is:

```
priority = number
```

where the larger the number, the higher the priority. An example of a class stanza with a high priority is:

```
priority = 1000
```

You can also use the **SYSPRIO** expression defined in **LoadL_config** as an alternative. An example **SYSPRIO** expression that emphasizes a job priority is:

```
SYSPRIO: (ClassSysprio * 100) - (QDate)
```

System administrators can experiment with either **priority** or **SYSPRIO** to determine the appropriate priority or expression for a specific LoadLeveler cluster. You only need to specify one or the other.

What happens if the central manager isn't operating?

In one of your machine stanzas specified in the administration file, you specified a machine to serve as the central manager.

It is possible for some problem to cause this central manager to become unusable such as network communication or software or hardware failures. In such cases, the other machines in the LoadLeveler cluster believe that the central manager machine is no longer operating. If you assigned one or more alternate central managers in the machine stanza, a new central manager will take control. The alternate central manager is chosen based upon the order in which its respective machine stanza appears in the administration file.

Once an alternate central manager takes control, it starts up its negotiator daemon and notifies all of the other machines in the LoadLeveler cluster that a new central manager has been selected. Figure 53 illustrates how a machine can become the alternate central manager.
The diagram illustrates that Machine Z is the primary central manager but

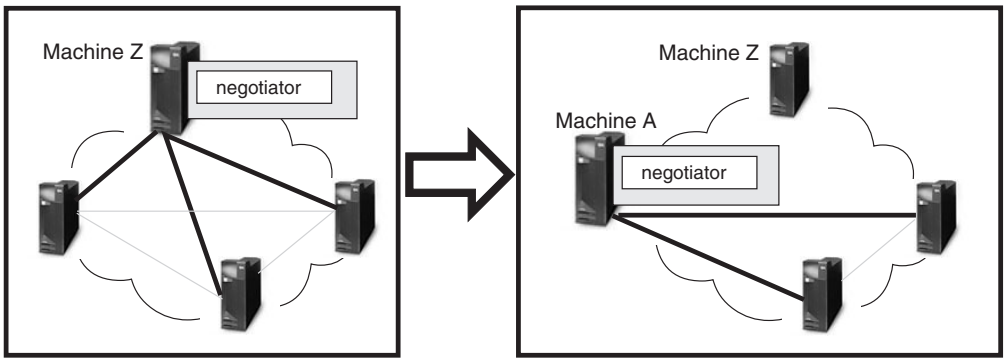

Figure 53. When the primary central manager is unavailable

Machine A took control of the LoadLeveler cluster by becoming the alternate central manager. Machine A remains in control as the alternate central manager until either:

- The primary central manager, Machine Z, resumes operation. In this case, Machine Z notifies Machine A that it is operating again and, therefore, Machine A terminates its negotiator daemon.
- Machine A also loses contact with the remaining machines in the pool. In this case, another machine authorized to serve as an alternate central manager takes control. Note that Machine A may remain as its own central manager.

Figure 54 illustrates how multiple central managers can function within the same LoadLeveler pool.

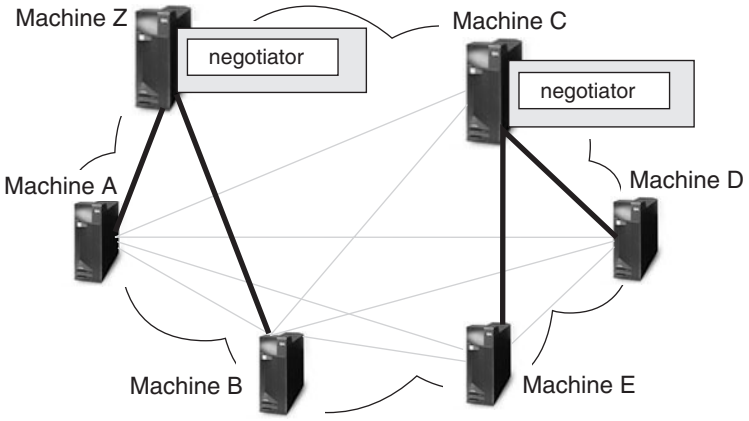

Figure 54. Multiple central managers

In this diagram, the primary central manager is serving Machines A and B. Due to some network failure, Machines C, D, and E have lost contact with the primary central manager machine and, therefore, Machine C which is authorized to serve as an alternate central manager, assumes that role. Machine C remains as the alternate central manager until either:

- The primary central manager is able to contact Machines C, D, and E. In this case, the primary central manager notifies the alternate central managers that it

is operating again and, therefore, Machine C terminates its negotiator daemon. The negotiator daemon running on the primary central manager machine is refreshed to discard any old job status information and to pick up the new job status information from the newly rejoined machines.

- Machine C loses contact with Machines D and E. In this case, if machine D or E is authorized to act as an alternate central manager, it assumes that role. Otherwise, there will be no central manager serving these machines. Note that Machine C remains as its own central manager.

While LoadLeveler can handle this situation of two concurrent central managers without any loss of integrity, some installations may find administering it somewhat confusing. To avoid any confusion, you should specify all primary and alternate central managers on the same LAN segment.

For information on selecting alternate central managers, refer to "Defining machines" on page 84.

How do I recover resources allocated by a Schedd machine?

If a node running the Schedd daemon fails, resources allocated to jobs scheduled by this Schedd cannot be freed up until you restart the Schedd.

Administrators must do the following to enable the recovery of Schedd resources:

1. Recognize that a node running the Schedd daemon is down and will be down long enough such that it is necessary for you to recover the Schedd resources.
2. Add the statement **schedd_fenced=true** to the machine stanza of the failed node. This statement specifies that the central manager ignores connections from the Schedd daemon running on this machine, and prevents conflicts from arising when a Schedd machine is restarted while **llmovespool** is running.
3. Reconfigure the central manager node so that it recognizes the "fenced" Schedd daemon. From the central manager machine issue **llctl reconfig**.
4. Issue the **llmovespool -d** *spool_directory* **-h** *target_schedd_hostname* command to move a job queue database to another Schedd within a local cluster.
5. Remove all files in the LoadLeveler spool directory of the failed node. Once the failed node is working again, you can remove the **schedd_fenced=true** statement.

For more information, see "ll_move_spool subroutine" on page 683 and "Procedure for recovering a job spool" on page 167.

Why can't I find a core file on Linux?

On Linux, when a LoadLeveler daemon terminates abnormally a core file is not generated. Why?

Although a LoadLeveler daemon begins its existence as a root process, it uses the system functions **seteuid()** and **setegid()** to switch to effective user ID of **loadl** and effective group ID of **loadl** immediately after startup if the file **/etc/LoadL.cfg** is not defined. If this file is defined, the user ID associated with the **LoadLUserid** keyword and the group ID associated with the **LoadLGroupid** keyword are used instead of the default **loadl** user and group IDs.

On Linux systems, unless the default kernel runtime behavior is modified, the standard kernel action for a process that has successfully invoked **seteuid()** and **setegid()** to have a different effective user ID and effective group ID is not to

dump a core file. So, if you want Linux to create a core file when a LoadLeveler daemon terminates abnormally you must use the file **/etc/LoadL.cfg** to set both **LoadLUserid** and **LoadLGroupid** to **root**.

On Red Hat Enterprise Linux 3.3 systems, the command **sysctl -w kernel.core_setuid_ok=1** can be used to change the default kernel core file creation behavior of setuid programs. If the **core_setuid_ok** option is enabled, the values of **LoadLUserid** and **LoadLGroupid** in the **/etc/LoadL.cfg** file do not have to be **root** for the successful creation of LoadLeveler core files.

Why am I seeing inconsistencies in my llfs output?

Generally, the sum of the used shares by all users and the sum of the used shares by all LoadLeveler groups should have similar values.

If there is a large (much larger than the number of entries in the **llfs** output) and increasing difference between the two sums, the cluster should be checked to make sure that all nodes have the same clock time. Large time differences among nodes in a cluster could lead to errors in the **llfs** output.

Why don't I see my job when I issue the llq command?

By default, the **llq** command requires validation of the user ID that issues the command.

A user ID must exist on the central manager machine in order for LoadLeveler to validate the user ID. If the user ID does not exist on the central manager machine, then the validation will fail and the **llq** command will not return job data. User ID validation can be disabled by setting the **LoadL_config** file keyword **CM_CHECK_USERID** to **false**. Note that when user ID validation is disabled, any user can query data for any job.

What happens if errors are found in my configuration or administration file?

When errors are found during administration file processing, processing continues in nearly all cases.

Because processing continues, it is possible that even though the administration file has been read, it might not resemble the intended configuration. This is especially true in cases where opening and closing braces are mismatched. It is possible for the parser to interpret stanzas as substanzas of another substanza, and when this happens, those stanzas are effectively ignored. Consider these cases:

- A machine stanza is interpreted to be a substanza within a class stanza. Because class stanzas only support substanzas of the user type, the machine substanza is completely ignored.
- A user stanza is incorrectly interpreted to be a substanza within a class. Although this is valid, that user stanza will not exist on its own, but will instead be part of the class stanza, which was not the administrator's intent.

It is difficult to determine whether an error in the administration file will completely change the meaning of the file or if the error will effect only a single keyword value. Because it is not necessarily desirable to shutdown LoadLeveler daemons and commands for every possible error, and because the behavior should be consistent, processing will continue. It is important for the administrator to be

aware of this behavior and to investigate and repair any configuration errors reported by the **llctl start** command (see "llctl - Control LoadLeveler daemons" on page 439 for more information).

Other questions

This topic contains answers to some miscellaneous questions asked by LoadLeveler customers.

Why do I have to setuid = 0?

The master daemon starts the **startd** daemon and the **startd** daemon starts the starter process.

The starter process runs the job. The job needs to be run by the userid of the submitter. You either have to have a separate master daemon running for every ID on the system or the master daemon has to be able to **su** to every userid and the only user ID that can **su** any other userid is **root**.

Why does LoadLeveler not execute my .profile or .login script?

When you submit a batch job to LoadLeveler, the operating system will execute your **.profile** script before executing the batch job if your login shell is the Korn shell.

On the other hand, if your login shell is the Bourne shell, on most operating systems (including AIX), the **.profile** script is not executed. Similarly, if your login shell is the C shell then AIX will execute your **.login** script before executing your LoadLeveler batch job but some other variants of UNIX may not invoke this script.

The reason for this discrepancy is due to the interactions of the shells and the operating system. To understand the nature of the problem, examine the following C program that attempts to open a login Korn shell and execute the ″ls″ command:

```
#include <stdio.h>
main()
{
execl("/bin/ksh","-","-c","ls",NULL);
}
```

UNIX documentations in general (SunOS, HP-UX, AIX, IRIX) give the impression that if the second argument is ″-″ then you get a login shell regardless of whether the first argument is /bin/ksh or /bin/csh or /bin/sh. In practice, this is not the case. Whether you get a login shell or not is implementation dependent and varies depending upon the UNIX version you are using. On AIX you get a login shell for /bin/ksh and /bin/csh but not the Bourne shell.

If your login shell is the Bourne shell and you would like the operating system to execute your **.profile** script before starting your batch job, add the following statement to your job command file:

```
# @ shell = /bin/ksh
```

LoadLeveler will open a login Korn shell to start your batch job which may be a shell script of any type (Bourne shell, C shell, or Korn shell) or just a simple executable.

What happens when a mksysb is created when LoadLeveler is running jobs?

When you create a mksysb (an image of the currently installed operating system) at a time when LoadLeveler is running jobs, the state of the jobs is saved as part of the mksysb.

When the mksysb is restored on a node, those jobs will appear to be on the node, in the same state as when they were saved, even though the jobs are not actually there. To delete these phantom jobs, you must remove all files from the LoadLeveler **spool** and **execute** directories and then restart LoadLeveler.

What can I do when a reserved node is down?

If the reservation has not started yet, the node might become available before the reservation start time.

If the node is still not available when the reservation starts, a LoadLeveler administrator may use the **llchres** command to remove the node and replace it with another.

How do I add or remove a node from the LoadLeveler administration file?

To add or remove a node from the LoadLeveler administration file, you must stop and restart LoadLeveler.

Because stopping LoadLeveler will cause all running jobs to be vacated, you might want to drain the cluster before stopping LoadLeveler.

To add or remove nodes from the **LoadL_admin** file, do the following:

1. (**Optional**) Drain all nodes to allow all running jobs to complete by issuing the following command:

   ```
   llctl -g drain startd allclasses
   ```

2. Stop LoadLeveler by issuing the following command:

   ```
   llctl -g stop
   ```

3. Add or remove nodes from the **LoadL_admin** file.
4. Start LoadLeveler by issuing the following command:

   ```
   llctl -g start
   ```

Why does a job stay in the running state?

If a job appears to be stuck in the running state, it is possible that the node is not up or that a task has not completed.

Run **llq –lx** command on the job which is stuck in running state. At the bottom of the **llq –lx** output, the display shows the nodes allocated to the job and status of the job on those nodes. Look for the first node whose status is `running`. Generally the first node whose state is `running`, failed to report status and caused the job to be stuck in running state. Verify that the node whose state is `running` is actually up and that the **LoadL_startd** daemon on that node is running. If node is up and **LoadL_startd** is running then verify that all the tasks of the job are completed on that node.

Why is a job in the hold state?

If a job is in the hold state for an unknown reason, it is possible that LoadLeveler moved the job into that state.

LoadLeveler will move a job to hold state after the number of startup attempts reaches the value set in the configuration keyword **MAX_JOB_REJECT** and the configuration keyword **ACTION_ON_MAX_REJECT** is set to hold. The reason for rejecting a job is sent to the user in mail if notification is enabled for the job.

Why does the llstatus –a command show that adapters are NOT_READY?

If **llstatus –a** shows that adapters are **NOT_READY**, you must verify that the interfaces are running and that they are defined correctly.

Use the **ifconfig** and **ibstat** commands to verify that the interfaces are up and running. If interfaces are running and static adapter stanzas are being used in the administration file, verify that the "`logical_id,`" "`network_id,`" and "`port_number`" values specified for the adapters in the **LoadL_admin** file and "`logical_id,`" "`network_id,`" and "`port_number`" values returned for the same adapters by **llextRPD** command are same. If they are not same, then either update the static adapter stanzas with latest **llextRPD** output or use dynamic adapters instead of static adapters. If you use dynamic adapters, then reconfigure LoadLeveler using the **llctl –g reconfig** command.

Run the command **lsrsrc IBM.NetworkInterface Name OpState** and verify that `OpState` is equal to 1. If **lsrsrc IBM.NetworkInterface Name OpState** returns 1 for `OpState`, then check the `PNSD log (/tmp/serverlog)` to verify that the adapter status is **UP**.

Troubleshooting in a multicluster environment

This topic will help you troubleshoot your multicluster environment.

How do I determine if I am in a multicluster environment?

Use this procedure to determine whether your are functioning in a multicluster environment.

- Issue the **llstatus** command.
  - Output of command will display "Cluster name is *cluster_name*".

How do I determine how my multicluster environment is defined and what are the inbound and outbound hosts defined for each cluster?

Use this procedure to determine how your multicluster environment is defined and what are the inbound and outbound hosts defined for each cluster.

- Issue **llstatus -C** command.
  - Output of command will display the local cluster's administration file cluster stanza information.
- Issue **llstatus -X all -C** command.
  - Output of command will display the administration file cluster stanza information for all clusters defined in the local cluster's configuration.

Why is my multicluster environment not enabled?

Use this procedure to determine why your multicluster environment is not enabled.

- Issue **llstatus -X all -C**.

  - The cluster stanzas defined for each cluster participating in the multicluster environment must have the same **outbound_hosts** and **inbound_hosts** defined.
  - Determine if any of the clusters are being started with **SCHEDD_STREAM_PORT** defined. The **inbound_schedd_port** keyword must be set for that cluster.
- Set the **D_MUSTER** debug flag for the **SCHEDD_DEBUG** configuration keyword on the machines defined as **inbound_hosts** and**outbound_hosts**, reconfigure LoadLeveler and examine the SchedLog on those machines for information about configuration errors.
- If the clusters are trying to enable OpenSSL, examine the SchedLog on the **inbound_hosts** and **outbound_hosts** for messages about SSL initialization errors and that multicluster is being disabled.

How do I find log messages from my multicluster-defined installation exits?

Use this procedure to determine how to find log messages from your multicluster-defined installation exits.

- Determine which machine is executing the installation exit.
  - For **CLUSTER_METRIC**:
    - If the user specifies the reserved word **any** as the **cluster_list** during job submission, the job is sent to the first outbound Schedd defined for the first configured remote cluster. The **CLUSTER_METRIC** is executed on this Schedd to determine where the job will be distributed. If this Schedd is not the **outbound_hosts schedd** for the assigned cluster, the job will be forwarded to the correct **outbound_hosts schedd**. If the user specifies a list of clusters as the **cluster_list** during job submission, the job is sent to the first outbound Schedd defined for the first specified remote cluster. The **CLUSTER_METRIC** is executed on this Schedd to determine where the job will be distributed. If this Schedd is not the **outbound_hosts schedd** for the assigned cluster, the job will be forwarded to the correct **outbound_hosts schedd**.
  - For **CLUSTER_USER_MAPPER**:
    - This installation exit is executed on the **inbound_hosts** of the local cluster when receiving a job submission, move job request or remote command.
  - For **CLUSTER_REMOTE_JOB_FILTER**:
    - This installation exit is executed on the **inbound_hosts** of the local cluster when receiving a job submission or move job request.
- Set the **D_MUSTER** debug flag for the **SCHEDD_DEBUG** configuration keyword on the machines defined as **inbound_hosts** and **outbound_hosts**, reconfigure LoadLeveler and examine the SchedLog on those machines for information about configuration errors.

Why won't my remote job be submitted or moved?

Use this procedure to determine why your remote job is not submitted or moved.

- Determine if the remote job filter has changed the number of steps within the job.
  - If the local submission filter on the submitting cluster has added or deleted steps from the original user's job command file, the remote job filter must add or delete the same number of steps. The job command file statements

returned by the remote job filter must contain the same number of steps as the job object received from the sending cluster.

- Determine if the job failed the assigned cluster's include and exclude rules for the cluster and/or class stanzas.
  - If the assigned cluster has **CLUSTER_USER_MAPPING** enabled, the mapped user ID is applied to the rules.
- Issue **llq** to determine if the job being moved has all of its steps in an idle-like state.
  - The **llmovejob** command should fail and report this situation.
- Issue **llq -x -d** *job_id* to determine if the job being moved has a job command file associated with it.
  - A job cannot be moved that was not submitted while in the multicluster environment.
- See "How do I find log messages from my multicluster-defined installation exits?" on page 715 to determine if an installation exit has returned an error.
- Determine that the file system in the assigned cluster has the desired availability and permissions.
  - User may be mapped to another user ID thus another **$HOME**.
  - User needs to have **initialdir** available.
  - **cluster_input_file** and **cluster_output_file** need requested file locations to be available.
  - If clusters share a common file system, users requesting **cluster_input_file** and **cluster_output_file** may have their remote location files removed if a local job is moved to another cluster. During a **llmovejob** operation, the files are copied from the remote location to the remote location instead of from the local location to the remote location. LoadLeveler only knows that the job being moved has access to the remote location because they were copied during the local submission. After the **llmovejob** is complete, LoadLeveler removes the files from the local cluster in the remote location, thus removing the files just copied.
- Determine if the job is an interactive jobs.
  - Interactive jobs may not be submitted to remote clusters.
- If the **llsubmit** or **llmovejob** command times out while waiting for a response from the remote cluster, LoadLeveler is not able to determine if the command was successful and it is recommended that the user issue **llq** to the remote cluster to determine if the job was submitted or moved.

Why did the CLUSTER_REMOTE_JOB_FILTER not update the job with all of the statements I defined?

Use this procedure to determine why the **CLUSTER_REMOTE_JOB_FILTER** did not update the job with all of the statements that you defined.

- See the CLUSTER_REMOTE_JOB_FILTER configuration file keyword description for a list of keywords that are not changed by the filter.

How do I find my remote job?

Use this procedure to find your remote job.

- Capture the **stdout** of the **llsubmit** and **llmovejob** commands to see the **outbound_hosts** machine assigned to the job, the **inbound_hosts** machine assigned to the job, the cluster assigned to the job, and the job identifier assigned to the job.

  - The Schedd host represented in the job identifier for remote jobs does not represent the managing Schedd of the job. It represents the Schedd that assigned the job number.
- Issue the **llq -X all** command and search for the desired job identifier.
- Check for pertinent mail messages.
  - If a job has been moved by an administrator, the submitting user will receive mail notification.
  - The job may have completed already. If the user has **notify_user** and **notification** set, mail will indicate job status.

Why won't my remote job run?

Use this procedure to determine why your remote job will not run.

If the remote job has been received by the central manager of the remote cluster:

- Follow the troubleshooting tips for local jobs in "Why won't my job run?" on page 700 or "Why won't my parallel job run?" on page 703.
- Use the information from the **llsubmit** and **llq** commands to determine the machines that have processed the job. Examine the Schedd logs on those machines for information relating to the specific job.
- Capture the stdout of the **llsubmit** and **llmovejob** commands to see the **outbound_hosts** machine assigned to the job, the **inbound_hosts** machine assigned to the job, the cluster assigned to the job, and the job identifier assigned to the job.

  Note: The Schedd host represented in the job identifier for remote jobs does not represent the managing Schedd of the job. It represents the Schedd that assigned the job number.
- Issue **llq -X remote_cluster -l job_ID**.
- Check for the multicluster environment related keywords (see the **llq** command for detailed data descriptions):
  - Scheduling Cluster - what cluster is the job running in.
  - Submitting Cluster - what cluster was the job submitted from
  - Sending Cluster - during move job what cluster did the job come from
  - Requested Cluster - cluster_list specified by user.
  - Schedd History - history of managing Schedds
  - Outbound Schedds - history of outbound Schedds
  - Submitting User - user name that the job was submitted under
- Check for pertinent mail messages.

Why does llq -X all show no jobs running when there are jobs running?

Use this procedure to determine why **llq -X all** shows no jobs running when there are jobs running.

- When not using **CLUSTER_USER_MAPPER**, check that the user's uid are the same between the local cluster and remote cluster.

Troubleshooting in a Blue Gene environment

This topic will help you troubleshoot your Blue Gene environment.

For information on preparing your job for submission to the Blue Gene system, see "Submitting and monitoring Blue Gene jobs" on page 226.

Why do all of my Blue Gene jobs fail even though llstatus shows that Blue Gene is present?

Use this procedure to determine why all of your Blue Gene jobs fail even though **llstatus** shows that Blue Gene is present

LoadLeveler queries Blue Gene information through the Blue Gene **Bridge** API. If LoadLeveler receives all requested information from the Blue Gene **Bridge** API without any problems, the **llstatus** output will indicate `Blue Gene is present`. Note, however, that other Blue Gene factors can cause jobs to fail.

In the event that the Blue Gene system is not completely ready to run jobs (for example, if the **bglmaster** status or **bgpmaster** status shows that some of the Blue Gene daemons are not running), then **mpirun** jobs might not be able to run successfully. To determine if that is the case, run an **mpirun** job outside of LoadLeveler and make sure that it can run to completion without problems. Sometimes file system failures can also cause all **mpirun** jobs to fail. Contact the Blue Gene system administrator to resolve the problem when an **mpirun** job fails outside of LoadLeveler. After those problems are resolved, run the jobs through LoadLeveler again.

Why does llstatus show that Blue Gene is absent?

Use this procedure to determine why **llstatus** shows that Blue Gene is absent.

LoadLeveler must load some of the Blue Gene libraries dynamically before it tries to call the Blue Gene **Bridge** API. LoadLeveler will indicate that `Blue Gene is absent` in the **llstatus** output in the following situations:

- If the environment variables needed to use the Blue Gene **Bridge** API and to run an **mpirun** job are not properly set
- If the Blue Gene libraries cannot be loaded
- If the Blue Gene database cannot be accessed

LoadLeveler jobs will not be able to run in these situations. The LoadLeveler central manager log will contain error messages indicating what kind of failures occurred. Contact the Blue Gene administrator to resolve the problems in the Blue Gene environment. After all Blue Gene issues have been resolved, LoadLeveler might need to be restarted. The **llstatus** command must show `Blue Gene is present` before LoadLeveler jobs can run again.

Why did my Blue Gene job fail when the job was submitted to a remote cluster?

Use this procedure to determine why your Blue Gene job failed when the job was submitted to a remote cluster.

If Blue Gene jobs are submitted to a remote cluster where the version of the Blue Gene software is not compatible with the version installed on the submitting cluster, the executable statement cannot be used to specify the **mpirun** program. The following job command file example shows how to invoke the **mpirun** program without using the executable statement.

```
#!/bin/bash#
# @ comment = "Script to invoke mpirun"
# @ error = $(job_name).$(jobid).out
# @ output = $(job_name).$(jobid).out
# @ wall_clock_limit = 00:20:00
# @ job_type = bluegene
# @ bg_size = 32
# @ queue
mpirun -exe myexe -verbose 1 -args "myargs"
```

Why does llmkres or llchres return ″Insufficient resources to meet the request″ for a Blue Gene reservation when resources appear to be available?

If it appears that a Blue Gene reservation does not have enough resources, there are several simple items that you can check to determine if there is a real problem.

There are many reasons why resources are not available for a reservation request. These reasons include but are not limited to:

- The resources are in use
- The resources are not included in the job class or cluster
- The available resources are not the right type

In the case of a Blue Gene reservation, be aware that the number of I/O nodes in a base partition affect the smallest partition size that can be supported by the base partition. If a base partition does not have enough I/O nodes, a reservation request asking for a smaller partition than it can support will not get satisfied by the resources on the base partition.

Helpful hints

This topic contains tips on running LoadLeveler, including some productivity aids.

Scaling considerations

If you are running LoadLeveler on a large number of nodes (128 or more), network traffic between LoadLeveler daemons can become excessive to the point of overwhelming a receiving daemon.

To reduce network traffic, consider the following daemon, keyword, and command recommendations for large installations.

- Set the **POLLS_PER_UPDATE*POLLING_FREQUENCY** interval to five minutes or more. This limits the volume of machine updates the startd daemons send to the negotiator. For example, set **POLLS_PER_UPDATE** to 10 and set **POLLING_FREQUENCY** to 30 seconds.
- If your installation's mix of jobs includes a high percentage of parallel jobs requiring many nodes, specify **schedd_host=yes** in the machine stanza of each Schedd machine. The Schedd daemons must communicate with hundreds of startd daemons every time a job runs. You can distribute this communication by activating many Schedd daemons. Typically, the number of Schedd machines in a LoadLeveler cluster ranges from 2 to 10, depending on the mix of workload and number of jobs in the system.
- If your installation allows jobs to be submitted from machines running the Schedd daemon, you should consider avoiding "Schedd affinity" by specifying **SCHEDD_SUBMIT_AFFINITY=FALSE** in the LoadLeveler configuration file.

By default, the **llsubmit** command submits a job to the machine where the command was invoked provided the Schedd daemon is running on the machine. (This is called Schedd affinity.)

- You can decrease the amount of time the negotiator daemon spends running negotiation loops by increasing the **NEGOTIATOR_INTERVAL** and the **NEGOTIATOR_CYCLE_DELAY**. For example, set **NEGOTIATOR_INTERVAL** to 600, and set **NEGOTIATOR_CYCLE_DELAY** to 30.
- Make sure the machine update interval is not too short by setting the **MACHINE_UPDATE_INTERVAL** to a value larger than three times the polling interval (**POLLS_PER_UPDATE*POLLING_FREQUENCY**). This prevents the negotiator from prematurely marking a machine as "down" or prematurely cancelling jobs.
- In a large LoadLeveler cluster, issuing the **llctl** command with the **-g** can take minutes to complete. To speed this up, set up a working collective containing the machines in the cluster and use the **dsh** command; for example, **dsh llctl reconfig**. This command also allows you to limit your operation to a subset of machines by defining other working collectives.

Hints for running jobs

The following subtopics provide some helpful hints that are useful for running jobs.

Determining when your job started and stopped

By reading the notification mail you receive after submitting a job, you can determine the time the job was submitted, started, and stopped.

Suppose you submit a job and receive the following mail when the job finishes:

```
Submitted at: Mon Jan 14 11:40:41 2008
Started   at: Mon Jan 14 11:45:00 2008
Exited    at: Mon Jan 14 12:49:10 2008

Real Time:   0 01:08:29
Job Step User Time:   0 00:30:15
Job Step System Time:   0 00:12:55
Total Job Step Time:   0 00:43:10

Starter User Time:   0 00:00:00
Starter System Time:   0 00:00:00
Total Starter Time:   0 00:00:00
```

This mail tells you the following:

Submitted at
The time you issued the **llsubmit** command or the time you submitted the job with the graphical user interface.

Started at
The time the starter process executed the job.

Exited at
The actual time your job completed.

Real Time
The wall clock time from submit to completion.

Job Step User Time
The CPU time the job consumed executing in user space.

Job Step System Time
The CPU time the system (AIX) consumed on behalf of the job.

Total Job Step Time
The sum of the **Job Step User Time** and **Job Step System Time** fields.

Starter User Time
The CPU time consumed by the LoadLeveler starter process for this job, executing in user space. Time consumed by the starter process is the only LoadLeveler overhead which can be directly attributed to a user's job.

Starter System Time
The CPU time the system (AIX) consumed on behalf of the LoadLeveler starter process running for this job.

Total Starter Time
The sum of the **Starter User Time** and **Starter System Time** fields.

You can also get the starting time by issuing **llsummary -l -x** and then issuing **awk /Date|Event/** against the resulting file. For this to work, you must have **ACCT = A_ON A_DETAIL** set in the **LoadL_config** file.

Running jobs at a specific time of day

Using a machine's local configuration file, you can set up the machine to run jobs at a certain time of day (sometimes called an *execution window*).

The following coding in the local configuration file runs jobs between 5:00 PM and 8:00 AM daily, and suspends jobs the rest of the day:

```
START: (tm_hour >= 1700) || (tm_hour <= 0800)
SUSPEND: (tm_hour > 0800)  && (tm_hour < 1700)
CONTINUE: (tm_hour >= 1700) || (tm_hour <= 0800)
```

Controlling the mix of idle and running jobs

The following keywords determine the mix of idle and running jobs for a user or group.

These keywords, which are described in detail in "Defining users" on page 97, are:

maxqueued
Controls the number of jobs in any of these states: Idle, Pending, Starting, Running, Preempt Pending, Preempted, Resume Pending, and Checkpointing.

maxjobs
Controls the number of jobs in any of these states: Running, Pending, or Starting; thus it controls a subset of what **maxqueued** controls. The **maxjobs** keyword effectively controls the number of jobs in the Running state, since Pending and Starting are usually temporary states.

Note: The **maxjobs** keyword can also be configured in the class stanza to limit the total number of running job steps of a particular class.

maxidle
Controls the number of jobs in any of these states: Idle, Pending, or Starting; thus it controls a subset of what **maxqueued** controls. The **maxidle** keyword effectively controls the number of jobs in the Idle state, since Pending and Starting are usually temporary states.

Administrators can restrict the number of queued, idle, and running job steps on a per-class, per-user basis. The LoadLeveler administrator specifies the per-class,

per-user constraints in the **LoadL_admin** file using user substanzas within each class stanza. For more information about substanzas, see "Defining user substanzas in class stanzas" on page 94.

What happens when you submit a job

This is what happens when you submit a job.

For a user's job to be allowed into the job queue and then dispatched:

- The total of other jobs (in the Idle, Pending, Starting, and Running states) for that user must be less than the **maxqueued** value for that user.
- The total idle jobs (those in the Idle, Pending, and Starting states) must be less than the **maxidle** value for the user.
- Constraints on the group's jobs and the user's jobs belonging to a particular class are considered.

Also, if the number of jobs exceeds the value specified by any of these **max** keywords, the job being considered is placed in the Not Queued state until one of the other jobs changes state. If the user is at the **maxqueued** limit, a job must complete, be canceled, or be held before the new job can enter the queue. If the user is at the **maxidle** limit, a job must start running, be canceled, or be held before the new job can enter the queue.

Once a job is in the queue, the job is not taken out of queue unless the user places a hold on the job, the job completes, or the job is canceled. This even applies to a job which is rejected or vacated and returned to the queue in the Idle state. (An exception to this, when you are running the default LoadLeveler scheduler, is parallel jobs which do not accumulate sufficient machines in a given time period. These jobs are moved to the Deferred state, meaning they must vie for the queue when their Deferred period expires.)

Once a job is in the queue, the job will run unless the **maxjobs** limit for the user is at a maximum.

Note the following restrictions for using these keywords:

- If **maxqueued** is greater than (**maxjobs** + **maxidle**), the **maxqueued** value will never be reached.
- If either **maxjobs** or **maxidle** is greater than **maxqueued**, then **maxqueued** will be the only restriction in effect, since **maxjobs** and **maxidle** will never be reached.

Sending output from several job steps to one output file

You can use dependencies in your job command file to send the output from many job steps to the same output file.

For example:

```
# @ step_name = step1
# @ executable = ssba.job
# @ output = ssba.tmp
# @ ...
# @ queue
#
# @ step_name = append1
# @ dependency = (step1 != CC_REMOVED)
# @ executable = append.ksh
# @ output = /dev/null
# @ queue
# @
```

```
# @ step_name = step2
# @ dependency = (append1 == 0)
# @ executable = ssba.job
# @ output = ssba.tmp
# @ ...
# @ queue
# @
# @ step_name = append2
# @ dependency = (step2 != CC_REMOVED)
# @ executable = append.ksh
# @ output = /dev/null
# @ queue
#
# ...
```

Then, the file **append.ksh** could contain the line **cat ssba.tmp >> ssba.log**. All your output will reside in **ssba.log**. (Your dependencies can look for different return values, depending on what you need to accomplish.)

You can achieve the same result from within **ssba.job** by appending your output to an output file rather than writing it to **stdout**. Then your output statement for each step would be **/dev/null** and you wouldn't need the append steps.

Hints for using machines

The following subtopics provide some helpful hints for using machines.

Setting up a single machine to have multiple job classes

You can define a machine to have multiple job classes which are active at different times.

For example, suppose you want a machine to run jobs of Class A any time, and you want the same machine to run Class B jobs between 6 p.m. and 8 a.m.

You can combine the **Class** keyword with a user-defined macro (called **Off_shift** in this example).

For example:

```
Off_Shift = ((tm_hour >= 18) || (tm_hour < 8))
```

Then define your START statement:

```
START : (Class == "A") || ((Class == "B") && $(Off_Shift))
```

Make sure you have the parenthesis around the **Off_Shift** macro, since the logical OR has a lower precedence than the logical AND in the START statement.

Also, to take weekends into account, code the following statements. Remember that Saturday is day 6 and Sunday is day 0.

```
Off_Shift = ((tm_wday == 6) || (tm_wday == 0) || (tm_hour >=18) \
|| (tm_hour < 8))

Prime_Shift = ((tm_wday != 6) && (tm_wday != 0) && (tm_hour >= 8) \
&& (tm_hour < 18))
```

Reporting the load average on machines

You can use the **/usr/bin/rup** command to report the load average on a machine.

The **rup** *machine_name* command gives you a report that looks similar to the following:

```
localhost    up 23 days, 10:25,    load average: 1.72, 1.05, 1.17
```

You can use this command to report the load average of your local machine or of remote machines. Another command, **/usr/bin/uptime**, returns the load average information for only your local host.

History files and Schedd

The **Schedd** daemon writes to the spool/history file only when a job is completed or removed.

Therefore, you can delete the history file and restart **Schedd** even when some jobs are scheduled to run on other hosts.

However, you should clean up the **spool/job_queue.dir** and **spool/job_queue.pag** files only when no jobs are being scheduled on the machine.

You should not delete these files if there are any jobs in the job queue that are being scheduled from this machine (for example, jobs with names such as *thismachine.clusterno.jobno*).

For fair share scheduling, **Schedd** daemons store historic CPU data for users and groups when their jobs terminate. Usually, a LoadLeveler cluster has more than one **Schedd** daemon. Each **Schedd** daemon only saves its own portion of the historic CPU data. The following database files in the directory specified by the **SPOOL** keyword on each Schedd machine contain the historic CPU data:

- fair_share_queue.dir
- fair_share_queue.pag

Getting help from IBM

Should you require help from IBM in resolving a LoadLeveler problem, you can get assistance by calling IBM Support.

Before you call, be sure you have the following information:

1. Your access code (customer number).
2. The LoadLeveler product number.
3. The name and version of the operating system you are using.
4. A telephone number where you can be reached.

In addition, issue the following command:

```
llctl version
```

This command will provide you with code level information. Provide this information to the IBM representative.

The number for IBM support in the United States is 1-800-IBM-4YOU (426-4968).

The Facsimile number is 800-2IBM-FAX (2426-329).

Appendix B. Sample command output

Access samples of command output.

The listings included in this topic are for the following commands:

- "llclass - Query class information" on page 433
- "llq - Query job status" on page 479
- "llstatus - Query machine status" on page 512
- "llsummary - Return job resource information for accounting" on page 535

llclass -l command output listing

The following listing shows **llclass -l** in a cluster with class stanzas configured in the **LoadL_admin** file.

The following listing shows **llclass -l** in a cluster with class stanzas configured in the **LoadL_admin** file for classes named high, medium, and low:

```
llclass -l low
=============== Class low ===============
                  Name: low
              Priority: 30
        Exclude_Users:
        Include_Users:
       Exclude_Groups:
       Include_Groups:
           Exclude_Bg:
           Include_Bg: R00-M0 R00-M1
                Admin:
             Max_node: -1
              Maxjobs: -1
Resource_requirement: ConsumableVirtualMemory(5.000 mb)
   Node Resource Req:
        Max Resources:
  Max Node Resources:
        Class_comment:
       Class_ckpt_dir: /LL/ckptfiles
           Ckpt_limit: undefined, undefined
    Wall_clock_limit: 00:10:00, 00:15:00 (600 seconds, 900 seconds)
Def_wall_clock_limit: 00:10:00, 00:15:00 (600 seconds, 900 seconds)
       Job_cpu_limit: undefined, undefined
           Cpu_limit: undefined, undefined
          Data_limit: undefined, undefined
            As_limit: undefined, undefined
         Nproc_limit: undefined, undefined
       Memlock_limit: undefined, undefined
         Locks_limit: undefined, undefined
        Nofile_limit: undefined, undefined
          Core_limit: undefined, undefined
          File_limit: undefined, undefined
         Stack_limit: undefined, undefined
           Rss_limit: undefined, undefined
                Nice: 0
          Free_slots: 64
       Maximum_slots: 64
     Max_total_tasks: 20
 Max_proto_instances: 2
 Stripe_min_networks: False
       Preempt_class:
```

```
                 Start_class:
                User default: maxidle(-1) maxqueued(-1) maxjobs(-1) max_total_tasks(-1)
                  User llbld: maxidle(-1) maxqueued(-1) maxjobs(10) max_total_tasks(15)


llclass -l medium
=============== Class medium ===============
                       Name: medium
                   Priority: 50
               Exclude_Users:
               Include_Users: llbld
              Exclude_Groups:
              Include_Groups:
                  Exclude_Bg:
                  Include_Bg:
                       Admin:
                   Max_node: -1
                    Maxjobs: -1
Resource_requirement: widgets(5)
   Node Resource Req: donuts(10)
        Max Resources:
  Max Node Resources:
        Class_comment:
       Class_ckpt_dir:
           Ckpt_limit: undefined, undefined
    Wall_clock_limit: 00:12:00, 00:12:00 (720 seconds, 720 seconds)
Def_wall_clock_limit: 00:12:00, 00:12:00 (720 seconds, 720 seconds)
       Job_cpu_limit: undefined, undefined
           Cpu_limit: 00:02:00, undefined (120 seconds, undefined)
          Data_limit: undefined, undefined
            As_limit: undefined, undefined
         Nproc_limit: undefined, undefined
       Memlock_limit: undefined, undefined
         Locks_limit: undefined, undefined
        Nofile_limit: undefined, undefined
          Core_limit: undefined, undefined
          File_limit: undefined, undefined
         Stack_limit: undefined, undefined
           Rss_limit: undefined, undefined
                Nice: 0
          Free_slots: 64
       Maximum_slots: 64
     Max_total_tasks: 20
 Max_proto_instances: 2
 Stripe_min_networks: True
       Preempt_class: ENOUGH:SU{low}
         Start_class:
        User default: maxidle(-1) maxqueued(-1) maxjobs(-1) max_total_tasks(-1)

llclass -l high
=============== Class high ===============
                       Name: high
                   Priority: 70
               Exclude_Users: loadl
               Include_Users:
              Exclude_Groups: No_Group
              Include_Groups:
                  Exclude_Bg:
                  Include_Bg:
                       Admin: loadlst
                   Max_node: -1
                    Maxjobs: -1
Resource_requirement:
   Node Resource Req:
        Max Resources:
  Max Node Resources:
        Class_comment:
```

```
      Class_ckpt_dir:
          Ckpt_limit: undefined, undefined
      Wall_clock_limit: 00:24:00, 00:20:00 (1440 seconds, 1200 seconds)
  Def_wall_clock_limit: 00:24:00, 00:20:00 (1440 seconds, 1200 seconds)
         Job_cpu_limit: undefined, undefined
             Cpu_limit: 00:15:00, undefined (900 seconds, undefined)
            Data_limit: 10.000 mb, 8.000 mb (10485760 bytes, 8388608 bytes)
              As_limit: undefined, undefined
           Nproc_limit: undefined, undefined
         Memlock_limit: undefined, undefined
           Locks_limit: undefined, undefined
          Nofile_limit: undefined, undefined
            Core_limit: undefined, undefined
            File_limit: 5.000 gb, 4.000 gb (5368709120 bytes, 4294967296 bytes)
           Stack_limit: undefined, undefined
             Rss_limit: undefined, undefined
                  Nice: 0
           Free_slots: 64
         Maximum_slots: 64
       Max_total_tasks: 20
   Max_proto_instances: 2
   Stripe_min_networks: False
         Preempt_class: ALL:VC{medium}
           Start_class:
          User default: maxidle(-1) maxqueued(-1) maxjobs(-1) max_total_tasks(-1)
```

llq -l command output listing

The following listing shows the **llq -l** output for a POE Parallel non-checkpointing job step.

```
============== Job Step z25c4s9.ppd.pok.ibm.com.25.0 ==============
        Job Step Id: z25c4s9.ppd.pok.ibm.com.25.0
           Job Name: btat
          Step Name: 0
  Structure Version: 10
              Owner: llbld
         Queue Date: Tue Oct 21 09:22:12 2008
             Status: Running
    Reservation ID:
  Requested Res. ID:
          Recurring: False
 Scheduling Cluster:
 Submitting Cluster:
    Sending Cluster:
  Requested Cluster:
     Schedd History:
   Outbound Schedds:
    Submitting User:
      Dispatch Time: Tue Oct 21 09:22:16 2008
    Completion Date:
    Completion Code:
        Favored Job: No
      User Priority: 50
       user_sysprio: 0
      class_sysprio: 30
      group_sysprio: 0
    System Priority: 0
          q_sysprio: 0
 Previous q_sysprio: 0
      Notifications: Error
 Virtual Image Size: 1.107 mb
         Large Page: N
         Coschedule: no
       SMT required: as_is
     Checkpointable: no
    Ckpt Start Time:
Good Ckpt Time/Date:
   Ckpt Elapse Time: 0 seconds
Fail Ckpt Time/Date:
    Ckpt Accum Time: 0 seconds
    Checkpoint File:
   Ckpt Execute Dir:
  Restart From Ckpt: no
 Restart Same Nodes: no
            Restart: yes
        Preemptable: yes
 Preempt Wait Count: 0
     Hold Job Until:
```

```
     User Hold Time: 00:00:00 (0 seconds)
               RSet: RSET_NONE
Mcm Affinity Option:
      Task Affinity:
       Cpus Per Core:  0
   Parallel Threads:  0
                Env:
                 In: /dev/null
                Out: btat.z25c4s9.25.0.out
                Err: btat.z25c4s9.25.0.err
Initial Working Dir: /tmp
         Dependency:
Data Stg Dependency:
          Resources: ConsumableVirtualMemory(5.000 mb)
     Node Resources:
          Step Type: General Parallel
         Node Usage: shared
    Submitting Host: z25c4s9.ppd.pok.ibm.com
        Schedd Host: z25c4s9.ppd.pok.ibm.com
       Job Queue Key:
        Notify User: llbld
              Shell: /bin/ksh
  LoadLeveler Group: No_Group
              Class: low
    Ckpt Hard Limit: undefined
    Ckpt Soft Limit: undefined
     Cpu Hard Limit: undefined
     Cpu Soft Limit: undefined
    Data Hard Limit: undefined
    Data Soft Limit: undefined
      As Hard Limit: undefined
      As Soft Limit: undefined
   Nproc Hard Limit: undefined
   Nproc Soft Limit: undefined
 Memlock Hard Limit: undefined
 Memlock Soft Limit: undefined
   Locks Hard Limit: undefined
   Locks Soft Limit: undefined
  Nofile Hard Limit: undefined
  Nofile Soft Limit: undefined
    Core Hard Limit: undefined
    Core Soft Limit: undefined
    File Hard Limit: undefined
    File Soft Limit: undefined
   Stack Hard Limit: undefined
   Stack Soft Limit: undefined
     Rss Hard Limit: undefined
     Rss Soft Limit: undefined
Step Cpu Hard Limit: undefined
Step Cpu Soft Limit: undefined
Wall Clk Hard Limit: 00:10:00 (600 seconds)
Wall Clk Soft Limit: 00:10:00 (600 seconds)
            Comment: "auto generated ll jcf"
            Account:
         Unix Group: usr
Negotiator Messages:
      Bulk Transfer: No
   Step rCxt Blocks: 0
Adapter Requirement: (sn_all,MPI,US,shared,AVERAGE,instances=2,)
          Step Cpus: 0
Step Virtual Memory: 60.000 mb
   Step Real Memory: 0.000 mb
Step Large Page Mem: 0.000 mb
     Cluster Option: none
--------------------------------------------------------------------------------
Node
----

   Name            :
   Requirements    :
   Preferences     :
   Blocking        : 2
   Total Tasks     : 12
   Node actual     : 3
   Allocated Hosts : z25c4s10.ppd.pok.ibm.com::ib0(MPI,US,0,Shared,0 rCxt Blks,1),\
                       ib0(MPI,US,1,Shared,0 rCxt Blks,1),\
                       ib1(MPI,US,64,Shared,0 rCxt Blks,2),ib1(MPI,US,65,Shared,0 rCxt Blks,2),ib0\
                       (MPI,US,2,Shared,0 rCxt Blks,1),\
                       ib0(MPI,US,3,Shared,0 rCxt Blks,1),ib1(MPI,US,66,Shared,0 rCxt Blks,2),ib1\
                       (MPI,US,67,Shared,0 rCxt Blks,2),\
                       ib0(MPI,US,4,Shared,0 rCxt Blks,1),ib0(MPI,US,5,Shared,0 rCxt Blks,1),ib1\
                       (MPI,US,68,Shared,0 rCxt Blks,2),\
                       ib1(MPI,US,69,Shared,0 rCxt Blks,2),ib0(MPI,US,6,Shared,0 rCxt Blks,1),ib0\
                       (MPI,US,7,Shared,0 rCxt Blks,1),\
                       ib1(MPI,US,70,Shared,0 rCxt Blks,2),ib1(MPI,US,71,Shared,0 rCxt Blks,2)
                     + z25c4s9.ppd.pok.ibm.com::ib0(MPI,US,0,Shared,0 rCxt Blks,1),\
                       ib0(MPI,US,1,Shared,0 rCxt Blks,1),\
                       ib1(MPI,US,64,Shared,0 rCxt Blks,2),ib1(MPI,US,65,Shared,0 rCxt Blks,2),\
                       ib0(MPI,US,2,Shared,0 rCxt Blks,1),\
                       ib0(MPI,US,3,Shared,0 rCxt Blks,1),ib1(MPI,US,66,Shared,0 rCxt Blks,2),\
                       ib1(MPI,US,67,Shared,0 rCxt Blks,2),\
```

```
                        ib0(MPI,US,4,Shared,0 rCxt Blks,1),ib0(MPI,US,5,Shared,0 rCxt Blks,1),\
                        ib1(MPI,US,68,Shared,0 rCxt Blks,2),\
                        ib1(MPI,US,69,Shared,0 rCxt Blks,2),ib0(MPI,US,6,Shared,0 rCxt Blks,1),\
                        ib0(MPI,US,7,Shared,0 rCxt Blks,1),\
                        ib1(MPI,US,70,Shared,0 rCxt Blks,2),ib1(MPI,US,71,Shared,0 rCxt Blks,2)
                     + z25c4s8.ppd.pok.ibm.com::ib0(MPI,US,0,Shared,0 rCxt Blks,1),
                        ib0(MPI,US,1,Shared,0 rCxt Blks,1),\
                        ib1(MPI,US,64,Shared,0 rCxt Blks,2),ib1(MPI,US,65,Shared,0 rCxt Blks,2),\
                        ib0(MPI,US,2,Shared,0 rCxt Blks,1),\
                        ib0(MPI,US,3,Shared,0 rCxt Blks,1),ib1(MPI,US,66,Shared,0 rCxt Blks,2),\
                        ib1(MPI,US,67,Shared,0 rCxt Blks,2),\
                        ib0(MPI,US,4,Shared,0 rCxt Blks,1),ib0(MPI,US,5,Shared,0 rCxt Blks,1),\
                        ib1(MPI,US,68,Shared,0 rCxt Blks,2),\
                        ib1(MPI,US,69,Shared,0 rCxt Blks,2),ib0(MPI,US,6,Shared,0 rCxt Blks,1),\
                        ib0(MPI,US,7,Shared,0 rCxt Blks,1),\
                        ib1(MPI,US,70,Shared,0 rCxt Blks,2),ib1(MPI,US,71,Shared,0 rCxt Blks,2)

   Master Task
   -----------

      Executable   : /usr/bin/poe
      Exec Args    : /tmp/llbld/bin/btat -t 1 -d 200 -m 100 -ilevel 6 -labelio yes -pmdlog no
      Num Task Inst: 1
      Task Instance: z25c4s10:-1,

   Task
   ----

      Num Task Inst: 12
      Task Instance: z25c4s10:0:ib0(MPI,US,0,Shared,0 rCxt Blks,1),ib0(MPI,US,1,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,64,Shared,0 rCxt Blks,2),ib1(MPI,US,65,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s10:1:ib0(MPI,US,2,Shared,0 rCxt Blks,1),ib0(MPI,US,3,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,66,Shared,0 rCxt Blks,2),ib1(MPI,US,67,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s10:2:ib0(MPI,US,4,Shared,0 rCxt Blks,1),ib0(MPI,US,5,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,68,Shared,0 rCxt Blks,2),ib1(MPI,US,69,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s10:3:ib0(MPI,US,6,Shared,0 rCxt Blks,1),ib0(MPI,US,7,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,70,Shared,0 rCxt Blks,2),ib1(MPI,US,71,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s9:4:ib0(MPI,US,0,Shared,0 rCxt Blks,1),ib0(MPI,US,1,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,64,Shared,0 rCxt Blks,2),ib1(MPI,US,65,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s9:5:ib0(MPI,US,2,Shared,0 rCxt Blks,1),ib0(MPI,US,3,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,66,Shared,0 rCxt Blks,2),ib1(MPI,US,67,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s9:6:ib0(MPI,US,4,Shared,0 rCxt Blks,1),ib0(MPI,US,5,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,68,Shared,0 rCxt Blks,2),ib1(MPI,US,69,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s9:7:ib0(MPI,US,6,Shared,0 rCxt Blks,1),ib0(MPI,US,7,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,70,Shared,0 rCxt Blks,2),ib1(MPI,US,71,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s8:8:ib0(MPI,US,0,Shared,0 rCxt Blks,1),ib0(MPI,US,1,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,64,Shared,0 rCxt Blks,2),ib1(MPI,US,65,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s8:9:ib0(MPI,US,2,Shared,0 rCxt Blks,1),ib0(MPI,US,3,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,66,Shared,0 rCxt Blks,2),ib1(MPI,US,67,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s8:10:ib0(MPI,US,4,Shared,0 rCxt Blks,1),ib0(MPI,US,5,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,68,Shared,0 rCxt Blks,2),ib1(MPI,US,69,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s8:11:ib0(MPI,US,6,Shared,0 rCxt Blks,1),ib0(MPI,US,7,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,70,Shared,0 rCxt Blks,2),ib1(MPI,US,71,Shared,0 rCxt Blks,2),

1 job step(s) in queue, 0 waiting, 0 pending, 1 running, 0 held, 0 preempted
```

llq -l command output listing for a Blue Gene enabled system

The following listing is a fragment of the **llq -l** output for a system where Blue Gene support is enabled and Blue Gene is present.

```
================ Job Step bgpdd2sys1.rchland.ibm.com.38.0 ================
        Job Step Id: bgpdd2sys1.rchland.ibm.com.38.0
           Job Name: bgp
          Step Name: 0
               ....
              RSet: RSET_NONE
Mcm Affinity Option:
      Task Affinity:
      Cpus Per Core:  0
   Parallel Threads:  0
               Cmd: /usr/bin/mpirun
              Args: -VERBOSE 2 -cwd /bgusr/ezhong -exe /bgusr/mmcsfvt0/MMCS_Test/bin/hello
               Env:
                In: /dev/null
               Out: bgl.bgpdd2sys1.38.0.out
               Err: bgl.bgpdd2sys1.38.0.err
Initial Working Dir: /bglhome/usr3/ezhong/cmd/bgp
         Dependency:
          Resources:
     Node Resources:
       Requirements:
        Preferences:
          Step Type: Blue Gene
     Size Requested: 32
```

```
     Size Allocated: 32
    Shape Requested:
    Shape Allocated:
   Wiring Requested: MESH
   Wiring Allocated: MESH
             Rotate: True
   Blue Gene Status:
   Blue Gene Job Id:
Partition Requested:
Partition Allocated: LL08032410490302
 BG Partition State: READY
Base Partition List: R00-M0
     IONodes Per BP: N00-J00,N00-J01
    BG Requirements:
         Error Text:
             ....
```

llq -l -x command output listing

The following listing shows the **llq -l -x** output for a POE Parallel non-checkpointing job step when the LoadLeveler cluster runs with Job Accounting enabled.

```
=============== Job Step z25c4s9.ppd.pok.ibm.com.25.0 ===============
        Job Step Id: z25c4s9.ppd.pok.ibm.com.25.0
           Job Name: btat
          Step Name: 0
  Structure Version: 10
              Owner: llbld
         Queue Date: Tue Oct 21 09:22:12 2008
             Status: Running
    Reservation ID:
  Requested Res. ID:
          Recurring: False
 Scheduling Cluster:
 Submitting Cluster:
    Sending Cluster:
  Requested Cluster:
     Schedd History:
   Outbound Schedds:
    Submitting User:
      Dispatch Time: Tue Oct 21 09:22:16 2008
    Completion Date:
    Completion Code:
        Favored Job: No
      User Priority: 50
       user_sysprio: 0
      class_sysprio: 30
      group_sysprio: 0
   System Priority:
         q_sysprio:
 Previous q_sysprio:
     Notifications: Error
 Virtual Image Size: 1.107 mb
        Large Page: N
        Coschedule: no
      SMT required: as_is
    Checkpointable: no
    Ckpt Start Time:
Good Ckpt Time/Date:
   Ckpt Elapse Time: 0 seconds
Fail Ckpt Time/Date:
    Ckpt Accum Time: 0 seconds
    Checkpoint File:
   Ckpt Execute Dir:
  Restart From Ckpt: no
 Restart Same Nodes: no
            Restart: yes
       Preemptable: yes
 Preempt Wait Count: 0
     Hold Job Until:
     User Hold Time: 00:00:00 (0 seconds)
               RSet: RSET_NONE
Mcm Affinity Option:
      Task Affinity:
      Cpus Per Core:  0
   Parallel Threads:  0
                Env: LANG=C LOGIN=llbld PATH=.:/bin:/usr/lpp/mmfs/bin:/usr/bin:/etc:/usr/ucb:/u/llbld/bin:\
                     /usr/sbin:/usr/bin/X11:/usr/afs/bin:/usr/dwm:/usr/lib/dwm:/usr/lpp/sysman/bin:\
                     /usr/lpp/sysmon/bin:/var/sysman:/usr/lpp/sysman/samples:/usr/lpp/ssp/bin:\
                     /usr/lpp/LoadL/full/bin:/opt/ibmll/LoadL/full/bin:/opt/ibmcmp/xlf/11.1/bin:\
                     /opt/ibmcmp/vac/9.0/bin:/opt/ibmcmp/vacpp/9.0/bin LC__FASTMSG=true LOGNAME=llbld\
                     MAIL=/usr/spool/mail/llbld LLA=/usr/lpp/LoadL/full LOCPATH=/usr/lib/nls/loc\
                     PS1=[z25c4s9][$PWD]>LLL=/opt/ibmll/LoadL/full AUTHSTATE=files SHELL=/bin/ksh\
                     ODMDIR=/etc/objrepos TERM=aixterm MAILMSG=[YOU HAVE NEW MAIL] PWD=/tmp\
```

```
                    TZ=EST5EDT ENV=/u/llbld/.kshrc A__z=! LOGNAME NLSPATH=/usr/lib/nls/msg/%L/%N:\
                    /usr/lib/nls/msg/%L/%N.cat MP_TIMEOUT=1200 MP_BUFFER_MEM=8M
                In: /dev/null
                Out: btat.z25c4s9.25.0.out
                Err: btat.z25c4s9.25.0.err
Initial Working Dir: /tmp
         Dependency:
Data Stg Dependency:
          Resources: ConsumableVirtualMemory(5.000 mb)
     Node Resources:
          Step Type: General Parallel
         Node Usage: shared
    Submitting Host: z25c4s9.ppd.pok.ibm.com
        Schedd Host: z25c4s9.ppd.pok.ibm.com
      Job Queue Key: 000025
        Notify User: llbld
              Shell: /bin/ksh
  LoadLeveler Group: No_Group
              Class: low
    Ckpt Hard Limit: undefined
    Ckpt Soft Limit: undefined
     Cpu Hard Limit: undefined
     Cpu Soft Limit: undefined
    Data Hard Limit: undefined
    Data Soft Limit: undefined
      As Hard Limit: undefined
      As Soft Limit: undefined
   Nproc Hard Limit: undefined
   Nproc Soft Limit: undefined
 Memlock Hard Limit: undefined
 Memlock Soft Limit: undefined
   Locks Hard Limit: undefined
   Locks Soft Limit: undefined
  Nofile Hard Limit: undefined
  Nofile Soft Limit: undefined
    Core Hard Limit: undefined
    Core Soft Limit: undefined
    File Hard Limit: undefined
    File Soft Limit: undefined
   Stack Hard Limit: undefined
   Stack Soft Limit: undefined
     Rss Hard Limit: undefined
     Rss Soft Limit: undefined
Step Cpu Hard Limit: undefined
Step Cpu Soft Limit: undefined
Wall Clk Hard Limit: 00:10:00 (600 seconds)
Wall Clk Soft Limit: 00:10:00 (600 seconds)
            Comment: "auto generated ll jcf"
            Account:
         Unix Group: usr
 User Space Windows: 48
Negotiator Messages:
       Bulk Transfer: No
   Step rCxt Blocks: 0
Adapter Requirement: (sn_all,MPI,US,shared,AVERAGE,instances=2,)
           Step Cpus: 0
Step Virtual Memory: 60.000 mb
   Step Real Memory: 0.000 mb
Step Large Page Mem: 0.000 mb
--------------- Detail for z25c4s9.ppd.pok.ibm.com.25.0 ---------------
       Running Host: z25c4s10.ppd.pok.ibm.com
      Machine Speed: 1.000000
  Starter User Time: 00:00:02.967966
Starter System Time: 00:00:03.136493
 Starter Total Time: 00:00:06.104459
     Starter maxrss: 2656
      Starter ixrss: 2432
      Starter idrss: 7545
      Starter isrss: 0
     Starter minflt: 0
     Starter majflt: 0
      Starter nswap: 0
    Starter inblock: 0
    Starter oublock: 0
     Starter msgsnd: 0
     Starter msgrcv: 0
   Starter nsignals: 29
      Starter nvcsw: 62085
     Starter nivcsw: 201
     Step User Time: 00:04:19.607642
   Step System Time: 00:00:29.497911
    Step Total Time: 00:04:49.105553
        Step maxrss: 27980
         Step ixrss: 6596
         Step idrss: 8785803
         Step isrss: 0
        Step minflt: 30386
        Step majflt: 0
         Step nswap: 0
       Step inblock: 0
       Step oublock: 0
```

```
       Step msgsnd: 0
       Step msgrcv: 0
     Step nsignals: 0
        Step nvcsw: 3277
       Step nivcsw: 84188
    Cluster Option: none
--------------------------------------------------------------------------------
Node
----

   Name           :
   Requirements   :
   Preferences    :
   Blocking       : 2
   Total Tasks    : 12
   Node actual    : 3
   Allocated Hosts : z25c4s10.ppd.pok.ibm.com:RUNNING:ib0(MPI,US,0,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,1,Shared,0 rCxt Blks,1),ib1(MPI,US,64,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,65,Shared,0 rCxt Blks,2),ib0(MPI,US,2,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,3,Shared,0 rCxt Blks,1),ib1(MPI,US,66,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,67,Shared,0 rCxt Blks,2),ib0(MPI,US,4,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,5,Shared,0 rCxt Blks,1),ib1(MPI,US,68,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,69,Shared,0 rCxt Blks,2),ib0(MPI,US,6,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,7,Shared,0 rCxt Blks,1),ib1(MPI,US,70,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,71,Shared,0 rCxt Blks,2)
                    + z25c4s9.ppd.pok.ibm.com:RUNNING:ib0(MPI,US,0,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,1,Shared,0 rCxt Blks,1),ib1(MPI,US,64,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,65,Shared,0 rCxt Blks,2),ib0(MPI,US,2,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,3,Shared,0 rCxt Blks,1),ib1(MPI,US,66,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,67,Shared,0 rCxt Blks,2),ib0(MPI,US,4,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,5,Shared,0 rCxt Blks,1),ib1(MPI,US,68,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,69,Shared,0 rCxt Blks,2),ib0(MPI,US,6,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,7,Shared,0 rCxt Blks,1),ib1(MPI,US,70,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,71,Shared,0 rCxt Blks,2)
                    + z25c4s8.ppd.pok.ibm.com:RUNNING:ib0(MPI,US,0,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,1,Shared,0 rCxt Blks,1),ib1(MPI,US,64,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,65,Shared,0 rCxt Blks,2),ib0(MPI,US,2,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,3,Shared,0 rCxt Blks,1),ib1(MPI,US,66,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,67,Shared,0 rCxt Blks,2),ib0(MPI,US,4,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,5,Shared,0 rCxt Blks,1),ib1(MPI,US,68,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,69,Shared,0 rCxt Blks,2),ib0(MPI,US,6,Shared,0 rCxt Blks,1),\
                      ib0(MPI,US,7,Shared,0 rCxt Blks,1),ib1(MPI,US,70,Shared,0 rCxt Blks,2),\
                      ib1(MPI,US,71,Shared,0 rCxt Blks,2)

   Master Task
   -----------

      Executable   : /usr/bin/poe
      Exec Args    : /tmp/llbld/bin/btat -t 1 -d 200 -m 100 -ilevel 6 -labelio yes -pmdlog no
      Num Task Inst: 1
      Task Instance: z25c4s10:-1,

   Task
   ----

      Num Task Inst: 12
      Task Instance: z25c4s10:0:ib0(MPI,US,0,Shared,0 rCxt Blks,1),ib0(MPI,US,1,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,64,Shared,0 rCxt Blks,2),ib1(MPI,US,65,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s10:1:ib0(MPI,US,2,Shared,0 rCxt Blks,1),ib0(MPI,US,3,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,66,Shared,0 rCxt Blks,2),ib1(MPI,US,67,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s10:2:ib0(MPI,US,4,Shared,0 rCxt Blks,1),ib0(MPI,US,5,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,68,Shared,0 rCxt Blks,2),ib1(MPI,US,69,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s10:3:ib0(MPI,US,6,Shared,0 rCxt Blks,1),ib0(MPI,US,7,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,70,Shared,0 rCxt Blks,2),ib1(MPI,US,71,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s9:4:ib0(MPI,US,0,Shared,0 rCxt Blks,1),ib0(MPI,US,1,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,64,Shared,0 rCxt Blks,2),ib1(MPI,US,65,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s9:5:ib0(MPI,US,2,Shared,0 rCxt Blks,1),ib0(MPI,US,3,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,66,Shared,0 rCxt Blks,2),ib1(MPI,US,67,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s9:6:ib0(MPI,US,4,Shared,0 rCxt Blks,1),ib0(MPI,US,5,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,68,Shared,0 rCxt Blks,2),ib1(MPI,US,69,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s9:7:ib0(MPI,US,6,Shared,0 rCxt Blks,1),ib0(MPI,US,7,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,70,Shared,0 rCxt Blks,2),ib1(MPI,US,71,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s8:8:ib0(MPI,US,0,Shared,0 rCxt Blks,1),ib0(MPI,US,1,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,64,Shared,0 rCxt Blks,2),ib1(MPI,US,65,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s8:9:ib0(MPI,US,2,Shared,0 rCxt Blks,1),ib0(MPI,US,3,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,66,Shared,0 rCxt Blks,2),ib1(MPI,US,67,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s8:10:ib0(MPI,US,4,Shared,0 rCxt Blks,1),ib0(MPI,US,5,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,68,Shared,0 rCxt Blks,2),ib1(MPI,US,69,Shared,0 rCxt Blks,2),
      Task Instance: z25c4s8:11:ib0(MPI,US,6,Shared,0 rCxt Blks,1),ib0(MPI,US,7,Shared,0 rCxt Blks,1),\
       ib1(MPI,US,70,Shared,0 rCxt Blks,2),ib1(MPI,US,71,Shared,0 rCxt Blks,2),
--------------------------------------------------------------------------------
Job Step Status on Allocated Hosts
----------------------------------

    z25c4s10.ppd.pok.ibm.com:RUNNING
    z25c4s9.ppd.pok.ibm.com:RUNNING
    z25c4s8.ppd.pok.ibm.com:RUNNING

1 job step(s) in queue, 0 waiting, 0 pending, 1 running, 0 held, 0 preempted
```

llstatus -l command output listing

The following listing shows the output from **llstatus -l** on a machine connected to a switch network.

```
================================================================================
Name                = z25c4s9.ppd.pok.ibm.com
Machine             = z25c4s9.ppd.pok.ibm.com
Arch                = ppc64
OpSys               = AIX61
SYSPRIO             = 0
MACHPRIO            = (0 -  LoadAvg)
VirtualMemory       = 506888 kb
Disk                = 7123364 kb
KeyboardIdle        = 1
Tmp                 = 90484 kb
LoadAvg             = 0.142212
ConfiguredClasses   = No_Class(16) high(16) medium(16) low(16) preempt(16) preemptable(16) super(16) large(16)
AvailableClasses    = No_Class(16) high(16) medium(16) low(16) preempt(16) preemptable(16) super(16) large(16)
DrainingClasses     =
DrainedClasses      =
Pool                =
FabricConnectivity  = 18338657682652659713:1,18338657682652659712:1
Adapter             = iba0(InfiniBand,,,,-1,0/0,0/0 rCxt Blks,11,READY)\
                       en1(ethernet,z25c4s9.ppd.pok.ibm.com,9.114.247.116,)\
                       network18338657682652659713(striped,,,,-1,64/64,0/0 rCxt Blks,11,READY)\
                       network18338657682652659713(aggregate,,,,-1,64/64,0/0 rCxt Blks,1,READY)\
                       network18338657682652659712(aggregate,,,,-1,64/64,0/0 rCxt Blks,1,READY)
Feature             =
Max_Starters        = 16
Max_Dstg_Starters   = 0
Prestarted_Starters = 1
Total Memory        = 7744 mb
Memory              = 7744 mb
FreeRealMemory      = 1467 mb
LargePageSize       = 16.000 mb
LargePageMemory     = 0 kb
FreeLargePageMemory = 0 kb
PagesFreed          = 0
PagesScanned        = 0
PagesPagedIn        = 0
PagesPagedOut       = 0
ConsumableResources =
ConfigTimeStamp     = Mon Oct 20 13:40:18 2008
Cpus                = 8
RSetSupportType     = RSET_NONE
Speed               = 1.000000
Subnet              = 9.114.247
MasterMachPriority  = 0.000000
CustomMetric        = 1
StartdAvail         = 1
State               = Idle
EnteredCurrentState = Mon Oct 20 13:40:18 2008
START               = T
SUSPEND             = F
CONTINUE            = T
VACATE              = F
KILL                = F
Machine Mode        = general
Running Tasks       = 0
ScheddAvail         = 1
ScheddState         = Avail
ScheddRunning       = 0
Pending             = 0
Starting            = 0
Idle                = 0
Unexpanded          = 0
Held                = 0
Removed             = 0
RemovedPending      = 0
Completed           = 0
TotalJobs           = 0
Running Steps       =
ReservationPermitted= T
Reservations        =
SMT                 = Enabled
TimeStamp           = Mon Oct 20 13:40:53 2008
```

llstatus -l -b command output listing

The following listing shows the output from **llstatus -l -b** command.

```
Total Blue Gene Base Partitions  8
Total Blue Gene Compute Nodes    4096
Machine Size in Base Partitons   X=1 Y=2 Z=4
Machine Size in Compute Nodes    X=8 Y=16 Z=32
```

```
        -- list of base partitions --
Z = 3
=====
   +------------+
   |        R021|
 1 |      <none>|
   |      <none>|
   |------------|
   |        R001|
 0 |      <none>|
   |      <none>|
   +------------+

Z = 2
=====
   +------------+
   |        R031|
 1 |       <sdb>|
   |          * |
   |------------|
   |        R011|
 0 |      <none>|
   |      <none>|
   +------------+

Z = 1
=====
   +------------+
   |        R030|
 1 |      <none>|
   |      <none>|
   |------------|
   |        R010|
 0 |       <sdb>|
   |          * |
   +------------+

Z = 0
=====
   +------------+
   |        R020|
 1 |      <none>|
   |      <none>|
   |------------|
   |        R000|
 0 |      <none>|
   |      <none>|
   +------------+

        -- list of switches --
Switch ID: X_R000
  Switch State: UP
  Base Partition: R000
  Switch Dimension: X
  Switch Connections:
    FromPort=PORT_S0 ToPort=PORT_S1 PartitionState=FREE  Partition=DD1FULL
Switch ID: X_R001
  Switch State: UP
  Base Partition: R001
  Switch Dimension: X
  Switch Connections:
    FromPort=PORT_S0 ToPort=PORT_S1 PartitionState=FREE  Partition=DD1FULL
Switch ID: X_R010
  Switch State: UP
  Base Partition: R010
  Switch Dimension: X
```

```
  Switch Connections:
    FromPort=PORT_S0 ToPort=PORT_S1 PartitionState=FREE  Partition=DD1FULL

.....

        -- list of wires --
Wire Id: R000X_R000
  Wire State: UP
  FromComponent=R000 FromPort=MINUS_X
  ToComponent=X_R000 ToPort=PORT_S0
  PartitionState=FREE Partition=DD1FULL
Wire Id: R000Y_R000
  Wire State: UP
  FromComponent=R000 FromPort=MINUS_Y
  ToComponent=Y_R000 ToPort=PORT_S0
  PartitionState=FREE Partition=DD1FULL
Wire Id: R000Z_R000
  Wire State: UP
  FromComponent=R000 FromPort=MINUS_Z
  ToComponent=Z_R000 ToPort=PORT_S0
  PartitionState=FREE Partition=DD1FULL
Wire Id: R001X_R001
  Wire State: UP
  FromComponent=R001 FromPort=MINUS_X
  ToComponent=X_R001 ToPort=PORT_S0
  PartitionState=FREE Partition=DD1FULL
Wire Id: R001Y_R001
  Wire State: UP
  FromComponent=R001 FromPort=MINUS_Y
  ToComponent=Y_R001 ToPort=PORT_S0
  PartitionState=FREE Partition=DD1FULL
Wire Id: R001Z_R001
  Wire State: UP
  FromComponent=R001 FromPort=MINUS_Z
  ToComponent=Z_R001 ToPort=PORT_S0
  PartitionState=FREE Partition=DD1FULL
```

llstatus -B command output listing

The following listing shows the output from **llstatus -B** command:

```
Base Partition Id: R00-M0
  Base Partition State: UP
  Location: (0,0,0)
  C-node Memory: 2048 mb
  Number of IONodes: 32
  Sub Divided Busy: True
  Node Card List:
    NodeCardId=N00      NodeCardState=UP    Quarter=Q1 SubDividedBusy=True
      IONodeId=J00      IPAddress=172.16.103.2    PartitionState=READY Partition=R00-M0-N00-J00
      IONodeId=J01      IPAddress=172.16.103.3    PartitionState=NONE  Partition=NONE
    NodeCardId=N01      NodeCardState=UP    Quarter=Q1 SubDividedBusy=True
      IONodeId=J00      IPAddress=172.16.103.4    PartitionState=READY Partition=R00-M0-N01-J01
      IONodeId=J01      IPAddress=172.16.103.5    PartitionState=NONE  Partition=NONE
    NodeCardId=N02      NodeCardState=UP    Quarter=Q1 PartitionState=READY Partition=GPFS_R00-M0-N02
    NodeCardId=N03      NodeCardState=UP    Quarter=Q1 SubDividedBusy=True
      IONodeId=J00      IPAddress=172.16.103.8    PartitionState=READY Partition=R00-M0-N03-J00
      IONodeId=J01      IPAddress=172.16.103.9    PartitionState=READY Partition=R00-M0-N03-J01
    NodeCardId=N04      NodeCardState=UP    Quarter=Q2 PartitionState=READY Partition=R00-M0-N04
    NodeCardId=N05      NodeCardState=UP    Quarter=Q2 SubDividedBusy=True
      IONodeId=J00      IPAddress=172.16.103.12   PartitionState=NONE  Partition=NONE
      IONodeId=J01      IPAddress=172.16.103.13   PartitionState=READY Partition=R00-M0-N05-J01
    NodeCardId=N06      NodeCardState=UP    Quarter=Q2 SubDividedBusy=True
      IONodeId=J00      IPAddress=172.16.103.14   PartitionState=READY Partition=R00-M0-N06-J00
      IONodeId=J01      IPAddress=172.16.103.15   PartitionState=NONE  Partition=NONE
    NodeCardId=N07      NodeCardState=UP    Quarter=Q2 PartitionState=NONE  Partition=NONE
    NodeCardId=N08      NodeCardState=UP    Quarter=Q3 PartitionState=NONE  Partition=NONE
    NodeCardId=N09      NodeCardState=UP    Quarter=Q3 PartitionState=READY Partition=R00-M0-N09
    NodeCardId=N10      NodeCardState=UP    Quarter=Q3 PartitionState=NONE  Partition=NONE
    NodeCardId=N11      NodeCardState=UP    Quarter=Q3 PartitionState=NONE  Partition=NONE
    NodeCardId=N12      NodeCardState=UP    Quarter=Q4 PartitionState=READY Partition=R00-M0-N12
    NodeCardId=N13      NodeCardState=UP    Quarter=Q4 PartitionState=NONE  Partition=NONE
    NodeCardId=N14      NodeCardState=UP    Quarter=Q4 PartitionState=NONE  Partition=NONE
    NodeCardId=N15      NodeCardState=UP    Quarter=Q4 PartitionState=READY Partition=R00-M0-N15
```

llstatus -P command output listing

The following listing shows the output from **llstatus -P** command:

```
Partition Id: R00-M0-N00-J00
  Partition State: READY
  Description: Generated via genSmallBlock
  Owner: jratt
  Users:
  Connection: MESH
  Size: 16
  Shape: 0x0x0
  Number of IONodes: 1
  IONodes / Base Partition: N00-J00
  MloaderImage: /bgsys/drivers/ppcfloor/boot/uloader
  CnLoadImage: /bgsys/drivers/ppcfloor/boot/cns,/bgsys/drivers/ppcfloor/boot/cnk
  IoLoadImage: /bgsys/drivers/ppcfloor/boot/cns,/bgsys/drivers/ppcfloor/boot/linux,/bgsys/drivers \
     /ppcfloor/boot/ramdisk
  Small Partitions: True
  Base Partition List: R00-M0
  Node Card List: N00
```

llsummary -l -x command output listing

The following listing is a fragment of the **llsummary -l -x** output for a POE parallel job step submitted from LoadLeveler `CLUSTER2` to LoadLeveler `CLUSTER1`.

```
================= Job e189f5rp01.ppd.pok.ibm.com.1 =================
            Job Id: e189f5rp01.ppd.pok.ibm.com.1
          Job Name: btat_MPI/IP/sn_single
  Structure Version: 210
             Owner: llbld
         Unix Group: usr
    Submitting Host: e189f5rp01.ppd.pok.ibm.com
  Submitting Userid: 602009
 Submitting Groupid: 100
 Scheduling Cluster: CLUSTER2
 Submitting Cluster: CLUSTER1
    Sending Cluster: CLUSTER1
    Submitting User: llbld
     Schedd History: e189f5rp04.ppd.pok.ibm.com
   Outbound Schedds: e189f5rp01.ppd.pok.ibm.com
    Number of Steps: 1
------------------ Step e189f5rp01.ppd.pok.ibm.com.1.0 ------------------
        Job Step Id: e189f5rp01.ppd.pok.ibm.com.1.0
          Step Name: Step_1
         Queue Date: Mon Mar 24 12:42:41 EDT 2008
 Job Accounting Key: 4968717789226364547
         Dependency:
             Status: Completed
      Dispatch Time: Mon Mar 24 12:42:43 EDT 2008
         Start Time: Mon Mar 24 12:42:43 EDT 2008
    Completion Date: Mon Mar 24 12:43:20 EDT 2008
    Completion Code: 0
        Start Count: 1
      User Priority: 50
       user_sysprio: 0
      class_sysprio: 40
      group_sysprio: 40
      Notifications: Always
 Virtual Image Size: 518 kb
     Checkpointable: yes
Good Ckpt Time/Date:
    Ckpt Accum Time: 0 seconds
    Checkpoint File: /ckptfiles/llbld/btat_MPI/IP/sn_single.e189f5rp01.ppd.pok.ibm.com.1.0.ckpt
  Restart From Ckpt: no
 Restart Same Nodes: no
            Restart: yes
     Hold Job Until:
               RSet: RSET_NONE
Mcm Affinity Options:
                Cmd: /bin/poe
               Args: /u/llbld/bin/btat -d 30 -v -ilevel 6 -labelio yes -pmdlog yes
                Env: LANG=en_US; LOGIN=llbld; PATH=.:/bin:/usr/bin:...
                 In: /dev/null
                Out: btat.e189f5rp04.1.0.out
                Err: btat.e189f5rp04.1.0.err
Initial Working Dir: /u/llbld/Checkpoint/cmd
       Requirements: (Arch == "R6000") && (OpSys == "AIX53")
        Preferences:
          Step Type: General Parallel
     Min Processors: 1
     Max Processors: 1
     Allocated Host: e189f5rp04.ppd.pok.ibm.com
         Node Usage: shared
```

```
     Reservation ID:
        Notify User: llbld
              Shell: /bin/ksh
  LoadLeveler Group: No_Group
              Class: No_Class
    Ckpt Hard Limit: undefined
    Ckpt Soft Limit: undefined
     Cpu Hard Limit: 00:30:00 (1800 seconds)
     Cpu Soft Limit: 00:25:00 (1500 seconds)
    Data Hard Limit: 8.200 gb (8804682956 bytes)
    Data Soft Limit: 7.100 gb (7623566950 bytes)
    Core Hard Limit: 11.200 gb (12025908428 bytes)
    Core Soft Limit: 11.100 gb (11918534246 bytes)
    File Hard Limit: unlimited
    File Soft Limit: unlimited
   Stack Hard Limit: 400.000 mb (419430400 bytes)
   Stack Soft Limit: 300.000 mb (314572800 bytes)
     Rss Hard Limit: 15.200 gb (16320875724 bytes)
     Rss Soft Limit: 15.100 gb (16213501542 bytes)
Step Cpu Hard Limit: undefined
Step Cpu Soft Limit: undefined
Wall Clk Hard Limit: 00:20:00 (1200 seconds)
Wall Clk Soft Limit: 00:20:00 (1200 seconds)
            Comment: "BTAT test running MPI/IP over switch"
            Account:
  Job Tracking Exit:
  Job Tracking Args:
      Task_geometry:
          Resources:
           Blocking: UNSPECIFIED
Adapter Requirement:
          Step Cpus: 1
Step Virtual Memory: 0.000 mb
   Step Real Memory: 0.000 mb
         Large Page: N
      Bulk Transfer: No
   Step rCxt Blocks: 0
--------------- Detail for e189f5rp01.ppd.pok.ibm.com.1.0 ---------------
       Running Host: e189f5rp04.ppd.pok.ibm.com
      Machine Speed: 1.000000
              Event: System
         Event Name: started
      Time of Event: Mon Mar 24 12:42:43 EDT 2008
  Starter User Time: 00:00:00.000000
Starter System Time: 00:00:00.000000
 Starter Total Time: 00:00:00.000000
     Starter maxrss: 0
      Starter ixrss: 0
      Starter idrss: 0
      Starter isrss: 0
     Starter minflt: 0
     Starter majflt: 0
      Starter nswap: 0
    Starter inblock: 0
    Starter oublock: 0
     Starter msgsnd: 0
     Starter msgrcv: 0
   Starter nsignals: 0
      Starter nvcsw: 0
     Starter nivcsw: 0
     Step User Time: 00:00:00.000000
   Step System Time: 00:00:00.000000
    Step Total Time: 00:00:00.000000
        Step maxrss: 0
         Step ixrss: 0
         Step idrss: 0
         Step isrss: 0
        Step minflt: 0
        Step majflt: 0
         Step nswap: 0
       Step inblock: 0
       Step oublock: 0
        Step msgsnd: 0
        Step msgrcv: 0
      Step nsignals: 0
         Step nvcsw: 0
        Step nivcsw: 0
              Event: System
         Event Name: completed
      Time of Event: Mon Mar 24 12:43:20 EDT 2008
  Starter User Time: 00:00:00.159357
Starter System Time: 00:00:00.043124
 Starter Total Time: 00:00:00.202481
     Starter maxrss: 2300
      Starter ixrss: 8976
      Starter idrss: 15224
      Starter isrss: 0
     Starter minflt: 0
     Starter majflt: 0
      Starter nswap: 0
    Starter inblock: 0
```

```
    Starter oublock: 0
     Starter msgsnd: 0
     Starter msgrcv: 0
   Starter nsignals: 4
      Starter nvcsw: 69
     Starter nivcsw: 3
     Step User Time: 00:02:04.062897
   Step System Time: 00:00:40.600541
    Step Total Time: 00:02:44.663438
        Step maxrss: 6328
         Step ixrss: 478068
         Step idrss: 70409520
         Step isrss: 0
        Step minflt: 20259
        Step majflt: 83
         Step nswap: 0
       Step inblock: 0
       Step oublock: 0
        Step msgsnd: 0
        Step msgrcv: 0
      Step nsignals: 4
         Step nvcsw: 3570827
        Step nivcsw: 2228899
-------------------------------------------------------------------------------
Node
----

   Name            :
   Requirements    : (Arch == "R6000") && (OpSys == "AIX53")
   Preferences     :
   Node minimum    : 1
   Node maximum    : 1
   Node actual     : 1
   Allocated Hosts : e189f5rp04.ppd.pok.ibm.com:PENDING:sn0(MPI,IP,-1,Shared,0 rCxt Blks,) \
                                                        sn0(MPI,IP,-1,Shared,0 rCxt Blks,) \
                                                        sn0(MPI,IP,-1,Shared,0 rCxt Blks,) \
                                                        sn0(MPI,IP,-1,Shared,0 rCxt Blks,)

   Master Task
   -----------

      Executable   : /bin/poe
      Exec Args    : /u/llbld/bin/btat -d 30 -v -ilevel 6 -labelio yes -pmdlog yes
      Num Task Inst: 1
      Task Instance: e189f5rp04:-1

   Task
   ----

      Num Task Inst: 4
      Task Instance: e189f5rp04:0:sn0(MPI,IP,-1,Shared,0 rCxt Blks,)
      Task Instance: e189f5rp04:1:sn0(MPI,IP,-1,Shared,0 rCxt Blks,)
      Task Instance: e189f5rp04:2:sn0(MPI,IP,-1,Shared,0 rCxt Blks,)
      Task Instance: e189f5rp04:3:sn0(MPI,IP,-1,Shared,0 rCxt Blks,)
```

llsummary -l -x command output listing for a Blue Gene-enabled system

The following listing is a fragment of the **llsummary -l -x** output for a Blue Gene job:

```
================== Job bgpdd2sys1.rchland.ibm.com.39 ==================
             Job Id: bgpdd2sys1.rchland.ibm.com.39
           Job Name: bgp
  Structure Version: 210
              Owner: ezhong
         Unix Group: ezhong
    Submitting Host: bgpdd2sys1.rchland.ibm.com
  Submitting Userid: 59491
 Submitting Groupid: 57237
    Number of Steps: 1
------------------ Step bgpdd2sys1.rchland.ibm.com.39.0 ------------------
        Job Step Id: bgpdd2sys1.rchland.ibm.com.39.0
          Step Name: 0
         Queue Date: Mon 24 Mar 2008 10:50:49 AM CDT
 Job Accounting Key: 5181336228204694831
         Dependency:
             Status: Completed
      Dispatch Time: Mon 24 Mar 2008 10:50:53 AM CDT
```

```
         Start Time: Mon 24 Mar 2008 10:50:54 AM CDT
    Completion Date: Mon 24 Mar 2008 10:51:11 AM CDT
    Completion Code: 256
        Start Count: 1
      User Priority: 50
       user_sysprio: 0
      class_sysprio: 0
      group_sysprio: 0
      Notifications: Always
 Virtual Image Size: 2.124 mb
     Checkpointable: no
Good Ckpt Time/Date:
    Ckpt Accum Time: 0
    Checkpoint File:
  Restart From Ckpt: no
 Restart Same Nodes: no
            Restart: yes
     Hold Job Until:
               RSet: RSET_NONE
Mcm Affinity Options:
      Task Affinity:
      Cpus Per Core: 0
   Parallel Threads: 0
                Cmd: /usr/bin/mpirun

.....

          Step Type: bluegene
     Min Processors:
     Max Processors:
     Size Requested: 32
     Size Allocated: 32
    Shape Requested:
    Shape Allocated:
   Wiring Requested: MESH
   Wiring Allocated: MESH
             Rotate:
Partition Requested:
Partition Allocated: LL08032410505103
Base Partition List: R00-M0
     IONodes Per BP: N00-J00,N00-J01
    BG Requirements:

.....
```

Appendix C. LoadLeveler port usage

This topic describes LoadLeveler port usage.

A **port number** is an integer that specifies the port to use to connect to the specified daemon. You can define these port numbers in the configuration file or the **/etc/services** file or you can accept the defaults. LoadLeveler first looks in the configuration file for these port numbers. If LoadLeveler does not find the value in the configuration file, it looks in the **/etc/services** file. If the value is not found in this file, the default is used.

Note: See Table 104 for the configuration file keywords associated with the port numbers.

The first column on each line in Table 104 represents the name of a service. In most cases, these services are also the names of daemons with the following exceptions:

- **LoadL_negotiator_collector** is the service name for a second stream port that is used by the **LoadL_negotiator** daemon.
- **LoadL_schedd_status** is the service name for a second stream port used by the **LoadL_schedd** daemon.

For each LoadLeveler service definition shown in Table 104, the following information is shown:

Service name
Specifies the service name. The service names shown are examples of how the names might appear in the **/etc/services** file.

Port number
Specifies the port number used for the service.

Protocol name
Specifies the transport protocol used for the service.

Source port range
A range of port numbers used on either the client side or daemon (server) side of the service.

Required or optional
Whether or not the service is required.

Description/associated keywords
A short description of the service along with its associated configuration file keyword or keywords.

Table 104. LoadLeveler default port usage

Service name	Port number	Protocol name	Source port range*	Required or optional	Description/associated keywords
LoadL_master	9616	tcp	LB	Required	Master port number for stream port
	9617	udp	LB	Required	Master port number for dgram port Keywords: • **MASTER_STREAM_PORT** (tcp) • **MASTER_DGRAM_PORT** (udp)

Table 104. LoadLeveler default port usage (continued)

Service name	Port number	Protocol name	Source port range*	Required or optional	Description/associated keywords
LoadL_negotiator	9614	tcp	LB	Required	Negotiator port number for stream port Keyword: **NEGOTIATOR_STREAM_PORT**
LoadL_negotiator_collector	9612 9613	tcp udp	LB LB	Required Required	Second negotiator stream port Negotiator port number for dgram port Keywords: • **CM_COLLECTOR_PORT** (tcp) • **COLLECTOR_DGRAM_PORT** (udp)
LoadL_schedd	9605	tcp	LB	Required	Schedd port number for stream port Keyword: **SCHEDD_STREAM_PORT**
LoadL_schedd_status	9606	tcp	LB	Required	Schedd stream port for job status data Keyword: **SCHEDD_STATUS_PORT**
LoadL_startd	9611	tcp	LB	Required	Startd port number for stream port Keyword: **STARTD_STREAM_PORT**

Note: * A value of LB indicates that the source port range value should be left blank. In other words, no source port range value should be specified.

For more information about configuration file keyword syntax and configuring the LoadLeveler environment, see the following:

- Chapter 4, "Configuring the LoadLeveler environment," on page 41
- Chapter 12, "Configuration file reference," on page 263

Accessibility features for TWS LoadLeveler

Accessibility features help users who have a disability, such as restricted mobility or limited vision, to use information technology products successfully.

Accessibility features

The following list includes the major accessibility features in IBM TWS LoadLeveler:

- Keyboard-only operation
- Interfaces that are commonly used by screen readers
- Keys that are discernible by touch but do not activate just by touching them
- Industry-standard devices for ports and connectors
- The attachment of alternative input and output devices

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Keyboard navigation

This product uses standard Microsoft® Windows® navigation keys.

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Glossary

This glossary includes terms and definitions for IBM Tivoli Workload Scheduler (TWS) LoadLeveler. The following cross-references are used in this glossary:

See	Refers the reader to (a) a term that is the expanded form of an abbreviation or acronym or (b) a synonym or more preferred term.
See also	Refers the reader to a related term.
Contrast with	Refers the reader to a term that has an opposed or substantively different meaning.

To view glossaries for other IBM products, go to http://www.ibm.com/software/globalization/terminology/index.html.

A

AFS. A distributed file system for large networks that is known for its ease of administration and expandability.

AIX. A UNIX operating system developed by IBM that is designed and optimized to run on POWER microprocessor-based hardware such as servers, workstations, and blades.

authentication. The process of validating the identity of a user or server.

authorization. The process of obtaining permission to perform specific actions.

B

Berkeley Load Average. The average number of processes on the operating system's ready-to-run queue.

C

C language. A language used to develop application programs in compact, efficient code that can be run on different types of computers with minimal change.

client. A system or process that is dependent on another system or process (usually called the *server*) to provide it with access to data, services, programs, or resources.

cluster. A collection of complete systems that work together to provide a single, unified computing capability.

D

daemon. A program that runs unattended to perform continuous or periodic functions, such as network control.

DCE. See *Distributed Computing Environment*.

default. Pertaining to an attribute, value, or option that is assumed when none is explicitly specified.

DFS. See *Distributed File System*.

Distributed Computing Environment (DCE). In network computing, a set of services and tools that supports the creation, use, and maintenance of distributed applications across heterogeneous operating systems and networks.

Distributed File Service (DFS). A component of a Distributed Computing Environment (DCE) that enables a single, integrated file system to be shared among all DCE users and host computers in a DCE cell. DFS prevents DCE users from simultaneously modifying the same information.

H

host. A computer that is connected to a network and provides an access point to that network. The host can be a client, a server, or both a client and server simultaneously.

L

LAPI. See *low-level application programming interface*.

low-level application programming interface (LAPI). An IBM message-passing interface that implements a one-sided communication model.

M

MCM. See *multiple chip module*.

memory affinity. A feature available in AIX to allocate memory attached to the same multiple chip module (MCM) on which the process runs. Memory affinity improves the performance of applications on IBM System p™ servers.

menu. A displayed list of items from which a user can make a selection.

Message Passing Interface (MPI). A library specification for message passing. MPI is a standard application programming interface (API) that can be used with parallel applications and that uses the best features of a number of existing message-passing systems.

Motif. User interface software, from Open Systems Foundation, for use with the X Window System.

MPI. See *Message Passing Interface*.

MPICH. A portable implementation of the Message Passing Interface (MPI).

MPICH-GM. A low-level message-passing system for Myrinet networks.

multiple chip module (MCM). The fundamental, processor, building block of IBM System p servers.

N

network. In data communication, a configuration in which two or more locations are physically connected for the purpose of exchanging data.

Network File System (NFS). A protocol, developed by Sun Microsystems, Incorporated, that enables a computer to access files over a network as if they were on its local disks.

NFS. See *Network File System*.

node. A computer location defined in a network.

P

parameter. A value or reference passed to a function, command, or program that serves as input or controls actions. The value is supplied by a user or by another program or process.

peer domain. A set of nodes configured for high availability by the configuration resource manager. Such a domain has no distinguished or master node. All nodes are aware of all other nodes, and administrative commands can be issued from any node in the domain. All nodes also have a consistent view of the domain membership.

process. A separately executable unit of work.

R

rCxt block. See *remote context blocks*.

RDMA. See *Remote Direct Memory Access*.

Reliable Scalable Cluster Technology (RSCT). A set of software components that together provide a comprehensive clustering environment for AIX and Linux. RSCT is the infrastructure used by a variety of IBM products to provide clusters with improved system availability, scalability, and ease of use.

remote context block (rCxt block). An interprocess communication buffer used by the low-level application programming interface (LAPI) for Remote Direct Memory Access (RDMA).

Remote Direct Memory Access (RDMA). A communication technique in which data is transmitted from the memory of one computer to that of another without passing through a processor. RDMA accommodates increased network speeds.

resource set (RSet). A data structure in AIX used to represent physical resources such as processors and memory. AIX uses resource sets to restrict a set of processes to a subset of the system's physical resources.

RSCT. See *Reliable Scalable Cluster Technology*.

RSCT peer domain. See *peer domain*.

RSet. See *resource set*.

S

server. In a network, hardware or software that provides facilities to clients. Examples of a server are a file server, a printer server, or a mail server.

shell. A software interface between users and an operating system. Shells generally fall into one of two categories: a command line shell, which provides a command line interface to the operating system; and a graphical shell, which provides a graphical user interface (GUI).

SMT. See *simultaneous multithreading*.

simultaneous multithreading (SMT). Pertaining to a processor design that combines hardware multithreading with superscalar processor technology. Using SMT, a single physical processor emulates multiple processors by enabling multiple threads to issue instructions simultaneously during each cycle.

system administrator. The person who controls and manages a computer system.

T

TCP. See *Transmission Control Protocol*.

Transmission Control Protocol (TCP). A communication protocol used in the Internet and in any network that follows the Internet Engineering Task Force (IETF) standards for internetwork protocol. TCP

provides a reliable host-to-host protocol in packet-switched communication networks and in interconnected systems of such networks.

U

UDP. See *User Datagram Protocol*.

User Datagram Protocol (UDP). An Internet protocol that provides unreliable, connectionless datagram service. It enables an application program on one machine or process to send a datagram to an application program on another machine or process.

W

working directory. The active directory. When a file name is specified without a directory, the current directory is searched.

workstation. A configuration of input/output equipment at which an operator works. A workstation is a terminal or microcomputer at which a user can run applications and that is usually connected to a mainframe or a network.

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Using and Administering
Version 3 Release 5

Publication No. SA22-7881-08

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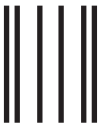

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