

# TORQUE Resource Manager

## Administrator Guide 4.2.9

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Adaptive Computing Enterprises Inc.

1712 S. East Bay Blvd., Suite 300

Provo, UT 84606

+1 (801) 717-3700

[www.adaptivecomputing.com](http://www.adaptivecomputing.com)



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# Welcome

Welcome to the *TORQUE Administrator Guide*, version 4.2.9. This guide is intended as a reference for both users and system administrators.



*Note:* [Advanced TORQUE Administration](#) is a video tutorial of a session offered at Moab Con that offers further details on advanced TORQUE administration.

For more information about this guide, see these topics:

- [TORQUE Administrator Guide overview on page xi](#)
- [Introduction on page ix](#)

## Introduction

This section contains some basic introduction information to help you get started using TORQUE. It contains these topics:

- [What is a Resource Manager? on page ix](#)
- [What are Batch Systems? on page ix](#)
- [Basic Job Flow on page x](#)

### What is a Resource Manager?

While TORQUE has a built-in scheduler, `pbs_sched`, it is typically used solely as a *resource manager* with a scheduler making requests to it. Resources managers provide the low-level functionality to start, hold, cancel, and monitor jobs. Without these capabilities, a scheduler alone cannot control jobs.

### What are Batch Systems?

While TORQUE is flexible enough to handle scheduling a conference room, it is primarily used in batch systems. Batch systems are a collection of computers and other resources (networks, storage systems, license servers, and so forth) that operate under the notion that the whole is greater than the sum of the parts. Some batch systems consist of just a handful of machines running single-processor jobs, minimally managed by the users themselves. Other systems have thousands and thousands of machines executing users' jobs simultaneously while tracking software licenses and access to hardware equipment and storage systems.

Pooling resources in a batch system typically reduces technical administration of resources while offering a uniform view to users. Once configured properly, batch systems abstract away many of the details involved with running and managing jobs, allowing higher resource utilization. For example, users

typically only need to specify the minimal constraints of a job and do not need to know the individual machine names of each host on which they are running. With this uniform abstracted view, batch systems can execute thousands and thousands of jobs simultaneously.

Batch systems are comprised of four different components: (1) Master Node, (2) Submit/Interactive Nodes, (3) Compute Nodes, and (4) Resources.

Component	Description
<b>Master Node</b>	A batch system will have a master node where <code>pbs_server</code> runs. Depending on the needs of the systems, a master node may be dedicated to this task, or it may fulfill the roles of other components as well.
<b>Submit/Interactive Nodes</b>	Submit or interactive nodes provide an entry point to the system for users to manage their workload. For these nodes, users are able to submit and track their jobs. Additionally, some sites have one or more nodes reserved for interactive use, such as testing and troubleshooting environment problems. These nodes have client commands (such as <code>qsub</code> and <code>qhold</code> ).
<b>Computer Nodes</b>	Compute nodes are the workhorses of the system. Their role is to execute submitted jobs. On each compute node, <code>pbs_mom</code> runs to start, kill, and manage submitted jobs. It communicates with <code>pbs_server</code> on the master node. Depending on the needs of the systems, a compute node may double as the master node (or more).
<b>Resources</b>	Some systems are organized for the express purpose of managing a collection of resources beyond compute nodes. Resources can include high-speed networks, storage systems, license managers, and so forth. Availability of these resources is limited and needs to be managed intelligently to promote fairness and increased utilization.

## Basic Job Flow

The life cycle of a job can be divided into four stages: (1) creation, (2) submission, (3) execution, and (4) finalization.

Stage	Description
<b>Creation</b>	<p>Typically, a submit script is written to hold all of the parameters of a job. These parameters could include how long a job should run (<b>walltime</b>), what resources are necessary to run, and what to execute. The following is an example submit file:</p> <pre>#PBS -N localBlast #PBS -S /bin/sh #PBS -l nodes=1:ppn=2,walltime=240:00:00 #PBS -M user@my.organization.com #PBS -m ea source ~/.bashrc cd \$HOME/work/dir sh myBlast.sh -i -v</pre> <p>This submit script specifies the name of the job (<code>localBlast</code>), what environment to use (<code>/bin/sh</code>), that it needs both processors on a single node (<b>nodes=1:ppn=2</b>), that it will run for at most 10 days, and that TORQUE should email "user@my.organization.com" when the job exits or aborts. Additionally, the user specifies where and what to execute.</p>
<b>Submission</b>	A job is submitted with the <code>qsub</code> command. Once submitted, the policies set by the administration and technical staff of the site dictate the priority of the job and therefore, when it will start executing.
<b>Execution</b>	Jobs often spend most of their lifecycle executing. While a job is running, its status can be queried with <code>qstat</code> .
<b>Finalization</b>	When a job completes, by default, the <code>stdout</code> and <code>stderr</code> files are copied to the directory where the job was submitted.

### Related topics

- [TORQUE Administrator Guide overview on page xi](#)

## TORQUE Administrator Guide overview

[Chapter 1: Overview on page 1](#) provides the details for installation and initialization, advanced configuration options, and (optional) `qmgr` option necessary to get the system up and running. System testing is also covered.

[Chapter 2: Submitting and managing jobs on page 39](#) covers different actions applicable to jobs. The first section details how to submit a job and request resources (nodes, software licenses, and so forth), and provides several examples. Other actions include monitoring, canceling, preemption, and keeping completed jobs.

[Chapter 3: Managing nodes on page 69](#) covers administrator tasks relating to nodes, which include the following: adding nodes, changing node properties, and identifying state. Also an explanation of how to configure restricted user access to nodes is covered in [Host security on page 71](#).

[Chapter 4: Setting server policies on page 77](#) details server-side configurations of queue and high availability.

[Chapter 5: Integrating schedulers for TORQUE on page 105](#) offers information about using the native scheduler versus an advanced scheduler.

[Chapter 6: Configuring data management on page 107](#) deals with issues of data management. For non-network file systems, [SCP setup on page 107](#) details setting up SSH keys and nodes to automate transferring data. [NFS and other networked filesystems on page 110](#) covers configuration for these file systems. This chapter also addresses the use of file staging using the **stagein** and **stageout** directives of the `qsub` command.

[Chapter 7: MPI \(Message Passing Interface\) support on page 113](#) offers details supporting MPI.

[Chapter 8: Resources on page 115](#) covers configuration, utilization, and states of resources.

[Chapter 9: Accounting records on page 119](#) explains how jobs are tracked by TORQUE for accounting purposes.

[Chapter 10: Job logging on page 121](#) explains how to enable job logs that contain information for completed jobs.

[Chapter 11: Troubleshooting on page 123](#) is a guide that offers help with general problems. It includes FAQ and instructions for how to set up and use compute node checks. It also explains how to debug TORQUE.

The appendices provide tables of commands, parameters, configuration options, error codes, the Quick Start Guide, and so forth.

- [Commands overview on page 145](#)
- [Server parameters on page 227](#)
- [Node manager \(MOM\) configuration on page 245](#)
- [Diagnostics and error codes on page 263](#)
- [Considerations before upgrading on page 271](#)
- [Large cluster considerations on page 273](#)
- [Prologue and epilogue scripts on page 281](#)
- [Running multiple TORQUE servers and MOMs on the same node on page 289](#)
- [Security overview on page 291](#)
- [Job submission filter \("qsub wrapper"\) on page 293](#)
- ["torque.cfg" configuration file on page 295](#)
- [TORQUE Quick Start Guide on page 301](#)
- [BLCR acceptance tests on page 305](#)

## Related topics

- [Introduction on page ix](#)

# Chapter 1: Overview

This section contains some basic information about TORQUE, including how to install and configure it on your system. For details, see these topics:

- [TORQUE installation overview on page 1](#)
- [Initializing/Configuring TORQUE on the server \(pbs\\_server\) on page 7](#)
- [Advanced configuration on page 14](#)
- [Manual setup of initial server configuration on page 26](#)
- [Server node file configuration on page 27](#)
- [Testing server configuration on page 29](#)
- [TORQUE on NUMA systems on page 31](#)
- [TORQUE Multi-MOM on page 35](#)

## TORQUE installation overview

This section contains information about TORQUE architecture and explains how to install TORQUE. It also describes how to install tpackages on compute nodes and how to enable TORQUE as a service.

For details, see these topics:

- [TORQUE architecture on page 1](#)
- [Installing TORQUE on page 2](#)
- [Compute nodes on page 5](#)
- [Enabling TORQUE as a service on page 7](#)

### Related topics

- [Troubleshooting on page 123](#)

## TORQUE architecture

A TORQUE cluster consists of one head node and many compute nodes. The head node runs the `pbs_server` daemon and the compute nodes run the `pbs_mom` daemon. Client commands for submitting and managing jobs can be installed on any host (including hosts not running `pbs_server` or `pbs_mom`).

The head node also runs a scheduler daemon. The scheduler interacts with `pbs_server` to make local policy decisions for resource usage and allocate nodes to jobs. A simple FIFO scheduler, and code to construct more advanced schedulers, is provided in the TORQUE source distribution. Most TORQUE users choose to use a packaged, advanced scheduler such as [Maui](#) or [Moab](#).

Users submit jobs to `pbs_server` using the `qsub` command. When `pbs_server` receives a new job, it informs the scheduler. When the scheduler finds nodes for the job, it sends instructions to run the job with the node list to `pbs_server`. Then, `pbs_server` sends the new job to the first node in the node list and instructs it to launch the job. This node is designated the execution host and is called *Mother Superior*. Other nodes in a job are called *sister MOMs*.

### Related topics

- [TORQUE installation overview on page 1](#)
- [Installing TORQUE on page 2](#)

## Installing TORQUE

Build the distribution on the machine that will act as the TORQUE server - the machine which monitors and controls all compute nodes by running the `pbs_server` daemon.

**i** The built distribution package works only on compute nodes of a similar architecture. Nodes with different architecture must have the installation package built on them individually.

The following software is required to run TORQUE 4.2.9:

- `libxml2-devel` package (package name may vary)
- `openssl-devel` package (package name may vary)
- ANSI C compiler. The native C compiler is recommended if it is ANSI; otherwise, use `gcc`.
- A fully POSIX make. If you are unable to "make" PBS with your make, we suggest using `gmake` from GNU.
- Tcl/Tk version 8 or higher if you plan to build the GUI portion of TORQUE or use a Tcl based scheduler.

**i Important:** If you intend to use TORQUE 4.2.9 with Moab, you must run Moab version 7.1 or later. TORQUE 4.2.9 will not work with versions earlier than Moab 7.1.

### To install TORQUE

1. Install the `gcc`, `libssl-devel`, and `libxml2-devel` packages to build 4.2.9. The package names may vary.

Use these commands to install the packages on the following operating systems:

**RHEL, CentOS, and Scientific Linux:**

```
[root]# yum update
[root]# yum install libxml2-devel openssl-devel gcc gcc-c++
```

**SLES** (You must have a licensed installation of SuSE and have installed the [SuSE Linux Enterprise Software Development Kit](#) and added the ISO to the repository):

```
[root]# zypper update
[root]# zypper install libxml2-devel libopenssl-devel gcc gcc-c++
```

2. Verify that the following ports are open for essential communication:

- For client communication to `pbs_server`, all privileged ports must be open (ports under 1024).
- For `pbs_server` communication to `pbs_mom`, the default port is 15003.
- For `pbs_mom` to `pbs_server`, the default port is 15001.

For more information on configuring ports, see [Configuring Ports on page 11](#).

3. TORQUE is now hosted at <https://github.com> under the adaptivecomputing organization. To download source, you will need to use the [git](#) utility. For example:

```
[root]# git clone https://github.com/adaptivecomputing/torque.git -b 4.2.9
4.2.9
```

To download a different version, replace each 4.2.9 with the desired version. After downloading a copy of the repository, you can list the current branches by typing `git branch -a` from within the directory of the branch you cloned.

**i** If you're checking source out from git, read the `README.building-40` file in the repository.

4. Extract the packaged file and navigate to the unpackaged directory.

```
[root]# tar -xzf torque-4.2.9.tar.gz
[root]# cd torque-4.2.9/
```

5. Do the following to configure the package:

- Run `./configure`. TORQUE has many options you can specify to configure your installation. For more information, see [Customizing the install on page 15](#).
- By default, the TORQUE directory is `/var/spool/torque`. If you want to change the location, use the `--with-server-home` configuration option.
- By default, `make install` installs all files in `/usr/local/bin`, `/usr/local/lib`, `/usr/local/sbin`, `/usr/local/include`, and `/usr/local/man`. You can specify an installation prefix other than `/usr/local` by using `--prefix` as an argument to `./configure`. Note that TORQUE cannot be installed into a directory path that contains a space.

**i** If you decide to use `--prefix` to specify a custom directory and that directory does not already exist, you must create it before running `./configure --prefix=...`

```
[root]# ./configure
```

6. Run `make` and `make install`.



TORQUE must be installed by a root user. If running `sudo` fails, switch to root with `su -`.

```
[root]# make
[root]# make install
```



OSX 10.4 users need to change `#define _TDARWIN` in `src/include/pbs_config.h` to `#define _TDARWIN_8`. Note that Mac OSX is not officially supported.

7. Configure the `trqauthd` daemon to start automatically at system boot (See [Configuring trqauthd for client commands on page 13](#)).

```
* If Debian distribution, do the following *
[root]# cp contrib/init.d/debian.trqauthd /etc/init.d/trqauthd

* If SLES distribution, do the following *
[root]# cp contrib/init.d/suse.trqauthd /etc/init.d/trqauthd

* If RHEL distribution, do the following *
[root]# cp contrib/init.d/trqauthd /etc/init.d/

[root]# chkconfig --add trqauthd
[root]# echo /usr/local/lib > /etc/ld.so.conf.d/torque.conf
[root]# ldconfig
[root]# service trqauthd start
```

8. The `make packages` command can be used to create self-extracting packages that can be copied and executed on your nodes. For information on creating packages and deploying them, see [Specifying compute nodes on page 9](#).

You will also want to `scp` the `init.d` scripts to the compute nodes and install them there.



The TORQUE initialization scripts are provided in the `/init.d` directory as a courtesy and may be modified at your discretion to work on your system.

9. Verify that the `/var/spool/torque/server_name` file exists and contains the correct name of the server.

```
[root]# echo <pbs_server's_hostname> > /var/spool/torque/server_name
```

10. After installation, verify that you have the `PATH` environment variable configured to include `/usr/local/bin/` and `/usr/local/sbin/` for both the installation user and the root user.

By default, `make install` creates a directory at `/var/spool/torque`. This directory is referred to as `TORQUE_HOME`. `TORQUE_HOME` has several sub-directories, including `server_priv/`, `server_logs/`, `mom_priv/`, `mom_logs/`, and other directories used in the configuration and running of TORQUE.

11. Verify you have environment variables configured so your system can find the shared libraries and binary files for TORQUE. This step is not necessary if the shared libraries are in their default



locations.

To set the library path, add the directory where the TORQUE libraries are installed. For example, if your TORQUE libraries are installed in `/usr/local/lib` (if you changed the default library path at configure time, use that path instead.), execute the following:

```
[root]# echo '/usr/local/lib' > /etc/ld.so.conf.d/torque.conf
[root]# ldconfig
```

12. Initialize `serverdb` by executing the `torque.setup` script.

```
[root]# ./torque.setup root
```

**i** If you are upgrading from TORQUE 2.5.9, run `pbs_server -u` before running `torque.setup`.

```
[root]# pbs_server -u
```

13. Add nodes to the `/var/spool/torque/server_priv/nodes` file. For information on syntax and options for specifying compute nodes, see [Node manager \(MOM\) configuration on page 245](#).
14. Configure the MOMs if necessary. See [Configuring TORQUE on compute nodes on page 10](#).
15. Configure `pbs_server` and `pbs_mom` to start automatically at system boot, then start their daemons. See [Enabling TORQUE as a service on page 7](#).

**i** While Adaptive Computing distributes the spec files to create RPMs, it doesn't support RPM installation. Not every Linux distribution uses RPM. Adaptive Computing provides a single solution using `make` and `make install` that works across all Linux distributions and most UNIX systems. We recognize the RPM format provides many advantages for deployment but it is up to the individual site to repackage the TORQUE installation to match their individual needs.

**i** If you have a multi-homed host, or if your host name resolves to the loopback address, you may encounter an "unauthorized request" error when running `qmgr`. The resolution is to as a manager manually add the host name of the specified interface to the `serverdb` file with the `attributes` tag.

```
<managers>root@napali.ib</managers>
```

## Related topics

- [TORQUE installation overview on page 1](#)
- [Compute nodes on page 5](#)

## Compute nodes

Use the Adaptive Computing tpackage system to create self-extracting tarballs which can be distributed and installed on compute nodes. The tpackages are customizable. See the `INSTALL` file for additional options and features.

## To create packages

1. Configure and make as normal, and then run `make packages`.

```
> make packages
Building ./torque-package-clients-linux-i686.sh ...
Building ./torque-package-mom-linux-i686.sh ...
Building ./torque-package-server-linux-i686.sh ...
Building ./torque-package-gui-linux-i686.sh ...
Building ./torque-package-devel-linux-i686.sh ...
Done.
```

The package files are self-extracting packages that can be copied and executed on your production machines. Use `--help` for options.

2. Copy the desired packages to a shared location.

```
> cp torque-package-mom-linux-i686.sh /shared/storage/
> cp torque-package-clients-linux-i686.sh /shared/storage/
```

3. Install the tpackages on the compute nodes.

Adaptive Computing recommends that you use a remote shell, such as SSH, to install tpackages on remote systems. Set up shared SSH keys if you do not want to supply a password for each host.



The only required package for the compute node is `mom-linux`. Additional packages are recommended so you can use client commands and submit jobs from compute nodes.

The following is an example of how to copy and install `mom-linux` in a distributed fashion.

```
> for i in node01 node02 node03 node04 ; do scp torque-package-mom-linux-i686.sh
${i}:/tmp/. ; done
> for i in node01 node02 node03 node04 ; do scp torque-package-clients-linux-
i686.sh ${i}:/tmp/. ; done
> for i in node01 node02 node03 node04 ; do ssh ${i} /tmp/torque-package-mom-linux-
i686.sh --install ; done
> for i in node01 node02 node03 node04 ; do ssh ${i} /tmp/torque-package-clients-
linux-i686.sh --install ; done
```

Alternatively, you can use a tool like `xCAT` instead of `ssh`.

## To use a tool like xCAT

1. Copy the tpackage to the nodes.

```
> prcp torque-package-linux-i686.sh noderange:/destinationdirectory/
```

2. Install the tpackage.

```
> psh noderange /tmp/torque-package-linux-i686.sh --install
```

Although optional, it is possible to use the TORQUE server as a compute node and install a `pbs_mom` with the `pbs_server` daemon.

**Related topics**

- [Installing TORQUE on page 2](#)
- [TORQUE installation overview on page 1](#)

## Enabling TORQUE as a service

**i** Enabling TORQUE as a service is optional. In order to run TORQUE as a service, you must enable running client commands (for instructions, see [Configuring trqauthd for client commands on page 13](#)).

The method for enabling TORQUE as a service is dependent on the Linux variant you are using. Startup scripts are provided in the `contrib/init.d/` directory of the source package. To enable TORQUE as a service, run the following on the host for the appropriate TORQUE daemon:

- RedHat (as root)

```
> cp contrib/init.d/pbs_mom /etc/init.d/pbs_mom
> chkconfig --add pbs_mom
> cp contrib/init.d/pbs_server /etc/init.d/pbs_server
> chkconfig --add pbs_server
```

- SuSE (as root)

```
> cp contrib/init.d/suse.pbs_mom /etc/init.d/pbs_mom
> insserv -d pbs_mom
> cp contrib/init.d/suse.pbs_server /etc/init.d/pbs_server
> insserv -d pbs_server
```

- Debian (as root)

```
> cp contrib/init.d/debian.pbs_mom /etc/init.d/pbs_mom
> update-rc.d pbs_mom defaults
> cp contrib/init.d/debian.pbs_server /etc/init.d/pbs_server
> update-rc.d pbs_server defaults
```

**i** You will need to customize these scripts to match your system.

These options can be added to the self-extracting packages. For more details, see the `INSTALL` file.

**Related topics**

- [TORQUE installation overview on page 1](#)

## Initializing/Configuring TORQUE on the server (pbs\_server)

The TORQUE server (`pbs_server`) contains all the information about a cluster. It knows about all of the MOM nodes in the cluster based on the information in the `$TORQUE_HOME/server_priv/nodes` file

(See [Configuring TORQUE on compute nodes on page 10](#)). It also maintains the status of each MOM node through updates from the MOMs in the cluster (see [pbsnodes on page 168](#)). All jobs are submitted via `qsub` to the server, which maintains a master database of all jobs and their states.

Schedulers such as Moab Workload Manager receive job, queue, and node information from `pbs_server` and submit all jobs to be run to `pbs_server`.

The server configuration is maintained in a file named `serverdb`, located in `$TORQUE_HOME/server_priv`. The `serverdb` file contains all parameters pertaining to the operation of TORQUE plus all of the queues which are in the configuration. For `pbs_server` to run, `serverdb` must be initialized.

You can initialize `serverdb` in two different ways, but the recommended way is to use the `./torque.setup` script:

- As root, execute `./torque.setup` from the build directory (see [./torque.setup on page 8](#)).
- Use `pbs_server -t create` (see [Initializing/Configuring TORQUE on the server \(pbs\\_server\) on page 7](#)).

Restart `pbs_server` after initializing `serverdb`.

```
> qterm
> pbs_server
```

## ./torque.setup

The `torque.setup` script uses `pbs_server -t create` to initialize `serverdb` and then adds a user as a manager and operator of TORQUE and other commonly used attributes. The syntax is as follows:

`./torque.setup username`

```
> ./torque.setup ken
> qmgr -c 'p s'

#
# Create queues and set their attributes.
#
#
# Create and define queue batch
#
create queue batch
set queue batch queue_type = Execution
set queue batch resources_default.nodes = 1
set queue batch resources_default.walltime = 01:00:00
set queue batch enabled = True
set queue batch started = True
#
# Set server attributes.
#
set server scheduling = True
set server acl_hosts = kmn
set server managers = ken@kmn
set server operators = ken@kmn
set server default_queue = batch
set server log_events = 511
set server mail_from = adm
set server node_check_rate = 150
set server tcp_timeout = 6
set server mom_job_sync = True
set server keep_completed = 300
```

## pbs\_server -t create

The `-t create` option instructs `pbs_server` to create the `serverdb` file and initialize it with a minimum configuration to run `pbs_server`.

```
> pbs_server -t create
```

To see the configuration and verify that TORQUE is configured correctly, use `qmgr`:

```
> qmgr -c 'p s'
#
# Set server attributes.
#
set server acl_hosts = kmn
set server log_events = 511
set server mail_from = adm
set server node_check_rate = 150
set server tcp_timeout = 6
```

A single queue named `batch` and a few needed server attributes are created.

This section contains these topics:

- [Specifying compute nodes on page 9](#)
- [Configuring TORQUE on compute nodes on page 10](#)
- [Finalizing configurations on page 14](#)


### Related topics

- [Node manager \(MOM\) configuration on page 245](#)
- [Advanced configuration on page 14](#)

## Specifying compute nodes

The environment variable `TORQUE_HOME` is where configuration files are stored. If you used the default locations during installation, you do not need to specify the `TORQUE_HOME` environment variable.

The `pbs_server` must recognize which systems on the network are its compute nodes. Specify each node on a line in the server's `nodes` file. This file is located at `TORQUE_HOME/server_priv/nodes`. In most cases, it is sufficient to specify just the names of the nodes on individual lines; however, various properties can be applied to each node.

 Only a root user can access the `server_priv` directory.

Syntax of `nodes` file:

```
node-name[:ts] [np=] [gpus=] [properties]
```

- The **node-name** must match the hostname on the node itself, including whether it is fully qualified or shortened.

- The **[;ts]** option marks the node as timeshared. Timeshared nodes are listed by the server in the node status report, but the server does not allocate jobs to them.
- The **[np=]** option specifies the number of virtual processors for a given node. The value can be less than, equal to, or greater than the number of physical processors on any given node.
- The **[gpus=]** option specifies the number of GPUs for a given node. The value can be less than, equal to, or greater than the number of physical GPUs on any given node.
- The node processor count can be automatically detected by the TORQUE server if **auto\_node\_np** is set to TRUE. This can be set using this command:

```
qmgr -c set server auto_node_np = True
```

Setting **auto\_node\_np** to TRUE overwrites the value of **np** set in `TORQUE_HOME/server_priv/nodes`.

- The **[properties]** option allows you to specify arbitrary strings to identify the node. Property strings are alphanumeric characters only and must begin with an alphabetic character.
- Comment lines are allowed in the nodes file if the first non-white space character is the pound sign (#).

The following example shows a possible node file listing.

`TORQUE_HOME/server_priv/nodes`:

```
# Nodes 001 and 003-005 are cluster nodes
#
node001 np=2 cluster01 rackNumber22
#
# node002 will be replaced soon
node002:ts waitingToBeReplaced
# node002 will be replaced soon
#
node003 np=4 cluster01 rackNumber24
node004 cluster01 rackNumber25
node005 np=2 cluster01 rackNumber26 RAM16GB
node006
node007 np=2
node008:ts np=4
...
```

## Related topics

- [Initializing/Configuring TORQUE on the server \(pbs\\_server\) on page 7](#)

## Configuring TORQUE on compute nodes

If using TORQUE self-extracting packages with default compute node configuration, no additional steps are required and you can skip this section.

If installing manually, or advanced compute node configuration is needed, edit the `TORQUE_HOME/mom_priv/config` file on each node. The recommended settings follow.

`TORQUE_HOME/mom_priv/config`:

```
$pbsserver    headnode    # hostname running pbs server
$logevent     225                # bitmap of which events to log
```

This file is identical for all compute nodes and can be created on the head node and distributed in parallel to all systems.

### Related topics

- [Initializing/Configuring TORQUE on the server \(pbs\\_server\) on page 7](#)

## Configuring Ports

You can optionally configure the various ports that TORQUE uses for communication. Most ports can be configured multiple ways. The ports you can configure are:

- [pbs\\_server listening port](#)
- [pbs\\_mom listening port](#)
- [port pbs\\_server uses to communicate to the pbs\\_mom](#)
- [port pbs\\_mom uses to communicate to the pbs\\_server](#)
- [port client commands use to communicate to the pbs\\_server](#)
- [port trqauthd uses to communicate to the pbs\\_server](#)



If you are running pbspro on the same system, be aware that it uses the same environment variables and `/etc/services` entries.

### Configuring the pbs\_server listening port

To configure the port the `pbs_server` listens on, follow any of these steps:

- Set an environment variable called `PBS_BATCH_SERVICE_PORT` to the port desired.
- Edit the `/etc/services` file and set `pbs port_num/tcp`.
- Start `pbs_server` with the `-p` option.

```
$ pbs_server -p port_num
```

- Edit the `$PBS_HOME/server_name` file and change `server_name` to `server_name:<port_num>`
- Start `pbs_server` with the `-H` option.

```
$ pbs_server -H server_name:port_num
```

### Configuring the pbs\_mom listening port

To configure the port the `pbs_mom` listens on, follow any of these steps:

- Set an environment variable called `PBS_MOM_SERVICE_PORT` to the port desired.
- Edit the `/etc/services` file and set `pbs_mom port_num/tcp`.
- Start `pbs_mom` with the `-M` option.

```
$ pbs_mom -M port_num
```

- Edit the `nodes` file entry for that list: add `mom_service_port=port_num`.

## Configuring the port `pbs_server` uses to communicate with `pbs_mom`

To configure the port the `pbs_server` uses to communicate with `pbs_mom`, follow any of these steps:

- Set an environment variable called `PBS_MOM_SERVICE_PORT` to the port desired.
- Edit the `/etc/services` file and set `pbs_mom port_num/tcp`.
- Start `pbs_mom` with the `-M` option.

```
$ pbs_server -M port_num
```

## Configuring the port `pbs_mom` uses to communicate with `pbs_server`

To configure the port the `pbs_mom` uses to communicate with `pbs_server`, follow any of these steps:

- Set an environment variable called `PBS_BATCH_SERVICE_PORT` to the port desired.
- Edit the `/etc/services` file and set `pbs port_num/tcp`.
- Start `pbs_mom` with the `-S` option.

```
$ pbs_mom -p port_num
```

- Edit the `nodes` file entry for that list: add `mom_service_port=port_num`.

## Configuring the port client commands use to communicate with `pbs_server`

To configure the port client commands use to communicate with `pbs_server`, follow any of these steps:

- Edit the `/etc/services` file and set `pbs port_num/tcp`.
- Edit the `$PBS_HOME/server_name` file and change `server_name` to `server_name:<port_num>`

## Configuring the port `trqauthd` uses to communicate with `pbs_server`

To configure the port `trqauthd` uses to communicate with `pbs_server`, follow any of these steps:

- Edit the `$PBS_HOME/server_name` file and change `server_name` to `server_name:<port_num>`

### Related topics

- [Initializing/Configuring TORQUE on the server \(pbs\\_server\) on page 7](#)
- [pbs\\_server](#)



- [pbs\\_mom](#)
- [trqauthd](#)
- [client commands](#)

## Configuring trqauthd for client commands

trqauthd is a daemon used by TORQUE client utilities to authorize user connections to pbs\_server. Once started, it remains resident. TORQUE client utilities then communicate with trqauthd on port 15005 on the loopback interface. It is multi-threaded and can handle large volumes of simultaneous requests.

### Running trqauthd

trqauthd must be run as root. It must also be running on any host where TORQUE client commands will execute.

By default, trqauthd is installed to `/usr/local/bin`.

trqauthd can be invoked directly from the command line or by the use of `init.d` scripts which are located in the `contrib/init.d` directory of the TORQUE source.

There are three `init.d` scripts for trqauthd in the `contrib/init.d` directory of the TORQUE source tree:

Script	Description
<b>debian.trqauthd</b>	Used for apt-based systems (debian, ubuntu are the most common variations of this)
<b>suse.trqauthd</b>	Used for suse-based systems
<b>trqauthd</b>	An example for other package managers (Redhat, Scientific, CentOS, and Fedora are some common examples)



You should edit these scripts to be sure they will work for your site.

Inside each of the scripts are the variables `PBS_DAEMON` and `PBS_HOME`. These two variables should be updated to match your TORQUE installation. `PBS_DAEMON` needs to point to the location of trqauthd. `PBS_HOME` needs to match your TORQUE installation.

Choose the script that matches your dist system and copy it to `/etc/init.d`. If needed, rename it to **trqauthd**.

### To start the daemon

```
/etc/init.d/trqauthd start
```

### To stop the daemon

```
/etc/init.d/trqauthd stop
```

OR

```
service trqauthd start/stop
```

**i** If you receive an error that says "Could not open socket in trq\_simple\_connect. error 97" and you use a CentOS, RedHat, or Scientific Linux 6+ operating system, check your `/etc/hosts` file for multiple entries of a single host name pointing to the same IP address. Delete the duplicate(s), save the file, and launch `trqauthd` again.

### Related topics

- [Initializing/Configuring TORQUE on the server \(pbs\\_server\) on page 7](#)

## Finalizing configurations

After configuring the `serverdb` and the `server_priv/nodes` files, and after ensuring minimal MOM configuration, restart the `pbs_server` on the server node and the `pbs_mom` on the compute nodes.

Compute Nodes:

```
> pbs_mom
```

Server Node:

```
> qterm -t quick
> pbs_server
```

After waiting several seconds, the `pbsnodes -a` command should list all nodes in state `free`.

### Related topics

- [Initializing/Configuring TORQUE on the server \(pbs\\_server\) on page 7](#)

## Advanced configuration

This section contains information about how you can customize the installation and configure the server to ensure that the server and nodes are communicating correctly. For details, see these topics:

- [Customizing the install on page 15](#)
- [Server configuration on page 21](#)

### Related topics

- [Server parameters on page 227](#)


## Customizing the install

The TORQUE `configure` command has several options available. Listed below are some suggested options to use when running `./configure`.

- By default, TORQUE does not install the admin manuals. To enable this, use `--enable-docs`.
- By default, only children MOM processes use syslog. To enable syslog for all of TORQUE, use `--enable-syslog`.

Table 1-1: Optional Features

Option	Description
<code>--disable-clients</code>	Directs TORQUE not to build and install the TORQUE client utilities such as <code>qsub</code> , <code>qstat</code> , <code>qdel</code> , etc.
<code>--disable-FEATURE</code>	Do not include FEATURE (same as <code>--enable-FEATURE=no</code> ).
<code>--disable-lib-tool-lock</code>	Avoid locking (might break parallel builds).
<code>--disable-mom</code>	Do not include the MOM daemon.
<code>--disable-mom-check-spool</code>	Don't check free space on spool directory and set an error.
<code>--disable-posixmemlock</code>	Disable the MOM's use of <code>mlockall</code> . Some versions of OSs seem to have buggy POSIX <code>MEMLOCK</code> .
<code>--disable-priv-ports</code>	Disable the use of privileged ports for authentication. Some versions of OSX have a buggy <code>bind()</code> and cannot bind to privileged ports.
<code>--disable-qsub-keep-override</code>	Do not allow the <code>qsub -k</code> flag to override <code>-o -e</code> .
<code>--disable-server</code>	Do not include server and scheduler.
<code>--disable-shell-pipe</code>	Give the job script file as standard input to the shell instead of passing its name via a pipe.

Option	Description
<b>--disable-spool</b>	If disabled, TORQUE will create output and error files directly in \$HOME/.pbs_spool if it exists or in \$HOME otherwise. By default, TORQUE will spool files in TORQUE_HOME/spool and copy them to the users home directory when the job completes.
<b>--disable-xopen-networking</b>	With HPUX and GCC, don't force usage of XOPEN and libxnet.
<b>--enable-acct-x</b>	Enable adding x attributes to accounting log.
<b>--enable-array</b>	Setting this under IRIX enables the SGI Origin 2000 parallel support. Normally autodetected from the /etc/config/array file.
<b>--enable-blcr</b>	Enable BLCR support.
<b>--enable-cpa</b>	Enable Cray's CPA support.
<b>--enable-cpu-set</b>	Enable Linux 2.6 kernel cpusets. <div style="border: 1px solid black; border-radius: 10px; padding: 5px; margin-top: 10px;">  It is recommended that you turn on this feature to prevent a job from expanding across more CPU cores than it is assigned. </div>
<b>--enable-debug</b>	Prints debug information to the console for pbs_server and pbs_mom while they are running. (This is different than <b>--with-debug</b> which will compile with debugging symbols.)
<b>--enable-dependency-tracking</b>	Do not reject slow dependency extractors.
<b>--enable-fast-install[=PKGS]</b>	Optimize for fast installation [default=yes].
<b>--enable-FEATURE [=ARG]</b>	Include FEATURE [ARG=yes].
<b>--enable-file-sync</b>	Open files with sync on each write operation. This has a negative impact on TORQUE performance. This is disabled by default.
<b>--enable-force-nofile</b>	Forces creation of nofile regardless of job submission parameters. Not on by default.

Option	Description
<b>--enable-gcc-warnings</b>	Enable gcc strictness and warnings. If using gcc, default is to error on any warning.
<b>--enable-geometry-requests</b>	TORQUE is compiled to use <a href="#">procs_bitmap</a> during job submission.
<b>--enable-gui</b>	Include the GUI-clients.
<b>--enable-main-tainer-mode</b>	This is for the autoconf utility and tells autoconf to enable so called rebuild rules. See <a href="#">main-tainer mode</a> for more information.
<b>--enable-maxdefault</b>	<p>Turn on the RESOURCEMAXDEFAULT flag.</p> <div style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p><b>i</b> Versions of TORQUE earlier than 2.4.5 attempted to apply queue and server defaults to a job that didn't have defaults specified. If a setting still did not have a value after that, TORQUE applied the queue and server maximum values to a job (meaning, the maximum values for an applicable setting were applied to jobs that had no specified or default value).</p> <p>In TORQUE 2.4.5 and later, the queue and server maximum values are no longer used as a value for missing settings. To re-enable this behavior in TORQUE 2.4.5 and later, use <code>--enable-maxdefault</code>.</p> </div>
<b>--enable-nochildsignal</b>	Turn on the NO_SIGCHLD flag.
<b>--enable-nodemask</b>	Enable nodemask-based scheduling on the Origin 2000.
<b>--enable-pemask</b>	Enable pemask-based scheduling on the Cray T3e.
<b>--enable-plock-daemons[=ARG]</b>	Enable daemons to lock themselves into memory: logical-or of 1 for pbs_server, 2 for pbs_scheduler, 4 for pbs_mom (no argument means 7 for all three).
<b>--enable-quick-commit</b>	Turn on the QUICKCOMMIT flag.
<b>--enable-shared[=PKGS]</b>	Build shared libraries [default=yes].

Option	Description
<b>--enable-shell-use-argv</b>	Enable this to put the job script name on the command line that invokes the shell. Not on by default. Ignores --enable-shell-pipe setting.
<b>--enable-sp2</b>	Build PBS for an IBM SP2.
<b>--enable-srfs</b>	Enable support for SRFS on Cray.
<b>--enable-static [=PKGS]</b>	Build static libraries [default=yes].
<b>--enable-syslog</b>	Enable (default) the use of syslog for error reporting.
<b>--enable-tcl-qstat</b>	Setting this builds qstat with Tcl interpreter features. This is enabled if Tcl is enabled.
<b>--enable-unix-sockets</b>	Enable the use of Unix Domain sockets for authentication.

Table 1-2: Optional packages

Option	Description
<b>--with-bocr=DIR</b>	BOCR installation prefix (Available in versions 2.5.6 and 3.0.2 and later).
<b>--with-bocr-include=DIR</b>	Include path for libocr.h (Available in versions 2.5.6 and 3.0.2 and later).
<b>--with-bocr-lib=DIR</b>	Lib path for libocr (Available in versions 2.5.6 and 3.0.2 and later).
<b>--with-bocr-bin=DIR</b>	Bin path for BOCR utilities (Available in versions 2.5.6 and 3.0.2 and later).
<b>--with-cpa-include=DIR</b>	Include path for cpalib.h.
<b>--with-cpa-lib=DIR</b>	Lib path for libcpalib.
<b>--with-debug=no</b>	Do not compile with debugging symbols.
<b>--with-default-server-r=HOSTNAME</b>	Set the name of the computer that clients will access when no machine name is specified as part of the queue name. It defaults to the hostname of the machine on which PBS is being compiled.

Option	Description
<b>--with-environ=PATH</b>	Set the path containing the environment variables for the daemons. For SP2 and AIX systems, suggested setting is to <code>/etc/environment</code> . Defaults to the file "pbs_environment" in the server-home. Relative paths are interpreted within the context of the server-home.
<b>--with-gnu-ld</b>	Assume the C compiler uses GNU ld [default=no].
<b>--with-mail-domain=MAILDOMAIN</b>	Override the default domain for outgoing mail messages, i.e. "user@maildomain". The default maildomain is the hostname where the job was submitted from.
<b>--with-modulefiles[=DIR]</b>	Use module files in specified directory [ <code>/etc/modulefiles</code> ].
<b>--with-momlogdir</b>	Use this directory for MOM logs.
<b>--with-momlogsuffix</b>	Use this suffix for MOM logs.
<b>--without-PACKAGE</b>	Do not use PACKAGE (same as <code>--with-PACKAGE=no</code> ).
<b>--without-readline</b>	Do not include readline support (default: included if found).
<b>--with-PACKAGE[=ARG]</b>	Use PACKAGE [ARG=yes].
<b>--with-pam=DIR</b>	Directory that holds the system PAM modules. Defaults to <code>/lib(64)/security</code> on Linux.
<b>--with-pic</b>	Try to use only PIC/non-PIC objects [default=use both].
<b>--with-qstatrc-file=FILE</b>	Set the name of the file that qstat will use if there is no ".qstatrc" file in the directory where it is being invoked. Relative path names will be evaluated relative to the server home directory (see above). If this option is not specified, the default name for this file will be set to "qstatrc" (no dot) in the server home directory.
<b>--with-rcp</b>	One of "scp", "rcp", "mom_rcp", or the full path of a remote file copy program. scp is the default if found, otherwise mom_rcp is used. Some rcp programs don't always exit with valid error codes in case of failure. mom_rcp is a copy of BSD rcp included with this source that has correct error codes, but it is also old, unmaintained, and doesn't have large file support.

Option	Description
<b>--with-sched=TYPE</b>	Sets the scheduler type. If TYPE is "c", the scheduler will be written in C. If TYPE is "tcl" the server will use a Tcl based scheduler. If TYPE is "basl", TORQUE will use the rule based scheduler. If TYPE is "no", then no scheduling is done. "c" is the default.
<b>--with-sched-code=PATH</b>	Sets the name of the scheduler to use. This only applies to BASL schedulers and those written in the C language. For C schedulers this should be a directory name and for BASL schedulers a filename ending in ".basl". It will be interpreted relative to <code>srcree/src/schedulers.SCHD_TYPE/samples</code> . As an example, an appropriate BASL scheduler relative path would be "nas.basl". The default scheduler code for "C" schedulers is "fifo".
<b>--with-scp</b>	In TORQUE 2.1 and later, SCP is the default remote copy protocol. See <a href="#">--with-rcp</a> if a different protocol is desired.
<b>--with-sendmail[=FILE]</b>	Sendmail executable to use.
<b>--with-server-home=DIR</b>	Set the server home/spool directory for PBS use. Defaults to <code>/var/spool/torque</code> .
<b>--with-server-name-file=FILE</b>	Set the file that will contain the name of the default server for clients to use. If this is not an absolute pathname, it will be evaluated relative to the server home directory that either defaults to <code>/usr/spool/PBS</code> or is set using the <code>--with-server-home</code> option to configure. If this option is not specified, the default name for this file will be set to "server_name".
<b>--with-tcl</b>	Directory containing tcl configuration ( <code>tclConfig.sh</code> ).
<b>--with-tclatrsep=CHAR</b>	Set the Tcl attribute separator character this will default to "." if unspecified.
<b>--with-tclinclude</b>	Directory containing the public Tcl header files.
<b>--with-tclx</b>	Directory containing tclx configuration ( <code>tclxConfig.sh</code> ).
<b>--with-tk</b>	Directory containing tk configuration ( <code>tkConfig.sh</code> ).
<b>--with-tkinclude</b>	Directory containing the public Tk header files.
<b>--with-tkx</b>	Directory containing tkx configuration ( <code>tkxConfig.sh</code> ).
<b>--with-tmpdir=DIR</b>	Set the tmp directory that <code>pbs_mom</code> will use. Defaults to <code>/tmp</code> . This is a Cray-specific feature.



Option	Description
<code>--with-xauth=PATH</code>	Specify path to xauth program.

## HAVE\_WORDEXP

`Wordxp()` performs a shell-like expansion, including environment variables. By default, `HAVE_WORDEXP` is set to `1` in `src/pbs_config.h`. If set to `1`, will limit the characters that can be used in a job name to those allowed for a file in the current environment, such as `BASH`. If set to `0`, any valid character for the file system can be used.

If a user would like to disable this feature by setting `HAVE_WORDEXP` to `0` in `src/include/pbs_config.h`, it is important to note that the error and the output file names will not expand environment variables, including `$PBS_JOBID`. The other important consideration is that characters that `BASH` dislikes, such as `0`, will not be allowed in the output and error file names for jobs by default.

### Related topics

- [Advanced configuration on page 14](#)
- [Server configuration on page 21](#)

## Server configuration

See these topics for details:

- [Server configuration overview on page 21](#)
- [Name service configuration on page 22](#)
- [Configuring job submission hosts on page 22](#)
- [Configuring TORQUE on a multi-homed server on page 23](#)
- [Architecture specific notes on page 23](#)
- [Specifying non-root administrators on page 23](#)
- [Setting up email on page 23](#)
- [Using MUNGE authentication on page 24](#)
- [Setting up the MOM hierarchy on page 25](#)

### Server configuration overview

There are several steps to ensure that the server and the nodes are completely aware of each other and able to communicate directly. Some of this configuration takes place within TORQUE directly using the `qmgr` command. Other configuration settings are managed using the `pbs_server` nodes file, DNS files such as `/etc/hosts` and the `/etc/hosts.equiv` file.

## Name service configuration

Each node, as well as the server, must be able to resolve the name of every node with which it will interact. This can be accomplished using `/etc/hosts`, DNS, NIS, or other mechanisms. In the case of `/etc/hosts`, the file can be shared across systems in most cases.

A simple method of checking proper name service configuration is to verify that the server and the nodes can "ping" each other.

## Configuring job submission hosts

### Using RCmd authentication

When jobs can be submitted from several different hosts, these hosts should be trusted via the R\* commands (such as `rsh` and `rcp`). This can be enabled by adding the hosts to the `/etc/hosts.equiv` file of the machine executing the `pbs_server` daemon or using other R\* command authorization methods. The exact specification can vary from OS to OS (see the man page for `ruserok` to find out how your OS validates remote users). In most cases, configuring this file is as simple as adding a line to your `/etc/hosts.equiv` file, as in the following:

```
/etc/hosts.equiv:
```

```
#[+ | -] [hostname] [username]
mynode.myorganization.com
.....
```

Either of the hostname or username fields may be replaced with a wildcard symbol (+). The (+) may be used as a stand-alone wildcard but not connected to a username or hostname, e.g., `+node01` or `+user01`. However, a (-) may be used in that manner to specifically exclude a user.



Following the Linux man page instructions for `hosts.equiv` may result in a failure. You cannot precede the user or hostname with a (+). To clarify, `node1 +user1` will not work and `user1` will not be able to submit jobs.

For example, the following lines will not work or will not have the desired effect:

```
+node02 user1
node02 +user1
```

These lines will work:

```
node03 +
+ jsmith
node04 -tjones
```

The most restrictive rules must precede more permissive rules. For example, to restrict user `tsmith` but allow all others, follow this format:

```
node01 -tsmith
node01 +
```

Please note that when a hostname is specified, it must be the fully qualified domain name (FQDN) of the host. Job submission can be further secured using the server or queue `acl_hosts` and `acl_host_enabled` parameters (for details, see [Queue attributes on page 78](#)).

## Using the "submit\_hosts" service parameter

Trusted submit host access may be directly specified without using RCmd authentication by setting the server [submit\\_hosts](#) parameter via **qmgr** as in the following example:

```
> qmgr -c 'set server submit_hosts = host1'
> qmgr -c 'set server submit_hosts += host2'
> qmgr -c 'set server submit_hosts += host3'
```

**i** Use of **submit\_hosts** is potentially subject to DNS spoofing and should not be used outside of controlled and trusted environments.

## Allowing job submission from compute hosts

If preferred, all compute nodes can be enabled as job submit hosts without setting `.rhosts` or `hosts.equiv` by setting the [allow\\_node\\_submit](#) parameter to **true**.

## Configuring TORQUE on a multi-homed server

If the `pbs_server` daemon is to be run on a multi-homed host (a host possessing multiple network interfaces), the interface to be used can be explicitly set using the [SERVERHOST](#) parameter.

## Architecture specific notes

With some versions of Mac OS/X, it is required to add the line `$restricted *.<DOMAIN>` to the `pbs_mom` configuration file. This is required to work around some socket bind bugs in the OS.

## Specifying non-root administrators

By default, only root is allowed to start, configure and manage the `pbs_server` daemon. Additional trusted users can be authorized using the parameters **managers** and **operators**. To configure these parameters use the **qmgr** command, as in the following example:

```
> qmgr
Qmgr: set server managers += josh@*.fsc.com
Qmgr: set server operators += josh@*.fsc.com
```

All manager and operator specifications must include a user name and either a fully qualified domain name or a host expression.

**i** To enable all users to be trusted as both operators and administrators, place the + (plus) character on its own line in the `server_priv/acl_svr/operators` and `server_priv/acl_svr/managers` files.

## Setting up email

Moab relies on emails from TORQUE about job events. To set up email, do the following:

## To set up email

1. Use the `--with-sendmail` configure option at configure time. TORQUE needs to know where the email application is. If this option is not used, TORQUE tries to find the sendmail executable. If it isn't found, TORQUE cannot send emails.

```
> ./configure --with-sendmail=<path_to_executable>
```

2. Set `mail_domain` in your server settings. If your domain is `clusterresources.com`, execute:

```
> qmgr -c 'set server mail_domain=clusterresources.com'
```

3. (Optional) You can override the default [mail\\_body\\_fmt](#) and [mail\\_subject\\_fmt](#) values via [qmgr](#):

```
> qmgr -c 'set server mail_body_fmt=Job: %i \n Name: %j \n On host: %h \n \n %m \n \n %d'
> qmgr -c 'set server mail_subject_fmt=Job %i - %r'
```

By default, users receive e-mails on job aborts. Each user can select which kind of e-mails to receive by using the `qsub -m` option when submitting the job. If you want to dictate when each user should receive e-mails, use a submit filter (for details, see [Job submission filter \("qsub wrapper"\) on page 293](#)).

## Using MUNGE authentication

MUNGE is an authentication service that creates and validates user credentials. It was developed by Lawrence Livermore National Laboratory (LLNL) to be highly scalable so it can be used in large environments such as HPC clusters. To learn more about MUNGE and how to install it, see <http://code.google.com/p/munge/>.

Configuring TORQUE to use MUNGE is a compile time operation. When you are building TORQUE, use `-enable-munge-auth` as a command line option with `./configure`.

```
> ./configure -enable-munge-auth
```

You can use only one authorization method at a time. If `-enable-munge-auth` is configured, the privileged port `ruserok` method is disabled.

TORQUE does not link any part of the MUNGE library into its executables. It calls the MUNGE and UNMUNGE utilities which are part of the MUNGE daemon. The MUNGE daemon must be running on the server and all submission hosts. The TORQUE client utilities call MUNGE and then deliver the encrypted credential to `pbs_server` where the credential is then unmunged and the server verifies the user and host against the authorized users configured in `serverdb`.

Authorized users are added to `serverdb` using `qmgr` and the **authorized\_users** parameter. The syntax for **authorized\_users** is `authorized_users=<user>@<host>`. To add an authorized user to the server you can use the following `qmgr` command:

```
> qmgr -c 'set server authorized_users=user1@hosta'
> qmgr -c 'set server authorized_users+=user2@hosta'
```

The previous example adds `user1` and `user2` from `hosta` to the list of authorized users on the server. Users can be removed from the list of authorized users by using the `-=` syntax as follows:

```
> qmgr -c 'set server authorized_users-=user1@hosta'
```

Users must be added with the `<user>@<host>` syntax. The user and the host portion can use the `*` wildcard to allow multiple names to be accepted with a single entry. A range of user or host names can be specified using a `[a-b]` syntax where *a* is the beginning of the range and *b* is the end.

```
> qmgr -c 'set server authorized_users=user[1-10]@hosta'
```

This allows user1 through user10 on hosta to run client commands on the server.

## Setting up the MOM hierarchy

The MOM hierarchy allows you to override the compute nodes' default behavior of reporting status updates directly to the `pbs_server`. Instead, you configure compute nodes so that each node sends its status update information to another compute node. The compute nodes pass the information up a tree or hierarchy until eventually the information reaches a node that will pass the information directly to `pbs_server`. This can significantly reduce traffic and time required to keep the cluster status up to date.

The name of the file that contains the configuration information is named `mom_hierarchy`. By default, it is located in the `/var/spool/torque/server_priv` directory. The file uses syntax similar to XML:

```
<path>
  <level> comma-separated node list </level>
  <level> comma-separated node list </level>
  ...
</path>
...
```

The `<path></path>` tag pair identifies a group of compute nodes. The `<level></level>` tag pair contains a comma-separated list of compute node names. Multiple paths can be defined with multiple levels within each path.

Within a `<path>` tag pair the levels define the hierarchy. All nodes in the top level communicate directly with the server. All nodes in lower levels communicate to the first available node in the level directly above it. If the first node in the upper level goes down, the nodes in the subordinate level will then communicate to the next node in the upper level. If no nodes are available in an upper level then the node will communicate directly to the server.

If an upper level node has fallen out and then becomes available, the lower level nodes will eventually find that the node is available and start sending their updates to that node.

**i** If you want to specify MOMs on a different port than the default, you must list the node in the form: `hostname:mom_manager_port`.

For example:

```
<path>
  <level>hostname:mom_manager_port</level>
  ...
</path>
...
```

### Putting the MOM hierarchy on the MOMs

You can put the MOM hierarchy file directly on the MOMs. This way, the `pbs_server` doesn't have to send the hierarchy to all the MOMs during each `pbs_server` startup. The hierarchy file still has to exist on the `pbs_server` and if the file versions conflict, the `pbs_server` version overwrites the local MOM file. Due to this, it is recommended that the hierarchy file either be symlinked to the MOMs or put on a global NFS share.

Once the hierarchy file exists on the MOMs, start `pbs_server` with the `-n` option which tells `pbs_server` to not send the hierarchy file on startup. Instead, `pbs_server` waits until a MOM requests it.

### Related topics

- [Advanced configuration on page 14](#)

## Manual setup of initial server configuration

On a new installation of TORQUE, the server database must be initialized using the command `pbs_server -t create`. This command creates a file in `$TORQUEHOME/server_priv` named `serverdb` which contains the server configuration information.

The following output from `qmgr` shows the base configuration created by the command `pbs_server -t create`:

```
qmgr -c 'p s'
#
# Set server attributes.
#
set server acl_hosts = kmn
set server log_events = 511
set server mail_from = adm
set server node_check_rate = 150
set server tcp_timeout = 6
```

This is a bare minimum configuration and it is not very useful. By using `qmgr`, the server configuration can be modified to set up TORQUE to do useful work. The following `qmgr` commands will create a queue and enable the server to accept and run jobs. These commands must be executed by root.

```
pbs_server -t create
qmgr -c "set server scheduling=true"
qmgr -c "create queue batch queue_type=execution"
qmgr -c "set queue batch started=true"
qmgr -c "set queue batch enabled=true"
qmgr -c "set queue batch resources_default.nodes=1"
qmgr -c "set queue batch resources_default.walltime=3600"
qmgr -c "set server default_queue=batch"
```

**i** When TORQUE reports a new queue to Moab a class of the same name is automatically applied to all nodes.

In this example, the configuration database is initialized and the scheduling interface is activated (using `'scheduling=true'`). This option allows the scheduler to receive job and node events which allow it to be more responsive (See [scheduling on page 243](#) for more information). The next command creates a

queue and specifies the queue type. Within PBS, the queue must be declared an `execution queue` in order for it to run jobs. Additional configuration (i.e., setting the queue to `started` and `enabled`) allows the queue to *accept* job submissions, and *launch* queued jobs.

The next two lines are optional, setting default `node` and `walltime` attributes for a submitted job. These defaults will be picked up by a job if values are not explicitly set by the submitting user. The final line, `default_queue=batch`, is also a convenience line and indicates that a job should be placed in the `batch` queue unless explicitly assigned to another queue.

Additional information on configuration can be found in the admin manual and in the [qmgr](#) main page.

### Related topics

- [TORQUE installation overview on page 1](#)

## Server node file configuration

This section contains information about configuring server node files. It explains how to specify node virtual processor counts and GPU counts, as well as how to specify node features or properties. For details, see these topics:

- [Basic node specification on page 27](#)
- [Specifying virtual processor count for a node on page 28](#)
- [Specifying GPU count for a node on page 28](#)
- [Specifying node features \(node properties\) on page 29](#)

### Related topics

- [TORQUE installation overview on page 1](#)
- [Server parameters on page 227](#)
- [Moab node feature overview](#)

## Basic node specification

For the `pbs_server` to communicate with each of the MOMs, it needs to know which machines to contact. Each node that is to be a part of the batch system must be specified on a line in the `server nodes` file. This file is located at `TORQUE_HOME/server_priv/nodes`. In most cases, it is sufficient to specify just the node name on a line as in the following example:

`server_priv/nodes:`

```
node001
node002
node003
node004
```

**Related topics**

- [Server node file configuration on page 27](#)

## Specifying virtual processor count for a node

By default each node has one virtual processor. Increase the number using the **np** attribute in the nodes file. The value of np can be equal to the number of physical cores on the node or it can be set to a value which represents available "execution slots" for the node. The value used is determined by the administrator based on hardware, system, and site criteria.

The following example shows how to set the np value in the nodes file. In this example, we are assuming that node001 and node002 have four physical cores. The administrator wants the value of np for node001 to reflect that it has four cores. However, node002 will be set up to handle multiple virtual processors without regard to the number of physical cores on the system.

```
server_priv/nodes:
```

```
node001 np=4
node002 np=12
...
```

**Related topics**

- [Server node file configuration on page 27](#)

## Specifying GPU count for a node

Administrators can manually set the number of GPUs on a node or if they are using NVIDIA GPUs and drivers, they can have them detected automatically. For more information about how to set up TORQUE with GPUS, see the [Moab Workload Manager accelerators documentation](#).

To manually set the number of GPUs on a node, use the **gpus** attribute in the nodes file. The value of GPUs is determined by the administrator based on hardware, system, and site criteria.

The following example shows how to set the GPU value in the nodes file. In the example, we assume node001 and node002 each have two physical GPUs. The administrator wants the value of node001 to reflect the physical GPUs available on that system and adds **gpus=2** to the nodes file entry for node001. However, node002 will be set up to handle multiple virtual GPUs without regard to the number of physical GPUs on the system.

```
server_priv/nodes:
```

```
node001 gpus=1
node002 gpus=4
...
```

**Related topics**

- [Server node file configuration on page 27](#)



## Specifying node features (node properties)

Node features can be specified by placing one or more white space-delimited strings on the line for the associated host as in the following example:

server\_priv/nodes:

```
node001 np=2 fast ia64
node002 np=4 bigmem fast ia64 smp
...
```

These features can be used by users to request specific nodes when submitting jobs. For example:

```
qsub -l nodes=1:bigmem+1:fast job.sh
```

This job submission will look for a node with the bigmem feature (node002) and a node with the fast feature (either node001 or node002).

### Related topics

- [Server node file configuration on page 27](#)

## Testing server configuration

If you have initialized TORQUE using the torque.setup script or started TORQUE using pbs\_server -t create and pbs\_server is still running, terminate the server by calling qterm. Next, start pbs\_server again without the -t create arguments. Follow the script below to verify your server configuration. The output for the examples below is based on the nodes file example in [Specifying node features](#) and [Server configuration](#).

```

# verify all queues are properly configured
> qstat -q

server:kmn

Queue      Memory      CPU Time      Walltime      Node      Run      Que      Lm      State
-----
batch      --          --            --            --          0        0        --      ER
                                         0        0

# view additional server configuration
> qmgr -c 'p s'
#
# Create queues and set their attributes
#
# Create and define queue batch
#
create queue batch
set queue batch queue_type = Execution
set queue batch resources_default.nodes = 1
set queue batch resources_default.walltime = 01:00:00
set queue batch enabled = True
set queue batch started = True
#
# Set server attributes.
#
set server scheduling = True
set server acl_hosts = kmn
set server managers = user1@kmn
set server operators = user1@kmn
set server default_queue = batch
set server log_events = 511
set server mail_from = adm
set server node_check_rate = 150
set server tcp_timeout = 300
set server job_stat_rate = 45
set server poll_jobs = True
set server mom_job_sync = True
set server keep_completed = 300
set server next_job_number = 0

# verify all nodes are correctly reporting
> pbsnodes -a
node001
  state=free
  np=2
  properties=bigmem,fast,ia64,smp
  ntype=cluster
  status=rectime=1328810402,varattr=,jobs=,state=free,netload=6814326158,gres=,loadave
=0.21,ncpus=6,physmem=8193724kb,
availmem=13922548kb,totmem=16581304kb,idletime=3,nusers=3,nsessions=18,sessions=1876
1120 1912 1926 1937 1951 2019 2057 28399 2126 2140 2323 5419 17948 19356 27726 22254
29569,uname=Linux kmn 2.6.38-11-generic #48-Ubuntu SMP Fri Jul 29 19:02:55 UTC 2011
x86_64,opsys=linux
  mom_service_port = 15002
  mom_manager_port = 15003
  gpus = 0
# submit a basic job - DO NOT RUN AS ROOT
> su - testuser
> echo "sleep 30" | qsub

# verify jobs display
> qstat

Job id      Name      User      Time Use      S      Queue
-----

```

```
0.kmn   STDIN   knielson   0   Q   batch
```

At this point, the job should be in the **Q** state and will not run because a scheduler is not running yet. TORQUE can use its native scheduler by running `pbs_sched` or an advanced scheduler (such as [Moab Workload Manager](#)). See [Integrating schedulers](#) for details on setting up an advanced scheduler.

### Related topics

- [TORQUE installation overview on page 1](#)

## TORQUE on NUMA systems

Starting in TORQUE version 3.0, TORQUE can be configured to take full advantage of Non-Uniform Memory Architecture (NUMA) systems. The following instructions are a result of development on SGI Altix and UV hardware.

For details, see these topics:

- [TORQUE NUMA configuration on page 31](#)
- [Building TORQUE with NUMA support on page 31](#)

### TORQUE NUMA configuration

There are three steps to configure TORQUE to take advantage of NUMA architectures:

1. Configure TORQUE with `--enable-numa-support`.
2. Create the `mom_priv/mom.layout` file.
3. Configure `server_priv/nodes`.

### Related topics

- [TORQUE on NUMA systems on page 31](#)

### Building TORQUE with NUMA support

To turn on NUMA support for TORQUE the `--enable-numa-support` option must be used during the configure portion of the installation. In addition to any other configuration options, add the `--enable-numa-support` option as indicated in the following example:

```
$ ./configure --enable-numa-support
```

 Don't use MOM hierarchy with NUMA.

When TORQUE is enabled to run with NUMA support, there is only a single instance of `pbs_mom` (MOM) that is run on the system. However, TORQUE will report that there are multiple nodes running in the

cluster. While `pbs_mom` and `pbs_server` both know there is only one instance of `pbs_mom`, they manage the cluster as if there were multiple separate MOM nodes.

The `mom.layout` file is a virtual mapping between the system hardware configuration and how the administrator wants TORQUE to view the system. Each line in `mom.layout` equates to a node in the cluster and is referred to as a NUMA node.

## Automatically Creating `mom.layout` (Recommended)

A perl script named `mom_gencfg` is provided in the `contrib/` directory that generates the `mom.layout` file for you. The script can be customized by setting a few variables in it. To automatically create the `mom.layout` file, follow these instructions (these instructions are also included in the script):

1. Verify `hwloc` version 1.1 or higher is installed - see `contrib/hwloc_install.sh`.
2. Install `Sys::Hwloc` from CPAN.
3. Verify `$PBS_HOME` is set to the proper value.
4. Update the variables in the 'Config Definitions' section of the script. Especially update `firstNodeId` and `nodesPerBoard` if desired. The `firstNodeId` variable should be set above 0 if you have a root cpuset that you wish to exclude and the `nodesPerBoard` variable is the number of NUMA nodes per board. Each node is defined in `/sys/devices/system/node`, in a subdirectory `node<node index>`
5. Back up your current file in case a variable is set incorrectly or neglected.
6. Run the script.
7. 

```
$ ./mom_gencfg
```

## Manually Creating `mom.layout`

To properly set up the `mom.layout` file, it is important to know how the hardware is configured. Use the `topology` command line utility and inspect the contents of `/sys/devices/system/node`. The `hwloc` library can also be used to create a custom discovery tool.

Typing `topology` on the command line of a NUMA system produces something similar to the following:

```
Partition number: 0
6 Blades
72 CPUs
378.43 Gb Memory Total
```

Blade	ID	asic	NASID	Memory
0	r001i01b00	UVHub 1.0	0	67089152 kB
1	r001i01b01	UVHub 1.0	2	67092480 kB
2	r001i01b02	UVHub 1.0	4	67092480 kB
3	r001i01b03	UVHub 1.0	6	67092480 kB
4	r001i01b04	UVHub 1.0	8	67092480 kB
5	r001i01b05	UVHub 1.0	10	67092480 kB

CPU	Blade	PhysID	CoreID	APIC-ID	Family	Model	Speed	L1 (KiB)	L2 (KiB)	L3 (KiB)
0	r001i01b00	00	00	0	6	46	2666	32d/32i	256	18432
1	r001i01b00	00	02	4	6	46	2666	32d/32i	256	18432
2	r001i01b00	00	03	6	6	46	2666	32d/32i	256	18432
3	r001i01b00	00	08	16	6	46	2666	32d/32i	256	18432
4	r001i01b00	00	09	18	6	46	2666	32d/32i	256	18432
5	r001i01b00	00	11	22	6	46	2666	32d/32i	256	18432
6	r001i01b00	01	00	32	6	46	2666	32d/32i	256	18432
7	r001i01b00	01	02	36	6	46	2666	32d/32i	256	18432
8	r001i01b00	01	03	38	6	46	2666	32d/32i	256	18432
9	r001i01b00	01	08	48	6	46	2666	32d/32i	256	18432
10	r001i01b00	01	09	50	6	46	2666	32d/32i	256	18432
11	r001i01b00	01	11	54	6	46	2666	32d/32i	256	18432
12	r001i01b01	02	00	64	6	46	2666	32d/32i	256	18432
13	r001i01b01	02	02	68	6	46	2666	32d/32i	256	18432
14	r001i01b01	02	03	70	6	46	2666	32d/32i	256	18432

From this partial output, note that this system has 72 CPUs on 6 blades. Each blade has 12 CPUs grouped into clusters of 6 CPUs. If the entire content of this command were printed you would see each Blade ID and the CPU ID assigned to each blade.

The topology command shows how the CPUs are distributed, but you likely also need to know where memory is located relative to CPUs, so go to `/sys/devices/system/node`. If you list the node directory you will see something similar to the following:

```
# ls -al
total 0
drwxr-xr-x 14 root root 0 Dec 3 12:14 .
drwxr-xr-x 14 root root 0 Dec 3 12:13 ..
-r--r--r-- 1 root root 4096 Dec 3 14:58 has_cpu
-r--r--r-- 1 root root 4096 Dec 3 14:58 has_normal_memory
drwxr-xr-x 2 root root 0 Dec 3 12:14 node0
drwxr-xr-x 2 root root 0 Dec 3 12:14 node1
drwxr-xr-x 2 root root 0 Dec 3 12:14 node10
drwxr-xr-x 2 root root 0 Dec 3 12:14 node11
drwxr-xr-x 2 root root 0 Dec 3 12:14 node2
drwxr-xr-x 2 root root 0 Dec 3 12:14 node3
drwxr-xr-x 2 root root 0 Dec 3 12:14 node4
drwxr-xr-x 2 root root 0 Dec 3 12:14 node5
drwxr-xr-x 2 root root 0 Dec 3 12:14 node6
drwxr-xr-x 2 root root 0 Dec 3 12:14 node7
drwxr-xr-x 2 root root 0 Dec 3 12:14 node8
drwxr-xr-x 2 root root 0 Dec 3 12:14 node9
-r--r--r-- 1 root root 4096 Dec 3 14:58 online
-r--r--r-- 1 root root 4096 Dec 3 14:58 possible
```

The directory entries `node0`, `node1`, ..., `node11` represent groups of memory and CPUs local to each other. These groups are a node board, a grouping of resources that are close together. In most cases, a node board is made up of memory and processor cores. Each bank of memory is called a memory node by the

operating system, and there are certain CPUs that can access that memory very rapidly. Note under the directory for node board node0 that there is an entry called `cpulist`. This contains the CPU IDs of all CPUs local to the memory in node board 0.

Now create the `mom.layout` file. The content of `cpulist 0-5` are local to the memory of node board 0, and the memory and `cpus` for that node are specified in the layout file by saying `nodes=0`. The `cpulist` for node board 1 shows 6-11 and memory node index 1. To specify this, simply write `nodes=1`. Repeat this for all twelve node boards and create the following `mom.layout` file for the 72 CPU system.

```
nodes=0
nodes=1
nodes=2
nodes=3
nodes=4
nodes=5
nodes=6
nodes=7
nodes=8
nodes=9
nodes=10
nodes=11
```

Each line in the `mom.layout` file is reported as a node to `pbs_server` by the `pbs_mom` daemon.

The `mom.layout` file does not need to match the hardware layout exactly. It is possible to combine node boards and create larger NUMA nodes. The following example shows how to do this:

```
nodes=0-1
```

The memory nodes can be combined the same as CPUs. The memory nodes combined must be contiguous. You cannot combine `mem 0` and `2`.

## Configuring `server_priv/nodes`

The `pbs_server` requires awareness of how the MOM is reporting nodes since there is only one MOM daemon and multiple MOM nodes. So, configure the `server_priv/nodes` file with the **`num_node_boards`** and **`numa_board_str`** attributes. The attribute `num_node_boards` tells `pbs_server` how many numa nodes are reported by the MOM. Following is an example of how to configure the `nodes` file with `num_node_boards`:

```
numa-10 np=72 num_node_boards=12
```

This line in the `nodes` file tells `pbs_server` there is a host named `numa-10` and that it has 72 processors and 12 nodes. The `pbs_server` divides the value of `np` (72) by the value for `num_node_boards` (12) and determines there are 6 CPUs per NUMA node.

In this example, the NUMA system is uniform in its configuration of CPUs per node board, but a system does not need to be configured with the same number of CPUs per node board. For systems with non-uniform CPU distributions, use the attribute **`numa_board_str`** to let `pbs_server` know where CPUs are located in the cluster.

The following is an example of how to configure the `server_priv/nodes` file for non-uniformly distributed CPUs:

```
Numa-11 numa_board_str=6,8,12
```

In this configuration, `pbs_server` knows it has three MOM nodes and the nodes have 6, 8, and 12 CPUs respectively. Note that the attribute `np` is not used. The `np` attribute is ignored because the number of CPUs per node is expressly given.

## Enforcement of memory resource limits

TORQUE can better enforce memory limits with the use of the utility **memacctd**. The `memacctd` utility is provided by SGI on SuSe Linux Enterprise Edition (SLES). It is a daemon that caches memory footprints when it is queried. When configured to use the memory monitor, TORQUE queries `memacctd`. It is up to the user to make sure `memacctd` is installed. See the [SGI memacctd man page](#) for more information.

### To configure TORQUE to use memacctd for memory enforcement

1. Start **memacctd** as instructed by SGI.
2. Reconfigure TORQUE with `--enable-memacct`. This will link in the necessary library when TORQUE is recompiled.
3. Recompile and reinstall TORQUE.
4. Restart all MOM nodes.
5. (Optional) Alter the [qsub](#) filter to include a default memory limit for all jobs that are not submitted with memory limit.

### Related topics

- [TORQUE NUMA configuration on page 31](#)
- [TORQUE on NUMA systems on page 31](#)

## TORQUE Multi-MOM

Starting in TORQUE version 3.0 users can run multiple MOMs on a single node. The initial reason to develop a multiple MOM capability was for testing purposes. A small cluster can be made to look larger since each MOM instance is treated as a separate node.

When running multiple MOMs on a node each MOM must have its own service and manager ports assigned. The default ports used by the MOM are 15002 and 15003. With the multi-mom alternate ports can be used without the need to change the default ports for `pbs_server` even when running a single instance of the MOM.

For details, see these topics:

- [Multi-MOM configuration on page 35](#)
- [Stopping pbs\\_mom in Multi-MOM mode on page 37](#)

## Multi-MOM configuration

There are three steps to setting up multi-MOM capability:

1. [Configure server\\_priv/nodes on page 36](#)
2. [/etc/hosts file on page 36](#)
3. [Starting pbs\\_mom with multi-MOM options on page 36](#)

## Configure server\_priv/nodes

The attributes **mom\_service\_port** and **mom\_manager\_port** were added to the nodes file syntax to accommodate multiple MOMs on a single node. By default `pbs_mom` opens ports 15002 and 15003 for the service and management ports respectively. For multiple MOMs to run on the same IP address they need to have their own port values so they can be distinguished from each other. `pbs_server` learns about the port addresses of the different MOMs from entries in the `server_priv/nodes` file. The following is an example of a nodes file configured for multiple MOMs:

```
hosta      np=2
hosta-1    np=2 mom_service_port=30001 mom_manager_port=30002
hosta-2    np=2 mom_service_port=31001 mom_manager_port=31002
hosta-3    np=2 mom_service_port=32001 mom_manager_port=32002
```

Note that all entries have a unique host name and that all port values are also unique. The entry `hosta` does not have a `mom_service_port` or `mom_manager_port` given. If unspecified, then the MOM defaults to ports 15002 and 15003.

## /etc/hosts file

Host names in the `server_priv/nodes` file must be resolvable. Creating an alias for each host enables the server to find the IP address for each MOM; the server uses the port values from the `server_priv/nodes` file to contact the correct MOM. An example `/etc/hosts` entry for the previous `server_priv/nodes` example might look like the following:

```
192.65.73.10 hosta hosta-1 hosta-2 hosta-3
```

Even though the host name and all the aliases resolve to the same IP address, each MOM instance can still be distinguished from the others because of the unique port value assigned in the `server_priv/nodes` file.

## Starting pbs\_mom with multi-MOM options

To start multiple instances of `pbs_mom` on the same node, use the following syntax (see [pbs\\_mom on page 151](#) for details):

```
pbs_mom -m -M <port value of MOM_service_port> -R <port value of MOM_manager_port> -A <name of MOM alias>
```

Continuing based on the earlier example, if you want to create four MOMs on `hosta`, type the following at the command line:

```
# pbs_mom -m -M 30001 -R 30002 -A hosta-1
# pbs_mom -m -M 31001 -R 31002 -A hosta-2
# pbs_mom -m -M 32001 -R 32002 -A hosta-3
# pbs_mom
```

Notice that the last call to `pbs_mom` uses no arguments. By default `pbs_mom` opens on ports 15002 and 15003. No arguments are necessary because there are no conflicts.



### Related topics

- [TORQUE Multi-MOM on page 35](#)
- [Stopping pbs\\_mom in Multi-MOM mode on page 37](#)

## Stopping pbs\_mom in Multi-MOM mode

Terminate `pbs_mom` by using the `momctl -s` command (for details, see [momctl](#)). For any MOM using the default manager port 15003, the `momctl -s` command stops the MOM. However, to terminate MOMs with a manager port value not equal to 15003, you must use the following syntax:

```
momctl -s -p <port value of MOM_manager_port>
```

The `-p` option sends the terminating signal to the MOM manager port and the MOM is terminated.

### Related topics

- [TORQUE Multi-MOM on page 35](#)
- [Multi-MOM configuration on page 35](#)



# Chapter 2: Submitting and managing jobs

This section contains information about how you can submit and manage jobs with TORQUE. For details, see the following topics:

- [Job submission on page 39](#)
- [Monitoring jobs on page 51](#)
- [Canceling jobs on page 51](#)
- [Job preemption on page 52](#)
- [Keeping completed jobs on page 52](#)
- [Job checkpoint and restart on page 53](#)
- [Job exit status on page 63](#)
- [Service jobs on page 67](#)

## Job submission

Job submission is accomplished using the `qsub` command, which takes a number of command line arguments and integrates such into the specified PBS command file. The PBS command file may be specified as a filename on the `qsub` command line or may be entered via STDIN.

- The PBS command file does not need to be executable.
- The PBS command file may be *piped* into `qsub` (i.e., `cat pbs.cmd | qsub`).
- In the case of parallel jobs, the PBS command file is staged to, and executed on, the first allocated compute node only. (Use `pbsdsh` to run actions on multiple nodes.)
- The command script is executed from the user's home directory in all cases. (The script may determine the submission directory by using the `$PBS_O_WORKDIR` environment variable)
- The command script will be executed using the default set of user environment variables unless the `-V` or `-v` flags are specified to include aspects of the job submission environment.
- PBS directives should be declared first in the job script.

```
#PBS -S /bin/bash
#PBS -m abe
#PBS -M <yourEmail@company.com>
echo sleep 300
```

*This is an example of properly declared PBS directives.*

```
#PBS -S /bin/bash
SOMEVARIABLE=42
#PBS -m abe
#PBS -M <yourEmail@company.com>
echo sleep 300
```

*This is an example of improperly declared PBS directives. PBS directives below "SOMEVARIABLE=42" are ignored.*

**i** By default, job submission is allowed only on the TORQUE server host (host on which **pbs\_server** is running). Enablement of job submission from other hosts is documented in [Server configuration on page 21](#).

**i** Versions of TORQUE earlier than 2.4.5 attempted to apply queue and server defaults to a job that didn't have defaults specified. If a setting still did not have a value after that, TORQUE applied the queue and server maximum values to a job (meaning, the maximum values for an applicable setting were applied to jobs that had no specified or default value).

In TORQUE 2.4.5 and later, the queue and server maximum values are no longer used as a value for missing settings.

This section contains these topics:

- [Multiple job submission on page 40](#)
- [Requesting resources on page 42](#)
- [Requesting generic resources on page 47](#)
- [Requesting floating resources on page 48](#)
- [Requesting other resources on page 48](#)
- [Exported batch environment variables on page 48](#)
- [Enabling trusted submit hosts on page 50](#)
- [Example submit scripts on page 50](#)

### Related topics

- Maui Documentation
- <http://www.lunarc.lu.se>
- [http://www.clusters.umaine.edu/wiki/index.php/Example\\_Submission\\_Scripts](http://www.clusters.umaine.edu/wiki/index.php/Example_Submission_Scripts)
- [Job submission filter \("qsub wrapper"\) on page 293](#) – Allow local checking and modification of submitted job

## Multiple job submission

Sometimes users will want to submit large numbers of jobs based on the same job script. Rather than using a script to repeatedly call `qsub`, a feature known as job arrays now exists to allow the creation of multiple jobs with one `qsub` command. Additionally, this feature includes a new job naming convention

that allows users to reference the entire set of jobs as a unit, or to reference one particular job from the set.

Job arrays are submitted through the `-t` option to `qsub`, or by using `#PBS -t` in your batch script. This option takes a comma-separated list consisting of either a single job ID number, or a pair of numbers separated by a dash. Each of these jobs created will use the same script and will be running in a nearly identical environment.

```
> qsub -t 0-4 job_script
1098[0].hostname

> qstat -t
1098[0].hostname ...
1098[1].hostname ...
1098[2].hostname ...
1098[3].hostname ...
1098[4].hostname ...
```

**i** Versions of TORQUE earlier than 2.3 had different semantics for the `-t` argument. In these versions, `-t` took a single integer number—a count of the number of jobs to be created.

Each `1098[x]` job has an environment variable called `PBS_ARRAYID`, which is set to the value of the array index of the job, so `1098[0].hostname` would have `PBS_ARRAYID` set to 0. This allows you to create job arrays where each job in the array performs slightly different actions based on the value of this variable, such as performing the same tasks on different input files. One other difference in the environment between jobs in the same array is the value of the `PBS_JOBNAME` variable.

```
# These two examples are equivalent in TORQUE 2.2
> qsub -t 0-99
> qsub -t 100

# You can also pass comma delimited lists of ids and ranges:
> qsub -t 0,10,20,30,40
> qsub -t 0-50,60,70,80
```

Running `qstat` displays a job summary, which provides an overview of the array's state. To see each job in the array, run `qstat -t`.

The [qalter](#), [qdel](#), [qhold](#), and [qrls](#) commands can operate on arrays—either the entire array or a range of that array. Additionally, any job in the array may be accessed normally by using that job's ID, just as you would with any other job. For example, running the following command would run only the specified job:

```
qrun 1098[0].hostname
```

## Slot Limit

The slot limit is a way for administrators to limit the number of jobs from a job array that can be eligible for scheduling at the same time. When a slot limit is used, TORQUE puts a hold on all jobs in the array that exceed the slot limit. When an eligible job in the array completes, TORQUE removes the hold flag from the next job in the array. Slot limits can be declared globally with the [max\\_slot\\_limit](#) parameter, or on a per-job basis with [qsub -t](#).

## Related topics

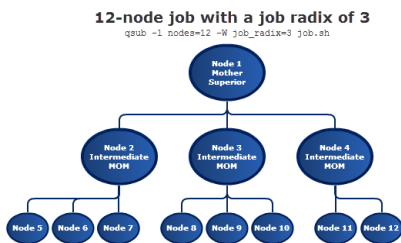
- [Job submission on page 39](#)

# Managing multi-node jobs

By default, when a multi-node job runs, the Mother Superior manages the job across all the sister nodes by communicating with each of them and updating `pbs_server`. Each of the sister nodes sends its updates and stdout and stderr directly to the Mother Superior. When you run an extremely large job using hundreds or thousands of nodes, you may want to reduce the amount of network traffic sent from the sisters to the Mother Superior by specifying a job radix. Job radix sets a maximum number of nodes with which the Mother Superior and resulting intermediate MOMs communicate and is specified using the [-W on page 215](#) option for `qsub`.

For example, if you submit a smaller, 12-node job and specify `job_radix=3`, Mother Superior and each resulting intermediate MOM is only allowed to receive communication from 3 subordinate nodes.

Image 2-1: Job radix example




The Mother Superior picks three sister nodes with which to communicate the job information. Each of those nodes (intermediate MOMs) receives a list of all sister nodes that will be subordinate to it. They each contact up to three nodes and pass the job information on to those nodes. This pattern continues until the bottom level is reached. All communication is now passed across this new hierarchy. The stdout and stderr data is aggregated and sent up the tree until it reaches the Mother Superior, where it is saved and copied to the `.o` and `.e` files.



Job radix is meant for extremely large jobs only. It is a tunable parameter and should be adjusted according to local conditions in order to produce the best results.


# Requesting resources

Various resources can be requested at the time of job submission. A job can request a particular node, a particular node attribute, or even a number of nodes with particular attributes. Either native TORQUE resources or external scheduler resource extensions may be specified. The native TORQUE resources are listed in the following table:

Resource	Format	Description
<b>arch</b>	string	Specifies the administrator defined system architecture required. This defaults to whatever the <b>PBS_MACH</b> string is set to in "local.mk".
<b>cput</b>	seconds, or [[HH:]MM:]SS	Maximum amount of CPU time used by all processes in the job.
<b>epilogue</b>	string	Specifies a user owned epilogue script which will be run before the system epilogue and epilogue.user scripts at the completion of a job. The syntax is <code>epilogue=&lt;file&gt;</code> . The file can be designated with an absolute or relative path. For more information, see <a href="#">Prologue and epilogue scripts on page 281</a> .
<b>feature</b>	string	Specifies a property or feature for the job. Feature corresponds to TORQUE node properties and Moab features. <pre>qsub script.sh -l procs=10,feature=bigmem</pre>
<b>file</b>	<a href="#">size</a>	The amount of total disk requested for the job. (Ignored on Unicos.)
<b>host</b>	string	Name of the host on which the job should be run. This resource is provided for use by the site's scheduling policy. The allowable values and effect on job placement is site dependent.
<b>mem</b>	<a href="#">size</a>	Maximum amount of physical memory used by the job. Ignored on Darwin, Digital Unix, Free BSD, HPUX 11, IRIX, NetBSD, and SunOS. Not implemented on AIX and HPUX 10. The <code>mem</code> resource will only work for single-node jobs. If your job requires multiple nodes, use <code>pmem</code> instead.
<b>ncpus</b>	integer	The number of processors in one task where a task cannot span nodes.  You cannot request both <code>ncpus</code> and <code>nodes</code> in the same job.
<b>nice</b>	integer	Number between -20 (highest priority) and 19 (lowest priority). Adjust the process execution priority.

Resource	Format	Description
<b>nodes</b>	{<node_count>   <hostname>} [:ppn=<ppn>] [:gpus=<gpu>] [:<property>] [:<property>...] [+ ...]	<p>Number and/or type of nodes to be reserved for exclusive use by the job. The value is one or more node_specs joined with the + (plus) character: node_spec [+node_spec...]. Each node_spec is a number of nodes required of the type declared in the node_spec and a name of one or more properties desired for the nodes. The number, the name, and each property in the node_spec are separated by a : (colon). If no number is specified, one (1) is assumed. The name of a node is its hostname. The properties of nodes are:</p> <ul style="list-style-type: none"> <li>• <b>ppn=#</b> - Specify the number of virtual processors per node requested for this job. The number of virtual processors available on a node by default is 1, but it can be configured in the \$TORQUE_HOME/server_priv/nodes file using the np attribute (see <a href="#">Server node file configuration on page 27</a>). The virtual processor can relate to a physical core on the node or it can be interpreted as an "execution slot" such as on sites that set the node np value greater than the number of physical cores (or hyper-thread contexts). The ppn value is a characteristic of the hardware, system, and site, and its value is to be determined by the administrator.</li> <li>• <b>gpus=#</b> - Specify the number of GPUs per node requested for this job. The number of GPUs available on a node can be configured in the \$TORQUE_HOME/server_priv/nodes file using the gpu attribute (see <a href="#">Server node file configuration on page 27</a>). The GPU value is a characteristic of the hardware, system, and site, and its value is to be determined by the administrator.</li> <li>• <b>property</b> - A string assigned by the system administrator specifying a node's features. Check with your administrator as to the node names and properties available to you.</li> </ul> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>i</b> TORQUE does not have a TPN (tasks per node) property. You can specify TPN in Moab Workload Manager with TORQUE as your resource manager, but TORQUE does not recognize the property when it is submitted directly to it via qsub.</p> </div> <p>See <a href="#">qsub -l nodes on page 46</a> for examples.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>i</b> By default, the node resource is mapped to a virtual node (that is, directly to a processor, not a full physical compute node). This behavior can be changed within Maui or Moab by setting the JOBNODEMATCHPOLICY parameter. See "Appendix F: Parameters" of the <a href="#">Moab Workload Manager Administrator Guide</a> for more information.</p> </div>
<b>opsys</b>	string	Specifies the administrator defined operating system as defined in the MOM configuration file.



Resource	Format	Description
<b>other</b>	string	<p>Allows a user to specify site specific information. This resource is provided for use by the site's scheduling policy. The allowable values and effect on job placement is site dependent.</p> <div style="border: 1px solid #0070C0; border-radius: 5px; padding: 5px; margin-top: 10px;">  This does not work for <code>msub</code> using Moab and Maui. </div>
<b>pccput</b>	seconds, or [[HH:]MM:]SS	Maximum amount of CPU time used by any single process in the job.
<b>pmem</b>	<a href="#">size</a>	Maximum amount of physical memory used by any single process of the job. (Ignored on Fujitsu. Not implemented on Digital Unix and HPUNIX.)
<b>procs</b>	procs=<integer>	<p><i>(Applicable in version 2.5.0 and later.)</i> The number of processors to be allocated to a job. The processors can come from one or more qualified node(s). Only one procs declaration may be used per submitted <a href="#">qsub</a> command.</p> <pre>&gt; qsub -l nodes=3 -l procs=2</pre>
<b>procs_bitmap</b>	string	<p>A string made up of 1's and 0's in reverse order of the processor cores requested. A <b>procs_bitmap=1110</b> means the job requests a node that has four available cores, but the job runs exclusively on cores two, three, and four. With this bitmap, core one is not used.</p> <p>For more information, see <a href="#">Scheduling cores on page 74</a>.</p>
<b>prologue</b>	string	<p>Specifies a user owned prologue script which will be run after the system prologue and prologue.user scripts at the beginning of a job. The syntax is <code>prologue=&lt;file&gt;</code>. The file can be designated with an absolute or relative path.</p> <p>For more information, see <a href="#">Prologue and epilogue scripts on page 281</a>.</p>
<b>pvmem</b>	<a href="#">size</a>	Maximum amount of virtual memory used by any single process in the job. (Ignored on Unicos.)
<b>size</b>	integer	For TORQUE, this resource has no meaning. It is passed on to the scheduler for interpretation. In the Moab scheduler, the size resource is intended for use in Cray installations only.
<b>software</b>	string	Allows a user to specify software required by the job. This is useful if certain software packages are only available on certain systems in the site. This resource is provided for use by the site's scheduling policy. The allowable values and effect on job placement is site dependent. (See "Scheduler License Manager" in the <a href="#">Moab Workload Manager Administrator Guide</a> for more information.)

Resource	Format	Description
<b>vmem</b>	<a href="#">size</a>	Maximum amount of virtual memory used by all concurrent processes in the job. (Ignored on Unicors.)
<b>walltime</b>	seconds, or [[HH:]MM:]SS	Maximum amount of real time during which the job can be in the running state.

### size

The size format specifies the maximum amount in terms of bytes or words. It is expressed in the form *integer[suffix]*. The suffix is a multiplier defined in the following table ("b" means bytes [the default] and "w" means words). The size of a word is calculated on the execution server as its word size.

Suffix		Multiplier
b	w	1
kb	kw	1024
mb	mw	1,048,576
gb	gw	1,073,741,824
tb	tw	1,099,511,627,776

### Example 2-1: `qsub -l nodes`

Usage	Description
<code>&gt; qsub -l nodes=12</code>	Request 12 nodes of any type
<code>&gt; qsub -l nodes=2:server+14</code>	Request 2 "server" nodes and 14 other nodes (a total of 16) - this specifies two node_specs, "2:server" and "14"
<code>&gt; qsub -l nodes=s=server:hippi+10:noserver+3:bigmem:hippi</code>	Request (a) 1 node that is a "server" and has a "hippi" interface, (b) 10 nodes that are not servers, and (c) 3 nodes that have a large amount of memory and have hipp
<code>&gt; qsub -l nodes=b2005+b1803+b1813</code>	Request 3 specific nodes by hostname

Usage	Description
<code>&gt; qsub -l nodes=4:ppn=2</code>	Request 2 processors on each of four nodes
<code>&gt; qsub -l nodes=1:ppn=4</code>	Request 4 processors on one node
<code>&gt; qsub -l nodes=2:blue:ppn=2+red:ppn=3+b1014</code>	Request 2 processors on each of two blue nodes, three processors on one red node, and the compute node "b1014"

**Example 2-2:**

This job requests a node with 200MB of available memory:

```
> qsub -l mem=200mb /home/user/script.sh
```

**Example 2-3:**

This job will wait until node01 is free with 200MB of available memory:

```
> qsub -l nodes=node01,mem=200mb /home/user/script.sh
```

**Related topics**

- [Job submission on page 39](#)

## Requesting generic resources

When **generic** resources have been assigned to nodes using the server's nodes file, these resources can be requested at the time of job submission using the *other* field. (See "Consumable Generic Resources" in the [Moab Workload Manager Administrator Guide](#) for details on configuration within Moab).

**Example 2-4: Generic**

This job will run on any node that has the generic resource **matlab**.

```
> qsub -l other=matlab /home/user/script.sh
```



This can also be requested at the time of job submission using the `-W x=GRES:matlab` flag.

**Related topics**

- [Requesting resources on page 42](#)
- [Job submission on page 39](#)

## Requesting floating resources

When **floating** resources have been set up inside Moab, they can be requested in the same way as **generic** resources. Moab will automatically understand that these resources are floating and will schedule the job accordingly. (See "Floating Generic Resources" in the [Moab Workload Manager Administrator Guide](#) for details on configuration within Moab.)

*Example 2-5: Floating*

This job will run on any node when there are enough floating resources available.

```
> qsub -l other=matlab /home/user/script.sh
```

**i** This can also be requested at the time of job submission using the `-W x=GRES:matlab` flag.

### Related topics

- [Requesting resources on page 42](#)
- [Job submission on page 39](#)

## Requesting other resources

Many other resources can be requested at the time of job submission using the Moab Workload Manager. See "Resource Manager Extensions" in the [Moab Workload Manager Administrator Guide](#) for a list of these supported requests and correct syntax.

### Related topics

- [Requesting resources on page 42](#)
- [Job submission on page 39](#)

## Exported batch environment variables

When a batch job is started, a number of variables are introduced into the job's environment that can be used by the batch script in making decisions, creating output files, and so forth. These variables are listed in the following table:

Variable	Description
<b>PBS_JOBNAME</b>	User specified jobname
<b>PBS_ARRAYID</b>	Zero-based value of job array index for this job (in version 2.2.0 and later)

Variable	Description
<b>PBS_GPUFILE</b>	Line-delimited list of GPUs allocated to the job located in <code>\$TORQUE_HOME/aux/jobidgpu</code> . Each line follows the following format: <code>&lt;host&gt;-gpu&lt;number&gt;</code> For example, <code>myhost-gpu1</code> .
<b>PBS_O_WORKDIR</b>	Job's submission directory
<b>PBS_ENVIRONMENT</b>	N/A
<b>PBS_TASKNUM</b>	Number of tasks requested
<b>PBS_O_HOME</b>	Home directory of submitting user
<b>PBS_MOMPORT</b>	Active port for MOM daemon
<b>PBS_O_LOGNAME</b>	Name of submitting user
<b>PBS_O_LANG</b>	Language variable for job
<b>PBS_JOBCOOKIE</b>	Job cookie
<b>PBS_JOBID</b>	Unique pbs job id
<b>PBS_NODENUM</b>	Node offset number
<b>PBS_NUM_NODES</b>	Number of nodes allocated to the job
<b>PBS_NUM_PPN</b>	Number of procs per node allocated to the job
<b>PBS_O_SHELL</b>	Script shell
<b>PBS_O_HOST</b>	Host on which job script is currently running
<b>PBS_QUEUE</b>	Job queue

Variable	Description
<b>PBS_NODEFILE</b>	File containing line delimited list on nodes allocated to the job
<b>PBS_NP</b>	Number of execution slots (cores) for the job
<b>PBS_O_PATH</b>	Path variable used to locate executables within job script

### Related topics

- [Requesting resources on page 42](#)
- [Job submission on page 39](#)

## Enabling trusted submit hosts

By default, only the node running the `pbs_server` daemon is allowed to submit jobs. Additional nodes can be trusted as submit hosts by taking any of the following steps:

- Set the `allow_node_submit` server parameter (see [Allowing job submission from compute hosts on page 23](#)).  
Allows any host trusted as a compute host to also be trusted as a submit host.
- Set the `submit_hosts` server parameter (see [Using the "submit\\_hosts" service parameter on page 23](#)).  
Allows specified hosts to be trusted as a submit host.
- Use `.rhosts` to enable `ruserok()` based authentication (see [Using RCmd authentication on page 22](#)).

See [Configuring job submission hosts on page 22](#) for more information.

**i** When you enable `allow_node_submit` on page 228, you must also enable the `allow_proxy_user` on page 228 parameter to allow user proxying when submitting and running jobs.

### Related topics

- [Job submission on page 39](#)

## Example submit scripts

The following is an example job test script:

```
#!/bin/sh
#
#This is an example script example.sh
#
#These commands set up the Grid Environment for your job:
#PBS -N ExampleJob
#PBS -l nodes=1,walltime=00:01:00
#PBS -q np_workq
#PBS -M YOURUNIQNAME@umich.edu
#PBS -m abe

#print the time and date
date

#wait 10 seconds
sleep 10

#print the time and date again
date
```

### Related topics

- [Job submission on page 39](#)

## Monitoring jobs

TORQUE allows users and administrators to monitor submitted jobs with the [qstat](#) command. If the command is run by a non-administrative user, it will output just that user's jobs. For example:

```
> qstat
Job id          Name          User          Time Use S Queue
-----
4807            scatter       user01        12:56:34 R batch
...
```

### Related topics

- [Submitting and managing jobs on page 39](#)

## Canceling jobs

TORQUE allows users and administrators to cancel submitted jobs with the [qdel](#) command. The job will be sent TERM and KILL signals killing the running processes. When the top-level job script exits, the job will exit. The only parameter is the ID of the job to be canceled.

If a job is canceled by an operator or manager, an email notification will be sent to the user. Operators and managers may add a comment to this email with the `-m` option.

```

$ qstat
Job id          Name          User          Time Use S Queue
-----
4807            scatter       user01        12:56:34 R batch
...
$ qdel -m "hey! Stop abusing the NFS servers" 4807
$

```

### Related topics

- [Submitting and managing jobs on page 39](#)

## Job preemption

TORQUE supports job preemption by allowing authorized users to suspend and resume jobs. This is supported using one of two methods. If the node supports OS-level preemption, TORQUE will recognize that during the configure process and enable it. Otherwise, the MOM may be configured to launch a custom *checkpoint script* in order to support preempting a job. Using a custom checkpoint script requires that the job understand how to resume itself from a checkpoint after the preemption occurs.

### Configuring a checkpoint script on a MOM

To configure the MOM to support a checkpoint script, the `$checkpoint_script` parameter must be set in the MOM's configuration file found in `TORQUE_HOME/mom_priv/config`. The checkpoint script should have execute permissions set. A typical configuration file might look as follows:

mom\_priv/config:

```

$pbsserver      node06
$logevent       255
$restricted     *.mycluster.org
$checkpoint_script /opt/moab/tools/mom-checkpoint.sh

```

The second thing that must be done to enable the checkpoint script is to change the value of `MOM_CHECKPOINT` to **1** in `/src/include/pbs_config.h`. (In some instances, `MOM_CHECKPOINT` may already be defined as 1.) The new line should be as follows:

/src/include/pbs\_config.h:

```
#define MOM_CHECKPOINT 1
```

### Related topics

- [Submitting and managing jobs on page 39](#)

## Keeping completed jobs

TORQUE provides the ability to report on the status of completed jobs for a configurable duration after the job has completed. This can be enabled by setting the [keep\\_completed on page 82](#) attribute on the job execution queue or the [keep\\_completed on page 234](#) parameter on the server. This should be set to



the number of seconds that jobs should be held in the queue. If you set `keep_completed` on the job execution queue, completed jobs will be reported in the **C** state and the exit status is seen in the `exit_status` job attribute.

**i** If the Mother Superior and TORQUE server are on the same server, expect the following behavior:

- When `keep_completed` is set, the job spool files will be deleted when the specified time arrives and TORQUE purges the job from memory.
- When `keep_completed` is not set, TORQUE deletes the job spool files upon job completion.
- If you manually purge a job (`qdel -p`) before the job completes or time runs out, TORQUE will never delete the spool files.

By maintaining status information about completed (or canceled, failed, etc.) jobs, administrators can better track failures and improve system performance. This allows TORQUE to better communicate with Moab Workload Manager and track the status of jobs. This gives Moab the ability to track specific failures and to schedule the workload around possible hazards. (See `NODEFAILURERESERVETIME` in "Appendix F: Parameters" of the [Moab Workload Manager Administrator Guide](#) for more information.)

### Related topics

- [Submitting and managing jobs on page 39](#)

## Job checkpoint and restart

While TORQUE has had a job checkpoint and restart capability for many years, this was tied to machine specific features. Now TORQUE supports BLCR—an architecture independent package that provides for process checkpoint and restart.

**i** The support for BLCR is only for serial jobs, not for any MPI type jobs.

This section contains these topics:

- [Introduction to BLCR on page 54](#)
- [Configuration files and scripts on page 54](#)
- [Starting a checkpointable job on page 61](#)
- [Checkpointing a job on page 62](#)
- [Restarting a job on page 62](#)
- [Acceptance tests on page 63](#)

### Related topics

- [Submitting and managing jobs on page 39](#)

## Introduction to BLCR

BLCR is a kernel level package. It must be downloaded and installed from [BLCR](#).

After building and making the package, it must be installed into the kernel with commands as follows. These can be installed into the file `/etc/modules` but all of the testing was done with explicit invocations of **modprobe**.

Installing BLCR into the kernel:

```
# /sbin/insmod /usr/local/lib/blcr/2.6.12-1.234/blcr_imports.ko
# /sbin/insmod /usr/local/lib/blcr/2.6.12-1.234/blcr_vmadump.ko
# /sbin/insmod /usr/local/lib/blcr/2.6.12-1.234/blcr.ko
```

The BLCR system provides four command line utilities:

- `cr_checkpoint`
- `cr_info`
- `cr_restart`
- `cr_run`

For more information about BLCR, see the [BLCR Administrator's Guide](#).

### Related topics

- [Job checkpoint and restart on page 53](#)

## Configuration files and scripts

Configuring and Building TORQUE for BLCR:

```
> ./configure --enable-unixsockets=no --enable-blcr
> make
> sudo make install
```


Depending on where BLCR is installed you may also need to use the following configure options to specify BLCR paths:

Option	Description
<code>--with-blcr-include=DIR</code>	include path for <code>libcr.h</code>
<code>--with-blcr-lib=DIR</code>	lib path for <code>libcr</code>
<code>--with-blcr-bin=DIR</code>	bin path for BLCR utilities

The `pbs_mom` configuration file located in `/var/spool/torque/mom_priv` must be modified to identify the script names associated with invoking the BLCR commands. The following variables should be used in the configuration file when using BLCR checkpointing.

Variable	Description
<code>\$checkpoint_interval</code>	How often periodic job checkpoints will be taken (minutes)
<code>\$checkpoint_script</code>	The name of the script file to execute to perform a job checkpoint
<code>\$restart_script</code>	The name of the script file to execute to perform a job restart
<code>\$checkpoint_run_exe</code>	The name of an executable program to be run when starting a checkpointable job (for BLCR, <code>cr_run</code> )

The following example shows the contents of the configuration file used for testing the BLCR feature in TORQUE.

 The script files below must be executable by the user. Be sure to use `chmod` to set the permissions to 754.

#### Example 2-6: Script file permissions

```
# chmod 754 blcr*
# ls -l
total 20
-rwxr-xr-- 1 root root 2112 2008-03-11 13:14 blcr_checkpoint_script
-rwxr-xr-- 1 root root 1987 2008-03-11 13:14 blcr_restart_script
-rw-r--r-- 1 root root 215 2008-03-11 13:13 config
drwxr-x--x 2 root root 4096 2008-03-11 13:21 jobs
-rw-r--r-- 1 root root 7 2008-03-11 13:15 mom.lock
```

#### Example 2-7: `mom_priv/config`

```
$checkpoint_script /var/spool/torque/mom_priv/blcr_checkpoint_script
$restart_script /var/spool/torque/mom_priv/blcr_restart_script
$checkpoint_run_exe /usr/local/bin/cr_run
$pbsserver makuu.cridomain
$loglevel 7
```

*Example 2-8: mom\_priv/blcr\_checkpoint\_script*

```

#!/usr/bin/perl
#####
#
# Usage: checkpoint_script
#
# This script is invoked by pbs_mom to checkpoint a job.
#
#####
use strict;
use Sys::Syslog;

# Log levels:
# 0 = none -- no logging
# 1 = fail -- log only failures
# 2 = info -- log invocations
# 3 = debug -- log all subcommands
my $logLevel = 3;

logPrint(2, "Invoked: $0 " . join(' ', @ARGV) . "\n");

my ($sessionId, $jobId, $userId, $signalNum, $checkpointDir, $checkpointName);
my $usage =
    "Usage: $0          \n";

# Note that depth is not used in this script but could control a limit to the number
of checkpoint
# image files that are preserved on the disk.
#
# Note also that a request was made to identify whether this script was invoked by the
job's
# owner or by a system administrator. While this information is known to pbs_server,
it
# is not propagated to pbs_mom and thus it is not possible to pass this to the script.

# Therefore, a workaround is to invoke qmgr and attempt to set a trivial variable.
# This will fail if the invoker is not a manager.

if (@ARGV == 7)
{
    ($sessionId, $jobId, $userId, $checkpointDir, $checkpointName, $signalNum $depth)
=
    @ARGV;
}
else { logDie(1, $usage); }

# Change to the checkpoint directory where we want the checkpoint to be created
chdir $checkpointDir
    or logDie(1, "Unable to cd to checkpoint dir ($checkpointDir): ${!}\n")
    if $logLevel;

my $cmd = "cr_checkpoint";
$cmd .= " --signal $signalNum" if $signalNum;
$cmd .= " --tree $sessionId";
$cmd .= " --file $checkpointName";
my $output = `$cmd 2>&1`;
my $rc = $? >> 8;
logDie(1, "Subcommand ($cmd) failed with rc=$rc:\n$output")
    if $rc && $logLevel >= 1;
logPrint(3, "Subcommand ($cmd) yielded rc=$rc:\n$output")
    if $logLevel >= 3;
exit 0;

#####
# logPrint($message)
# Write a message (to syslog) and die
#####
sub logPrint
{

```

```
my ($level, $message) = @_;  
my @severity = ('none', 'warning', 'info', 'debug');  
  
return if $level > $logLevel;  
  
openlog('checkpoint_script', '', 'user');  
syslog($severity[$level], $message);  
closelog();  
}  
  
#####  
# logDie($message)  
# Write a message (to syslog) and die  
#####  
sub logDie  
{  
    my ($level, $message) = @_;  
    logPrint($level, $message);  
    die($message);  
}
```

*Example 2-9: mom\_priv/blcr\_restart\_script*

```

#!/usr/bin/perl
#####
#
# Usage: restart_script
#
# This script is invoked by pbs_mom to restart a job.
#
#####
use strict;
use Sys::Syslog;

# Log levels:
# 0 = none -- no logging
# 1 = fail -- log only failures
# 2 = info -- log invocations
# 3 = debug -- log all subcommands
my $logLevel = 3;

logPrint(2, "Invoked: $0 " . join(' ', @ARGV) . "\n");

my ($sessionId, $jobId, $userId, $checkpointDir, $restartName);
my $usage =
"Usage: $0 \n";
if (@ARGV == 5)
{
    ($sessionId, $jobId, $userId, $checkpointDir, $restartName) =
        @ARGV;
}
else { logDie(1, $usage); }

# Change to the checkpoint directory where we want the checkpoint to be created
chdir $checkpointDir
    or logDie(1, "Unable to cd to checkpoint dir ($checkpointDir): $!\n")
    if $logLevel;

my $cmd = "cr_restart";
$cmd .= " $restartName";
my $output = ` $cmd 2>&1 `;
my $rc = $? >> 8;
logDie(1, "Subcommand ($cmd) failed with rc=$rc:\n$output")
    if $rc && $logLevel >= 1;
logPrint(3, "Subcommand ($cmd) yielded rc=$rc:\n$output")
    if $logLevel >= 3;
exit 0;

#####
# logPrint($message)
# Write a message (to syslog) and die
#####
sub logPrint
{
    my ($level, $message) = @_ ;
    my @severity = ('none', 'warning', 'info', 'debug');

    return if $level > $logLevel;
    openlog('restart_script', '', 'user');
    syslog($severity[$level], $message);
    closelog();
}

#####
# logDie($message)
# Write a message (to syslog) and die
#####
sub logDie
{
    my ($level, $message) = @_ ;

    logPrint($level, $message);
}

```



```
die($message);
}
```

## Related topics

- [Job checkpoint and restart on page 53](#)

## Starting a checkpointable job

Not every job is checkpointable. A job for which checkpointing is desirable must be started with the `-c` command line option. This option takes a comma-separated list of arguments that are used to control checkpointing behavior. The list of valid options available in the 2.4 version of TORQUE is show below.

Option	Description
<b>none</b>	No checkpointing (not highly useful, but included for completeness).
<b>enabled</b>	Specify that checkpointing is allowed, but must be explicitly invoked by either the <code>qhold</code> or <code>qchkpt</code> commands.
<b>shutdown</b>	Specify that checkpointing is to be done on a job at <code>pbs_mom</code> shutdown.
<b>periodic</b>	Specify that periodic checkpointing is enabled. The default interval is 10 minutes and can be changed by the <code>\$checkpoint_interval</code> option in the MOM configuration file, or by specifying an interval when the job is submitted.
<b>interval=minutes</b>	Specify the checkpoint interval in minutes.
<b>depth=number</b>	Specify a number (depth) of checkpoint images to be kept in the checkpoint directory.
<b>dir=path</b>	Specify a checkpoint directory (default is <code>/var/spool/torque/checkpoint</code> ).

### Example 2-10: Sample test program

```
#include "stdio.h"
int main( int argc, char *argv[] )
{
  int i;
  for (i=0; i<100; i++)
  {
    printf("i = %d\n", i);
    fflush(stdout);
    sleep(1);
  }
}
```

### Example 2-11: Instructions for building test program

```
> gcc -o test test.c
```

*Example 2-12: Sample test script*

```
#!/bin/bash ./test
```

*Example 2-13: Starting the test job*

```
> qstat
> qsub -c enabled,periodic,shutdown,interval=1 test.sh
77.jakaa.cridomain
> qstat
```

Job id	Name	User	Time Use	S	Queue
77.jakaa	test.sh	jsmith		0 Q	batch

```
>
```

If you have no scheduler running, you might need to start the job with [qrun](#).

As this program runs, it writes its output to a file in `/var/spool/torque/spool`. This file can be observed with the command `tail -f`.

**Related topics**

- [Job checkpoint and restart on page 53](#)

## Checkpointing a job

Jobs are checkpointed by issuing a [qhold](#) command. This causes an image file representing the state of the process to be written to disk. The directory by default is `/var/spool/torque/checkpoint`.

This default can be altered at the queue level with the `qmgr` command. For example, the command `qmgr -c set queue batch checkpoint_dir=/tmp` would change the checkpoint directory to `/tmp` for the queue 'batch'.

The default directory can also be altered at job submission time with the `-c dir=/tmp` command line option.

The name of the checkpoint directory and the name of the checkpoint image file become attributes of the job and can be observed with the command `qstat -f`. Notice in the output the names **checkpoint\_dir** and **checkpoint\_name**. The variable `checkpoint_name` is set when the image file is created and will not exist if no checkpoint has been taken.

A job can also be checkpointed without stopping or holding the job with the command [qchkpt](#).

**Related topics**

- [Job checkpoint and restart on page 53](#)

## Restarting a job

### Restarting a job in the Held state

The [qrls](#) command is used to restart the hibernated job. If you were using the `tail -f` command to watch the output file, you will see the test program start counting again.

It is possible to use the [qalter](#) command to change the name of the checkpoint file associated with a job. This could be useful if there were several job checkpoints and it restarting the job from an older image was specified.

## Restarting a job in the Completed state

In this case, the job must be moved to the Queued state with the [qrerun](#) command. Then the job must go to the Run state either by action of the scheduler or if there is no scheduler, through using the [qrun](#) command.

### Related topics

- [Job checkpoint and restart on page 53](#)

## Acceptance tests

A number of tests were made to verify the functioning of the BLCR implementation. See [BLCR acceptance tests on page 305](#) for a description of the testing.

### Related topics

- [Job checkpoint and restart on page 53](#)

## Job exit status

Once a job under TORQUE has completed, the `exit_status` attribute will contain the result code returned by the job script. This attribute can be seen by submitting a `qstat -f` command to show the entire set of information associated with a job. The `exit_status` field is found near the bottom of the set of output lines.

**Example 2-14: qstat -f (job failure)**

```

Job Id: 179.host
Job_Name = STDIN
Job_Owner = user@host
job_state = C
queue = batchq server = host
Checkpoint = u ctime = Fri Aug 29 14:55:55 2008
Error_Path = host:/opt/moab/STDIN.e179
exec_host = node1/0
Hold_Types = n
Join_Path = n
Keep_Files = n
Mail_Points = a
mtime = Fri Aug 29 14:55:55 2008
Output_Path = host:/opt/moab/STDIN.o179
Priority = 0
qtime = Fri Aug 29 14:55:55 2008
Rerunable = True Resource_List.ncpus = 2
Resource_List.nodect = 1
Resource_List.nodes = node1
Variable_List = PBS_O_HOME=/home/user,PBS_O_LOGNAME=user,
PBS_O_PATH=/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:,PBS_O_
SHELL=/bin/bash,PBS_O_HOST=host,
PBS_O_WORKDIR=/opt/moab,PBS_O_QUEUE=batchq
sched_hint = Post job file processing error; job 179.host on host node1/0Ba
d UID for job execution REJHOST=pala.cridomain MSG=cannot find user 'user' in
password file
etime = Fri Aug 29 14:55:55 2008
exit_status = -1

```

**i** The value of `Resource_List.*` is the amount of resources requested.

This code can be useful in diagnosing problems with jobs that may have unexpectedly terminated.

If TORQUE was unable to start the job, this field will contain a negative number produced by the `pbs_mom`. Otherwise, if the job script was successfully started, the value in this field will be the return value of the script.

**Example 2-15: TORQUE supplied exit codes**

Name	Value	Description
<b>JOB_EXEC_OK</b>	0	Job execution successful
<b>JOB_EXEC_FAIL1</b>	-1	Job execution failed, before files, no retry
<b>JOB_EXEC_FAIL2</b>	-2	Job execution failed, after files, no retry
<b>JOB_EXEC_RETRY</b>	-3	Job execution failed, do retry
<b>JOB_EXEC_INITABT</b>	-4	Job aborted on MOM initialization
<b>JOB_EXEC_INITRST</b>	-5	Job aborted on MOM init, chkpt, no migrate

Name	Value	Description
<b>JOB_EXEC_INITRMG</b>	-6	Job aborted on MOM init, chkpt, ok migrate
<b>JOB_EXEC_BADRESRT</b>	-7	Job restart failed
<b>JOB_EXEC_CMDFAIL</b>	-8	Exec() of user command failed
<b>JOB_EXEC_STDOUTFAIL</b>	-9	Could not create/open stdout stderr files
<b>JOB_EXEC_OVERLIMIT_MEM</b>	-10	Job exceeded a memory limit
<b>JOB_EXEC_OVERLIMIT_WT</b>	-11	Job exceeded a walltime limit
<b>JOB_EXEC_OVERLIMIT_CPUT</b>	-12	Job exceeded a CPU time limit

## Example 2-16: Exit code from C program

```

$ cat error.c
#include
#include

int
main(int argc, char *argv)
{
    exit(256+11);
}

$ gcc -o error error.c

$ echo ./error | qsub
180.xxx.yyy

$ qstat -f
Job Id: 180.xxx.yyy
  Job_Name = STDIN
  Job_Owner = test.xxx.yyy
  resources_used.cput = 00:00:00
  resources_used.mem = 0kb
  resources_used.vmem = 0kb
  resources_used.walltime = 00:00:00
  job_state = C
  queue = batch
  server = xxx.yyy
  Checkpoint = u
  ctime = Wed Apr 30 11:29:37 2008
  Error_Path = xxx.yyy:/home/test/STDIN.e180
  exec_host = node01/0
  Hold_Types = n
  Join_Path = n
  Keep_Files = n
  Mail_Points = a
  mtime = Wed Apr 30 11:29:37 2008
  Output_Path = xxx.yyy:/home/test/STDIN.o180
  Priority = 0
  qtime = Wed Apr 30 11:29:37 2008
  Rerunnable = True
  Resource_List.needsnodes = 1
  Resource_List.nodect = 1
  Resource_List.nodes = 1
  Resource_List.walltime = 01:00:00
  session_id = 14107
  substate = 59
  Variable_List = PBS_O_HOME=/home/test,PBS_O_LANG=en_US.UTF-8,
    PBS_O_LOGNAME=test,
    PBS_O_PATH=/usr/local/perltests/bin:/home/test/bin:/usr/local/s
    bin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games,
    PBS_O_SHELL=/bin/bash,PBS_SERVER=xxx.yyy,
    PBS_O_HOST=xxx.yyy,PBS_O_WORKDIR=/home/test,
    PBS_O_QUEUE=batch
  euser = test
  egroup = test
  hashname = 180.xxx.yyy
  queue_rank = 8
  queue_type = E
  comment = Job started on Wed Apr 30 at 11:29
  etime = Wed Apr 30 11:29:37 2008
  exit_status = 11
  start_time = Wed Apr 30 11:29:37 2008
  start_count = 1

```

Notice that the C routine `exit` passes only the low order byte of its argument. In this case, `256+11` is really 267 but the resulting exit code is only 11 as seen in the output.

### Related topics

- [Job checkpoint and restart on page 53](#)
- [Submitting and managing jobs on page 39](#)

## Service jobs

TORQUE service jobs are a special kind of job that is treated differently by TORQUE than normal batch jobs. TORQUE service jobs are *not* related to Moab's dynamic service jobs. A TORQUE service job cannot dynamically grow and shrink in size over time.

Jobs are marked as service jobs at the time they are submitted to Moab or TORQUE. Just like a normal job, a script file is specified with the job. In a batch job, the contents of the script file are taken by TORQUE and executed on the compute nodes. For a service job, however, the script file is assumed to respond to certain command-line arguments. Instead of just executing the script, TORQUE will use these command-line arguments to start, stop, and check on the status of the job. Listed below are the three command-line arguments that must be supported by any script submitted as part of a TORQUE service job:

- `start`: The script should take this argument and launch its service/workload. The script should remain executing/running until the service stops.
- `stop`: The script should take this argument and stop the service/workload that was earlier started.
- `status`: The script should take this argument and return, via standard out, either "running" if the service/workload is running as expected or "stopped" if the service is not running.

This feature was created with long-running services in mind. The command-line arguments should be familiar to users who interact with Unix services, as each of the service scripts found in `/etc/init.d/` also accept and respond to the arguments as explained above.

For example, if a user wants to start the Apache 2 server on a compute node, they can use a TORQUE service job and specify a script which will start, stop, and check on the status of the "httpd" daemon--possibly by using the already present `/etc/init.d/httpd` script.



If you wish to submit service jobs only through TORQUE, no special version of Moab is required. If you wish to submit service jobs using Moab's `msub`, then Moab 5.4 is required.

For details, see these topics:

- [Submitting service jobs on page 68](#)
- [Submitting service jobs in MCM on page 68](#)
- [Managing service jobs on page 68](#)

## Submitting service jobs

There is a new option to `qsub`, "-s" which can take either a 'y' or 'n' (yes or no, respectively). When "-s y" is present, then the job is marked as a service job.

```
qsub -l walltime=100:00:00,nodes=1 -s y service_job.py
```

The example above submits a job to TORQUE with a walltime of 100 hours, one node, and it is marked as a service job. The script "service\_job.py" will be used to start, stop, and check the status of the service/workload started on the compute nodes.

Moab, as of version 5.4, is able to accept the "-s y" option when `mbsub` is used for submission. Moab will then pass this information to TORQUE when the job is migrated.

### Related topics

- [Service jobs on page 67](#)

## Submitting service jobs in MCM

Submitting a service job in MCM requires the latest Adaptive Computing Suite snapshot of MCM. It also requires MCM to be started with the "--future=2" option.

Once MCM is started, open the **Create Workload** window and verify **Show Advanced Options** is checked. Notice that there is a **Service** checkbox that can be selected in the **Flags/Options** area. Use this to specify the job is a service job.

### Related topics

- [Service jobs on page 67](#)

## Managing service jobs

Managing a service job is done much like any other job; only a few differences exist.

Examining the job with `qstat -f` will reveal that the job has the `service = True` attribute. Non-service jobs will not make any mention of the "service" attribute.

Canceling a service job is done with `qdel`, `mjobctl -c`, or through any of the GUI's as with any other job. TORQUE, however, cancels the job by calling the service script with the "stop" argument instead of killing it directly. This behavior also occurs if the job runs over its wallclock and TORQUE/Moab is configured to cancel the job.

If a service job completes when the script exits after calling it with "start," or if TORQUE invokes the script with "status" and does not get back "running," it will *not* be terminated by using the "stop" argument.

### Related topics

- [Service jobs on page 67](#)



# Chapter 3: Managing nodes

This section contains information about adding and configuring compute nodes. It explains how to work with host security for systems that require dedicated access to compute nodes. It also contains information about scheduling specific cores on a node at job submission.

For details, see these topics:

- [Adding nodes on page 69](#)
- [Node properties on page 70](#)
- [Changing node state on page 71](#)
- [Host security on page 71](#)
- [Linux cpuset support on page 72](#)
- [Scheduling cores on page 74](#)

## Adding nodes

TORQUE can add and remove nodes either dynamically with [qmgr](#) or by manually editing the `TORQUE_HOME/server_priv/nodes` file (see [Initializing/Configuring TORQUE on the server \(pbs\\_server\) on page 7](#)).

### Run-time node changes

TORQUE can dynamically add nodes with the `qmgr` command. For example, the following command will add node **node003**:

```
> qmgr -c "create node node003"
```

The above command appends the `$TORQUE_HOME/server_priv/nodes` file with:

```
node003
```

Nodes can also be removed with a similar command:

```
> qmgr -c "delete node node003"
```

**i** Typically, an administrator will want to change the state of a node instead of remove it (for details, see [Changing node state on page 71](#)).

**i** When you make changes to nodes – whether by using `qmgr` or directly editing the `nodes` file – you must restart `pbs_server` for those changes to take effect.

### Related topics

- [Managing nodes](#) on page 69

## Node properties

TORQUE can associate properties with nodes to aid in identifying groups of nodes. It's typical for a site to conglomerate a heterogeneous set of resources. To identify the different sets, properties can be given to each node in a set. For example, a group of nodes that has a higher speed network connection could have the property "ib". TORQUE can set, update, or remove properties either dynamically with `qmgr` or by manually editing the `nodes` file.

### Run-time node changes

TORQUE can dynamically change the properties of a node with the `qmgr` command. For example, note the following to give **node001** the properties of "bigmem" and "dualcore":

```
> qmgr -c "set node node001 properties = bigmem"
> qmgr -c "set node node001 properties += dualcore"
```

To relinquish a stated property, use the "-" operator.

### Manual node changes

The properties of each node are enumerated in `TORQUE_HOME/server_priv/nodes`. The feature(s) must be in a space delimited list after the node name. For example, to give **node001** the properties of "bigmem" and "dualcore" and **node002** the properties of "bigmem" and "matlab," edit the `nodes` file to contain the following:

`server_priv/nodes:`

```
node001 bigmem dualcore
node002 np=4 bigmem matlab
```

**i** For changes to the `nodes` file to be activated, `pbs_server` must be restarted.

**i** For a full description of this file, please see the *PBS Administrator Guide*.

### Related topics

- [Job submission](#) on page 39
- [Managing nodes](#) on page 69

## Changing node state

A common task is to prevent jobs from running on a particular node by marking it *offline* with `pbsnodes -o nodename`. Once a node has been marked offline, the scheduler will no longer consider it available for new jobs. Simply use `pbsnodes -c nodename` when the node is returned to service.

Also useful is `pbsnodes -l`, which lists all nodes with an interesting state, such as down, unknown, or offline. This provides a quick glance at nodes that might be having a problem. (See [pbsnodes](#) for details.)

### Related topics

- [Managing nodes on page 69](#)

## Host security

### Enabling PAM with TORQUE

TORQUE is able to take advantage of the authentication services provided through Pluggable Authentication Modules (PAM) to help administrators manage access to compute nodes by users. The PAM module available in TORQUE is located in the PAM security directory. This module, when used in conjunction with other PAM modules, restricts access to the compute node unless the user has a job currently running on the node. The following configurations are examples only. For more information about PAM, see the [PAM \(Pluggable Authentication Modules\) documentation](#) from LinuxDocs.

To enable TORQUE PAM configure TORQUE using the `--with-pam` option. Using `--with-pam` is sufficient but if your PAM security modules are not in the default `/lib/security` or `/lib64/security` directory, you can specify the location using `--with-pam=<DIR>` where `<DIR>` is the directory where you want the modules to be installed. When TORQUE is installed the files `pam_pbssimpleauth.la` and `pam_pbssimpleauth.so` appear in `/lib/security`, `/lib64/security`, or the directory designated on the configuration line.

PAM is very flexible and policies vary greatly from one site to another. The following example restricts users trying to access a node using SSH. Administrators need to assess their own installations and decide how to apply the TORQUE PAM restrictions.

In this example, after installing TORQUE with PAM enabled, you would add the following two lines to `/etc/pam.d/ssh`:

```
account required pam_pbssimpleauth.so
account required pam_access.so
```

In `/etc/security/access.conf` make sure all users who access the compute node are added to the configuration. This is an example which allows the users `root`, `george`, `allen`, and `michael` access.

```
 -:ALL EXCEPT root george allen michael torque:ALL
```

With this configuration, if user `george` has a job currently running on the compute node, `george` can use `ssh` to login to the node. If there are currently no jobs running, `george` is disconnected when attempting to login.

TORQUE PAM is good at keeping users out who do not have jobs running on a compute node. However, it does not have the ability to force a user to log out once they are in. To accomplish this use epilogue or prologue scripts to force users off the system.

## Legacy TORQUE PAM configuration

There is an alternative PAM configuration for TORQUE that has been available since 2006. It can be found in the `contrib/pam_authuser` directory of the source tree. Adaptive Computing does not currently support this method but the instructions are given here for those who are currently using it and for those who wish to use it.

For systems requiring dedicated access to compute nodes (for example, users with sensitive data), TORQUE prologue and epilogue scripts provide a vehicle to leverage the authentication provided by linux-PAM modules. (See [Prologue and epilogue scripts on page 281](#) for more information.)

### To allow only users with running jobs (and root) to access compute nodes

1. Untar `contrib/pam_authuser.tar.gz` (found in the src tar ball).
2. Compile `pam_authuser.c` with `make` and `make install` on every compute node.
3. Edit `/etc/system-auth` as described in `README.pam_authuser`, again on every compute node.
4. Either make a tarball of the epilogue\* and prologue\* scripts (to preserve the symbolic link) and untar it in the `mom_priv` directory, or just copy epilogue\* and prologue\* to `mom_priv/`.

The prologue\* scripts are Perl scripts that add the user of the job to `/etc/authuser`. The epilogue\* scripts then remove the first occurrence of the user from `/etc/authuser`. File locking is employed in all scripts to eliminate the chance of race conditions. There is also some commented code in the epilogue\* scripts, which, if uncommented, kills all processes owned by the user (using `pkill`), provided that the user doesn't have another valid job on the same node.

[prologue](#) and [epilogue](#) scripts were added to the `pam_authuser` tarball in version 2.1 of TORQUE.

#### Related topics

- [Managing nodes on page 69](#)

## Linux cpuset support

- [Cpuset overview on page 72](#)
- [Cpuset support on page 73](#)
- [Cpuset configuration on page 73](#)
- [Cpuset advantages / disadvantages on page 73](#)

### Cpuset overview

Linux kernel 2.6 Cpusets are logical, hierarchical groupings of CPUs and units of memory. Once created, individual processes can be placed within a cpuset. The processes will only be allowed to run/access the

specified CPUs and memory. Cpusets are managed in a virtual file system mounted at `/dev/cpuset`. New cpusets are created by simply making new directories. Cpusets gain CPUs and memory units by simply writing the unit number to files within the cpuset.

## Cpuset support

**i** All nodes using cpusets must have the `hwloc` library version 1.2 or higher installed. If you use CentOS 6, an automatic download `- yum install hwloc-devel`, for instance - will install the correct version; however, if you use CentOS 5 or SLES11 SP2, you will need to build it from the source using `contrib/hwloc_install.sh` or equivalent.

When started, `pbs_mom` will create an initial top-level cpuset at `/dev/cpuset/torque`. This cpuset contains all CPUs and memory of the host machine. If this "torqueset" already exists, it will be left unchanged to allow the administrator to override the default behavior. All subsequent cpusets are created within the torqueset.

When a job is started, the jobset is created at `/dev/cpuset/torque/$jobid` and populated with the CPUs listed in the `exec_host job` attribute. Also created are individual tasksets for each CPU within the jobset. This happens before prologue, which allows it to be easily modified, and it happens on all nodes.

The top-level batch script process is executed in the jobset. Tasks launched through the TM interface (`pbsdsh` and PW's `mpirexec`) will be executed within the appropriate taskset.

On job exit, all tasksets and the jobset are deleted.

## Cpuset configuration

### To configure cpuset

1. As root, mount the virtual filesystem for cpusets:

```
mkdir /dev/cpuset
mount -t cpuset none /dev/cpuset
```

**i** Do this for each MOM that is to use cpusets.

2. Because cpuset usage is a build-time option in TORQUE, you must add `--enable-cpuset` to your configure options:

```
./configure --enable-cpuset
```

3. Use this configuration for the MOMs across your system.

## Cpuset advantages / disadvantages

Presently, any job can request a single CPU and proceed to use everything available in the machine. This is occasionally done to circumvent policy, but most often is simply an error on the part of the user. Cpuset support will easily constrain the processes to not interfere with other jobs.

Jobs on larger NUMA systems may see a performance boost if jobs can be intelligently assigned to specific CPUs. Jobs may perform better if striped across physical processors, or contained within the fewest number of memory controllers.

TM tasks are constrained to a single core, thus a multi-threaded process could seriously suffer.

### Related topics

- [Managing nodes on page 69](#)
- [Geometry request configuration on page 74](#)

## Scheduling cores

In TORQUE 2.4 and later, you can request specific cores on a node at job submission by using geometry requests. To use this feature, specify the [procs\\_bitmap](#) resource request of `qsub-1` (see [qsub](#)) at job submission.

For details about scheduling cores, see these topics:

- [Geometry request configuration on page 74](#)
- [Geometry request usage on page 75](#)
- [Geometry request considerations on page 75](#)

## Geometry request configuration

A Linux kernel of 2.6 or later is required to use geometry requests, because this feature uses Linux cpusets in its implementation. In order to use this feature, the `cpuset` directory has to be mounted. For more information on how to mount the `cpuset` directory, see [Linux cpuset support on page 72](#). If the operating environment is suitable for geometry requests, configure TORQUE with the `--enable-geometry-requests` option.

```
> ./configure --prefix=/home/john/torque --enable-geometry-requests
```

TORQUE is configured to install to `/home/john/torque` and to enable the geometry requests feature.

**i** The geometry request feature uses a subset of the cpusets feature. When you configure TORQUE using `--enable-cpuset` and `--enable-geometry-requests` at the same time, and use `-l procs_bitmap=X`, the job will get the requested cpuset. Otherwise, the job is treated as if only `--enable-cpuset` was configured.

### Related topics

- [Scheduling cores on page 74](#)

## Geometry request usage

Once enabled, users can submit jobs with a geometry request by using the `procs_bitmap=<string>` resource request. [procs\\_bitmap](#) requires a numerical string made up of 1's and 0's. A 0 in the bitmap means the job cannot run on the core that matches the 0's index in the bitmap. The index is in reverse order of the number of cores available. If a job is submitted with `procs_bitmap=1011`, then the job requests a node with four free cores, and uses only cores one, two, and four.

**i** The geometry request feature requires a node that has all cores free. A job with a geometry request cannot run on a node that has cores that are busy, even if the node has more than enough cores available to run the job.

```
qsub -l procs_bitmap=0011 ossl.sh
```

The job **ossl.sh** is submitted with a geometry request of **0011**.

In the above example, the submitted job can run only on a node that has four cores. When a suitable node is found, the job runs exclusively on cores one and two.

### Related topics

- [Scheduling cores on page 74](#)

## Geometry request considerations

As previously stated, jobs with geometry requests require a node with all of its cores available. After the job starts running on the requested cores, the node cannot run other jobs, even if the node has enough free cores to meet the requirements of the other jobs. Once the geometry requesting job is done, the node is available to other jobs again.

### Related topics

- [Scheduling cores on page 74](#)

## Scheduling accelerator hardware

TORQUE works with accelerators (such as NVIDIA GPUs and Intel MICs) and can collect and report metrics from them or submit workload to them. This feature requires the use of the Moab scheduler. Refer to the [Moab Workload Manager accelerators documentation](#) for information on configuring accelerators in TORQUE.





# Chapter 4: Setting server policies

This section explains how to set up and configure your queue. It lists the queue attributes and describes how to set up a routing queue. This section also explains how to set up TORQUE to run in high availability mode. For details, see these topics:

- [Queue configuration on page 77](#)
- [Server high availability on page 91](#)

## Queue configuration

Under TORQUE, queue configuration is accomplished using the [Server high availability](#) command. With this tool, the first step is to create the queue. This is accomplished using the `create` subcommand of `qmgr` as in the following example:

```
> qmgr -c "create queue batch queue_type=execution"
```

Once created, the queue must be configured to be operational. At a minimum, this includes setting the options **started** and **enabled**. Further configuration is possible using any combination of the attributes listed in what follows.

For Boolean attributes, *T*, *t*, *1*, *Y*, and *y* are all synonymous with "TRUE," and *F*, *f*, *0*, *N*, and *n* all mean "FALSE."

For [queue\\_type](#), *E* and *R* are synonymous with "Execution" and "Routing" (respectively).

See these topics for more details:

- [Queue attributes on page 78](#)
- [Example queue configuration on page 88](#)
- [Setting a default queue on page 89](#)
- [Mapping a queue to subset of resources on page 89](#)
- [Creating a routing queue on page 89](#)

### Related topics

- [Server parameters on page 227](#)
- [qalter on page 170](#) - command which can move jobs from one queue to another

## Queue attributes

This section lists the following queue attributes:

- [acl\\_groups](#) on page 79
- [acl\\_group\\_enable](#) on page 79
- [acl\\_group\\_sloppy](#) on page 79
- [acl\\_hosts](#) on page 80
- [acl\\_host\\_enable](#) on page 80
- [acl\\_logic\\_or](#) on page 80
- [acl\\_users](#) on page 80
- [acl\\_user\\_enable](#) on page 81
- [disallowed\\_types](#) on page 81
- [enabled](#) on page 81
- [features\\_required](#) on page 82
- [keep\\_completed](#) on page 82
- [kill\\_delay](#) on page 82
- [max\\_queueable](#) on page 83
- [max\\_running](#) on page 83
- [max\\_user\\_queueable](#) on page 83
- [max\\_user\\_run](#) on page 84
- [priority](#) on page 84
- [queue\\_type](#) on page 84
- [required\\_login\\_property](#) on page 85
- [resources\\_available](#) on page 85
- [resources\\_default](#) on page 85
- [resources\\_max](#) on page 85
- [resources\\_min](#) on page 86
- [route\\_destinations](#) on page 86
- [started](#) on page 87

This section also lists some queue resource limits (see [Assigning queue resource limits](#) on page 87).




For Boolean attributes, *T*, *t*, *1*, *Y*, and *y* are all synonymous with "TRUE," and *F*, *f*, *0*, *N*, and *n* all mean "FALSE."

acl_groups	
<b>Format</b>	<GROUP>[@<HOST>][+<USER>[@<HOST>]]...
<b>Default</b>	---
<b>Description</b>	<p>Specifies the list of groups which may submit jobs to the queue. If <code>acl_group_enable</code> is set to true, only users with a primary group listed in <code>acl_groups</code> may utilize the queue.</p> <div style="border: 1px solid #0070C0; border-radius: 10px; padding: 5px; margin-top: 10px;"> <p><b>i</b> If the <code>PBSACLUSEGROUPLIST</code> variable is set in the <code>pbs_server</code> environment, <code>acl_groups</code> checks against all groups of which the job user is a member.</p> </div>
<b>Example</b>	<pre style="border: 1px dashed #ccc; padding: 5px; margin-top: 10px;">&gt; qmgr -c "set queue batch acl_groups=staff" &gt; qmgr -c "set queue batch acl_groups+=ops@h2" &gt; qmgr -c "set queue batch acl_groups+=staff@h3"</pre> <div style="border: 1px solid #0070C0; border-radius: 10px; padding: 5px; margin-top: 10px;"> <p><b>i</b> Used in conjunction with <a href="#">acl_group_enable</a>.</p> </div>

acl_group_enable	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	If <b>TRUE</b> , constrains TORQUE to only allow jobs submitted from groups specified by the <a href="#">acl_groups</a> parameter.
<b>Example</b>	<pre style="border: 1px dashed #ccc; padding: 5px; margin-top: 10px;">qmgr -c "set queue batch acl_group_enable=true"</pre>


acl_group_sloppy	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	If <b>TRUE</b> , <a href="#">acl_groups</a> will be checked against all groups of which the job users is a member.
<b>Example</b>	---

acl_hosts	
<b>Format</b>	<HOST>[+<HOST>]...
<b>Default</b>	---
<b>Description</b>	Specifies the list of hosts that may submit jobs to the queue.
<b>Example</b>	<pre>qmgr -c "set queue batch acl_hosts=h1+h2+h3"</pre> <div style="border: 1px solid #0070c0; border-radius: 5px; padding: 5px; margin-top: 5px;">  Used in conjunction with <a href="#">acl_host_enable</a>.         </div>

acl_host_enable	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	If <b>TRUE</b> , constrains TORQUE to only allow jobs submitted from hosts specified by the <a href="#">acl_hosts</a> parameter.
<b>Example</b>	<pre>qmgr -c "set queue batch acl_host_enable=true"</pre>

acl_logic_or	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	If <b>TRUE</b> , user and group acls are logically OR'd together, meaning that either acl may be met to allow access. If <b>FALSE</b> or unset, then both acls are AND'd, meaning that both acls must be satisfied.
<b>Example</b>	<pre>qmgr -c "set queue batch acl_logic_or=true"</pre>

acl_users	
<b>Format</b>	<USER>[@<HOST>][+<USER>[@<HOST>]]...
<b>Default</b>	---

acl_users	
<b>Description</b>	Specifies the list of users who may submit jobs to the queue. If <a href="#">acl_user_enable</a> is set to <b>TRUE</b> , only users listed in <code>acl_users</code> may use the queue.
<b>Example</b>	<pre>&gt; qmgr -c "set queue batch acl_users=john" &gt; qmgr -c "set queue batch acl_users+=steve@h2" &gt; qmgr -c "set queue batch acl_users+=stevek@h3"</pre>
	 Used in conjunction with <a href="#">acl_user_enable</a> .

acl_user_enable	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	If <b>TRUE</b> , constrains TORQUE to only allow jobs submitted from users specified by the <a href="#">acl_users</a> parameter.
<b>Example</b>	<pre>qmgr -c "set queue batch acl_user_enable=true"</pre>

disallowed_types	
<b>Format</b>	<type>[+<type>]...
<b>Default</b>	---
<b>Description</b>	Specifies classes of jobs that are not allowed to be submitted to this queue. Valid types are interactive, batch, rerunnable, nonrerunnable, fault_tolerant (as of version 2.4.0 and later), fault_intolerant (as of version 2.4.0 and later), and job_array (as of version 2.4.1 and later).
<b>Example</b>	<pre>qmgr -c "set queue batch disallowed_types = interactive" qmgr -c "set queue batch disallowed_types += job_array"</pre>


enabled	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE

enabled	
<b>Description</b>	Specifies whether the queue accepts new job submissions.
<b>Example</b>	<pre>qmgr -c "set queue batch enabled=true"</pre>

features_required	
<b>Format</b>	feature1 [feature2 [,feature3...]]
<b>Default</b>	---
<b>Description</b>	Specifies that all jobs in this queue will require these features in addition to any they may have requested. A feature is a synonym for a property.
<b>Example</b>	<pre>qmgr -c 's q batch features_required=fast'</pre>

keep_completed	
<b>Format</b>	<INTEGER>
<b>Default</b>	0
<b>Description</b>	Specifies the number of seconds jobs should be held in the Completed state after exiting. For more information, see <a href="#">Keeping completed jobs on page 52</a> .
<b>Example</b>	<pre>qmgr -c "set queue batch keep_completed=120"</pre>

kill_delay	
<b>Format</b>	<INTEGER>
<b>Default</b>	2

kill_delay	
<b>Description</b>	<p>Specifies the number of seconds between sending a SIGTERM and a SIGKILL to a job in a specific queue that you want to cancel. It is possible that the job script, and any child processes it spawns, can receive several SIGTERM signals before the SIGKILL signal is received.</p> <div style="border: 1px solid #0070C0; border-radius: 10px; padding: 5px; margin-top: 10px;"> <p> All MOMs must be configured with <code>\$exec with exec true</code> in order for <b>kill_delay</b> to work, even when relying on default <b>kill_delay</b> settings.</p> </div>
<b>Example</b>	<pre>qmgr -c "set queue batch kill_delay=30"</pre>

max_queuable	
<b>Format</b>	<INTEGER>
<b>Default</b>	unlimited
<b>Description</b>	Specifies the maximum number of jobs allowed in the queue at any given time (includes idle, running, and blocked jobs).
<b>Example</b>	<pre>qmgr -c "set queue batch max_queuable=20"</pre>

max_running	
<b>Format</b>	<INTEGER>
<b>Default</b>	unlimited
<b>Description</b>	Specifies the maximum number of jobs in the queue allowed to run at any given time.
<b>Example</b>	<pre>qmgr -c "set queue batch max_running=20"</pre>

max_user_queuable	
<b>Format</b>	<INTEGER>
<b>Default</b>	unlimited

**max\_user\_queuable**

<b>Description</b>	Specifies the maximum number of jobs, per user, allowed in the queue at any given time (includes idle, running, and blocked jobs). Version 2.1.3 and greater.
--------------------	---

<b>Example</b>	<pre>qmgr -c "set queue batch max_user_queuable=20"</pre>
----------------	---

**max\_user\_run**

<b>Format</b>	<INTEGER>
---------------	-----------

<b>Default</b>	unlimited
----------------	-----------

<b>Description</b>	Specifies the maximum number of jobs, per user, in the queue allowed to run at any given time.
--------------------	--

<b>Example</b>	<pre>qmgr -c "set queue batch max_user_run=10"</pre>
----------------	--

**priority**

<b>Format</b>	<INTEGER>
---------------	-----------

<b>Default</b>	0
----------------	---

<b>Description</b>	Specifies the priority value associated with the queue.
--------------------	---

<b>Example</b>	<pre>qmgr -c "set queue batch priority=20"</pre>
----------------	--

**queue\_type**

<b>Format</b>	One of <i>e</i> , <i>execution</i> , <i>r</i> , or <i>route</i> (see <a href="#">Creating a routing queue on page 89</a> )
---------------	--

<b>Default</b>	---
----------------	-----

<b>Description</b>	Specifies the queue type.
--------------------	---------------------------



This value must be explicitly set for all queues.

<b>Example</b>	<pre>qmgr -c "set queue batch queue_type=execution"</pre>
----------------	---



required_login_property	
<b>Format</b>	<STRING>
<b>Default</b>	---
<b>Description</b>	Adds the specified login property as a requirement for all jobs in this queue.
<b>Example</b>	<pre>qmgr -c 's q &lt;queueName&gt; required_login_property=INDUSTRIAL'</pre>


resources_available	
<b>Format</b>	<STRING>
<b>Default</b>	---
<b>Description</b>	Specifies to cumulative resources available to all jobs running in the queue. See <a href="#">qsub will not allow the submission of jobs requesting many processors on page 132</a> for more information.
<b>Example</b>	<pre>qmgr -c "set queue batch resources_available.nodect=20"</pre> <div style="border: 1px solid #0070C0; padding: 5px; margin-top: 5px;"> <p><b>i</b> You must restart pbs_server for changes to take effect. Also, resources_available is constrained by the smallest of queue.resources_available and server.resources_available.</p> </div>

resources_default	
<b>Format</b>	<STRING>
<b>Default</b>	---
<b>Description</b>	Specifies default resource requirements for jobs submitted to the queue.
<b>Example</b>	<pre>qmgr -c "set queue batch resources_default.walltime=3600"</pre>

resources_max	
<b>Format</b>	<STRING>

resources_max	
<b>Default</b>	---
<b>Description</b>	Specifies the maximum resource limits for jobs submitted to the queue.
<b>Example</b>	<pre>qmgr -c "set queue batch resources_max.nodect=16"</pre>


resources_min	
<b>Format</b>	<STRING>
<b>Default</b>	---
<b>Description</b>	Specifies the minimum resource limits for jobs submitted to the queue.
<b>Example</b>	<pre>qmgr -c "set queue batch resources_min.nodect=2"</pre>

route_destinations	
<b>Format</b>	<queue>[@<host>]
<b>Default</b>	---
<b>Description</b>	Specifies the potential destination queues for jobs submitted to the associated routing queue. <div style="border: 1px solid #0070C0; padding: 5px; margin-top: 10px;">  This attribute is only valid for routing queues (see <a href="#">Creating a routing queue on page 89</a>). </div>
<b>Example</b>	<pre>&gt; qmgr -c "set queue route route_destinations=fast" &gt; qmgr -c "set queue route route_destinations+=slow" &gt; qmgr -c "set queue route route_destinations+=medium@hostname"</pre> <p>To set multiple queue specifications, use multiple commands:</p> <pre>&gt; qmgr -c 's s route_destinations=batch' &gt; qmgr -c 's s route_destinations+=long' &gt; qmgr -c 's s route_destinations+=short'</pre>

started	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	Specifies whether jobs in the queue are allowed to execute.
<b>Example</b>	<pre>qmgr -c "set queue batch started=true"</pre>

## Assigning queue resource limits

Administrators can use resources limits to help direct what kind of jobs go to different queues. There are four queue attributes where resource limits can be set: [resources\\_available](#), [resources\\_default](#), [resources\\_max](#), and [resources\\_min](#). The list of supported resources that can be limited with these attributes are *arch*, *mem*, *nodect*, *nodes*, *procct*, *pvmem*, *vmem*, and *walltime*.

Resource	Format	Description
<b>arch</b>	string	Specifies the administrator defined system architecture required.
<b>mem</b>	<a href="#">size</a>	Amount of physical memory used by the job. (Ignored on Darwin, Digital Unix, Free BSD, HPUX 11, IRIX, NetBSD, and SunOS. Also ignored on Linux if number of nodes is not 1. Not implemented on AIX and HPUX 10.)
<b>ncpus</b>	integer	Sets the number of processors in one task where a task cannot span nodes. <div style="border: 1px solid #0070C0; border-radius: 10px; padding: 5px; margin-top: 10px;">  You cannot request both ncpus and nodes in the same queue. </div>
<b>nodect</b>	integer	Sets the number of nodes available. By default, TORQUE will set the number of nodes available to the number of nodes listed in the <code>\$TORQUE_HOME/server_priv/nodes</code> file. <code>nodect</code> can be set to be greater than or less than that number. Generally, it is used to set the node count higher than the number of physical nodes in the cluster.
<b>nodes</b>	integer	Specifies the number of nodes.
<b>procct</b>	integer	Sets limits on the total number of execution slots (procs) allocated to a job. The number of procs is calculated by summing the products of all node and ppn entries for a job. For example <code>qsub -l nodes=2:ppn=2+3:ppn=4 job.sh</code> would yield a procct of $16. 2*2 (2:ppn=2) + 3*4 (3:ppn=4)$ .

Resource	Format	Description
<b>pvmem</b>	<a href="#">size</a>	Amount of virtual memory used by any single process in a job.
<b>vmem</b>	<a href="#">size</a>	Amount of virtual memory used by all concurrent processes in the job.
<b>walltime</b>	seconds, or [[HH:] MM:]SS	Amount of real time during which a job can be in a running state.

*size*

The size format specifies the maximum amount in terms of bytes or words. It is expressed in the form *integer[suffix]*. The suffix is a multiplier defined in the following table ("b" means bytes [the default] and "w" means words). The size of a word is calculated on the execution server as its word size.

Suffix		Multiplier
b	w	1
kb	kw	1024
mb	mw	1,048,576
gb	gw	1,073,741,824
tb	tw	1,099,511,627,776

### Related topics

- [Queue configuration on page 77](#)
- [Example queue configuration on page 88](#)

## Example queue configuration

The following series of **qmgr** commands will create and configure a queue named batch:

```
qmgr -c "create queue batch queue_type=execution"
qmgr -c "set queue batch started=true"
qmgr -c "set queue batch enabled=true"
qmgr -c "set queue batch resources_default.nodes=1"
qmgr -c "set queue batch resources_default.walltime=3600"
```

This queue will accept new jobs and, if not explicitly specified in the job, will assign a nodecount of 1 and a walltime of 1 hour to each job.

**Related topics**

- [Queue configuration on page 77](#)

## Setting a default queue

By default, a job must explicitly specify which queue it is to run in. To change this behavior, the server parameter [default\\_queue](#) may be specified as in the following example:

```
qmgr -c "set server default_queue=batch"
```

**Related topics**

- [Queue configuration on page 77](#)

## Mapping a queue to subset of resources

TORQUE does not currently provide a simple mechanism for mapping queues to nodes. However, schedulers such as [Moab](#) and [Maui](#) can provide this functionality.

The simplest method is using `default_resources.neednodes` on an execution queue, setting it to a particular node attribute. Maui/Moab will use this information to ensure that jobs in that queue will be assigned nodes with that attribute. For example, suppose we have some nodes bought with money from the chemistry department, and some nodes paid by the biology department.

```
$TORQUE_HOME/server_priv/nodes:
node01 np=2 chem
node02 np=2 chem
node03 np=2 bio
node04 np=2 bio
qmgr:
set queue chem resources_default.neednodes=chem
set queue bio resources_default.neednodes=bio
```



This example does not preclude other queues from accessing those nodes. One solution is to use some other generic attribute with all other nodes and queues.

More advanced configurations can be made with standing reservations and QoSs.

**Related topics**

- [Queue configuration on page 77](#)

## Creating a routing queue

A routing queue will steer a job to a destination queue based on job attributes and queue constraints. It is set up by creating a queue of [queue\\_type](#) "Route" with a [route\\_destinations](#) attribute set, as in the following example.

```

qmgr

# routing queue
create queue route
set queue route queue_type = Route
set queue route route_destinations = reg_64
set queue route route_destinations += reg_32
set queue route route_destinations += reg
set queue route enabled = True
set queue route started = True

# queue for jobs using 1-15 nodes
create queue reg
set queue reg queue_type = Execution
set queue reg resources_min.ncpus = 1
set queue reg resources_min.nodect = 1
set queue reg resources_default.ncpus = 1
set queue reg resources_default.nodes = 1
set queue reg enabled = True
set queue reg started = True

# queue for jobs using 16-31 nodes
create queue reg_32
set queue reg_32 queue_type = Execution
set queue reg_32 resources_min.ncpus = 31
set queue reg_32 resources_min.nodes = 16
set queue reg_32 resources_default.walltime = 12:00:00
set queue reg_32 enabled = True
set queue reg_32 started = True

# queue for jobs using 32+ nodes
create queue reg_64
set queue reg_64 queue_type = Execution
set queue reg_64 resources_min.ncpus = 63
set queue reg_64 resources_min.nodes = 32
set queue reg_64 resources_default.walltime = 06:00:00
set queue reg_64 enabled = True
set queue reg_64 started = True

# have all jobs go through the routing queue
set server default_queue = batch
set server resources_default.ncpus = 1
set server resources_default.walltime = 24:00:00
...

```

In this example, the compute nodes are dual processors and default walltimes are set according to the number of processors/nodes of a job. Jobs with 32 nodes (63 processors) or more will be given a default walltime of 6 hours. Also, jobs with 16-31 nodes (31-62 processors) will be given a default walltime of 12 hours. All other jobs will have the server default walltime of 24 hours.

The ordering of the `route_destinations` is important. In a routing queue, a job is assigned to the first possible destination queue based on the [resources\\_max](#), [resources\\_min](#), [acl\\_users](#), and [acl\\_groups](#) attributes. In the preceding example, the attributes of a single processor job would first be checked against the `reg_64` queue, then the `reg_32` queue, and finally the `reg` queue.

Adding the following settings to the earlier configuration elucidates the queue resource requirements:

```

qmgr

set queue reg resources_max.ncpus = 30
set queue reg resources_max.nodect = 15
set queue reg_16 resources_max.ncpus = 62
set queue reg_16 resources_max.nodect = 31

```

The time of enforcement of server and queue defaults is important in this example. TORQUE applies server and queue defaults differently in job centric and queue centric modes. For job centric mode, TORQUE waits to apply the server and queue defaults until the job is assigned to its final execution queue. For queue centric mode, it enforces server defaults before it is placed in the routing queue. In either mode, queue defaults override the server defaults. TORQUE defaults to job centric mode. To set queue centric mode, set `queue_centric_limits`, as in what follows:

```
qmgr
set server queue_centric_limits = true
```

An artifact of job centric mode is that if a job does not have an attribute set, the server and routing queue defaults are not applied when queue resource limits are checked. Consequently, a job that requests 32 nodes (not `ncpus=32`) will not be checked against a `min_resource.ncpus` limit. Also, for the preceding example, a job without any attributes set will be placed in the `reg_64` queue, since the server `ncpus` default will be applied after the job is assigned to an execution queue.

**i** Routine queue defaults are not applied to job attributes in versions 2.1.0 and before.

**i** If the error message "qsub: Job rejected by all possible destinations" is reported when submitting a job, it may be necessary to add queue location information, (i.e., in the routing queue's `route_destinations` attribute, change "batch" to "batch@localhost").

### Related topics

- [Queue configuration on page 77](#)
- [Queue attributes on page 78](#)

## Server high availability

You can now run TORQUE in a redundant or high availability mode. This means that there can be multiple instances of the server running and waiting to take over processing in the event that the currently running server fails.

**i** The high availability feature is available in the 2.3 and later versions of TORQUE. TORQUE 2.4 includes several enhancements to high availability (see [Server high availability on page 91](#)).

For more details, see these sections:

- [Redundant server host machines on page 92](#)
- [Server high availability on page 91](#)
- [Enhanced high availability with Moab on page 93](#)
- [How commands select the correct server host on page 93](#)
- [Job names on page 94](#)

- [Persistence of the pbs\\_server process on page 94](#)
- [High availability of the NFS server on page 94](#)
- [Installing TORQUE in high availability mode on page 94](#)
- [Installing TORQUE in high availability mode on headless nodes on page 99](#)
- [Example setup of high availability on page 103](#)

## Redundant server host machines

High availability enables TORQUE to continue running even if `pbs_server` is brought down. This is done by running multiple copies of `pbs_server` which have their `torque/server_priv` directory mounted on a shared file system.

**i** Do not use symlinks when sharing the TORQUE home directory or `server_priv` directories. A workaround for this is to use `mount --rbind /path/to/share /var/spool/torque`. Also, it is highly recommended that you only share the `server_priv` and not the entire `$TORQUEHOMEDIR`.

The `torque/server_name` must include the host names of all nodes that run `pbs_server`. All MOM nodes also must include the host names of all nodes running `pbs_server` in their `torque/server_name` file. The syntax of the `torque/server_name` is a comma delimited list of host names.

For example:

```
host1,host2,host3
```

**i** When configuring high availability, do not use `$pbsserver` to specify the host names. You must use the `$TORQUEHOMEDIR/server_name` file.

All instances of `pbs_server` need to be started with the `--ha` command line option that allows the servers to run at the same time. Only the first server to start will complete the full startup. The second server to start will block very early in the startup when it tries to lock the file `torque/server_priv/server.lock`. When the second server cannot obtain the lock, it will spin in a loop and wait for the lock to clear. The sleep time between checks of the lock file is one second.

Notice that not only can the servers run on independent server hardware, there can also be multiple instances of the `pbs_server` running on the same machine. This was not possible before as the second one to start would always write an error and quit when it could not obtain the lock.

## Enabling high availability

To use high availability, you must start each instance of `pbs_server` with the `--ha` option.

Prior to version 4.0, TORQUE with HA was configured with an `--enable-high-availability` option. That option is no longer required.

Three server options help manage high availability. The server parameters are [lock\\_file](#), [lock\\_file\\_update\\_time](#), and [lock\\_file\\_check\\_time](#).



The `lock_file` option allows the administrator to change the location of the lock file. The default location is `torque/server_priv`. If the `lock_file` option is used, the new location must be on the shared partition so all servers have access.

The `lock_file_update_time` and `lock_file_check_time` parameters are used by the servers to determine if the primary server is active. The primary `pbs_server` will update the lock file based on the `lock_file_update_time` (default value of 3 seconds). All backup `pbs_servers` will check the lock file as indicated by the `lock_file_check_time` parameter (default value of 9 seconds). The `lock_file_update_time` must be less than the `lock_file_check_time`. When a failure occurs, the backup `pbs_server` takes up to the `lock_file_check_time` value to take over.

```
> qmgr -c "set server lock_file_check_time=5"
```

In the above example, after the primary `pbs_server` goes down, the backup `pbs_server` takes up to 5 seconds to take over. It takes additional time for all MOMs to switch over to the new `pbs_server`.



The clock on the primary and redundant servers must be synchronized in order for high availability to work. Use a utility such as NTP to ensure your servers have a synchronized time.

## Enhanced high availability with Moab

When TORQUE is run with an external scheduler such as Moab, and the `pbs_server` is not running on the same host as Moab, `pbs_server` needs to know where to find the scheduler. To do this, use the `-l` option as demonstrated in the example below (the port is required and the default is 15004).

```
> pbs_server -l <moabhost:port>
```

If Moab is running in HA mode, add a `-l` option for each redundant server.

```
> pbs_server -l <moabhost1:port> -l <moabhost2:port>
```

If `pbs_server` and Moab run on the same host, use the `--ha` option as demonstrated in the example below.

```
> pbs_server --ha
```

The root user of each Moab host must be added to the [operators](#) and [managers](#) lists of the server. This enables Moab to execute root level operations in TORQUE.

## How commands select the correct server host

The various commands that send messages to `pbs_server` usually have an option of specifying the server name on the command line, or if none is specified will use the default server name. The default server name comes either from the environment variable `PBS_DEFAULT` or from the file `torque/server_name`.

When a command is executed and no explicit server is mentioned, an attempt is made to connect to the first server name in the list of hosts from `PBS_DEFAULT` or `torque/server_name`. If this fails, the next server name is tried. If all servers in the list are unreachable, an error is returned and the command fails.

Note that there is a period of time after the failure of the current server during which the new server is starting up where it is unable to process commands. The new server must read the existing configuration and job information from the disk, so the length of time that commands cannot be received varies. Commands issued during this period of time might fail due to timeouts expiring.

## Job names

Job names normally contain the name of the host machine where `pbs_server` is running. When job names are constructed, only the server name in `$PBS_DEFAULT` or the first name from the server specification list, `$TORQUE_HOME/server_name`, is used in building the job name.

## Persistence of the `pbs_server` process

The system administrator must ensure that `pbs_server` continues to run on the server nodes. This could be as simple as a *cron* job that counts the number of `pbs_server`'s in the process table and starts some more if needed.

## High availability of the NFS server

One consideration of this implementation is that it depends on NFS file system also being redundant. NFS can be set up as a redundant service. See the following.

- [Setting Up A Highly Available NFS Server](#)
- [Making NFS Work On Your Network](#)
- [Sourceforge Linux NFS FAQ](#)
- [NFS v4 main site](#)

There are also other ways to set up a shared file system. See the following:

- [Red Hat Global File System](#)
- [Data sharing with a GFS storage cluster](#)

## Installing TORQUE in high availability mode

The following procedure demonstrates a TORQUE installation in high availability (HA) mode.

## Requirements

- gcc (GCC) 4.1.2
- BASH shell
- Servers configured the following way:
  - 2 main servers with identical architecture:
    - `server1` — Primary server running TORQUE with a shared file system (this example uses NFS)
    - `server2` — Secondary server running with TORQUE with a shared file system (this example uses NFS)
  - `fileServer` — Shared file system (this example uses NFS)
  - Compute nodes



These systems can be CentOS 5.7 or higher, RHEL 5.7 or higher, or SLES 6.3 or higher.

## To install TORQUE in HA mode

1. Stop all firewalls or update your firewall to allow traffic from TORQUE services.

```
> service iptables stop
> chkconfig iptables off
```

If you are unable to stop the firewall due to infrastructure restriction, open the following ports:

- 15001 [tcp,udp]
- 15002 [tcp,udp]
- 15003 [tcp,udp]

2. Disable SELinux

```
> vi /etc/sysconfig/selinux
SELINUX=disabled
```

3. Update your main `~/.bashrc` profile to ensure you are always referencing the applications to be installed on all servers.

```
# TORQUE
export TORQUEHOME=/var/spool/torque

# Library Path
export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:${TORQUEHOME}/lib

# Update system paths
export PATH=${TORQUEHOME}/bin:${TORQUEHOME}/sbin:$ {PATH}
```

4. Verify `server1` and `server2` are resolvable via either DNS or looking for an entry in the `/etc/hosts` file.
5. Configure the NFS Mounts by following these steps:

- a. Create mount point folders on fileServer.

```
fileServer# mkdir -m 0755 /var/spool/torque
fileServer# mkdir -m 0750 /var/spool/torque/server_priv
```

- b. Update /etc/exports on fileServer. The IP addresses should be that of server2.

```
/var/spool/torque/server_priv 192.168.0.0/255.255.255.0(rw, sync, no_root_squash)
```

- c. Update the list of NFS exported file systems.

```
fileServer# exportfs -r
```

6. If the NFS daemons are not already running on fileServer, start them.

```
> systemctl restart rpcbind.service
> systemctl start nfs-server.service
> systemctl start nfs-lock.service
> systemctl start nfs-idmap.service
```

7. Mount the exported file systems on server1 by following these steps:

- a. Create the directory reference and mount them.

```
server1# mkdir /var/spool/torque/server_priv
```

Repeat this process for server2.

- b. Update /etc/fstab on server1 to ensure that NFS mount is performed on startup.

```
fileServer:/var/spool/torque/server_priv /var/spool/torque/server_priv nfs
rsize= 8192, wsize=8192, timeo=14, intr
```

Repeat this step for server2.

8. Install TORQUE by following these steps:

- a. Download and extract TORQUE 4.2.9 on server1.

```
server1# wget http://github.com/adaptivecomputing/torque/branches/4.2.9/torque-4.2.9.tar.gz
server1# tar -xvzf torque-4.2.9.tar.gz
```

- b. Navigate to the TORQUE directory and compile TORQUE on server1.

```
server1# configure
server1# make
server1# make install
server1# make packages
```

- c. If the installation directory is shared on both head nodes, then run `make install` on server1.

```
server1# make install
```

If the installation directory is not shared, repeat step 8a-b (downloading and installing TORQUE) on server2.

## 9. Start trqauthd.

```
server1# /etc/init.d/trqauthd start
```

## 10. Configure TORQUE for HA.

- a. List the host names of all nodes that run `pbs_server` in the `torque/server_name` file. You must also include the host names of all nodes running `pbs_server` in the `torque/server_name` file of each MOM node. The syntax of `torque/server_name` is a comma-delimited list of host names.

```
server1
server2
```

- b. Create a simple queue configuration for TORQUE job queues on server1.

```
server1# pbs_server -t create
server1# qmgr -c "set server scheduling=true"
server1# qmgr -c "create queue batch queue_type=execution"
server1# qmgr -c "set queue batch started=true"
server1# qmgr -c "set queue batch enabled=true"
server1# qmgr -c "set queue batch resources_default.nodes=1"
server1# qmgr -c "set queue batch resources_default.walltime=3600"
server1# qmgr -c "set server default_queue=batch"
```

**i** Because `server_priv/*` is a shared drive, you do not need to repeat this step on server2.

- c. Add the root users of TORQUE to the TORQUE configuration as an operator and manager.

```
server1# qmgr -c "set server managers += root@server1"
server1# qmgr -c "set server managers += root@server2"
server1# qmgr -c "set server operators += root@server1"
server1# qmgr -c "set server operators += root@server2"
```

**i** Because `server_priv/*` is a shared drive, you do not need to repeat this step on Server 2.

- d. You must update the lock file mechanism for TORQUE in order to determine which server is the primary. To do so, use the `lock_file_update_time` and `lock_file_check_time` parameters. The primary `pbs_server` will update the lock file based on the specified `lock_file_update_time` (default value of 3 seconds). All backup `pbs_servers` will check the lock file as indicated by the `lock_file_check_time` parameter (default value of 9 seconds). The `lock_file_update_time` must be less than the `lock_file_check_time`. When a failure occurs, the backup `pbs_server` takes up to the `lock_file_check_time` value to take over.

```
server1# qmgr -c "set server lock_file_check_time=5"
server1# qmgr -c "set server lock_file_update_time=3"
```

**i** Because `server_priv/*` is a shared drive, you do not need to repeat this step on server2.

- e. List the servers running `pbs_server` in the TORQUE `acl_hosts` file.

```
server1# qmgr -c "set server acl_hosts += server1"
server1# qmgr -c "set server acl_hosts += server2"
```

**i** Because `server_priv/*` is a shared drive, you do not need to repeat this step on `server2`.

- f. Restart the running `pbs_server` in HA mode.

```
server1# qterm
```

- g. Start the `pbs_server` on the secondary server.

```
server1# pbs_server --ha -l server2:port
server2# pbs_server --ha -l server1:port
```

11. Check the status of TORQUE in HA mode.

```
server1# qmgr -c "p s"
server2# qmgr -c "p s"
```

*The commands above returns all settings from the active TORQUE server from either node.*

Drop one of the `pbs_servers` to verify that the secondary server picks up the request.

```
server1# qterm
server2# qmgr -c "p s"
```

Stop the `pbs_server` on `server2` and restart `pbs_server` on `server1` to verify that both nodes can handle a request from the other.

12. Install a `pbs_mom` on the compute nodes.

- a. Copy the install scripts to the compute nodes and install.
- b. Navigate to the shared source directory of TORQUE and run the following:

```
node1# torque-package-mom-linux-x86_64.sh --install
node2# torque-package-clients-linux-x86_64.sh --install
```

Repeat this for each compute node. Verify that the `/var/pool/ torque/server-name` file shows all your compute nodes.

- c. On `server1` or `server2`, configure the nodes file to identify all available MOMs. To do so, edit the `/var/spool/torque/server_priv/nodes` file.

```
node1 np=2
node2 np=2
```

**i** Change the `np` flag to reflect number of available processors on that node.

- d. Recycle the `pbs_servers` to verify that they pick up the MOM configuration.

```
server1# qterm; pbs_server --ha -l server2:port
server2# qterm; pbs_server --ha -l server1:port
```

- e. Start the `pbs_mom` on each execution node.

```
node5# pbs_mom
node6# pbs_mom
```

## Installing TORQUE in high availability mode on headless nodes

The following procedure demonstrates a TORQUE installation in high availability (HA) mode on nodes with no local hard drive.

### Requirements

- gcc (GCC) 4.1.2
- BASH shell
- Servers (these cannot be two VMs on the same hypervisor) configured the following way:
  - 2 main servers with identical architecture
    - `server1` — Primary server running TORQUE with a file system share (this example uses NFS)
    - `server2` — Secondary server running with TORQUE with a file system share (this example uses NFS)
  - Compute nodes
  - `fileServer` — A shared file system server (this example uses NFS)

 These systems can be CentOS 5.7 or higher, RHEL 5.7 or higher, or SLES 6.3 or higher.

### To install TORQUE in HA mode on a node with no local hard drive

1. Stop all firewalls or update your firewall to allow traffic from TORQUE services.

```
> service iptables stop
> chkconfig iptables off
```

If you are unable to stop the firewall due to infrastructure restriction, open the following ports:

- 15001 [tcp,udp]
- 15002 [tcp,udp]
- 15003 [tcp,udp]

2. Disable SELinux

```
> vi /etc/sysconfig/selinux
SELINUX=disabled
```

3. Update your main `~/ .bashrc` profile to ensure you are always referencing the applications to be installed on all servers.

```
# TORQUE
export TORQUEHOME=/var/spool/torque

# Library Path
export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:${TORQUEHOME}/lib

# Update system paths
export PATH=${TORQUEHOME}/bin:${TORQUEHOME}/sbin:${PATH}
```

4. Verify server1 and server2 are resolvable via either DNS or looking for an entry in the /etc/hosts file.

5. Configure the NFS Mounts by following these steps:

- a. Create mount point folders on fileServer.

```
fileServer# mkdir -m 0755 /var/spool/torque
```

- b. Update /etc/exports on fileServer. The IP addresses should be that of server2.

```
/var/spool/torque/ 192.168.0.0/255.255.255.0(rw,sync,no_root_squash)
```

- c. Update the list of NFS exported file systems.

```
fileServer# exportfs -r
```

6. If the NFS daemons are not already running on fileServer, start them.

```
> systemctl restart rpcbind.service
> systemctl start nfs-server.service
> systemctl start nfs-lock.service
> systemctl start nfs-idmap.service
```

7. Mount the exported file systems on server1 by following these steps:

- a. Create the directory reference and mount them.

```
server1# mkdir /var/spool/torque
```

Repeat this process for server2.

- b. Update /etc/fstab on server1 to ensure that NFS mount is performed on startup.

```
fileServer:/var/spool/torque/server_priv /var/spool/torque/server_priv nfs
rsize= 8192,wsiz=8192,timeo=14,intr
```

Repeat this step for server2.

8. Install TORQUE by following these steps:

- a. Download and extract TORQUE 4.2.9 on server1.

```
server1# wget http://github.com/adaptivecomputing/torque/branches/4.2.9/torque-4.2.9.tar.gz
server1# tar -xvzf torque-4.2.9.tar.gz
```

- b. Navigate to the TORQUE directory and compile TORQUE with the HA flag on server1.



```
server1# configure --prefix=/var/spool/torque
server1# make
server1# make install
server1# make packages
```

- c. If the installation directory is shared on both head nodes, then run `make install` on `server1`.

```
server1# make install
```

If the installation directory is not shared, repeat step 8a-b (downloading and installing TORQUE) on `server2`.

9. Start `trqauthd`.

```
server1# /etc/init.d/trqauthd start
```

10. Configure TORQUE for HA.

- a. List the host names of all nodes that run `pbs_server` in the `torque/server_name` file. You must also include the host names of all nodes running `pbs_server` in the `torque/server_name` file of each MOM node. The syntax of `torque/server_name` is a comma-delimited list of host names.

```
server1,server2
```

- b. Create a simple queue configuration for TORQUE job queues on `server1`.

```
server1# pbs_server -t create
server1# qmgr -c "set server scheduling=true"
server1# qmgr -c "create queue batch queue_type=execution"
server1# qmgr -c "set queue batch started=true"
server1# qmgr -c "set queue batch enabled=true"
server1# qmgr -c "set queue batch resources_default.nodes=1"
server1# qmgr -c "set queue batch resources_default.walltime=3600"
server1# qmgr -c "set server default_queue=batch"
```

**i** Because `TORQUEHOME` is a shared drive, you do not need to repeat this step on `server2`.

- c. Add the root users of TORQUE to the TORQUE configuration as an operator and manager.

```
server1# qmgr -c "set server managers += root@server1"
server1# qmgr -c "set server managers += root@server2"
server1# qmgr -c "set server operators += root@server1"
server1# qmgr -c "set server operators += root@server2"
```

**i** Because `TORQUEHOME` is a shared drive, you do not need to repeat this step on `server2`.

- d. You must update the lock file mechanism for TORQUE in order to determine which server is the primary. To do so, use the `lock_file_update_time` and `lock_file_check_time` parameters. The primary `pbs_server` will update the lock file based on the specified `lock_file_update_time` (default value of 3 seconds). All backup `pbs_servers` will check the lock file as

indicated by the `lock_file_check_time` parameter (default value of 9 seconds). The `lock_file_update_time` must be less than the `lock_file_check_time`. When a failure occurs, the backup `pbs_server` takes up to the `lock_file_check_time` value to take over.

```
server1# qmgr -c "set server lock_file_check_time=5"
server1# qmgr -c "set server lock_file_update_time=3"
```

**i** Because `TORQUEHOME` is a shared drive, you do not need to repeat this step on `server2`.

- e. List the servers running `pbs_server` in the TORQUE `acl_hosts` file.

```
server1# qmgr -c "set server acl_hosts += server1"
server1# qmgr -c "set server acl_hosts += server2"
```

**i** Because `TORQUEHOME` is a shared drive, you do not need to repeat this step on `server2`.

- f. Restart the running `pbs_server` in HA mode.

```
server1# qterm
```

- g. Start the `pbs_server` on the secondary server.

```
server1# pbs_server --ha -l server2:port
server2# pbs_server --ha -l server1:port
```

11. Check the status of TORQUE in HA mode.

```
server1# qmgr -c "p s"
server2# qmgr -c "p s"
```

*The commands above returns all settings from the active TORQUE server from either node.*

Drop one of the `pbs_servers` to verify that the secondary server picks up the request.

```
server1# qterm
server2# qmgr -c "p s"
```

Stop the `pbs_server` on `server2` and restart `pbs_server` on `server1` to verify that both nodes can handle a request from the other.

12. Install a `pbs_mom` on the compute nodes.

- a. On `server1` or `server2`, configure the nodes file to identify all available MOMs. To do so, edit the `/var/spool/torque/server_priv/nodes` file.

```
node1 np=2
node2 np=2
```

**i** Change the `np` flag to reflect number of available processors on that node.

- b. Recycle the `pbs_servers` to verify that they pick up the MOM configuration.

```
server1# qterm; pbs_server --ha -l server2:port
server2# qterm; pbs_server --ha -l server1:port
```

- c. Start the `pbs_mom` on each execution node.

```
server1# pbs_mom -d <mom-server1>
server2# pbs_mom -d <mom-server2>
```

## Example setup of high availability

1. The machines running `pbs_server` must have access to a shared `server_priv/` directory (usually an NFS share on a MoM).
2. All MoMs must have the same content in their `server_name` file. This can be done manually or via an NFS share. The `server_name` file contains a comma-delimited list of the hosts that run `pbs_server`.

```
# List of all servers running pbs_server
server1,server2
```

3. The machines running `pbs_server` must be listed in [acl\\_hosts](#).

```
> qmgr -c "set server acl_hosts += server1"
> qmgr -c "set server acl_hosts += server2"
```

4. Start `pbs_server` with the `--ha` option.

```
[root@server1]$ pbs_server --ha
[root@server2]$ pbs_server --ha
```

## Related topics

- [Setting server policies on page 77](#)
- [Queue configuration on page 77](#)



# Chapter 5: Integrating schedulers for TORQUE

Selecting the cluster scheduler is an important decision and significantly affects cluster utilization, responsiveness, availability, and intelligence. The default TORQUE scheduler, `pbs_sched`, is very basic and will provide poor utilization of your cluster's resources. Other options, such as Maui Scheduler or Moab Workload Manager, are highly recommended. If you are using [Maui](#) or [Moab](#), refer to the Moab-PBS Integration Guide. If using `pbs_sched`, simply start the `pbs_sched` daemon.

**i** If you are installing Moab Cluster Suite, TORQUE and Moab were configured at installation for interoperability and no further action is required.




# Chapter 6: Configuring data management

This section contains information about SCP-based data management with TORQUE. It describes how to use TORQUE with NFS and other networked filesystems. It also outlines file staging requirements. For details, see these topics:

- [SCP setup on page 107](#)
- [NFS and other networked filesystems on page 110](#)
- [File stage-in/stage-out on page 111](#)

## SCP setup

To use SCP-based data management, TORQUE must be authorized to migrate data to any of the compute nodes. If this is not already enabled within the cluster, this can be achieved with the process described below. This process enables uni-directional access for a particular user from a *source* host to a *destination* host.

 These directions were written using [OpenSSH version 3.6](#) and may not transfer correctly to older versions.

To set up TORQUE for SCP, follow the directions in each of these topics:

- [Generating SSH key on source host on page 107](#)
- [Copying public SSH key to each destination host on page 108](#)
- [Configuring the SSH daemon on each destination host on page 108](#)
- [Validating correct SSH configuration on page 109](#)
- [Enabling bi-directional SCP access on page 109](#)
- [Compiling TORQUE to support SPC on page 109](#)
- [Troubleshooting on page 110](#)

### Related topics

- [Configuring data management on page 107](#)

## Generating SSH key on source host

On the source host as the transfer user, execute the following:

```
> ssh-keygen -t rsa
```

This will prompt for a passphrase (optional) and create two files (`id_rsa` and `id_rsa.pub`) inside `~/.ssh/`.

### Related topics

- [SCP setup on page 107](#)
- [Copying public SSH key to each destination host on page 108](#)

## Copying public SSH key to each destination host

Transfer public key to each destination host as the transfer user:

Easy key copy:

```
ssh-copy-id [-i [identity_file]] [user@]machine
```

Manual steps to copy keys:

```
> scp ~/.ssh/id_rsa.pub destHost:~ (enter password)
```

Create an `authorized_keys` file on each destination host:

```
> ssh destHost (enter password)
> cat id_rsa.pub >> .ssh/authorized_keys
```

If the `.ssh` directory does not exist, create it with 700 privileges (`mkdir .ssh; chmod 700 .ssh`):

```
> chmod 700 .ssh/authorized_keys
```

### Related topics

- [Generating SSH key on source host on page 107](#)
- [SCP setup on page 107](#)

## Configuring the SSH daemon on each destination host

Some configuration of the SSH daemon may be required on the destination host. (Because this is not always the case, see [Validating correct SSH configuration on page 109](#) and test the changes made to this point. If the tests fail, proceed with this step and then try testing again.) Typically, this is done by editing the `/etc/ssh/sshd_config` file (root access needed). To verify correct configuration, see that the following attributes are set (not commented):

```
RSAAuthentication yes
PubkeyAuthentication yes
```

If configuration changes were required, the SSH daemon will need to be restarted (root access needed):

```
> /etc/init.d/sshd restart
```



**Related topics**

- [SCP setup on page 107](#)

## Validating correct SSH configuration

If all is properly configured, the following command issued on the *source* host should succeed and not prompt for a password:

```
> scp destHost:/etc/motd /tmp
```

**i** If this is your first time accessing *destination* from *source*, it may ask you if you want to add the fingerprint to a file of known hosts. If you specify yes, this message should no longer appear and should not interfere with scp copying via TORQUE. Also, it is important that the full hostname appear in the `known_hosts` file. To do this, use the full hostname for *destHost*, as in `machine.domain.org` instead of just `machine`.

**Related topics**

- [SCP setup on page 107](#)

## Enabling bi-directional SCP access

The preceding steps allow *source* access to *destination* without prompting for a password. The reverse, however, is not true. Repeat the steps, but this time using the *destination* as the *source*, etc. to enable bi-directional SCP access (i.e. *source* can send to *destination* and *destination* can send to *source* without password prompts.)

**Related topics**

- [SCP setup on page 107](#)

## Compiling TORQUE to support SPC

**i** In TORQUE 2.1 and later, SCP is the default remote copy protocol. These instructions are only necessary for earlier versions.

TORQUE must be re-configured (and then rebuilt) to use SCP by passing in the `--with-scp` flag to the configure script:

```
> ./configure --prefix=xxx --with-scp
> make
```

**i** If special SCP flags are required in your local setup, these can be specified using the `$rcpcmd` parameter.

**Related topics**

- [SCP setup on page 107](#)

## Troubleshooting

If, after following all of the instructions in this section (see [SCP setup on page 107](#)), TORQUE is still having problems transferring data with SCP, set the `PBSDEBUG` environment variable and restart the `pbs_mom` for details about copying. Also check the MOM log files for more details.

**Related topics**

- [SCP setup on page 107](#)

## NFS and other networked filesystems

When a batch job starts, its `stdin` file (if specified) is copied from the submission directory on the remote submission host. This file is placed in the `$PBSMOMHOME` directory on the mother superior node (i.e., `/usr/spool/PBS/spool`). As the job runs, `stdout` and `stderr` files are generated and placed in this directory using the naming convention `$JOBID.OU` and `$JOBID.ER`.

When the job completes, the MOM copies the files into the directory from which the job was submitted. By default, this file copying will be accomplished using a remote copy facility such as `rcp` or `scp`.

If a shared file system such as NFS, DFS, or AFS is available, a site can specify that the MOM should take advantage of this by specifying the `$usecp` directive inside the MOM configuration file (located in the `$PBSMOMHOME/mom_priv` directory) using the following format:

```
$usecp <HOST>:<SRCDIR> <DSTDIR>
```

`<HOST>` can be specified with a leading wildcard (`'*`) character. The following example demonstrates this directive:

```
mom_priv/config
# /home is NFS mounted on all hosts
$usecp */home /home
# submission hosts in domain fte.com should map '/data' directory on submit host to
# '/usr/local/data' on compute host
$usecp *.fte.com:/data /usr/local/data
```

If for any reason the MOM daemon is unable to copy the output or error files to the submission directory, these files are instead copied to the `undelivered` directory also located in `$PBSMOMHOME`.

**Related topics**

- [Configuring data management on page 107](#)

## File stage-in/stage-out

File staging requirements are specified using the `stagein` and `stageout` directives of the `qsub` command. Stagein requests occur before the job starts execution, while stageout requests happen after a job completes.

On completion of the job, all staged-in and staged-out files are removed from the execution system. The `file_list` is in the form `local_file@hostname:remote_file[,...]` regardless of the direction of the copy. The name `local_file` is the name of the file on the system where the job executed. It may be an absolute path or relative to the home directory of the user. The name `remote_file` is the destination name on the host specified by `hostname`. The name may be absolute or relative to the user's home directory on the destination host. The use of wildcards in the file name is not recommended.

The file names map to a remote copy program (`rcp/scp/cp`, depending on configuration) called on the execution system in the following manner:

For `stagein`: `rcp/scp hostname:remote_file local_file`

For `stageout`: `rcp/scp local_file hostname:remote_file`

### Examples

```
# stage /home/john/input_source.txt from node13.fsc to /home/john/input_
destination.txt on master compute node
> qsub -l nodes=1,walltime=100 -W stagein=input_
source.txt@node13.fsc:/home/john/input_destination.txt
```

```
# stage /home/bill/output_source.txt on master compute node to /tmp/output_
destination.txt on node15.fsc
> qsub -l nodes=1,walltime=100 -W stageout=/tmp/output_
source.txt@node15.fsc:/home/bill/output_destination.txt
```

```
$ fortune >xxx;echo cat xxx|qsub -W stagein=xxx@`hostname`:xxx
199.myhost.mydomain
$ cat STDIN*199
Anyone who has had a bull by the tail knows five or six more things
than someone who hasn't.
-- Mark Twain
```

### Related topics

- [Configuring data management on page 107](#)



# Chapter 7: MPI (Message Passing Interface) support

A message passing library is used by parallel jobs to augment communication between the tasks distributed across the cluster. TORQUE can run with any message passing library and provides limited integration with some [MPI](#) libraries.

For more information, see these topics:

- [MPICH on page 113](#)
- [Open MPI on page 114](#)

## MPICH

One of the most popular MPI libraries is [MPICH](#) available from [Argonne National Lab](#). If using this release, you may want to consider also using the [mpiexec](#) tool for launching MPI applications. Support for `mpiexec` has been integrated into TORQUE.

### MPIExec Overview

`mpiexec` is a replacement program for the script `mpirun`, which is part of the `mpich` package. It is used to initialize a parallel job from within a PBS batch or interactive environment. `mpiexec` uses the task manager library of PBS to spawn copies of the executable on the nodes in a PBS allocation.

Reasons to use `mpiexec` rather than a script (`mpirun`) or an external daemon (`mpd`):

- Starting tasks with the task manager (TM) interface is much faster than invoking a separate `rsh` \* once for each process.
- Resources used by the spawned processes are accounted correctly with `mpiexec`, and reported in the PBS logs, because all the processes of a parallel job remain under the control of PBS, unlike when using `mpirun`-like scripts.
- Tasks that exceed their assigned limits of CPU time, wallclock time, memory usage, or disk space are killed cleanly by PBS. It is quite hard for processes to escape control of the resource manager when using `mpiexec`.
- You can use `mpiexec` to enforce a security policy. If all jobs are forced to spawn using `mpiexec` and the PBS execution environment, it is not necessary to enable `rsh` or `ssh` access to the compute nodes in the cluster.

For more information, see the [mpiexec](#) homepage.

## MPIExec Troubleshooting

Although problems with `mpiexec` are rare, if issues do occur, the following steps may be useful:

- Determine current version using `mpiexec --version` and review the [change log](#) available on the [MPI homepage](#) to determine if the reported issue has already been corrected.
- Send email to the `mpiexec` mailing list at [mpiexec@osc.edu](mailto:mpiexec@osc.edu).
- Browse the `mpiexec` user list [archives](#) for similar problems and resolutions.
- Read the FAQ contained in the `README` file and the `mpiexec` man pages contained within the `mpiexec` distribution.
- Increase the logging of `mpiexec` operation with `mpiexec --verbose` (reports messages to `stderr`).
- Increase logging of the master and slave resource manager execution daemons associated with the job (with TORQUE, use `$loglevel` to 5 or higher in `$TORQUEROOT/mom_priv/config` and look for `'tm'` messages after associated `join job` messages).
- Use `tracejob` (included with TORQUE) or `qtracejob` (included with OSC's `pbstools` package) to isolate failures within the cluster.
- If the message `'exec: Error: get_hosts: pbs_connect: Access from host not allowed, or unknown host'` appears, this indicates that `mpiexec` cannot communicate with the `pbs_server` daemon. In most cases, this indicates that the `$TORQUEROOT/server_name` file points to the wrong server or the node cannot resolve the server's name. The [qstat](#) command can be run on the node to test this.

## General MPI Troubleshooting

When using MPICH, some sites have issues with orphaned MPI child processes remaining on the system after the master MPI process has been terminated. To address this, TORQUE epilogue scripts can be created that properly clean up the orphaned processes (see [Prologue and epilogue scripts on page 281](#)).

### Related topics

- [MPI \(Message Passing Interface\) support on page 113](#)

# Open MPI

[Open MPI](#) is a new MPI implementation that combines technologies from multiple projects to create the best possible library. It supports the TM interface for integration with TORQUE. More information is available in the [FAQ](#).

### Related topics

- [MPI \(Message Passing Interface\) support on page 113](#)

# Chapter 8: Resources

A primary task of any resource manager is to monitor the state, health, configuration, and utilization of managed resources. TORQUE is specifically designed to monitor compute hosts for use in a batch environment. TORQUE is not designed to monitor non-compute host resources such as software licenses, networks, file systems, and so forth, although these resources can be integrated into the cluster using some scheduling systems.

With regard to monitoring compute nodes, TORQUE reports about a number of attributes broken into three major categories:

- [Configuration on page 115](#)
- [Utilization on page 116](#)
- [Node states on page 116](#)

## Configuration

Configuration includes both detected hardware configuration and specified batch attributes.

Attribute	Description	Details
<b>Architecture (arch)</b>	operating system of the node	The value reported is a derivative of the operating system installed.
<b>Node Features (properties)</b>	arbitrary string attributes associated with the node	No node features are specified by default. If required, they are set using the <code>nodes</code> file located in the <code>TORQUE_HOME/server_priv</code> directory. They may specify any string and are most commonly used to allow users to request certain subsets of nodes when submitting jobs.
<b>Local Disk (size)</b>	configured local disk	By default, local disk space is not monitored. If the MOM configuration <a href="#">size [fs=&lt;FS&gt;]</a> parameter is set, TORQUE will report, in kilobytes, configured disk space within the specified directory.
<b>Memory (physmem)</b>	local memory/RAM	Local memory/RAM is monitored and reported in kilobytes.

Attribute	Description	Details
<b>Processors (ncpus/np)</b>	real/virtual processors	The number of processors detected by TORQUE is reported via the <i>ncpus</i> attribute. However, for scheduling purposes, other factors are taken into account. In its default configuration, TORQUE operates in "dedicated" mode with each node possessing a single virtual processor. In dedicated mode, each job task will consume one virtual processor and TORQUE will accept workload on each node until all virtual processors on that node are in use. While the number of virtual processors per node defaults to 1, this may be configured using the <i>nodes</i> file located in the <code>TORQUE_HOME/server_priv</code> directory. An alternative to dedicated mode is "timeshared" mode. If TORQUE's time-shared mode is enabled, TORQUE will accept additional workload on each node until the node's <i>maxload</i> limit is reached.
<b>Swap (totmem)</b>	virtual memory/Swap	Virtual memory/Swap is monitored and reported in kilobytes.

## Utilization

Utilization includes information regarding the amount of node resources currently in use as well as information about who or what is consuming it.

Attribute	Description	Details
<b>Disk (size)</b>	local disk availability	By default, local disk space is not monitored. If the MOM configuration <a href="#">size [fs=&lt;FS&gt;]</a> parameter is set, TORQUE will report configured and currently available disk space within the specified directory in kilobytes.
<b>Memory (availmem)</b>	real memory/RAM	Available real memory/RAM is monitored and reported in kilobytes.
<b>Network (netload)</b>	local network adapter usage	Reports total number of bytes transferred in or out by the network adapter.
<b>Processor Utilization (loadave)</b>	node's cpu load average	Reports the node's 1 minute bsd load average.

## Node states

State information includes administrative status, general node health information, and general usage status.



Attribute	Description	Details
<b>Idle Time (idletime)</b>	time since local keyboard/mouse activity has been detected	Time in seconds since local keyboard/mouse activity has been detected.
<b>State (state)</b>	monitored/admin node state	<p>A node can be in one or more of the following states:</p> <ul style="list-style-type: none"> <li>• <i>busy</i> - node is full and will not accept additional work</li> <li>• <i>down</i> - node is failing to report, is detecting local failures with node</li> <li>• <i>free</i> - node is ready to accept additional work</li> <li>• <i>job-exclusive</i> - all available virtual processors are assigned to jobs</li> <li>• <i>job-sharing</i> - node has been allocated to run multiple shared jobs and will remain in this state until jobs are complete</li> <li>• <i>offline</i> - node has been instructed by an admin to no longer accept work</li> <li>• <i>reserve</i> - node has been reserved by the server</li> <li>• <i>time-shared</i> - node always allows multiple jobs to run concurrently</li> <li>• <i>unknown</i> - node has not been detected</li> </ul>



# Chapter 9: Accounting records

TORQUE maintains accounting records for batch jobs in the following directory:

```
$TORQUEROOT/server_priv/accounting/<TIMESTAMP>
```

\$TORQUEROOT defaults to /usr/spool/PBS and <TIMESTAMP> is in the format: YYYYMMDD.

These records include events, time stamps, and information on resources requested and used.

Records for four different event types are produced and are described in the following table:

Record marker	Record type	Description
A	abort	Job has been aborted by the server
C	checkpoint	Job has been checkpointed and held
D	delete	Job has been deleted
E	exit	Job has exited (either successfully or unsuccessfully)
Q	queue	Job has been submitted/queued
R	rerun	Attempt to rerun the job has been made
S	start	Attempt to start the job has been made (if the job fails to properly start, it may have multiple job start records)
T	restart	Attempt to restart the job (from checkpoint) has been made (if the job fails to properly start, it may have multiple job start records)

## Accounting Variables

The following table offers accounting variable descriptions. Descriptions for accounting variables not indicated in the table, particularly those prefixed with **Resources\_List**, are available at [Job submission on page 39](#).

Variable	Description
<b>ctime</b>	Time job was created
<b>etime</b>	Time job became eligible to run
<b>qtime</b>	Time job was queued
<b>start</b>	Time job started to run

A sample record in this file can look like the following:

```
08/26/2014 17:07:44;Q;11923.napali;queue=batch
08/26/2014 17:07:50;S;11923.napali;user=dbeer group=company jobname=STDIN queue=batch
ctime=1409094464 qtime=1409094464 etime=1409094464 start=1409094470 owner=dbeer@napali
exec_host=napali/0+napali/1+napali/2+napali/3+napali/4+napali/5+torque-devtest-
03/0+torque-devtest-03/1+torque-devtest-03/2+torque-devtest-03/3+torque-devtest-
03/4+torque-devtest-03/5 Resource_List.nodes=2:ppn=6 Resource_List.nodect=2
Resource_List.nodes=2:ppn=6
08/26/2014 17:08:04;E;11923.napali;user=dbeer group=company jobname=STDIN queue=batch
ctime=1409094464 qtime=1409094464 etime=1409094464 start=1409094470 owner=dbeer@napali
exec_host=napali/0+napali/1+napali/2+napali/3+napali/4+napali/5+torque-devtest-
03/0+torque-devtest-03/1+torque-devtest-03/2+torque-devtest-03/3+torque-devtest-
03/4+torque-devtest-03/5 Resource_List.nodes=2:ppn=6 Resource_List.nodect=2
Resource_List.nodes=2:ppn=6 session=11352 total_execution_slots=12 unique_node_count=2
end=1409094484 Exit_status=265 resources_used.cput=00:00:00 resources_used.mem=82700kb
resources_used.vmem=208960kb resources_used.walltime=00:00:14 Error_Path=/dev/pts/11
Output_Path=/dev/pts/11
```

**i** The value of `Resource_List.*` is the amount of resources requested, and the value of `resources_used.*` is the amount of resources actually used.

**i** `total_execution_slots` and `unique_node_count` display additional information regarding the job resource usage.

# Chapter 10: Job logging

New in TORQUE 2.5.3 is the ability to log job information for completed jobs. The information stored in the log file is the same information produced with the command `qstat -f`. The log file data is stored using an XML format. Data can be extracted from the log using the utility `showjobs` found in the `contrib/` directory of the TORQUE source tree. Custom scripts that can parse the XML data can also be used.

For details about job logging, see these topics:

- [Job log location and name on page 121](#)
- [Enabling job logs on page 121](#)

## Job log location and name

When job logging is enabled (See [Enabling job logs on page 121](#).), the job log is kept at `$TORQUE_HOME/job_logs`. The naming convention for the job log is the same as for the server log or MOM log. The log name is created from the current year/month/day.

For example, if today's date is 26 October, 2010 the log file is named 20101026.

A new log file is created each new day that data is written to the log.

### Related topics

- [Enabling job logs on page 121](#)
- [Job logging on page 121](#)

## Enabling job logs

There are five new server parameters used to enable job logging. These parameters control what information is stored in the log and manage the log files.

Parameter	Description
<b>record_job_info</b>	This must be set to true in order for job logging to be enabled. If not set to true, the remaining server parameters are ignored.

Parameter	Description
<b>record_job_script</b>	If set to true, this adds the contents of the script executed by a job to the log.
<b>job_log_file_max_size</b>	This specifies a soft limit (in kilobytes) for the job log's maximum size. The file size is checked every five minutes and if the <i>current day</i> file size is greater than or equal to this value, it is rolled from <i>&lt;filename&gt;</i> to <i>&lt;filename.1&gt;</i> and a new empty log is opened. If the current day file size exceeds the maximum size a second time, the <i>&lt;filename.1&gt;</i> log file is rolled to <i>&lt;filename.2&gt;</i> , the current log is rolled to <i>&lt;filename.1&gt;</i> , and a new empty log is opened. Each new log causes all other logs to roll to an extension that is one greater than its current number. Any value less than 0 is ignored by pbs_server (meaning the log will not be rolled).
<b>job_log_file_roll_depth</b>	This sets the maximum number of new log files that are kept in a day if the <a href="#">job_log_file_max_size</a> parameter is set. For example, if the roll depth is set to 3, no file can roll higher than <i>&lt;filename.3&gt;</i> . If a file is already at the specified depth, such as <i>&lt;filename.3&gt;</i> , the file is deleted so it can be replaced by the incoming file roll, <i>&lt;filename.2&gt;</i> .
<b>job_log_keep_days</b>	This maintains logs for the number of days designated. If set to 4, any log file older than 4 days old is deleted.

### Related topics

- [Job log location and name on page 121](#)
- [Job logging on page 121](#)

# Chapter 11: Troubleshooting

There are a few general strategies that can be followed to determine the cause of unexpected behavior. These are a few of the tools available to help determine where problems occur. See these topics for details:

- [Host resolution](#) on page 123
- [Firewall configuration](#) on page 124
- [TORQUE log files](#) on page 124
- [Using "tracejob" to locate job failures](#) on page 125
- [Using GDB to locate job failures](#) on page 127
- [Other diagnostic options](#) on page 128
- [Stuck jobs](#) on page 128
- [Frequently asked questions \(FAQ\)](#) on page 129
- [Compute node health check](#) on page 134
- [Debugging](#) on page 136

## Host resolution

The TORQUE server host must be able to perform both forward and reverse name lookup on itself and on all compute nodes. Likewise, each compute node must be able to perform forward and reverse name lookup on itself, the TORQUE server host, and all other compute nodes. In many cases, name resolution is handled by configuring the node's `/etc/hosts` file although *DNS* and *NIS* services may also be used. Commands such as `nslookup` or `dig` can be used to verify proper host resolution.



Invalid host resolution may exhibit itself with compute nodes reporting as down within the output of `pbsnodes-a` and with failure of the `momctl -d3` command.

### Related topics

- [Troubleshooting](#) on page 123

## Firewall configuration

Be sure that, if you have firewalls running on the server or node machines, you allow connections on the appropriate ports for each machine. TORQUE `pbs_mom` daemons use UDP ports 1023 and below if privileged ports are configured (privileged ports is the default). The `pbs_server` and `pbs_mom` daemons use TCP and UDP ports 15001-15004 by default.

Firewall based issues are often associated with server to MOM communication failures and messages such as 'premature end of message' in the log files.

Also, the `tcpdump` program can be used to verify the correct network packets are being sent.

### Related topics

- [Troubleshooting on page 123](#)

## TORQUE log files

### `pbs_server` and `pbs_mom` log files

The `pbs_server` keeps a daily log of all activity in the `TORQUE_HOME/server_logs` directory. The `pbs_mom` also keeps a daily log of all activity in the `TORQUE_HOME/mom_logs/` directory. These logs contain information on communication between server and MOM as well as information on jobs as they enter the queue and as they are dispatched, run, and terminated. These logs can be very helpful in determining general job failures. For MOM logs, the verbosity of the logging can be adjusted by setting the `$loglevel` parameter in the `mom_priv/config` file. For server logs, the verbosity of the logging can be adjusted by setting the server `log_level` attribute in `qmgr`.

For both `pbs_mom` and `pbs_server` daemons, the log verbosity level can also be adjusted by setting the environment variable `PBSLOGLEVEL` to a value between 0 and 7. Further, to dynamically change the log level of a running daemon, use the `SIGUSR1` and `SIGUSR2` signals to increase and decrease the active loglevel by one. Signals are sent to a process using the `kill` command.

For example, `kill -USR1 `pgrep pbs_mom`` would raise the log level up by one.

The current loglevel for `pbs_mom` can be displayed with the command `momctl -d3`.

### `trqauthd` log files

As of TORQUE 4.1.3, `trqauthd` logs its events in the `$TORQUE_HOME/client_logs` directory. It names the log files in the format `<YYYYMMDD>`, creating a new log daily as events occur.



**i** You might see some peculiar behavior if you mount the `client_logs` directory for shared access via network-attached storage.

When `trqauthd` first gets access on a particular day, it writes an "open" message to the day's log file. It also writes a "close" message to the last log file it accessed prior to that, which is usually the previous day's log file, but not always. For example, if it is Monday and no client commands were executed over the weekend, `trqauthd` writes the "close" message to Friday's file.

Since the various `trqauthd` binaries on the submit hosts (and potentially, the compute nodes) each write an "open" and "close" message on the first access of a new day, you'll see multiple (seemingly random) accesses when you have a shared log.

The `trqauthd` records the following events along with the date and time of the occurrence:

- When `trqauthd` successfully starts. It logs the event with the IP address and port.
- When a user successfully authenticates with `trqauthd`.
- When a user fails to authenticate with `trqauthd`.
- When `trqauthd` encounters any unexpected errors.

*Example 11-1: `trqauthd` logging sample*

```
2012-10-05 15:05:51.8404 Log opened
2012-10-05 15:05:51.8405 TORQUE authd daemon started and listening on IP:port
101.0.1.0:12345
2012-10-10 14:48:05.5688 User hfrye at IP:port abc:12345 logged in
```

### Related topics

- [Troubleshooting on page 123](#)

## Using "tracejob" to locate job failures

### Overview

The `tracejob` utility extracts job status and job events from accounting records, MOM log files, server log files, and scheduler log files. Using it can help identify where, how, a why a job failed. This tool takes a job id as a parameter as well as arguments to specify which logs to search, how far into the past to search, and other conditions.

### Syntax

```
tracejob [-a|s|l|m|q|v|z] [-c count] [-w size] [-p path] [ -n <DAYS>] [-f
filter_type] <JOBID>
```

```
-p : path to PBS_SERVER_HOME
-w : number of columns of your terminal
-n : number of days in the past to look for job(s) [default 1]
-f : filter out types of log entries, multiple -f's can be specified
    error, system, admin, job, job_usage, security, sched, debug,
```

```

        debug2, or absolute numeric hex equivalent
-z : toggle filtering excessive messages
-c : what message count is considered excessive
-a : don't use accounting log files
-s : don't use server log files
-l : don't use scheduler log files
-m : don't use MOM log files
-q : quiet mode - hide all error messages
-v : verbose mode - show more error messages

```

## Example

```

> tracejob -n 10 1131
Job: 1131.icluster.org
03/02/2005 17:58:28 S enqueueing into batch, state 1 hop 1
03/02/2005 17:58:28 S Job Queued at request of dev@icluster.org, owner =
dev@icluster.org, job name = STDIN, queue = batch
03/02/2005 17:58:28 A queue=batch
03/02/2005 17:58:41 S Job Run at request of dev@icluster.org
03/02/2005 17:58:41 M evaluating limits for job
03/02/2005 17:58:41 M phase 2 of job launch successfully completed
03/02/2005 17:58:41 M saving task (TMomFinalizeJob3)
03/02/2005 17:58:41 M job successfully started
03/02/2005 17:58:41 M job 1131.koa.icluster.org reported successful start on 1 node
(s)
03/02/2005 17:58:41 A user=dev group=dev jobname=STDIN queue=batch ctime=1109811508
qttime=1109811508 etime=1109811508 start=1109811521
exec_host=icluster.org/0 Resource_List.neednodes=1 Resource_
List.nodect=1
Resource_List.nodes=1 Resource_List.walltime=00:01:40
03/02/2005 18:02:11 M walltime 210 exceeded limit 100
03/02/2005 18:02:11 M kill_job
03/02/2005 18:02:11 M kill_job found a task to kill
03/02/2005 18:02:11 M sending signal 15 to task
03/02/2005 18:02:11 M kill_task: killing pid 14060 task 1 with sig 15
03/02/2005 18:02:11 M kill_task: killing pid 14061 task 1 with sig 15
03/02/2005 18:02:11 M kill_task: killing pid 14063 task 1 with sig 15
03/02/2005 18:02:11 M kill_job done
03/02/2005 18:04:11 M kill_job
03/02/2005 18:04:11 M kill_job found a task to kill
03/02/2005 18:04:11 M sending signal 15 to task
03/02/2005 18:06:27 M kill_job
03/02/2005 18:06:27 M kill_job done
03/02/2005 18:06:27 M performing job clean-up
03/02/2005 18:06:27 A user=dev group=dev jobname=STDIN queue=batch ctime=1109811508
qttime=1109811508 etime=1109811508 start=1109811521
exec_host=icluster.org/0 Resource_List.neednodes=1 Resource_
List.nodect=1
Resource_List.nodes=1 Resource_List.walltime=00:01:40
session=14060
end=1109811987 Exit status=265 resources_used.cput=00:00:00
resources_used.mem=3544kb resources_used.vmem=10632kb
resources_used.walltime=00:07:46
...

```

**i** The `tracejob` command operates by searching the `pbs_server` accounting records and the `pbs_server`, `MOM`, and `scheduler` logs. To function properly, it must be run on a node and as a user which can access these files. By default, these files are all accessible by the user `root` and only available on the cluster management node. In particular, the files required by `tracejob` are located in the following directories:

```
TORQUE_HOME/server_priv/accounting
```

```
TORQUE_HOME/server_logs
```

```
TORQUE_HOME/mom_logs
```

```
TORQUE_HOME/sched_logs
```

**i** `tracejob` may only be used on systems where these files are made available. Non-root users may be able to use this command if the permissions on these directories or files are changed appropriately.

**i** The value of `Resource_List.*` is the amount of resources requested, and the value of `resources_used.*` is the amount of resources actually used.

### Related topics

- [Troubleshooting on page 123](#)

## Using GDB to locate job failures

If either the `pbs_mom` or `pbs_server` fail unexpectedly (and the log files contain no information on the failure) `gdb` can be used to determine whether or not the program is crashing. To start `pbs_mom` or `pbs_server` under [GDB](#) export the environment variable `PBSDEBUG=yes` and start the program (i.e., `gdb pbs_mom` and then issue the `run` subcommand at the `gdb` prompt).

`GDB` may run for some time until a failure occurs and at which point, a message will be printed to the screen and a `gdb` prompt again made available. If this occurs, use the `gdb where` subcommand to determine the exact location in the code. The information provided may be adequate to allow local diagnosis and correction. If not, this output may be sent to the mailing list or to [help](#) for further assistance.

**i** See the `PBSCOREDUMP` parameter for enabling creation of core files (see [Debugging on page 136](#)).

### Related topics

- [Troubleshooting on page 123](#)

## Other diagnostic options

When *PBSDEBUG* is set, some client commands will print additional diagnostic information.

```
$ export PBSDEBUG=yes
$ cmd
```

To debug different kinds of problems, it can be useful to see where in the code time is being spent. This is called profiling and there is a Linux utility "gprof" that will output a listing of routines and the amount of time spent in these routines. This does require that the code be compiled with special options to instrument the code and to produce a file, *gmon.out*, that will be written at the end of program execution.

The following listing shows how to build TORQUE with profiling enabled. Notice that the output file for *pbs\_mom* will end up in the *mom\_priv* directory because its startup code changes the default directory to this location.

```
# ./configure "CFLAGS=-pg -lgcov -fPIC"
# make -j5
# make install
# pbs_mom ... do some stuff for a while ...
# momctl -s
# cd /var/spool/torque/mom_priv
# gprof -b `which pbs_mom` gmon.out |less
#
```

Another way to see areas where a program is spending most of its time is with the *valgrind* program. The advantage of using *valgrind* is that the programs do not have to be specially compiled.

```
# valgrind --tool=callgrind pbs_mom
```

### Related topics

- [Troubleshooting on page 123](#)

## Stuck jobs

If a job gets stuck in TORQUE, try these suggestions to resolve the issue:

- Use the [qdel](#) command to cancel the job.
- Force the MOM to send an obituary of the job ID to the server.

```
> qsig -s 0 <JOBID>
```

- You can try clearing the stale jobs by using the [momctl](#) command on the compute nodes where the jobs are still listed.

```
> momctl -c 58925 -h compute-5-20
```

- Setting the [qmgr](#) server setting *mom\_job\_sync* to *True* might help prevent jobs from hanging.

```
> qmgr -c "set server mom_job_sync = True"
```

To check and see if this is already set, use:

```
> qmgr -c "p s"
```

- If the suggestions above cannot remove the stuck job, you can try [qdel -p](#). However, since the `-p` option purges all information generated by the job, this is not a recommended option unless the above suggestions fail to remove the stuck job.

```
> qdel -p <JOBID>
```

- The last suggestion for removing stuck jobs from compute nodes is to restart the `pbs_mom`.

For additional troubleshooting, run a tracejob on one of the stuck jobs. You can then create an [online support ticket](#) with the full server log for the time period displayed in the trace job.

### Related topics

- [Troubleshooting on page 123](#)

## Frequently asked questions (FAQ)

- [Cannot connect to server: error=15034 on page 130](#)
- [Deleting 'stuck' jobs on page 130](#)
- [Which user must run TORQUE? on page 130](#)
- [Scheduler cannot run jobs - rc: 15003 on page 130](#)
- [PBS\\_Server: pbsd\\_init, Unable to read server database on page 131](#)
- [qsub will not allow the submission of jobs requesting many processors on page 132](#)
- [qsub reports 'Bad UID for job execution' on page 132](#)
- [Why does my job keep bouncing from running to queued? on page 132](#)
- [How do I use PVM with TORQUE? on page 133](#)
- [My build fails attempting to use the TCL library on page 133](#)
- [My job will not start, failing with the message 'cannot send job to mom, state=PRERUN' on page 133](#)
- [How do I determine what version of TORQUE I am using? on page 133](#)
- [How do I resolve autogen.sh errors that contain "error: possibly undefined macro: AC\\_MSG\\_ERROR"? on page 133](#)
- [How do I resolve compile errors with libssl or libcrypto for TORQUE 4.0 on Ubuntu 10.04? on page 133](#)
- [Why are there so many error messages in the client logs \(trqauthd logs\) when I don't notice client commands failing? on page 134](#)

## Cannot connect to server: error=15034

This error occurs in TORQUE clients (or their APIs) because TORQUE cannot find the `server_name` file and/or the `PBS_DEFAULT` environment variable is not set. The `server_name` file or `PBS_DEFAULT` variable indicate the `pbs_server`'s hostname that the client tools should communicate with. The `server_name` file is usually located in TORQUE's local state directory. Make sure the file exists, has proper permissions, and that the version of TORQUE you are running was built with the proper directory settings. Alternatively you can set the `PBS_DEFAULT` environment variable. Restart TORQUE daemons if you make changes to these settings.

## Deleting 'stuck' jobs

To manually delete a "stale" job which has no process, and for which the mother superior is still alive, sending a sig 0 with `qsig` will often cause MOM to realize the job is stale and issue the proper JobObit notice. Failing that, use `momctl -c` to forcefully cause MOM to purge the job. The following process should never be necessary:

- Shut down the MOM on the mother superior node.
- Delete all files and directories related to the job from `TORQUE_HOME/mom_priv/jobs`.
- Restart the MOM on the mother superior node.

If the mother superior MOM has been lost and cannot be recovered (i.e. hardware or disk failure), a job running on that node can be purged from the output of `qstat` using the `qdel on page 180 -p` command or can be removed manually using the following steps:

### To remove job X

1. Shut down `pbs_server`.

```
> qterm
```

2. Remove job spool files.

```
> rm TORQUE_HOME/server_priv/jobs/X.SC TORQUE_HOME/server_priv/jobs/X.JB
```

3. Restart `pbs_server`

```
> pbs_server
```

## Which user must run TORQUE?

TORQUE (`pbs_server` & `pbs_mom`) must be started by a user with root privileges.

## Scheduler cannot run jobs - rc: 15003

For a scheduler, such as [Moab](#) or [Maui](#), to control jobs with TORQUE, the scheduler needs to be run by a user in the server operators / managers list (see [qmgr](#)). The default for the server operators / managers list is `root@localhost`. For TORQUE to be used in a grid setting with Silver, the scheduler needs to be run as `root`.

## PBS\_Server: pbsd\_init, Unable to read server database

If this message is displayed upon starting `pbs_server` it means that the local database cannot be read. This can be for several reasons. The most likely is a version mismatch. Most versions of TORQUE can read each other's databases. However, there are a few incompatibilities between OpenPBS and TORQUE. Because of enhancements to TORQUE, it cannot read the job database of an OpenPBS server (job structure sizes have been altered to increase functionality). Also, a compiled in 32-bit mode cannot read a database generated by a 64-bit `pbs_server` and vice versa.

### To reconstruct a database (excluding the job database)

1. First, print out the old data with this command:

```
%> qmgr -c "p s"
#
# Create queues and set their attributes.
#
#
# Create and define queue batch
# create queue batch
set queue batch queue_type = Execution
set queue batch acl_host_enable = False
set queue batch resources_max.nodect = 6
set queue batch resources_default.nodes = 1
set queue batch resources_default.walltime = 01:00:00
set queue batch resources_available.nodect = 18
set queue batch enabled = True
set queue batch started = True
#
# Set server attributes.
#
set server scheduling = True
set server managers = griduser@oahu.icluster.org
set server managers += scott@*.icluster.org
set server managers += wightman@*.icluster.org
set server operators = griduser@oahu.icluster.org
set server operators += scott@*.icluster.org
set server operators += wightman@*.icluster.org
set server default_queue = batch
set server log_events = 511
set server mail_from = adm
set server resources_available.nodect = 80
set server node_ping_rate = 300
set server node_check_rate = 600
set server tcp_timeout = 6
```

2. Copy this information somewhere.
3. Restart `pbs_server` with the following command:

```
> pbs_server -t create
```

4. When you are prompted to overwrite the previous database, enter `y`, then enter the data exported by the `qmgr` command as in this example:

```
> cat data | qmgr
```

5. Restart `pbs_server` without the flags:

```
> qterm
> pbs_server
```

This will reinitialize the database to the current version.

**i** Reinitializing the server database will reset the next jobid to 1

## qsub will not allow the submission of jobs requesting many processors

TORQUE's definition of a node is context sensitive and can appear inconsistent. The `qsub -l nodes=<X>` expression can at times indicate a request for X processors and other time be interpreted as a request for X nodes. While `qsub` allows multiple interpretations of the keyword `nodes`, aspects of the TORQUE server's logic are not so flexible. Consequently, if a job is using `-l nodes` to specify processor count and the requested number of processors exceeds the available number of physical nodes, the server daemon will reject the job.

To get around this issue, the server can be told it has an inflated number of nodes using the `resources_available` attribute. To take effect, this attribute should be set on both the server and the associated queue as in the example below. (See [resources\\_available](#) for more information.)

```
> qmgr
Qmgr: set server resources_available.nodect=2048
Qmgr: set queue batch resources_available.nodect=2048
```

**i** The `pbs_server` daemon will need to be restarted before these changes will take effect.

## qsub reports 'Bad UID for job execution'

```
[guest@login2]$ qsub test.job
qsub: Bad UID for job execution
```

Job submission hosts must be explicitly specified within TORQUE or enabled via RCmd security mechanisms in order to be trusted. In the example above, the host 'login2' is not configured to be trusted. This process is documented in [Configuring job submission hosts on page 22](#).

## Why does my job keep bouncing from running to queued?

There are several reasons why a job will fail to start. Do you see any errors in the MOM logs? Be sure to increase the loglevel on MOM if you don't see anything. Also be sure TORQUE is configured with `--enable-syslog` and look in `/var/log/messages` (or wherever your syslog writes).

Also verify the following on all machines:

- DNS resolution works correctly with matching forward and reverse
- Time is synchronized across the head and compute nodes
- User accounts exist on all compute nodes
- User home directories can be mounted on all compute nodes
- Prologue scripts (if specified) exit with 0

If using a scheduler such as [Moab](#) or [Maui](#), use a scheduler tool such as `checkjob` to identify job start issues.



## How do I use PVM with TORQUE?

- Start the master pvmd on a compute node and then add the slaves
- mpiexec can be used to launch slaves using rsh or ssh (use `export PVM_RSH=/usr/bin/ssh` to use ssh)

**i** Access can be managed by rsh/ssh without passwords between the batch nodes, but denying it from anywhere else, including the interactive nodes. This can be done with xinetd and sshd configuration (root is allowed to ssh everywhere). This way, the pvm daemons can be started and killed from the job script.

The problem is that this setup allows the users to bypass the batch system by writing a job script that uses rsh/ssh to launch processes on the batch nodes. If there are relatively few users and they can more or less be trusted, this setup can work.

## My build fails attempting to use the TCL library

TORQUE builds can fail on TCL dependencies even if a version of TCL is available on the system. TCL is only utilized to support the xpbsmon client. If your site does not use this tool (most sites do not use xpbsmon), you can work around this failure by rerunning `configure` with the `--disable-gui` argument.

## My job will not start, failing with the message 'cannot send job to mom, state=PRERUN'

If a node crashes or other major system failures occur, it is possible that a job may be stuck in a corrupt state on a compute node. TORQUE 2.2.0 and higher automatically handle this when the `mom_job_sync` parameter is set via [qmgr](#) (the default). For earlier versions of TORQUE, set this parameter and restart the `pbs_mom` daemon.

This error can also occur if not enough free space is available on the partition that holds TORQUE.

## How do I determine what version of TORQUE I am using?

There are times when you want to find out what version of TORQUE you are using. An easy way to do this is to run the following command:

```
qmgr
> qmgr -c "p s" | grep pbs_ver
```

## How do I resolve autogen.sh errors that contain "error: possibly undefined macro: AC\_MSG\_ERROR"?

Verify the `pkg-config` package is installed.

## How do I resolve compile errors with libssl or libcrypto for TORQUE 4.0 on Ubuntu 10.04?

When compiling TORQUE 4.0 on Ubuntu 10.04 the following errors might occur:

```
libtool: link: gcc -Wall -pthread -g -D_LARGEFILE64_SOURCE -o .libs/trqauthd trq_auth_
daemon.o trq_main.o -ldl -lssl -lcrypto -L/home/adaptive/torques/torque-
4.0.0/src/lib/Libpbs/.libs /home/adaptive/torques/torque-
4.0.0/src/lib/Libpbs/.libs/libtorque.so -lpthread -lrt -pthread
/usr/bin/ld: cannot find -lssl
collect2: ld returned 1 exit status
make[3]: *** [trqauthd] Error 1

libtool: link: gcc -Wall -pthread -g -D_LARGEFILE64_SOURCE -o .libs/trqauthd trq_auth_
daemon.o trq_main.o -ldl -lssl -lcrypto -L/home/adaptive/torques/torque-
4.0.0/src/lib/Libpbs/.libs /home/adaptive/torques/torque-
4.0.0/src/lib/Libpbs/.libs/libtorque.so -lpthread -lrt -pthread
/usr/bin/ld: cannot find -lcrypto
collect2: ld returned 1 exit status
make[3]: *** [trqauthd] Error 1
```

To resolve the compile issue, use these commands:

```
> cd /usr/lib
> ln -s /lib/libcrypto.so.0.9. libcrypto.so
> ln -s /lib/libssl.so.0.9.8 libssl.so
```

### Why are there so many error messages in the client logs (trqauthd logs) when I don't notice client commands failing?

If a client makes a connection to the server and the trqauthd connection for that client command is authorized *before* the client's connection, the trqauthd connection is rejected. The connection is retried, but if all retry attempts are rejected, trqauthd logs a message indicating a failure. Some client commands then open a new connection to the server and try again. The client command fails only if all its retries fail.

#### Related topics

- [Troubleshooting on page 123](#)

## Compute node health check

TORQUE provides the ability to perform health checks on each compute node. If these checks fail, a failure message can be associated with the node and routed to the scheduler. Schedulers (such as [Moab](#)) can forward this information to administrators by way of scheduler triggers, make it available through scheduler diagnostic commands, and automatically mark the node down until the issue is resolved. (See the RMMMSGIGNORE parameter in the "Parameters" Appendix of the Moab Workload Manager Administrator's Guide for more information.)

Additionally, Michael Jennings at LBNL has authored an open-source bash node health check script project. It offers an easy way to perform some of the most common node health checking tasks, such as verifying network and filesystem functionality. More information is available on the [project's page](#).

For more information about node health checks, see these topics:

- [Configuring MOMs to launch a health check on page 135](#)
- [Creating the health check script on page 135](#)

- [Adjusting node state based on the health check output on page 136](#)
- [Example health check script on page 136](#)

#### Related topics

- [Troubleshooting on page 123](#)

## Configuring MOMs to launch a health check

The health check feature is configured via the `mom_priv/config` file using the parameters described below:

Parameter	Format	Default	Description
<code>\$node_check_script</code>	<STRING>	N/A	(Required) Specifies the fully qualified pathname of the health check script to run
<code>\$node_check_interval</code>	<INTEGER>	1	(Optional) Specifies the number of MOM intervals between health checks (by default, each MOM interval is 45 seconds long - this is controlled via the <a href="#">\$status_update_time on page 258</a> node parameter. The integer may be followed by a list of event names (currently supported are <code>jobstart</code> and <code>jobend</code> ). (For more information, see <a href="#">pbs_mom</a> .)

#### Related topics

- [Compute node health check on page 134](#)

## Creating the health check script

The health check script is executed directly by the `pbs_mom` daemon under the root user id. It must be accessible from the compute node and may be a script or compile executable program. It may make any needed system calls and execute any combination of system utilities but should not execute resource manager client commands. Also, as of TORQUE 1.0.1, the `pbs_mom` daemon blocks until the health check is completed and does not possess a built-in timeout. Consequently, it is advisable to keep the launch script execution time short and verify that the script will not block even under failure conditions.

If the script detects a failure, it should return the keyword **ERROR** to stdout followed by an error message. When a failure is detected, the **ERROR** keyword should be printed to stdout before any other data. The message (up to 1024 characters) immediately following the **ERROR** keyword must all be contained on the same line. The message is assigned to the node attribute 'message' of the associated node.

**Related topics**

- [Compute node health check on page 134](#)

## Adjusting node state based on the health check output

If the health check reports an error, the node attribute "message" is set to the error string returned. Cluster schedulers can be configured to adjust a given node's state based on this information. For example, by default, [Moab](#) sets a node's state to down if a node error message is detected. The node health script continues to run at the configured interval (see [Configuring MOMs to launch a health check on page 135](#) for more information), and if it does not generate the error message again during one of its later executions, Moab picks that up at the beginning of its next iteration and restores the node to an online state.

**Related topics**

- [Compute node health check on page 134](#)

## Example health check script

As mentioned, the health check can be a shell script, PERL, Python, C-executable, or anything which can be executed from the command line capable of setting STDOUT. The example below demonstrates a very simple health check:

```
#!/bin/sh
/bin/mount | grep global
if [ $? != "0" ]
then
    echo "ERROR cannot locate filesystem global"
fi
```

**Related topics**

- [Compute node health check on page 134](#)

# Debugging

TORQUE supports a number of diagnostic and debug options including the following:

*PBSDEBUG* environment variable - If set to 'yes', this variable will prevent `pbs_server`, `pbs_mom`, and/or `pbs_sched` from backgrounding themselves allowing direct launch under a debugger. Also, some client commands will provide additional diagnostic information when this value is set.

*PBSLOGLEVEL* environment variable - Can be set to any value between 0 and 7 and specifies the logging verbosity level (default = 0)

*PBSCOREDUMP* environment variable - If set, it will cause the offending resource manager daemon to create a core file if a *SIGSEGV*, *SIGILL*, *SIGFPE*, *SIGSYS*, or *SIGTRAP* signal is received. The core dump will

be placed in the daemon's home directory (`$PBSHOME/mom_priv` for `pbs_mom` and `$PBSHOME/server_priv` for `pbs_server`).

**i** To enable core dumping in a Red Hat system, you must add the following line to the `/etc/init.d/pbs_mom` and `/etc/init.d/pbs_server` scripts:

```
export DAEMON_COREFILE_LIMIT=unlimited
```

`NDEBUG #define` - if set at build time, will cause additional low-level logging information to be output to stdout for `pbs_server` and `pbs_mom` daemons.

`tracejob` reporting tool - can be used to collect and report logging and accounting information for specific jobs (for more information, see [Using "tracejob" to locate job failures on page 125](#))

**i** `PBSLOGLEVEL` and `PBSCOREDUMP` must be added to the `$PBSHOME/pbs_environment` file, not just the current environment. To set these variables, add a line to the `pbs_environment` file as either "variable=value" or just "variable". In the case of "variable=value", the environment variable is set up as the value specified. In the case of "variable", the environment variable is set based upon its value in the current environment.

## TORQUE error codes

Error code name	Number	Description
<b>PBSE_FLOOR</b>	15000	No error
<b>PBSE_UNKJOBID</b>	15001	Unknown job identifier
<b>PBSE_NOATTR</b>	15002	Undefined attribute
<b>PBSE_ATTRRO</b>	15003	Attempt to set READ ONLY attribute
<b>PBSE_IVALREQ</b>	15004	Invalid request
<b>PBSE_UNKREQ</b>	15005	Unknown batch request
<b>PBSE_TOOMANY</b>	15006	Too many submit retries
<b>PBSE_PERM</b>	15007	No permission
<b>PBSE_IFF_NOT_FOUND</b>	15008	"pbs_iff" not found; unable to authenticate
<b>PBSE_MUNGE_NOT_FOUND</b>	15009	"munge" executable not found; unable to authenticate

Error code name	Number	Description
<b>PBSE_BADHOST</b>	15010	Access from host not allowed
<b>PBSE_JOBEXIST</b>	15011	Job already exists
<b>PBSE_SYSTEM</b>	15012	System error occurred
<b>PBSE_INTERNAL</b>	15013	Internal server error occurred
<b>PBSE_REGROUTE</b>	15014	Parent job of dependent in rte queue
<b>PBSE_UNKSIG</b>	15015	Unknown signal name
<b>PBSE_BADATVAL</b>	15016	Bad attribute value
<b>PBSE_MODATTRUN</b>	15017	Cannot modify attribute in run state
<b>PBSE_BADSTATE</b>	15018	Request invalid for job state
<b>PBSE_UNKQUE</b>	15020	Unknown queue name
<b>PBSE_BADCRED</b>	15021	Invalid credential in request
<b>PBSE_EXPIRED</b>	15022	Expired credential in request
<b>PBSE_QUNOENB</b>	15023	Queue not enabled
<b>PBSE_QACCESS</b>	15024	No access permission for queue
<b>PBSE_BADUSER</b>	15025	Bad user - no password entry
<b>PBSE_HOPCOUNT</b>	15026	Max hop count exceeded
<b>PBSE_QUEEXIST</b>	15027	Queue already exists
<b>PBSE_ATTRTYPE</b>	15028	Incompatible queue attribute type
<b>PBSE_QUEBUSY</b>	15029	Queue busy (not empty)
<b>PBSE_QUENBIG</b>	15030	Queue name too long

Error code name	Number	Description
<b>PBSE_NOSUP</b>	15031	Feature/function not supported
<b>PBSE_QUENOEN</b>	15032	Cannot enable queue,needs add def
<b>PBSE_PROTOCOL</b>	15033	Protocol (ASN.1) error
<b>PBSE_BADATLST</b>	15034	Bad attribute list structure
<b>PBSE_NOCONNECTS</b>	15035	No free connections
<b>PBSE_NOSERVER</b>	15036	No server to connect to
<b>PBSE_UNKRESC</b>	15037	Unknown resource
<b>PBSE_EXCQRESC</b>	15038	Job exceeds queue resource limits
<b>PBSE_QUENODFLT</b>	15039	No default queue defined
<b>PBSE_NORERUN</b>	15040	Job not rerunnable
<b>PBSE_ROUTEREJ</b>	15041	Route rejected by all destinations
<b>PBSE_ROUTEEXPD</b>	15042	Time in route queue expired
<b>PBSE_MOMREJECT</b>	15043	Request to MOM failed
<b>PBSE_BADSCRIPT</b>	15044	(qsub) Cannot access script file
<b>PBSE_STAGEIN</b>	15045	Stage-In of files failed
<b>PBSE_RESCUNAV</b>	15046	Resources temporarily unavailable
<b>PBSE_BADGRP</b>	15047	Bad group specified
<b>PBSE_MAXQUED</b>	15048	Max number of jobs in queue
<b>PBSE_CKPBSY</b>	15049	Checkpoint busy, may be retries
<b>PBSE_EXLIMIT</b>	15050	Limit exceeds allowable

Error code name	Number	Description
<b>PBSE_BADACCT</b>	15051	Bad account attribute value
<b>PBSE_ALRDYEXIT</b>	15052	Job already in exit state
<b>PBSE_NOCOPYFILE</b>	15053	Job files not copied
<b>PBSE_CLEANEDOUT</b>	15054	Unknown job id after clean init
<b>PBSE_NOSYNCMSTR</b>	15055	No master in sync set
<b>PBSE_BADDEPEND</b>	15056	Invalid dependency
<b>PBSE_DUPLIST</b>	15057	Duplicate entry in list
<b>PBSE_DISPROTO</b>	15058	Bad DIS based request protocol
<b>PBSE_EXECTHERE</b>	15059	Cannot execute there
<b>PBSE_SISREJECT</b>	15060	Sister rejected
<b>PBSE_SISCOMM</b>	15061	Sister could not communicate
<b>PBSE_SVRDOWN</b>	15062	Requirement rejected -server shutting down
<b>PBSE_CKPSHORT</b>	15063	Not all tasks could checkpoint
<b>PBSE_UNKNODE</b>	15064	Named node is not in the list
<b>PBSE_UNKNODEATR</b>	15065	Node-attribute not recognized
<b>PBSE_NONODES</b>	15066	Server has no node list
<b>PBSE_NODENBIG</b>	15067	Node name is too big
<b>PBSE_NODEEXIST</b>	15068	Node name already exists
<b>PBSE_BADNDATVAL</b>	15069	Bad node-attribute value
<b>PBSE_MUTUALEX</b>	15070	State values are mutually exclusive



Error code name	Number	Description
<b>PBSE_GMODERR</b>	15071	Error(s) during global modification of nodes
<b>PBSE_NORELYMOM</b>	15072	Could not contact MOM
<b>PBSE_NOTSNODE</b>	15073	No time-shared nodes
<b>PBSE_JOBTYPE</b>	15074	Wrong job type
<b>PBSE_BADACLHOST</b>	15075	Bad ACL entry in host list
<b>PBSE_MAXUSERQUED</b>	15076	Maximum number of jobs already in queue for user
<b>PBSE_BADDISALLOWTYPE</b>	15077	Bad type in "disallowed_types" list
<b>PBSE_NOINTERACTIVE</b>	15078	Interactive jobs not allowed in queue
<b>PBSE_NOBATCH</b>	15079	Batch jobs not allowed in queue
<b>PBSE_NORERUNABLE</b>	15080	Rerunable jobs not allowed in queue
<b>PBSE_NONONRERUNABLE</b>	15081	Non-rerunable jobs not allowed in queue
<b>PBSE_UNKARRAYID</b>	15082	Unknown array ID
<b>PBSE_BAD_ARRAY_REQ</b>	15083	Bad job array request
<b>PBSE_TIMEOUT</b>	15084	Time out
<b>PBSE_JOBNOTFOUND</b>	15085	Job not found
<b>PBSE_NOFAULTTOLERANT</b>	15086	Fault tolerant jobs not allowed in queue
<b>PBSE_NOFAULTINTOLERANT</b>	15087	Only fault tolerant jobs allowed in queue
<b>PBSE_NOJOBARRAYS</b>	15088	Job arrays not allowed in queue
<b>PBSE_RELAYED_TO_MOM</b>	15089	Request was relayed to a MOM
<b>PBSE_MEM_MALLOC</b>	15090	Failed to allocate memory for memmgr

Error code name	Number	Description
<b>PBSE_MUTEX</b>	15091	Failed to allocate controlling mutex (lock/unlock)
<b>PBSE_TRHEADATTR</b>	15092	Failed to set thread attributes
<b>PBSE_THREAD</b>	15093	Failed to create thread
<b>PBSE_SELECT</b>	15094	Failed to select socket
<b>PBSE_SOCKET_FAULT</b>	15095	Failed to get connection to socket
<b>PBSE_SOCKET_WRITE</b>	15096	Failed to write data to socket
<b>PBSE_SOCKET_READ</b>	15097	Failed to read data from socket
<b>PBSE_SOCKET_CLOSE</b>	15098	Socket closed
<b>PBSE_SOCKET_LISTEN</b>	15099	Failed to listen in on socket
<b>PBSE_AUTH_INVALID</b>	15100	Invalid auth type in request
<b>PBSE_NOT_IMPLEMENTED</b>	15101	Functionality not yet implemented
<b>PBSE_QUEENOTAVAILABLE</b>	15102	Queue is not available

**Related topics**

- [Troubleshooting on page 123](#)

# Appendices

The appendices provide tables of commands, parameters, configuration options, error codes, the Quick Start Guide, and so forth.

- [Commands overview on page 145](#)
- [Server parameters on page 227](#)
- [Node manager \(MOM\) configuration on page 245](#)
- [Diagnostics and error codes on page 263](#)
- [Considerations before upgrading on page 271](#)
- [Large cluster considerations on page 273](#)
- [Prologue and epilogue scripts on page 281](#)
- [Running multiple TORQUE servers and MOMs on the same node on page 289](#)
- [Security overview on page 291](#)
- [Job submission filter \("qsub wrapper"\) on page 293](#)
- ["torque.cfg" configuration file on page 295](#)
- [TORQUE Quick Start Guide on page 301](#)
- [BLCR acceptance tests on page 305](#)



# Commands overview

## Client commands

Command	Description
<a href="#"><u>momctl</u></a>	Manage/diagnose MOM (node execution) daemon
<a href="#"><u>pbsdsh</u></a>	Launch tasks within a parallel job
<a href="#"><u>pbsnodes</u></a>	View/modify batch status of compute nodes
<a href="#"><u>qalter</u></a>	Modify queued batch jobs
<a href="#"><u>qchkpt</u></a>	Checkpoint batch jobs
<a href="#"><u>qdel</u></a>	Delete/cancel batch jobs
<a href="#"><u>qgpumode</u></a>	Specifies new mode for GPU
<a href="#"><u>qgpureset</u></a>	Reset the GPU
<a href="#"><u>qhold</u></a>	Hold batch jobs
<a href="#"><u>qmgr</u></a>	Manage policies and other batch configuration
<a href="#"><u>qmove</u></a> on page 189	Move batch jobs
<a href="#"><u>qorder</u></a> on page 190	Exchange order of two batch jobs in any queue
<a href="#"><u>qrerun</u></a>	Rerun a batch job
<a href="#"><u>qrls</u></a>	Release batch job holds

Command	Description
<a href="#"><u>qrun</u></a>	Start a batch job
<a href="#"><u>qsig</u></a>	Send a signal to a batch job
<a href="#"><u>qstat</u></a>	View queues and jobs
<a href="#"><u>qsub</u></a>	Submit jobs
<a href="#"><u>qterm</u></a>	Shutdown pbs server daemon
<b>tracejob</b>	Trace job actions and states recorded in TORQUE logs (see <a href="#">Using "tracejob" to locate job failures</a> on page 125)

## Binary executables

Command	Description
<b>pbs_iff</b>	Interprocess authentication service
<a href="#"><u>pbs_mom</u></a>	Start MOM (node execution) daemon
<a href="#"><u>pbs_server</u></a>	Start server daemon
<a href="#"><u>pbs_track</u></a>	Tell pbs_mom to track a new process

## Related topics

- [Node manager \(MOM\) configuration](#) on page 245
- [Server parameters](#) on page 227

# momctl

*(PBS MOM Control)*

## Synopsis

```
momctl -c { <JOBID> | all }
momctl -C
momctl -d { <INTEGER> | <JOBID> }
momctl -f <FILE>
momctl -h <HOST>\[,<HOST>\]...
```

```

momctl -p <PORT NUMBER>
momctl -q <ATTRIBUTE>
momctl -r { <FILE> | LOCAL:<FILE> }
momctl -s

```

## Overview

The `momctl` command allows remote shutdown, reconfiguration, diagnostics, and querying of the `pbs_mom` daemon.

## Format

<b>-c — Clear</b>	
<b>Format</b>	{ <JOBID>   <i>all</i> }
<b>Default</b>	---
<b>Description</b>	Makes the MOM unaware of the job's existence. It does not clean up any processes associated with the job.
<b>Example</b>	<code>momctl - node1 -c 15406</code>

<b>-C — Cycle</b>	
<b>Format</b>	---
<b>Default</b>	---
<b>Description</b>	Cycle <code>pbs_mom(s)</code>
<b>Example</b>	<code>momctl - node1 -C</code> Cycle <code>pbs_mom</code> on <code>node1</code> .

<b>-d — Diagnose</b>	
<b>Format</b>	{ <INTEGER>   <JOBID> }
<b>Default</b>	0

## -d — Diagnose

**Description** Diagnose MOM(s)  
(For more details, see [Diagnose detail on page 150](#) below.)

**Example**

```
momctl - node1 -d 2
```

Print level 2 and lower diagnose information for the MOM on node1.

## -f — Host File

**Format** <FILE>

**Default** ---

**Description** A file containing only comma or whitespace (space, tab, or new line) delimited hostnames

**Example**

```
momctl -f hosts.txt -d
```

Print diagnose information for the MOMs running on the hosts specified in `hosts.txt`.

## -h — Host List

**Format** <HOST>[,<HOST>]...

**Default** localhost

**Description** A comma separated list of hosts

**Example**

```
momctl -h node1,node2,node3 -d
```

Print diagnose information for the MOMs running on node1, node2, and node3.

## -p — Port

**Format** <PORT\_NUMBER>

**Default** TORQUE's default port number

**Description** The port number for the specified MOM(s)



## -p — Port

### Example

```
momctl -p 5455 -h node1 -d
```

Request diagnose information over port 5455 on node1.

## -q — Query

### Format

<ATTRIBUTE>

### Default

---

### Description

Query <ATTRIBUTE> on specified MOM, where <ATTRIBUTE> is a property listed by [pbsnodes](#) -a (see [Query attributes on page 150](#) for a list of attributes)

### Example

```
momctl -q physmem
```

Print the amount of physmem on localhost.

## -r — Reconfigure

### Format

{ <FILE> | LOCAL:<FILE> }

### Default

---

### Description

Reconfigure MOM(s) with remote or local config file, <FILE>. This does not work if \$remote\_reconf is not set to true when the MOM is started.

### Example

```
momctl -r /home/user1/new.config -h node1
```

Reconfigure MOM on node1 with /home/user1/new.cofig on node1.

## -s — Shutdown

### Format

### Default

---

### Description

Shutdown pbs\_mom

### Example

```
momctl -s
```

Terminates pbs\_mom process on localhost.

## Query attributes

Attribute	Description
arch	node hardware architecture
<b>availmem</b>	available RAM
<b>loadave</b>	1 minute load average
<b>ncpus</b>	number of CPUs available on the system
<b>netload</b>	total number of bytes transferred over all network interfaces
<b>nsessions</b>	number of sessions active
<b>nusers</b>	number of users active
<b>physmem</b>	configured RAM
<b>sessions</b>	list of active sessions
<b>totmem</b>	configured RAM plus configured swap

## Diagnose detail

Level	Description
<b>0</b>	<p>Display the following information:</p> <ul style="list-style-type: none"><li>• Local hostname</li><li>• Expected server hostname</li><li>• Execution version</li><li>• MOM home directory</li><li>• MOM config file version (if specified)</li><li>• Duration MOM has been executing</li><li>• Duration since last request from pbs_server daemon</li><li>• Duration since last request to pbs_server daemon</li><li>• RM failure messages (if any)</li><li>• Log verbosity level</li><li>• Local job list</li></ul>

Level	Description
1	All information for level 0 plus the following: <ul style="list-style-type: none"> <li>Interval between updates sent to server</li> <li>Number of initialization messages sent to pbs_server daemon</li> <li>Number of initialization messages received from pbs_server daemon</li> <li>Prolog/epilog alarm time</li> <li>List of trusted clients</li> </ul>
2	All information from level 1 plus the following: <ul style="list-style-type: none"> <li>PID</li> <li>Event alarm status</li> </ul>
3	All information from level 2 plus the following: <ul style="list-style-type: none"> <li>syslog enabled</li> </ul>

#### Example A-1: MOM diagnostics

```

momctl -d 1

Host: nsrc/nsrc.fllcl.com      Server: 10.10.10.113      Version: torque_1.1.0p4
HomeDirectory:                /usr/spool/PBS/mom_priv
ConfigVersion:                147
MOM active:                   7390 seconds
Last Msg From Server:        7389 seconds (CLUSTER_ADDRS)
Server Update Interval:      20 seconds
Server Update Interval:      20 seconds
Init Msgs Received:          0 hellos/1 cluster-addr
Init Msgs Sent:              1 hellos
LOGLEVEL:                    0 (use SIGUSR1/SIGUSR2 to adjust)
Prolog Alarm Time:           300 seconds
Trusted Client List:         12.14.213.113,127.0.0.1
JobList:                      NONE

diagnostics complete

```

#### Example A-2: System shutdown

```

> momctl -s -f /opt/clusterhostfile

shutdown request successful on node001
shutdown request successful on node002
shutdown request successful on node003
shutdown request successful on node004
shutdown request successful on node005
shutdown request successful on node006

```

## pbs\_mom

Start a pbs batch execution mini-server.

## Synopsis

```
pbs_mom [-a alarm] [-A alias] [-C chkdiritory] [-c config] [-d directory] [-h  
hostname]  
[-L logfile] [-M MOMport] [-R RPPport] [-p|-r] [-P purge] [-w] [-x]
```

## Description

The `pbs_mom` command is located within the `TORQUE_HOME` directory and starts the operation of a batch Machine Oriented Mini-server (MOM) on the execution host. To insure that the `pbs_mom` command is not runnable by the general user community, the server will only execute if its real and effective uid is zero.

The first function of `pbs_mom` is to place jobs into execution as directed by the server, establish resource usage limits, monitor the job's usage, and notify the server when the job completes. If they exist, `pbs_mom` will execute a prologue script before executing a job and an epilogue script after executing the job.

The second function of `pbs_mom` is to respond to resource monitor requests. This was done by a separate process in previous versions of PBS but has now been combined into one process. It provides information about the status of running jobs, memory available etc.

The last function of `pbs_mom` is to respond to task manager requests. This involves communicating with running tasks over a TCP socket as well as communicating with other MOMs within a job (a.k.a. a "sisterhood").

`pbs_mom` will record a diagnostic message in a log file for any error occurrence. The log files are maintained in the `mom_logs` directory below the home directory of the server. If the log file cannot be opened, the diagnostic message is written to the system console.

## Options

Flag	Name	Description
<b>-a</b>	alarm	Used to specify the alarm timeout in seconds for computing a resource. Every time a resource request is processed, an alarm is set for the given amount of time. If the request has not completed before the given time, an alarm signal is generated. The default is 5 seconds.
<b>-A</b>	alias	Used to specify this multimom's alias name. The alias name needs to be the same name used in the <code>mom.hierarchy</code> file. It is only needed when running multiple MOMs on the same machine. For more information, see <a href="#">TORQUE Multi-MOM on page 35</a> .
<b>-C</b>	chkdiritory	Specifies The path of the directory used to hold checkpoint files. (Currently this is only valid on Cray systems.) The default directory is <code>TORQUE_HOME/spool/checkpoint</code> (see the <b>-d</b> option). The directory specified with the <b>-C</b> option must be owned by root and accessible (rwx) only by root to protect the security of the checkpoint files.

Flag	Name	Description
<b>-c</b>	config	Specifies an alternative configuration file, see description below. If this is a relative file name it will be relative to <code>TORQUE_HOME/mom_priv</code> , (see the <b>-d</b> option). If the specified file cannot be opened, <code>pbs_mom</code> will abort. If the <b>-C</b> option is not supplied, <code>pbs_mom</code> will attempt to open the default configuration file "config" in <code>TORQUE_HOME/mom_priv</code> . If this file is not present, <code>pbs_mom</code> will log the fact and continue.
<b>-d</b>	directory	Specifies the path of the directory which is the home of the server's working files, <code>TORQUE_HOME</code> . This option is typically used along with <b>-M</b> when debugging MOM. The default directory is given by <code>\$PBS_SERVER_HOME</code> which is typically <code>/usr/spool/PBS</code> .
<b>-h</b>	hostname	Set MOM's hostname. This can be useful on multi-homed networks.
<b>-L</b>	logfile	Specify an absolute path name for use as the log file. If not specified, MOM will open a file named for the current date in the <code>TORQUE_HOME/mom_logs</code> directory (see the <b>-d</b> option).
<b>-M</b>	port	Specifies the port number on which the mini-server (MOM) will listen for batch requests.
<b>-p</b>	n/a	Specifies the impact on jobs which were in execution when the mini-server shut down. On any restart of MOM, the new mini-server will not be the parent of any running jobs, MOM has lost control of her offspring (not a new situation for a mother). With the <b>-p</b> option, MOM will allow the jobs to continue to run and monitor them indirectly via polling. This flag is redundant in that this is the default behavior when starting the server. The <b>-p</b> option is mutually exclusive with the <b>-R</b> and <b>-q</b> options.
<b>-P</b>	purge	Specifies the impact on jobs which were in execution when the mini-server shut down. With the <b>-P</b> option, it is assumed that either the entire system has been restarted or the MOM has been down so long that it can no longer guarantee that the pid of any running process is the same as the recorded job process pid of a recovering job. Unlike the <b>-p</b> option, no attempt is made to try and preserve or recover running jobs. All jobs are terminated and removed from the queue.
<b>-q</b>	n/a	Specifies the impact on jobs which were in execution when the mini-server shut down. With the <b>-q</b> option, MOM will allow the processes belonging to jobs to continue to run, but will not attempt to monitor them. The <b>-q</b> option is mutually exclusive with the <b>-p</b> and <b>-R</b> options.
<b>-R</b>	port	Specifies the port number on which the mini-server (MOM) will listen for resource monitor requests, task manager requests and inter-MOM messages. Both a UDP and a TCP port of this number will be used.

Flag	Name	Description
<b>-r</b>	n/a	Specifies the impact on jobs which were in execution when the mini-server shut down. With the -r option, MOM will kill any processes belonging to jobs, mark the jobs as terminated, and notify the batch server which owns the job. The -r option is mutually exclusive with the <b>-p</b> and <b>-g</b> options.  Normally the mini-server is started from the system boot file without the <b>-p</b> or the -r option. The mini-server will make no attempt to signal the former session of any job which may have been running when the mini-server terminated. It is assumed that on reboot, all processes have been killed. If the -r option is used following a reboot, process IDs (pids) may be reused and MOM may kill a process that is not a batch session.
<b>-w</b>	wait_for_server	When started with -w, pbs_moms wait until they get their MOM hierarchy file from <a href="#">pbs_server</a> to send their first update, or until 10 minutes pass. This reduces network traffic on startup and can bring up clusters faster.
<b>-x</b>	n/a	Disables the check for privileged port resource monitor connections. This is used mainly for testing since the privileged port is the only mechanism used to prevent any ordinary user from connecting.

## Configuration file

The configuration file may be specified on the command line at program start with the **-C** flag. The use of this file is to provide several types of run time information to `pbs_mom`: static resource names and values, external resources provided by a program to be run on request via a shell escape, and values to pass to internal set up functions at initialization (and re-initialization).

Each item type is on a single line with the component parts separated by white space. If the line starts with a hash mark (pound sign, #), the line is considered to be a comment and is skipped.

### *Static Resources*

For static resource names and values, the configuration file contains a list of resource names/values pairs, one pair per line and separated by white space. An example of static resource names and values could be the number of tape drives of different types and could be specified by:

- tape3480 4
- tape3420 2
- tapedat 1
- tape8mm 1

### *Shell Commands*

If the first character of the value is an exclamation mark (!), the entire rest of the line is saved to be executed through the services of the `system(3)` standard library routine.

The shell escape provides a means for the resource monitor to yield arbitrary information to the scheduler. Parameter substitution is done such that the value of any qualifier sent with the query, as

explained below, replaces a token with a percent sign (%) followed by the name of the qualifier. For example, here is a configuration file line which gives a resource name of "escape":

```
escape !echo %xxx %yyy
```

If a query for "escape" is sent with no qualifiers, the command executed would be `echo %xxx %yyy`.

If one qualifier is sent, `escape[xxx=hi there]`, the command executed would be `echo hi there %yyy`.

If two qualifiers are sent, `escape[xxx=hi][yyy=there]`, the command executed would be `echo hi there`.

If a qualifier is sent with no matching token in the command line, `escape[zzz=snafu]`, an error is reported.

#### *size[fs=<FS>]*

Specifies that the available and configured disk space in the <FS> filesystem is to be reported to the pbs\_ server and scheduler. To request disk space on a per job basis, specify the file resource, as in `qsub -l nodes=1, file=1000kb`. For example, the available and configured disk space in the `/localscratch` filesystem will be reported:

```
size[fs=/localscratch]
```

#### *Initialization Value*

An initialization value directive has a name which starts with a dollar sign (\$) and must be known to the MOM via an internal table. The entries in this table now are:

Entry	Description
<b>pbsclient</b>	<p>Causes a host name to be added to the list of hosts which will be allowed to connect to the MOM as long as they are using a privileged port for the purposes of resource monitor requests. For example, here are two configuration file lines which will allow the hosts "fred" and "wilma" to connect:</p> <pre>\$pbsclient fred \$pbsclient wilma</pre> <p>Two host names are always allowed to connect to pbs_mom "localhost" and the name returned to pbs_mom by the system call <code>gethostname()</code>. These names need not be specified in the configuration file. The hosts listed as "clients" can issue Resource Manager (RM) requests. Other MOM nodes and servers do not need to be listed as clients.</p>

Entry	Description
<b>restricted</b>	<p>Causes a host name to be added to the list of hosts which will be allowed to connect to the MOM without needing to use a privileged port. These names allow for wildcard matching. For example, here is a configuration file line which will allow queries from any host from the domain "ibm.com".</p> <pre>\$restricted *.ibm.com</pre> <p>The restriction which applies to these connections is that only internal queries may be made. No resources from a config file will be found. This is to prevent any shell commands from being run by a non-root process. This parameter is generally not required except for some versions of OSX.</p>
<b>logevent</b>	<p>Sets the mask that determines which event types are logged by pbs_mom. For example:</p> <pre>\$logevent 0x1fff \$logevent 255</pre> <p>The first example would set the log event mask to 0x1ff (511) which enables logging of all events including debug events. The second example would set the mask to 0x0ff (255) which enables all events except debug events.</p>
<b>cputmult</b>	<p>Sets a factor used to adjust cpu time used by a job. This is provided to allow adjustment of time charged and limits enforced where the job might run on systems with different cpu performance. If the MOM's system is faster than the reference system, set cputmult to a decimal value greater than 1.0. If the MOM's system is slower, set cputmult to a value between 1.0 and 0.0. For example:</p> <pre>\$cputmult 1.5 \$cputmult 0.75</pre>
<b>usecp</b>	<p>Specifies which directories should be staged with cp instead of rcp/scp. If a shared filesystem is available on all hosts in a cluster, this directive is used to make these filesystems known to the MOM. For example, if /home is NFS mounted on all nodes in a cluster:</p> <pre>\$usecp */:/home /home</pre>
<b>wallmult</b>	<p>Sets a factor to adjust wall time usage by to job to a common reference system. The factor is used for walltime calculations and limits in the same way that cputmult is used for cpu time.</p>
<b>configversion</b>	<p>Specifies the version of the config file data, a string.</p>
<b>check_poll_time</b>	<p>Specifies the MOM interval in seconds that TORQUE polls the sisters for job information. The MOM checks each job for updated resource usages, exited processes, over-limit conditions, etc., once per interval. This value should be equal or lower to pbs_server's job_stat_rate. High values result in stale information reported to pbs_server. Low values result in increased system usage by the MOM. Default is 45 seconds.</p>



Entry	Description
<b>down_on_error</b>	Causes the MOM to report itself as state "down" to pbs_server in the event of a failed health check. This feature is experimental. (For more information, see <a href="#">Health check on page 160</a> .)
<b>ideal_load</b>	Ideal processor load. Represents a low water mark for the load average. A node that is currently busy will consider itself free after falling below ideal_load.
<b>loglevel</b>	Specifies the verbosity of logging with higher numbers specifying more verbose logging. Values may range between 0 and 7.
<b>log_file_max_size</b>	If this is set to a value > 0, then pbs_mom will roll the current log file to log-file-name.1 when its size is greater than or equal to the value of log_file_max_size. This value is interpreted as kilobytes.
<b>log_file_roll_depth</b>	If this is set to a value >=1 and log_file_max_size is set, then pbs_mom will allow logs to be rolled up to the specified number of logs. At every roll, the oldest log will be the one to be deleted to make room for rolling. pbs_mom will continue rolling the log files to log-file-name.log_file_roll_depth.
<b>max_load</b>	Maximum processor load. Nodes over this load average are considered busy (see <a href="#">ideal_load</a> above).
<b>enablemomrestart</b>	Enables automatic restarts of the MOM. If enabled, the MOM will check if its binary has been updated and restart itself at a safe point when no jobs are running; thus making upgrades easier. The check is made by comparing the mtime of the pbs_mom executable. Command-line args, the process name, and the PATH env variable are preserved across restarts. It is recommended that this not be enabled in the config file, but enabled when desired with momctl (see <a href="#">Resources on page 159</a> for more information.)
<b>node_check_script</b>	Specifies the fully qualified pathname of the health check script to run (see <a href="#">Health check on page 160</a> for more information).
<b>node_check_interval</b>	Specifies when to run the MOM health check. The check can be either periodic, event-driven, or both. The value starts with an integer specifying the number of MOM intervals between subsequent executions of the specified health check. After the integer is an optional comma-separated list of event names. Currently supported are "jobstart" and "jobend". This value defaults to 1 with no events indicating the check is run every MOM interval. (see <a href="#">Health check on page 160</a> for more information.)

```

$node_check_interval 0,Disabled
$node_check_interval 0,jobstartOnly
$node_check_interval 10,jobstart,jobend

```

Entry	Description
<b>prologalarm</b>	Specifies maximum duration (in seconds) which the MOM will wait for the job prolog or job epilog to complete. This parameter defaults to 300 seconds (5 minutes).
<b>rcpcmd</b>	Specify the full path and argument to be used for remote file copies. This overrides the compile-time default found in configure. This must contain 2 words: the full path to the command and the options. The copy command must be able to recursively copy files to the remote host and accept arguments of the form "user@host:files." For example: <pre>\$rcpcmd /usr/bin/rpc -rp \$rcpcmd /usr/bin/scp -rpB</pre>
<b>remote_checkpoint_dirs</b>	Specifies which server checkpoint directories are remotely mounted. It tells the MOM which directories are shared with the server. Using remote checkpoint directories eliminates the need to copy the checkpoint files back and forth between the MOM and the server. All entries must be on the same line, separated by a space. <pre>\$remote_checkpoint_dirs /checkpointFiles /bigStorage /fast</pre> <p><i>This informs the MOM that the /checkpointFiles, /bigStorage, and /fast directories are remotely mounted checkpoint directories.</i></p>
<b>remote_reconfig</b>	Enables the ability to remotely reconfigure pbs_mom with a new config file. Default is disabled. This parameter accepts various forms of true, yes, and 1.
<b>timeout</b>	Specifies the number of seconds before TCP messages will time out. TCP messages include job obituaries, and TM requests if RPP is disabled. Default is 60 seconds.
<b>tmpdir</b>	Sets the directory base name for a per-job temporary directory. Before job launch, the MOM appends the jobid of running jobs to the tmpdir base name and creates the directory. After the job exits, the MOM recursively deletes the directory with the jobid in its name. TORQUE creates and removes the directory as the job owner and group, so the owner must have write permissions to create the directory. The environment variable TMPDIR will be set for all prologue and epilogue scripts, the job script, and TM tasks for each job. It is recommended that you create the tmpdir directory before running any jobs on the MOM and that you make it readable and writable to all users who will run jobs. If you do not specify a base tmpdir directory, the first job run on the MOM will create the directory and set the directory owner to its own. After that, no other users will be able to run jobs on that MOM.
<b>status_update_time</b>	Specifies (in seconds) how often the MOM updates its status information to pbs_server. This value should correlate with the server's scheduling interval and its "node_check_rate" attribute. High values for "status_update_time" cause pbs_server to report stale information, while low values increase the load of pbs_server and the network. Default is 45 seconds.

Entry	Description
<b>varattr</b>	<p>This is similar to a shell escape above, but includes a TTL. The command will only be run every TTL seconds. A TTL of -1 will cause the command to be executed only once. A TTL of 0 will cause the command to be run every time varattr is requested. This parameter may be used multiple times, but all output will be grouped into a single "varattr" attribute in the request and status output. If the command has no output, the name will be skipped in the output.</p> <pre>\$varattrseta \$varattrsetb</pre>
<b>xauthpath</b>	Specifies the path to the xauth binary to enable X11 forwarding.
<b>ignvmem</b>	If set to true, then pbs_mom will ignore vmem/pvmem limit enforcement.
<b>ignwalltime</b>	If set to true, then pbs_mom will ignore walltime limit enforcement.
<b>mom_host</b>	Sets the local hostname as used by pbs_mom.

## Resources

Resource Manager queries can be made with [momctl](#) `-q` options to retrieve and set pbs\_mom options. Any configured static resource may be retrieved with a request of the same name. These are resource requests not otherwise documented in the PBS ERS.

Request	Description
<b>cycle</b>	Forces an immediate MOM cycle.
<b>status_update_time</b>	Retrieve or set the \$status_update_time parameter.
<b>check_poll_time</b>	Retrieve or set the \$check_poll_time parameter.
<b>configversion</b>	Retrieve the config version.
<b>jobstartblocktime</b>	Retrieve or set the \$jobstartblocktime parameter.
<b>enablemomrestart</b>	Retrieve or set the \$enablemomrestart parameter.
<b>loglevel</b>	Retrieve or set the \$loglevel parameter.
<b>down_on_error</b>	Retrieve or set the EXPERIMENTAL \$down_on_error parameter.

Request	Description
<b>diag0 - diag4</b>	Retrieves varied diagnostic information.
<b>rcpcmd</b>	Retrieve or set the \$rcpcmd parameter.
<b>version</b>	Retrieves the pbs_mom version.

## Health check

The health check script is executed directly by the pbs\_mom daemon under the root user id. It must be accessible from the compute node and may be a script or compiled executable program. It may make any needed system calls and execute any combination of system utilities but should not execute resource manager client commands. Also, the pbs\_mom daemon blocks until the health check is completed and does not possess a built-in timeout. Consequently, it is advisable to keep the launch script execution time short and verify that the script will not block even under failure conditions.

If the script detects a failure, it should return the keyword "Error" to `stdout` followed by an error message. The message (up to 256 characters) immediately following the Error string will be assigned to the node attribute message of the associated node.

If the script detects a failure when run from "jobstart", then the job will be rejected. You can use this behavior with an advanced scheduler, such as Moab Workload Manager, to cause the job to be routed to another node. TORQUE currently ignores Error messages by default, but you can configure an advanced scheduler to react appropriately.

If the experimental `$down_on_error` MOM setting is enabled, the MOM will set itself to state down and report to pbs\_server. Additionally, the experimental `$down_on_error` server attribute can be enabled which has the same effect but moves the decision to pbs\_server. It is redundant to have MOM's `$down_on_error` and pbs\_servers `down_on_error` features enabled. See "down\_on\_error" in pbs\_server\_attributes(7B).

## Files

File	Description
<b>\$PBS_SERVER_HOME/server_name</b>	Contains the hostname running pbs_server
<b>\$PBS_SERVER_HOME/mom_priv</b>	The default directory for configuration files, typically <code>(/usr/spool/pbs)/mom_priv</code>
<b>\$PBS_SERVER_HOME/mom_logs</b>	Directory for log files recorded by the server
<b>\$PBS_SERVER_HOME/mom_priv/-prologue</b>	The administrative script to be run before job execution

File	Description
<code>\$PBS_SERVER_HOME/mom_priv/epilogue</code>	The administrative script to be run after job execution

## Signal handling

`pbs_mom` handles the following signals:

Signal	Description
<b>SIGHUP</b>	Causes <code>pbs_mom</code> to re-read its configuration file, close and reopen the log file, and re-initialize resource structures.
<b>SIGALRM</b>	Results in a log file entry. The signal is used to limit the time taken by certain children processes, such as the prologue and epilogue.
<b>SIGINT and SIGTERM</b>	Results in <code>pbs_mom</code> exiting without terminating any running jobs. This is the action for the following signals as well: <code>SIGXCPU</code> , <code>SIGXFSZ</code> , <code>SIGCPULIM</code> , and <code>SIGSHUTDN</code> .
<b>SIGUSR1, SIGUSR2</b>	Causes the MOM to increase and decrease logging levels, respectively.
<b>SIGPIPE, SIGINFO</b>	Are ignored.
<b>SIGBUS, SIGFPE, SIGILL, SIGTRAP, and SIGSYS</b>	Cause a core dump if the <code>PBSCOREDUMP</code> environmental variable is defined.

All other signals have their default behavior installed.

## Exit status

If the `pbs_mom` command fails to begin operation, the server exits with a value greater than zero.

## Related topics

- [pbs\\_server\(8B\)](#)

## Non-Adaptive Computing topics

- [pbs\\_scheduler\\_basl\(8B\)](#)
- [pbs\\_scheduler\\_tcl\(8B\)](#)
- PBS External Reference Specification
- PBS Administrators Guide

# pbs\_server

(PBS Server) pbs batch system manager

## Synopsis

```
pbs_server [-a active] [-c] [-d config_path] [-f force overwrite] [-p port] [-A acctfile]
[-l location] [-L logfile] [-S scheduler_port]
[-H hostname] [-t type] [--ha]
[-n don't send hierarchy] [--about] [-v] [--version]
```

## Description

The `pbs_server` command starts the operation of a batch server on the local host. Typically, this command will be in a local boot file such as `/etc/rc.local`. If the batch server is already in execution, `pbs_server` will exit with an error. To ensure that the `pbs_server` command is not runnable by the general user community, the server will only execute if its real and effective uid is zero.

The server will record a diagnostic message in a log file for any error occurrence. The log files are maintained in the `server_logs` directory below the home directory of the server. If the log file cannot be opened, the diagnostic message is written to the system console.

As of TORQUE 4.0, the `pbs_server` is multi-threaded which leads to quicker response to client commands, is more robust, and allows for higher job throughput.

## Options

Option	Name	Description
<b>-A</b>	acctfile	Specifies an absolute path name of the file to use as the accounting file. If not specified, the file name will be the current date in the <code>PBS_HOME/server_priv/accounting</code> directory.
<b>-a</b>	active	Specifies if scheduling is active or not. This sets the server attribute scheduling. If the option argument is "true" ("True", "t", "T", or "1"), the server is active and the PBS job scheduler will be called. If the argument is "false" ("False", "f", "F", or "0"), the server is idle, and the scheduler will not be called and no jobs will be run. If this option is not specified, the server will retain the prior value of the scheduling attribute.
<b>-c</b>	wait_for_moms	This directs <code>pbs_server</code> to send the MOM hierarchy only to MOMs that request it for the first 10 minutes. After 10 minutes, it attempts to send the MOM hierarchy to MOMs that haven't requested it already. This greatly reduces traffic on start up.

Option	Name	Description
<b>-d</b>	config_directory	Specifies the path of the directory which is home to the server's configuration files, PBS_HOME. A host may have multiple servers. Each server must have a different configuration directory. The default configuration directory is given by the symbol \$PBS_SERVER_HOME which is typically var/spool/torque.
<b>-f</b>	force overwrite	Forces an overwrite of the server database. This can be useful to bypass the <i>yes/no</i> prompt when running something like <code>pbs_server -t create</code> and can ease installation and configuration of TORQUE via scripts.
<b>-H</b>	hostname	Causes the server to start under a different hostname as obtained from <code>gethostname (2)</code> . Useful for servers with multiple network interfaces to support connections from clients over an interface that has a hostname assigned that differs from the one that is returned by <code>gethostname(2)</code> .
<b>--ha</b>	high_availability	Starts server in high availability mode (for details, see <a href="#">Server high availability on page 91</a> ).
<b>-L</b>	logfile	Specifies an absolute path name of the file to use as the log file. If not specified, the file will be the current date in the <code>PBS_HOME/server_logs</code> directory (see the <b>-d</b> option).
<b>-l</b>	location	Specifies where to find Moab when it does not reside on the same host as TORQUE.
<b>-n</b>	no send	This directs <code>pbs_server</code> to not send the hierarchy to all the MOMs on startup. Instead, the hierarchy is only sent if a MOM requests it. This flag works only in conjunction with the <a href="#">local MOM hierarchy</a> feature.
<b>-p</b>	port	Specifies the port number on which the server will listen for batch requests. If multiple servers are running on a single host, each must have its own unique port number. This option is for use in testing with multiple batch systems on a single host.
<b>-S</b>	scheduler_port	Specifies the port number to which the server should connect when contacting the scheduler. The argument <code>scheduler_conn</code> is of the same syntax as under the <b>-M</b> option.

Option	Name	Description
<b>-t</b>	type	<p>Specifies the impact on jobs which were in execution, running, when the server shut down. If the running job is not rerunnable or restartable from a checkpoint image, the job is aborted. If the job is rerunnable or restartable, then the actions described below are taken. When the type argument is:</p> <ul style="list-style-type: none"> <li>• <i>hot</i> – All jobs are requeued except non-rerunnable jobs that were executing. Any rerunnable job which was executing when the server went down will be run immediately. This returns the server to the same state as when it went down. After those jobs are restarted, then normal scheduling takes place for all remaining queued jobs.</li> </ul> <p>If a job cannot be restarted immediately because of a missing resource, such as a node being down, the server will attempt to restart it periodically for up to 5 minutes. After that period, the server will revert to a normal state, as if warm started, and will no longer attempt to restart any remaining jobs which were running prior to the shutdown.</p> <ul style="list-style-type: none"> <li>• <i>warm</i> – All rerunnable jobs which were running when the server went down are requeued. All other jobs are maintained. New selections are made for which jobs are placed into execution. Warm is the default if <code>-t</code> is not specified.</li> <li>• <i>cold</i> – All jobs are deleted. Positive confirmation is required before this direction is accepted.</li> <li>• <i>create</i> – The server will discard any existing configuration files, queues and jobs, and initialize configuration files to the default values. The server is idled.</li> </ul>

## Files

File	Description
<b>TORQUE_HOME/server_priv</b>	Default directory for configuration files, typically <code>/usr/spool/pbs/server_priv</code>
<b>TORQUE_HOME/server_logs</b>	Directory for log files recorded by the server

## Signal handling

On receipt of the following signals, the server performs the defined action:

Action	Description
<b>SIGHUP</b>	The current server log and accounting log are closed and reopened. This allows for the prior log to be renamed and a new log started from the time of the signal.
<b>SIGINT</b>	Causes an orderly shutdown of <code>pbs_server</code> .



Action	Description
<b>SIGUSR1, SIGUSR2</b>	Causes server to increase and decrease logging levels, respectively.
<b>SIGTERM</b>	Causes an orderly shutdown of pbs_server.
<b>SIGSHUTDN</b>	On systems (Unicos) where SIGSHUTDN is defined, it also causes an orderly shutdown of the server.
<b>SIGPIPE</b>	This signal is ignored.

All other signals have their default behavior installed.

## Exit status

If the server command fails to begin batch operation, the server exits with a value greater than zero.

## Related topics

- [pbs\\_mom\(8B\)](#)
- [pbsnodes\(8B\)](#)
- [qmgr\(1B\)](#)
- [qrun\(8B\)](#)
- [qsub\(1B\)](#)
- [qterm\(8B\)](#)

## Non-Adaptive Computing topics

- [pbs\\_connect\(3B\)](#)
- [pbs\\_sched\\_basl\(8B\)](#)
- [pbs\\_sched\\_tcl\(8B\)](#)
- [qdisable\(8B\)](#)
- [qenable\(8B\)](#)
- [qstart\(8B\)](#)
- [qstop\(8B\)](#)
- [PBS External Reference Specification](#)

## `pbs_track`

Starts a new process and informs pbs\_mom to start tracking it.

## Synopsis

```
pbs_track -j <JOBID> [-b] <executable> [args]
```

## Description

The `pbs_track` command tells a `pbs_mom` daemon to monitor the lifecycle and resource usage of the process that it launches using `exec()`. The `pbs_mom` is told about this new process via the Task Manager API, using `tm_adopt()`. The process must also be associated with a job that already exists on the `pbs_mom`.

By default, `pbs_track` will send its PID to TORQUE via `tm_adopt()`. It will then perform an `exec()`, causing `<executable>` to run with the supplied arguments. `pbs_track` will not return until the launched process has completed because it becomes the launched process.

This command can be considered related to the [pbsdsh](#) command which uses the `tm_spawn()` API call. The `pbsdsh` command asks a `pbs_mom` to launch and track a new process on behalf of a job. When it is not desirable or possible for the `pbs_mom` to spawn processes for a job, `pbs_track` can be used to allow an external entity to launch a process and include it as part of a job.

This command improves integration with TORQUE and SGI's MPT MPI implementation.

## Options

Option	Description
<code>-j</code> <code>&lt;JOBID&gt;</code>	Job ID the new process should be associated with.
<code>-b</code>	Instead of having <code>pbs_track</code> send its PID to TORQUE, it will <code>fork()</code> first, send the child PID to TORQUE, and then execute from the forked child. This essentially "backgrounds" <code>pbs_track</code> so that it will return after the new process is launched.

## Operands

The `pbs_track` command accepts a path to a program/executable (`<executable>`) and, optionally, one or more arguments to pass to that program.

## Exit status

Because the `pbs_track` command becomes a new process (if used without `-b`), its exit status will match that of the new process. If the `-b` option is used, the exit status will be zero if no errors occurred before launching the new process.

If `pbs_track` fails, whether due to a bad argument or other error, the exit status will be set to a non-zero value.

## Related topics

- [pbsdsh\(1B\)](#)

## Non-Adaptive Computing topics

- [tm\\_spawn\(3B\)](#)

# pbsdsh

Distribute tasks to nodes under pbs.



Some limitations exist in the way that pbsdsh can be used. Please note the following situations are not currently supported:

- Running multiple instances of pbsdsh concurrently within a single job.
- Using the -o and -s options concurrently; although requesting these options together is permitted, only the output from the first node is displayed rather than output from every node in the chain.

## Synopsis

```
pbsdsh [-c copies] [-o] [-s] [-u] [-v] program [args]
pbsdsh [-n node] [-o] [-s] [-u] [-v] program [args]
pbsdsh [-h nodename] [-o] [-v] program [args]
```

## Description

Executes (spawns) a normal Unix program on one or more nodes under control of the Portable Batch System, PBS. Pbsdsh uses the Task Manager API (see `tm_spawn(3)`) to distribute the program on the allocated nodes.

When run without the `-c` or the `-n` option, pbsdsh will spawn the program on all nodes allocated to the PBS job. The spawns take place concurrently – all execute at (about) the same time.

Users will find the `PBS_TASKNUM`, `PBS_NODENUM`, and the `PBS_VNODENUM` environmental variables useful. They contain the TM task id, the node identifier, and the cpu (virtual node) identifier.

## Options

Option	Name	Description
<code>-c</code>	copies	The program is spawned on the first Copies nodes allocated. This option is mutually exclusive with <code>-n</code> .
<code>-h</code>	hostname	The program is spawned on the node specified.
<code>-n</code>	node	The program is spawned on one node which is the n-th node allocated. This option is mutually exclusive with <code>-c</code> .
<code>-o</code>	---	Capture stdout of the spawned program. Normally stdout goes to the job's output.
<code>-s</code>	---	If this option is given, the program is run in turn on each node, one after the other.

Option	Name	Description
<b>-u</b>	---	The program is run once on each node (unique). This ignores the number of allocated processors on a given node.
<b>-v</b>	---	Verbose output about error conditions and task exit status is produced.

## Operands

The first operand, `program`, is the program to execute.

Additional operands are passed as arguments to the program.

## Standard error

The `pbsdsh` command will write a diagnostic message to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the command, the exit status will be a value of zero.

If the `pbsdsh` command fails to process any operand, or fails to contact the MOM daemon on the localhost the command exits with a value greater than zero.

## Related topics

- [qsub\(1B\)](#)

## Non-Adaptive Computing topics

- [tm\\_spawn\(3B\)](#)

# pbsnodes

PBS node manipulation.

## Synopsis

```
pbsnodes [-{a|x}] [-q] [-s server] [node[:property]]
pbsnodes -l [-q] [-s server] [state] [nodename[:property] ...]
pbsnodes [-{c|d|o|r}] [-q] [-s server] [-n -l] [-N "note"] [node[:property]]
```

## Description

The `pbsnodes` command is used to mark nodes down, free or offline. It can also be used to list nodes and their state. Node information is obtained by sending a request to the PBS job server. Sets of nodes can be operated on at once by specifying a node property prefixed by a colon. (For more information, see Node states.)

Nodes do not exist in a single state, but actually have a set of states. For example, a node can be simultaneously "busy" and "offline". The "free" state is the absence of all other states and so is never combined with other states.

In order to execute `pbsnodes` with other than the `-a` or `-l` options, the user must have PBS Manager or Operator privilege.

## Options

Option	Description
<code>-a</code>	All attributes of a node or all nodes are listed. This is the default if no flag is given.
<code>-x</code>	Same as <code>-a</code> , but the output has an XML-like format.
<code>-c</code>	Clear OFFLINE from listed nodes.
<code>-d</code>	Print MOM diagnosis on the listed nodes. Not yet implemented. Use <code>momctl</code> instead.
<code>-o</code>	Add the OFFLINE state. This is different from being marked DOWN. OFFLINE prevents new jobs from running on the specified nodes. This gives the administrator a tool to hold a node out of service without changing anything else. The OFFLINE state will never be set or cleared automatically by <code>pbs_server</code> ; it is purely for the manager or operator.
<code>-p</code>	Purge the node record from <code>pbs_server</code> . Not yet implemented.
<code>-r</code>	Reset the listed nodes by clearing OFFLINE and adding DOWN state. <code>pbs_server</code> will ping the node and, if they communicate correctly, free the node.
<code>-l</code>	List node names and their state. If no state is specified, only nodes in the DOWN, OFFLINE, or UNKNOWN states are listed. Specifying a state string acts as an output filter. Valid state strings are "active", "all", "busy", "down", "free", "job-exclusive", "job-sharing", "offline", "reserve", "state-unknown", "time-shared", and "up". <ul style="list-style-type: none"> <li>• Using <i>all</i> displays all nodes and their attributes.</li> <li>• Using <i>active</i> displays all nodes which are job-exclusive, job-sharing, or busy.</li> <li>• Using <i>up</i> displays all nodes in an "up state". Up states include job-exclusive, job-sharing, reserve, free, busy and time-shared.</li> <li>• All other strings display the nodes which are currently in the state indicated by the string.</li> </ul>
<code>-N</code>	Specify a "note" attribute. This allows an administrator to add an arbitrary annotation to the listed nodes. To clear a note, use <code>-N ""</code> or <code>-N n</code> .
<code>-n</code>	Show the "note" attribute for nodes that are DOWN, OFFLINE, or UNKNOWN. This option requires <code>-l</code> .

Option	Description
<b>-q</b>	Suppress all error messages.
<b>-s</b>	Specify the PBS server's hostname or IP address.

### Related topics

- [pbs\\_server\(8B\)](#)

### Non-Adaptive Computing topics

- PBS External Reference Specification

## qalter

Alter batch job.

### Synopsis


```
qalter [-a date_time] [-A account_string] [-c interval] [-e path_name]
[-h hold_list] [-j join_list] [-k keep_list] [-l resource_list]
[-m mail_options] [-M mail_list] [-n] [-N name] [-o path_name]
[-p priority] [-r y|n] [-S path_name_list] [-u user_list]
[-v variable_list] [-W additional_attributes]
[-t array_range]
job_identifier ...
```


### Description

The `qalter` command modifies the attributes of the job or jobs specified by `job_identifier` on the command line. Only those attributes listed as options on the command will be modified. If any of the specified attributes cannot be modified for a job for any reason, none of that job's attributes will be modified.

The `qalter` command accomplishes the modifications by sending a Modify Job batch request to the batch server which owns each job.

## Options

Option	Name	Description
<b>-a</b>	date_time	<p>Replaces the time at which the job becomes eligible for execution. The date_time argument syntax is:</p> <pre>[[ [CC] YY] MM] DD] hhmm [ . SS]</pre> <p>If the month, MM, is not specified, it will default to the current month if the specified day DD, is in the future. Otherwise, the month will be set to next month. Likewise, if the day, DD, is not specified, it will default to today if the time hhmm is in the future. Otherwise, the day will be set to tomorrow.</p> <p>This attribute can be altered once the job has begun execution, but it will not take effect unless the job is rerun.</p>
<b>-A</b>	account_string	<p>Replaces the account string associated with the job. This attribute cannot be altered once the job has begun execution.</p>
<b>-c</b>	checkpoint_interval	<p>Replaces the interval at which the job will be checkpointed. If the job executes upon a host which does not support checkpointing, this option will be ignored.</p> <p>The interval argument is specified as:</p> <ul style="list-style-type: none"> <li>• <i>n</i> – No checkpointing is to be performed.</li> <li>• <i>s</i> – Checkpointing is to be performed only when the server executing the job is shutdown.</li> <li>• <i>c</i> – Checkpointing is to be performed at the default minimum cpu time for the queue from which the job is executing.</li> <li>• <i>c=minutes</i> – Checkpointing is performed at intervals of the specified amount of time in minutes. Minutes are the number of minutes of CPU time used, not necessarily clock time.</li> </ul> <div style="border: 1px solid black; border-radius: 10px; padding: 5px; margin-top: 10px;"> <p> This value must be greater than zero. If the number is less than the default checkpoint time, the default time will be used.</p> </div> <p>This attribute can be altered once the job has begun execution, but the new value does not take effect unless the job is rerun.</p>

Option	Name	Description
<b>-e</b>	path_name	<p>Replaces the path to be used for the standard error stream of the batch job. The path argument is of the form:</p> <pre>[hostname:]path_name</pre> <p>where <i>hostname</i> is the name of a host to which the file will be returned and <i>path_name</i> is the path name on that host in the syntax recognized by POSIX 1003.1. The argument will be interpreted as follows:</p> <ul style="list-style-type: none"> <li>• <i>path_name</i> – Where <i>path_name</i> is not an absolute path name, then the <code>qalter</code> command will expand the path name relative to the current working directory of the command. The command will supply the name of the host upon which it is executing for the <i>hostname</i> component.</li> <li>• <i>hostname:path_name</i> – Where <i>path_name</i> is not an absolute path name, then the <code>qalter</code> command will not expand the path name. The execution server will expand it relative to the home directory of the user on the system specified by <i>hostname</i>.</li> </ul> <p>This attribute can be altered once the job has begun execution, but it will not take effect unless the job is rerun.</p>
<b>-h</b>	hold_list	<p>Updates the types of holds on the job. The <code>hold_list</code> argument is a string of one or more of the following characters:</p> <ul style="list-style-type: none"> <li>• <i>u</i> – Add the USER type hold.</li> <li>• <i>s</i> – Add the SYSTEM type hold if the user has the appropriate level of privilege. (Typically reserved to the batch administrator.)</li> <li>• <i>o</i> – Add the OTHER (or OPERATOR ) type hold if the user has the appropriate level of privilege. (Typically reserved to the batch administrator and batch operator.)</li> <li>• <i>n</i> – Set to none and clear the hold types which could be applied with the user's level of privilege. Repetition of characters is permitted, but "n" may not appear in the same option argument with the other three characters.</li> </ul> <p>This attribute can be altered once the job has begun execution, but the hold will not take effect unless the job is rerun.</p>
<b>-j</b>	join	<p>Declares which standard streams of the job will be merged together. The <code>join</code> argument value may be the characters "oe" and "eo", or the single character "n".</p> <p>An argument value of <code>oe</code> directs that the standard output and standard error streams of the job will be merged, intermixed, and returned as the standard output. An argument value of <code>eo</code> directs that the standard output and standard error streams of the job will be merged, intermixed, and returned as the standard error.</p> <p>A value of <code>n</code> directs that the two streams will be two separate files. This attribute can be altered once the job has begun execution, but it will not take effect unless the job is rerun.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p> If using either the <code>-e</code> or the <code>-o</code> option and the <code>-j eo oe</code> option, the <code>-j</code> option takes precedence and all standard error and output messages go to the chosen output file.</p> </div>



Option	Name	Description
<b>-k</b>	keep	<p>Defines which if either of standard output or standard error of the job will be retained on the execution host. If set for a stream, this option overrides the path name for that stream.</p> <p>The argument is either the single letter "e", "o", or "n", or one or more of the letters "e" and "o" combined in either order.</p> <ul style="list-style-type: none"> <li>• <i>n</i> – No streams are to be retained.</li> <li>• <i>e</i> – The standard error stream is to be retained on the execution host. The stream will be placed in the home directory of the user under whose user id the job executed. The file name will be the default file name given by:  <code>job_name.e.sequence</code>            where <code>job_name</code> is the name specified for the job, and <code>sequence</code> is the sequence number component of the job identifier.</li> <li>• <i>o</i> – The standard output stream is to be retained on the execution host. The stream will be placed in the home directory of the user under whose user id the job executed. The file name will be the default file name given by:  <code>job_name.o.sequence</code>            where <code>job_name</code> is the name specified for the job, and <code>sequence</code> is the sequence number component of the job identifier.</li> <li>• <i>eo</i> – Both the standard output and standard error streams will be retained.</li> <li>• <i>oe</i> – Both the standard output and standard error streams will be retained.</li> </ul> <p>This attribute cannot be altered once the job has begun execution.</p>
<b>-l</b>	resource_list	<p>Modifies the list of resources that are required by the job. The <code>resource_list</code> argument is in the following syntax:</p> <pre>resource_name [= [value]] [, resource_name [= [value]] , ... ]</pre> <p>If a requested modification to a resource would exceed the resource limits for jobs in the current queue, the server will reject the request.</p> <p>If the job is running, only certain resources can be altered. Which resources can be altered in the run state is system dependent. A user may only lower the limit for those resources.</p>
<b>-m</b>	mail_options	<p>Replaces the set of conditions under which the execution server will send a mail message about the job. The <code>mail_options</code> argument is a string which consists of the single character "n", or one or more of the characters "a", "b", and "e".</p> <p>If the character "n" is specified, no mail will be sent.</p> <p>For the letters "a", "b", and "e":</p> <ul style="list-style-type: none"> <li>• <i>a</i> – Mail is sent when the job is aborted by the batch system.</li> <li>• <i>b</i> – Mail is sent when the job begins execution.</li> <li>• <i>e</i> – Mail is sent when the job ends.</li> </ul>

Option	Name	Description
<b>-M</b>	user_list	<p>Replaces the list of users to whom mail is sent by the execution server when it sends mail about the job.</p> <p>The user_list argument is of the form:</p> <pre>user[@host] [, user[@host], ...]</pre>
<b>-n</b>	node-exclusive	<p>Sets or unsets exclusive node allocation on a job. Use the y and n options to enable or disable the feature. This affects only cpusets and compatible schedulers.</p> <pre>&gt; qalter ... -n y #enables exclusive node allocation on a job &gt; qalter ... -n n #disables exclusive node allocation on a job</pre>
<b>-N</b>	name	<p>Renames the job. The name specified may be up to and including 15 characters in length. It must consist of printable, nonwhite space characters with the first character alphabetic.</p>
<b>-o</b>	path	<p>Replaces the path to be used for the standard output stream of the batch job. The path argument is of the form:</p> <pre>[hostname:]path_name</pre> <p>where <i>hostname</i> is the name of a host to which the file will be returned and <i>path_name</i> is the path name on that host in the syntax recognized by POSIX. The argument will be interpreted as follows:</p> <ul style="list-style-type: none"> <li>• <i>path_name</i> – Where <i>path_name</i> is not an absolute path name, then the <code>qalter</code> command will expand the path name relative to the current working directory of the command. The command will supply the name of the host upon which it is executing for the <i>hostname</i> component.</li> <li>• <i>hostname:path_name</i> – Where <i>path_name</i> is not an absolute path name, then the <code>qalter</code> command will not expand the path name. The execution server will expand it relative to the home directory of the user on the system specified by <i>hostname</i>.</li> </ul> <p>This attribute can be altered once the job has begun execution, but it will not take effect unless the job is rerun.</p>
<b>-p</b>	priority	<p>Replaces the priority of the job. The priority argument must be an integer between -1024 and +1023 inclusive.</p> <p>This attribute can be altered once the job has begun execution, but it will not take effect unless the job is rerun.</p>
<b>-r</b>	[y/n]	<p>Declares whether the job is rerunable (see the <a href="#">qrerun</a> command). The option argument <i>c</i> is a single character. PBS recognizes the following characters: y and n. If the argument is "y", the job is marked rerunable.</p> <p>If the argument is "n", the job is marked as not rerunable.</p>

Option	Name	Description
<b>-S</b>	path	<p>Declares the shell that interprets the job script.</p> <p>The option argument path_list is in the form:</p> <pre>path[@host] [,path[@host], ...]</pre> <p>Only one path may be specified for any host named. Only one path may be specified without the corresponding host name. The path selected will be the one with the host name that matched the name of the execution host. If no matching host is found, then the path specified (without a host) will be selected.</p> <p>If the <code>-S</code> option is not specified, the option argument is the null string, or no entry from the path_list is selected, the execution will use the login shell of the user on the execution host.</p> <p>This attribute can be altered once the job has begun execution, but it will not take effect unless the job is rerun.</p>
<b>-t</b>	array_range	<p>The array_range argument is an integer id or a range of integers. Multiple ids or id ranges can be combined in a comma delimited list. Examples: <code>-t 1-100</code> or <code>-t 1, 10, 50-100</code></p> <p>If an array range isn't specified, the command tries to operate on the entire array. The command acts on the array (or specified range of the array) just as it would on an individual job.</p> <p>An optional "slot limit" can be specified to limit the amount of jobs that can run concurrently in the job array. The default value is unlimited. The slot limit must be the last thing specified in the array_request and is delimited from the array by a percent sign (%).</p> <pre>qalter weatherSimulationArray[] -t %20</pre> <p>Here, the array weatherSimulationArray[] is configured to allow a maximum of 20 concurrently running jobs.</p> <p>Slot limits can be applied at job submit time with <a href="#">qsub</a>, or can be set in a global server parameter policy with <a href="#">max_slot_limit</a>.</p>
<b>-u</b>	user_list	<p>Replaces the user name under which the job is to run on the execution system.</p> <p>The user_list argument is of the form:</p> <pre>user[@host] [,user[@host], ...]</pre> <p>Only one user name may be given for per specified host. Only one of the user specifications may be supplied without the corresponding host specification. That user name will be used for execution on any host not named in the argument list.</p> <p>This attribute cannot be altered once the job has begun execution.</p>
<b>-W</b>	additional_attributes	<p>The <code>-w</code> option allows for the modification of additional job attributes.</p> <p>Note if white space occurs anywhere within the option argument string or the equal sign, "=", occurs within an attribute_value string, then the string must be enclosed with either single or double quote marks.</p> <p>To see the attributes PBS currently supports within the <code>-w</code> option, see <a href="#">Table A-1: -W additional_attributes on page 176</a>.</p>

Table A-1: -W additional\_attributes

Attribute	Description
<b>depend=dependency_list</b>	<p>Redefines the dependencies between this and other jobs. The <code>dependency_list</code> is in the form:</p> <pre>type[:argument[:argument...]][,type:argument...]</pre> <p>The argument is either a numeric count or a PBS job id according to type. If argument is a count, it must be greater than 0. If it is a job id and is not fully specified in the form: <code>seq_number.server.name</code>, it will be expanded according to the default server rules. If argument is null (the preceding colon need not be specified), the dependency of the corresponding type is cleared (unset).</p> <ul style="list-style-type: none"> <li>• <i>synccount:count</i> – This job is the first in a set of jobs to be executed at the same time. Count is the number of additional jobs in the set.</li> <li>• <i>syncwith:jobid</i> – This job is an additional member of a set of jobs to be executed at the same time. In the above and following dependency types, jobid is the job identifier of the first job in the set.</li> <li>• <i>after:jobid [:jobid...]</i> – This job may be scheduled for execution at any point after jobs jobid have started execution.</li> <li>• <i>afterok:jobid [:jobid...]</i> – This job may be scheduled for execution only after jobs jobid have terminated with no errors. See the csh warning under "Extended Description".</li> <li>• <i>afternotok:jobid [:jobid...]</i> – This job may be scheduled for execution only after jobs jobid have terminated with errors. See the csh warning under "Extended Description".</li> <li>• <i>afterany:jobid [:jobid...]</i> – This job may be scheduled for execution after jobs jobid have terminated, with or without errors.</li> <li>• <i>on:count</i> – This job may be scheduled for execution after count dependencies on other jobs have been satisfied. This dependency is used in conjunction with any of the 'before' dependencies shown below. If job A has <i>on:2</i>, it will wait for two jobs with 'before' dependencies on job A to be fulfilled before running.</li> <li>• <i>before:jobid [:jobid...]</i> – When this job has begun execution, then jobs jobid... may begin.</li> <li>• <i>beforeok:jobid [:jobid...]</i> – If this job terminates execution without errors, then jobs jobid... may begin. See the csh warning under "Extended Description".</li> <li>• <i>beforenotok:jobid [:jobid...]</i> – If this job terminates execution with errors, then jobs jobid... may begin. See the csh warning under "Extended Description".</li> <li>• <i>beforeany:jobid [:jobid...]</i> – When this job terminates execution, jobs jobid... may begin.</li> </ul> <p>If any of the before forms are used, the job referenced by jobid must have been submitted with a dependency type of on.</p> <p>If any of the before forms are used, the jobs referenced by jobid must have the same owner as the job being altered. Otherwise, the dependency will not take effect.</p> <p>Error processing of the existence, state, or condition of the job specified to qalter is a deferred service, i.e. the check is performed after the job is queued. If an error is detected, the job will be deleted by the server. Mail will be sent to the job submitter stating the error.</p>

Attribute	Description
<b>group_list=g_list</b>	<p>Alters the group name under which the job is to run on the execution system.</p> <p>The <code>g_list</code> argument is of the form:</p> <pre>group[@host] [,group[@host], ...]</pre> <p>Only one group name may be given per specified host. Only one of the group specifications may be supplied without the corresponding host specification. That group name will be used for execution on any host not named in the argument list.</p>
<b>stagein=file_list</b> <b>stageout=file_list</b>	<p>Alters which files are staged (copied) in before job start or staged out after the job completes execution. The <code>file_list</code> is in the form:</p> <pre>local_file@hostname:remote_file[, ...]</pre> <p>The name <code>local_file</code> is the name on the system where the job executes. It may be an absolute path or a path relative to the home directory of the user. The name <code>remote_file</code> is the destination name on the host specified by <code>hostname</code>. The name may be absolute or relative to the user's home directory on the destination host.</p>

## Operands

The `qalter` command accepts one or more `job_identifier` operands of the form:

```
sequence_number[.server_name][@server]
```

## Standard error

Any error condition, either in processing the options or the operands, or any error received in reply to the batch requests will result in an error message being written to standard error.

## Exit status

Upon successful processing of all the operands presented to the `qalter` command, the exit status will be a value of zero.

If the `qalter` command fails to process any operand, the command exits with a value greater than zero.

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## Related topics

- [qdel](#)
- [qhold](#)

- [qrls](#)
- [qsub](#)

## Non-Adaptive Computing topics

- Batch Environment Services
- [qmove](#)
- [touch](#)

# qchkpt

Checkpoint pbs batch jobs.

## Synopsis

```
qchkpt <JOBID>[ <JOBID>] ...
```

## Description

The `qchkpt` command requests that the PBS MOM generate a checkpoint file for a running job.

This is an extension to POSIX.2d.

The `qchkpt` command sends a Chkpt Job batch request to the server as described in the general section.

## Options

None.

## Operands

The `qchkpt` command accepts one or more `job_identifier` operands of the form:

```
sequence_number[.server_name] [@server]
```

## Examples

```
> qchkpt 3233 request a checkpoint for job 3233
```

## Standard error

The `qchkpt` command will write a diagnostic message to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the `qchkpt` command, the exit status will be a value of zero.

If the `qchkpt` command fails to process any operand, the command exits with a value greater than zero.

## Related topics

- [qhold](#)(1B)
- [qrls](#)(1B)
- [qalter](#)(1B)
- [qsub](#)(1B)

## Non-Adaptive Computing topics

- [pbs\\_alterjob](#)(3B)
- [pbs\\_holdjob](#)(3B),
- [pbs\\_rlsjob](#)(3B)
- [pbs\\_job\\_attributes](#)(7B)
- [pbs\\_resources\\_unicos8](#)(7B)

# qdel

*(delete job)*

## Synopsis

```
qdel [{-a <asynchronous delete>|-m <message>|-p|-W <delay>|-t <array_range>}]  
<JOBID>[ <JOBID>]... | 'all' | 'ALL'
```

## Description

The `qdel` command deletes jobs in the order in which their job identifiers are presented to the command. A job is deleted by sending a Delete Job batch request to the batch server that owns the job. A job that has been deleted is no longer subject to management by batch services.

A batch job may be deleted by its owner, the batch operator, or the batch administrator.

A batch job being deleted by a server will be sent a SIGTERM signal following by a SIGKILL signal. The time delay between the two signals is an attribute of the execution queue from which the job was run (set table by the administrator). This delay may be overridden by the `-W` option.

See the PBS ERS section 3.1.3.3, "Delete Job Request", for more information.

## Options

Option	Name	Description
<code>-a</code>	asynchronous delete	Performs an asynchronous delete. The server responds to the user before contacting the MOM. The option <code>qdel -a all</code> performs <code>qdel all</code> due to restrictions from being single-threaded.



Option	Name	Description
<b>-W</b>	delay	Specifies the wait delay between the sending of the SIGTERM and SIGKILL signals. The argument is the length of time in seconds of the delay.
<b>-p</b>	purge	Forcibly purges the job from the server. This should only be used if a running job will not exit because its allocated nodes are unreachable. The admin should make every attempt at resolving the problem on the nodes. If a job's mother superior recovers after purging the job, any epilogue scripts may still run. This option is only available to a batch operator or the batch administrator.
<b>-m</b>	message	Specify a comment to be included in the email. The argument message specifies the comment to send. This option is only available to a batch operator or the batch administrator.
<b>-t</b>	array_range	The array_range argument is an integer id or a range of integers. Multiple ids or id ranges can be combined in a comma delimited list (examples: -t 1-100 or -t 1,10,50-100).  If an array range isn't specified, the command tries to operate on the entire array. The command acts on the array (or specified range of the array) just as it would on an individual job.

## Operands

The `qdel` command accepts one or more `job_identifier` operands of the form:

```
sequence_number[.server_name] [@server]
```

or

```
all
```

## Examples

```
> qdel 1324
> qdel 1324-3 To delete one job of a job array
> qdel all To delete all jobs (Version 2.3.0 and later)
```

## Standard error

The `qdel` command will write a diagnostic messages to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the `qdel` command, the exit status will be a value of zero.

If the `qdel` command fails to process any operand, the command exits with a value greater than zero.

## Related topics

- [qsub\(1B\)](#)
- [qsig\(1B\)](#)

## Non-Adaptive Computing topics

- [pbs\\_deljob\(3B\)](#)

# qgpumode

*(GPU mode)*

## Synopsis

```
qgpumode -H host -g gpuid -m mode
```

## Description

The `qgpumode` command specifies the mode for the GPU. This command triggers an immediate update of the `pbs_server`.

## Options

Option	Description
<b>-H</b>	Specifies the host where the GPU is located.
<b>-g</b>	Specifies the ID of the GPU. This varies depending on the version of the Nvidia driver used. For driver 260.x, it is 0, 1, and so on. For driver 270.x, it is the PCI bus address, i.e., 0:5:0.

Option	Description
<b>-m</b>	<p>Specifies the new mode for the GPU:</p> <ul style="list-style-type: none"> <li>• <b>0 (Default/Shared)</b>: Default/shared compute mode. Multiple threads can use <code>cudaSetDevice()</code> with this device.</li> <li>• <b>1 (Exclusive Thread)</b>: Compute-exclusive-thread mode. Only one thread in one process is able to use <code>cudaSetDevice()</code> with this device.</li> <li>• <b>2 (Prohibited)</b>: Compute-prohibited mode. No threads can use <code>cudaSetDevice()</code> with this device.</li> <li>• <b>3 (Exclusive Process)</b>: Compute-exclusive-process mode. Many threads in one process are able to use <code>cudaSetDevice()</code> with this device.</li> </ul> <pre>qgpumode -H node01 -g 0 -m 1</pre> <p><i>This puts the first GPU on node01 into mode 1 (exclusive)</i></p> <pre>qgpumode -H node01 -g 0 -m 0</pre> <p><i>This puts the first GPU on node01 into mode 0 (shared)</i></p>

### Related topics

- [qgpureset on page 183](#)

## qgpureset

(reset GPU)

### Synopsis

```
qgpureset -H host -g gpuid -p -v
```

### Description

The `qgpureset` command resets the GPU.

### Options

Option	Description
<b>-H</b>	Specifies the host where the GPU is located.
<b>-g</b>	Specifies the ID of the GPU. This varies depending on the version of the Nvidia driver used. For driver 260.x, it is 0, 1, and so on. For driver 270.x, it is the PCI bus address, i.e., 0:5:0.

Option	Description
<b>-p</b>	Specifies to reset the GPU's permanent ECC error count.
<b>-v</b>	Specifies to reset the GPU's volatile ECC error count.

## Related topics

- [ggpumode on page 182](#)

# qhold

*(hold job)*

## Synopsis

```
qhold [{"-h" <HOLD LIST>|"-t" <array_range>}] <JOBID>[<JOBID>] ...
```

## Description

The `qhold` command requests that the server place one or more holds on a job. A job that has a hold is not eligible for execution. There are three supported holds: USER, OTHER (also known as operator), and SYSTEM.

A user may place a USER hold upon any job the user owns. An "operator", who is a user with "operator privilege," may place either an USER or an OTHER hold on any job. The batch administrator may place any hold on any job.

If no `-h` option is given, the USER hold will be applied to the jobs described by the `job_identifier` operand list.

If the job identified by `job_identifier` is in the queued, held, or waiting states, then the hold type is added to the job. The job is then placed into held state if it resides in an execution queue.

If the job is in running state, then the following additional action is taken to interrupt the execution of the job. If checkpoint/restart is supported by the host system, requesting a hold on a running job will (1) cause the job to be checkpointed, (2) the resources assigned to the job will be released, and (3) the job is placed in the held state in the execution queue.

If checkpoint/restart is not supported, `qhold` will only set the requested hold attribute. This will have no effect unless the job is rerun with the [qrerun](#) command.

## Options

Option	Name	Description
<b>-h</b>	hold_list	The hold_list argument is a string consisting of one or more of the letters "u", "o", or "s" in any combination. The hold type associated with each letter is: <ul style="list-style-type: none"><li>• <i>u</i> – USER</li><li>• <i>o</i> – OTHER</li><li>• <i>s</i> – SYSTEM</li></ul>
<b>-t</b>	array_range	The array_range argument is an integer id or a range of integers. Multiple ids or id ranges can be combined in a comma delimited list (examples: -t 1-100 or -t 1,10,50-100) . If an array range isn't specified, the command tries to operate on the entire array. The command acts on the array (or specified range of the array) just as it would on an individual job.

## Operands

The `qhold` command accepts one or more `job_identifier` operands of the form:

```
sequence_number[.server_name] [@server]
```

## Example

```
> qhold -h u 3233 place user hold on job 3233
```

## Standard error

The `qhold` command will write a diagnostic message to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the `qhold` command, the exit status will be a value of zero.

If the `qhold` command fails to process any operand, the command exits with a value greater than zero.

## Related topics

- [qrls\(1B\)](#)
- [qalter\(1B\)](#)
- [qsub\(1B\)](#)

## Non-Adaptive Computing topics

- [pbs\\_alterjob\(3B\)](#)
- [pbs\\_holdjob\(3B\)](#)
- [pbs\\_rlsjob\(3B\)](#)

- pbs\_job\_attributes(7B)
- pbs\_resources\_unicos8(7B)

## qmgr

(PBS Queue Manager) PBS batch system manager.

### Synopsis

```
qmgr [-a] [-c command] [-e] [-n] [-z] [server...]
```

### Description

The `qmgr` command provides an administrator interface to query and configure batch system parameters (see [Server parameters on page 227](#)).

The command reads directives from standard input. The syntax of each directive is checked and the appropriate request is sent to the batch server or servers.

The list or print subcommands of `qmgr` can be executed by general users. Creating or deleting a queue requires PBS Manager privilege. Setting or unsetting server or queue attributes requires PBS Operator or Manager privilege.

**i** By default, the user `root` is the only PBS Operator and Manager. To allow other users to be privileged, the server attributes `operators` and `managers` will need to be set (i.e., as `root`, issue `'qmgr -c 'set server managers += <USER1>@<HOST>'`). See "TORQUE/PBS Integration Guide - RM Access Control" in the Moab Workload Manager [Administrator's Guide](#).

If `qmgr` is invoked without the `-c` option and standard output is connected to a terminal, `qmgr` will write a prompt to standard output and read a directive from standard input.

Commands can be abbreviated to their minimum unambiguous form. A command is terminated by a new line character or a semicolon, ";", character. Multiple commands may be entered on a single line. A command may extend across lines by escaping the new line character with a back-slash "\".

Comments begin with the "#" character and continue to end of the line. Comments and blank lines are ignored by `qmgr`.

### Options

Option	Name	Description
<code>-a</code>	---	Abort <code>qmgr</code> on any syntax errors or any requests rejected by a server.
<code>-c</code>	command	Execute a single command and exit <code>qmgr</code> .
<code>-e</code>	---	Echo all commands to standard output.

Option	Name	Description
<b>-n</b>	---	No commands are executed, syntax checking only is performed.
<b>-z</b>	---	No errors are written to standard error.

## Operands

The *server* operands identify the name of the batch server to which the administrator requests are sent. Each *server* conforms to the following syntax:

```
host_name[:port]
```

where *host\_name* is the network name of the host on which the server is running and *port* is the port number to which to connect. If *port* is not specified, the default port number is used.

If *server* is not specified, the administrator requests are sent to the local server.

## Standard input

The `qmgr` command reads standard input for directives until end of file is reached, or the exit or quit directive is read.

## Standard output

If Standard Output is connected to a terminal, a command prompt will be written to standard output when `qmgr` is ready to read a directive.

If the `-e` option is specified, `qmgr` will echo the directives read from standard input to standard output.

## Standard error

If the `-z` option is not specified, the `qmgr` command will write a diagnostic message to standard error for each error occurrence.


## Directive syntax

A `qmgr` directive is one of the following forms:

```
command server [names] [attr OP value[,attr OP value,...]]
command queue [names] [attr OP value[,attr OP value,...]]
command node [names] [attr OP value[,attr OP value,...]]
```

where *command* is the command to perform on an object.

Commands are:

Command	Description
<b>active</b>	Sets the active objects. If the active objects are specified, and the name is not given in a <code>qmgr cmd</code> the active object names will be used.
<b>create</b>	Is to create a new object, applies to queues and nodes.
<b>delete</b>	Is to destroy an existing object, applies to queues and nodes.
<b>set</b>	Is to define or alter attribute values of the object.
<b>unset</b>	Is to clear the value of attributes of the object. <div style="border: 1px solid #0070c0; border-radius: 10px; padding: 5px; margin-top: 10px;">  This form does not accept an OP and value, only the attribute name. </div>
<b>list</b>	Is to list the current attributes and associated values of the object.
<b>print</b>	Is to print all the queue and server attributes in a format that will be usable as input to the <code>qmgr</code> command.
<b>names</b>	Is a list of one or more names of specific objects The name list is in the form: <code>[name] [@server] [, queue_name [@server] . . . ]</code> with no intervening white space. The name of an object is declared when the object is first created. If the name is <code>@server</code> , then all the objects of specified type at the server will be affected.
<b>attr</b>	Specifies the name of an attribute of the object which is to be set or modified. If the attribute is one which consist of a set of resources, then the attribute is specified in the form: <code>attribute_name.resource_name</code>
<b>OP</b>	Operation to be performed with the attribute and its value: <ul style="list-style-type: none"> <li>• "=" – set the value of the attribute. If the attribute has an existing value, the current value is replaced with the new value.</li> <li>• "+=" – increase the current value of the attribute by the amount in the new value.</li> <li>• "-=" – decrease the current value of the attribute by the amount in the new value.</li> </ul>
<b>value</b>	The value to assign to an attribute. If the value includes white space, commas or other special characters, such as the "#" character, the value string must be enclosed in quote marks ("").

The following are examples of `qmgr` directives:



```

create queue fast priority=10,queue_type=e,enabled = true,max_running=0
set queue fast max_running +=2
create queue little
set queue little resources_max.mem=8mw,resources_max.cput=10
unset queue fast max_running
set node state = "down,offline"
active server s1,s2,s3
list queue @server1
set queue max_running = 10          - uses active queues

```

## Exit status

Upon successful processing of all the operands presented to the `qmgr` command, the exit status will be a value of zero.

If the `qmgr` command fails to process any operand, the command exits with a value greater than zero.

## Related topics

- [pbs\\_server](#) (8B)

## Non-Adaptive Computing topics

- [pbs\\_queue\\_attributes](#) (7B)
- [pbs\\_server\\_attributes](#) (7B)
- [qstart](#) (8B), [qstop](#) (8B)
- [qenable](#) (8B), [qdisable](#) (8)
- [PBS External Reference Specification](#)

# qmove

Move PBS batch jobs.

## Synopsis

```
qmove destination jobId [jobId ...]
```

## Description

To move a job is to remove the job from the queue in which it resides and instantiate the job in another queue. The `qmove` command issues a Move Job batch request to the batch server that currently owns each job specified by *jobId*.

A job in the **Running**, **Transiting**, or **Exiting** state cannot be moved.

## Operands

The first operand, the new *destination*, is one of the following:

queue

@server

queue@server

If the *destination* operand describes only a queue, then `qmove` will move jobs into the queue of the specified name at the job's current server. If the *destination* operand describes only a batch server, then `qmove` will move jobs into the default queue at that batch server. If the *destination* operand describes both a queue and a batch server, then `qmove` will move the jobs into the specified queue at the specified server.

All following operands are *jobIds* which specify the jobs to be moved to the new *destination*. The `qmove` command accepts one or more *jobId* operands of the form: `sequenceNumber [.serverName] [@server]`

## Standard error

The `qmove` command will write a diagnostic message to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the `qmove` command, the exit status will be a value of zero.

If the `qmove` command fails to process any operand, the command exits with a value greater than zero.

## Related topics

- [qsub on page 204](#)

## Related topics(non-Adaptive Computing topics)

- `pbs_movejob(3B)`

# qorder

Exchange order of two PBS batch jobs in any queue.

## Synopsis

```
qorder job1_identifier job2_identifier
```

## Description

To order two jobs is to exchange the jobs' positions in the queue(s) in which the jobs reside. The two jobs must be located on the same server. No attribute of the job, such as priority, is changed. The impact of changing the order in the queue(s) is dependent on local job schedule policy. For information about your local job schedule policy, contact your systems administrator.



A job in the **running** state cannot be reordered.

## Operands

Both operands are *job\_identifiers* that specify the jobs to be exchanged. The `qorder` command accepts two *job\_identifier* operands of the following form: `sequence_number [.server_name] [@server]`

The two jobs must be in the same location, so the server specification for the two jobs must agree.

## Standard error

The `qorder` command will write diagnostic messages to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the `qorder` command, the exit status will be a value of zero.

If the `qorder` command fails to process any operand, the command exits with a value greater than zero.

## Related topics

- [qsub on page 204](#)
- [qmove on page 189](#)

## Related topics(non-Adaptive Computing topics)

- [pbs\\_orderjob\(3B\)](#)
- [pbs\\_movejob\(3B\)](#)

# qrerun

*(Rerun a batch job)*

## Synopsis

```
qrerun [{-f}] <JOBID>[ <JOBID>] ...
```

## Description

The `qrerun` command directs that the specified jobs are to be rerun if possible. To rerun a job is to terminate the session leader of the job and return the job to the queued state in the execution queue in which the job currently resides.

If a job is marked as not rerunable then the rerun request will fail for that job. If the mini-server running the job is down, or it rejects the request, the Rerun Job batch request will return a failure unless `-f` is used.

Using `-f` violates IEEE Batch Processing Services Standard and should be handled with great care. It should only be used under exceptional circumstances. The best practice is to fix the problem mini-server host and let `qrerun` run normally. The nodes may need manual cleaning (see the `-r` option on the [qsub](#) and [galter](#) commands).

## Options

Option	Description
<b>-f</b>	Force a rerun on a job

```
qrerun -f 15406
```

## Operands

The `qrerun` command accepts one or more `job_identifier` operands of the form:

```
sequence_number[.server_name][@server]
```

## Standard error

The `qrerun` command will write a diagnostic message to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the `qrerun` command, the exit status will be a value of zero.

If the `qrerun` command fails to process any operand, the command exits with a value greater than zero.

## Examples

```
> qrerun 3233
```

(Job 3233 will be re-run.)

### Related topics

- [qsub\(1B\)](#)
- [qalter\(1B\)](#)

### Non-Adaptive Computing topics

- [pbs\\_alterjob\(3B\)](#)
- [pbs\\_rerunjob\(3B\)](#)

# qrls

*(Release hold on PBS batch jobs)*

## Synopsis

```
qrls [{-h <HOLD LIST>|-t <array_range>}] <JOBID>[ <JOBID>] ...
```

## Description

The `qrls` command removes or releases holds which exist on batch jobs.

A job may have one or more types of holds which make the job ineligible for execution. The types of holds are USER, OTHER, and SYSTEM. The different types of holds may require that the user issuing the `qrls` command have special privileges. A user may always remove a USER hold on their own jobs, but only privileged users can remove OTHER or SYSTEM holds. An attempt to release a hold for which the user does not have the correct privilege is an error and no holds will be released for that job.

If no `-h` option is specified, the USER hold will be released.

If the job has no `execution_time` pending, the job will change to the queued state. If an `execution_time` is still pending, the job will change to the waiting state.

## Options

Command	Name	Description
<b>-h</b>	hold_list	Defines the types of hold to be released from the jobs. The <code>hold_list</code> option argument is a string consisting of one or more of the letters "u", "o", and "s" in any combination. The hold type associated with each letter is: <ul style="list-style-type: none"><li>• <i>u</i> - USER</li><li>• <i>o</i> - OTHER</li><li>• <i>s</i> - SYSTEM</li></ul>
<b>-t</b>	array_range	The <code>array_range</code> argument is an integer id or a range of integers. Multiple ids or id ranges can be combined in a comma delimited list. Examples: <code>-t 1-100</code> or <code>-t 1,10,50-100</code>  If an array range isn't specified, the command tries to operate on the entire array. The command acts on the array (or specified range of the array) just as it would on an individual job.

## Operands

The `qrls` command accepts one or more `job_identifier` operands of the form:

```
sequence_number[.server_name] [@server]
```

## Examples

```
> qrls -h u 3233 release user hold on job 3233
```

## Standard error

The `qrls` command will write a diagnostic message to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the `qrls` command, the exit status will be a value of zero.

If the `qrls` command fails to process any operand, the command exits with a value greater than zero.

## Related topics

### Related topics

- [qsub\(1B\)](#)
- [qalter\(1B\)](#)
- [qhold\(1B\)](#)

## Non-Adaptive Computing topics)

- [pbs\\_alterjob\(3B\)](#)
- [pbs\\_holdjob\(3B\)](#)
- [pbs\\_rlsjob\(3B\)](#)

# qrun

*(Run a batch job)*

## Synopsis

```
qrun [{-H <HOST>|-a}] <JOBID>[ <JOBID>] ...
```

## Overview

The `qrun` command runs a job.

## Format

-H	
<b>Format</b>	<STRING> Host Identifier
<b>Default</b>	---
<b>Description</b>	Specifies the host within the cluster on which the job(s) are to be run. The host argument is the name of a host that is a member of the cluster of hosts managed by the server. If the option is not specified, the server will select the "worst possible" host on which to execute the job.
<b>Example</b>	<pre>qrun -H hostname 15406</pre>

-a	
<b>Format</b>	---
<b>Default</b>	---
<b>Description</b>	Run the job(s) asynchronously.
<b>Example</b>	<code>qrun -a 15406</code>

## Command details

The `qrun` command is used to force a batch server to initiate the execution of a batch job. The job is run regardless of scheduling position or resource requirements.

In order to execute `qrun`, the user must have PBS Operation or Manager privileges.

## Examples

```
> qrun 3233
```

(Run job 3233.)

## qsig

*(Signal a job)*

## Synopsis

```
qsig [{-s <SIGNAL>}] <JOBID> [ <JOBID>] ...
      [-a]
```


## Description

The `qsig` command requests that a signal be sent to executing batch jobs. The signal is sent to the session leader of the job. If the `-s` option is not specified, SIGTERM is sent. The request to signal a batch job will be rejected if:

- The user is not authorized to signal the job.
- The job is not in the running state.
- The requested signal is not supported by the system upon which the job is executing.

The `qsig` command sends a Signal Job batch request to the server which owns the job.

## Options

Option	Name	Description
<b>-s</b>	signal	<p>Declares which signal is sent to the job.</p> <p>The signal argument is either a signal name, e.g. SIGKILL, the signal name without the SIG prefix, e.g. KILL, or an unsigned signal number, e.g. 9. The signal name SIGNULL is allowed; the server will send the signal 0 to the job which will have no effect on the job, but will cause an obituary to be sent if the job is no longer executing. Not all signal names will be recognized by <code>qsig</code>. If it doesn't recognize the signal name, try issuing the signal number instead.</p> <p>Two special signal names, "suspend" and "resume", are used to suspend and resume jobs. Cray systems use the Cray-specific <code>suspend()/resume()</code> calls.</p> <p>On non-Cray system, <code>suspend</code> causes a SIGTSTP to be sent to all processes in the job's top task, wait 5 seconds, and then send a SIGSTOP to all processes in all tasks on all nodes in the job. This differs from TORQUE 2.0.0 which did not have the ability to propagate signals to sister nodes. <code>Resume</code> sends a SIGCONT to all processes in all tasks on all nodes.</p> <p>When suspended, a job continues to occupy system resources but is not executing and is not charged for walltime. The job will be listed in the "S" state. Manager or operator privilege is required to suspend or resume a job.</p> <div style="border: 1px solid #005596; border-radius: 10px; padding: 5px;"><p> Interactive jobs may not resume properly because the top-level shell will background the suspended child process.</p></div>
<b>-a</b>	asynchronously	Makes the command run asynchronously.

## Operands

The `qsig` command accepts one or more `job_identifier` operands of the form:

```
sequence_number[.server_name][@server]
```

## Examples

```
> qsig -s SIGKILL 3233    send a SIGKILL to job 3233
> qsig -s KILL 3233      send a SIGKILL to job 3233
> qsig -s 9 3233         send a SIGKILL to job 3233
```

## Standard error

The `qsig` command will write a diagnostic message to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the `qsig` command, the exit status will be a value of zero.

If the `qsig` command fails to process any operand, the command exits with a value greater than zero.



## Related topics

- [qsub\(1B\)](#)

## Non-Adaptive Computing topics

- [pbs\\_sigjob\(3B\)](#)
- [pbs\\_resources\\_\\*\(7B\)](#) where \* is system type
- [PBS ERS](#)

# qstat

Show status of PBS batch jobs.

## Synopsis

```
qstat [-c on page 197] [-f [-1]] [-W site_specific] [job_identifier... |
destination...] [time]
qstat [-a|-i|-r|-e] [-c on page 197] [-n [-1]] [-s] [-G|-M] [-R] [-u user_
list]
[job_identifier... | destination...]
qstat -Q [-f [-1]] [-c on page 197] [-W site_specific] [destination...]
qstat -q [-c on page 197] [-G|-M] [destination...]
qstat -B [-c on page 197] [-f [-1]] [-W site_specific] [server_name...]
qstat -t [-c on page 197]
```

## Description

The `qstat` command is used to request the status of jobs, queues, or a batch server. The requested status is written to standard out.

When requesting job status, synopsis format 1 or 2, `qstat` will output information about each job identifier or all jobs at each destination. Jobs for which the user does not have status privilege are not displayed.

When requesting queue or server status, synopsis format 3 through 5, `qstat` will output information about each destination.



You can configure TORQUE with `CFLAGS='DTXT'` to change the alignment of text in `qstat` output. This noticeably improves `qstat -r` output.

## Options

Option	Description
<code>-c</code>	Completed jobs are not displayed in the output. If desired, you can set the <code>PBS_QSTAT_NO_COMPLETE</code> environment variable to cause all <code>qstat</code> requests to not show completed jobs by default.

Option	Description
<b>-f</b>	Specifies that a full status display be written to standard out. The [time] value is the amount of wall-time, in seconds, remaining for the job. [time] does not account for walltime multipliers.
<b>-a</b>	All jobs are displayed in the alternative format (see <a href="#">Standard output on page 200</a> ). If the operand is a destination id, all jobs at that destination are displayed. If the operand is a job id, information about that job is displayed.
<b>-e</b>	If the operand is a job id or not specified, only jobs in executable queues are displayed. Setting the PBS_QSTAT_EXEONLY environment variable will also enable this option.
<b>-i</b>	Job status is displayed in the alternative format. For a destination id operand, statuses for jobs at that destination which are not running are displayed. This includes jobs which are queued, held or waiting. If an operand is a job id, status for that job is displayed regardless of its state.
<b>-r</b>	If an operand is a job id, status for that job is displayed. For a destination id operand, statuses for jobs at that destination which are running are displayed, this includes jobs which are suspended.
<b>-n</b>	In addition to the basic information, nodes allocated to a job are listed.
<b>-1</b>	In combination with <a href="#">-n</a> , the -1 option puts all of the nodes on the same line as the job ID. In combination with <a href="#">-f</a> , attributes are not folded to fit in a terminal window. This is intended to ease the parsing of the <code>qstat</code> output.
<b>-s</b>	In addition to the basic information, any comment provided by the batch administrator or scheduler is shown.
<b>-G</b>	Show size information in giga-bytes.
<b>-M</b>	Show size information, disk or memory in mega-words. A word is considered to be 8 bytes.
<b>-R</b>	In addition to other information, disk reservation information is shown. Not applicable to all systems.
<b>-t</b>	Normal <code>qstat</code> output displays a summary of the array instead of the entire array, job for job. <code>qstat -t</code> expands the output to display the entire array. Note that arrays are now named with brackets following the array name; for example: <pre>dbbeer@napali:~/dev/torque/array_changes\$ echo sleep 20   qsub -t 0-299 189 [] .napali</pre> Individual jobs in the array are now also noted using square brackets instead of dashes; for example, here is part of the output of <code>qstat -t</code> for the preceding array: <pre>189[299].napali STDIN[299] dbbeer 0 Q batch</pre>

Option	Description
<b>-u</b>	Job status is displayed in the alternative format. If an operand is a job id, status for that job is displayed. For a destination id operand, statuses for jobs at that destination which are owned by the user(s) listed in user_list are displayed. The syntax of the user_list is: user_name[@host] [, user_name[@host], ...] Host names may be wild carded on the left end, e.g. "*.nasa.gov". User_name without a "@host" is equivalent to "user_name@*", that is at any host.
<b>-Q</b>	Specifies that the request is for queue status and that the operands are destination identifiers.
<b>-q</b>	Specifies that the request is for queue status which should be shown in the alternative format.
<b>-B</b>	Specifies that the request is for batch server status and that the operands are the names of servers.

## Operands

If neither the **-Q** nor the **-B** option is given, the operands on the qstat command must be either job identifiers or destinations identifiers.

If the operand is a job identifier, it must be in the following form:

```
sequence_number[.server_name] [@server]
```

where *sequence\_number.server\_name* is the job identifier assigned at submittal time (see [qsub](#)). If the *.server\_name* is omitted, the name of the default server will be used. If *@server* is supplied, the request will be for the job identifier currently at that Server.

If the operand is a destination identifier, it is one of the following three forms:

- queue
- @server
- queue@server

If queue is specified, the request is for status of all jobs in that queue at the default server. If the @server form is given, the request is for status of all jobs at that server. If a full destination identifier, queue@server, is given, the request is for status of all jobs in the named queue at the named server.

If the **-Q** option is given, the operands are destination identifiers as specified above. If queue is specified, the status of that queue at the default server will be given. If queue@server is specified, the status of the named queue at the named server will be given. If @server is specified, the status of all queues at the named server will be given. If no destination is specified, the status of all queues at the default server will be given.

If the **-B** option is given, the operand is the name of a server.

## Standard output

### Displaying job status

If job status is being displayed in the default format and the **-f** option is not specified, the following items are displayed on a single line, in the specified order, separated by white space:

- the job identifier assigned by PBS.
- the job name given by the submitter.
- the job owner.
- the CPU time used.
- the job state:

Item	Description
<b>C</b>	Job is completed after having run.
<b>E</b>	Job is exiting after having run.
<b>H</b>	Job is held.
<b>Q</b>	Job is queued, eligible to run or routed.
<b>R</b>	Job is running.
<b>T</b>	Job is being moved to new location.
<b>W</b>	Job is waiting for its execution time ( <b>-a</b> option) to be reached.
<b>S</b>	(Unicos only) Job is suspended.

- the queue in which the job resides.

If job status is being displayed and the **-f** option is specified, the output will depend on whether `qstat` was compiled to use a Tcl interpreter. See [Configuration on page 203](#) for details. If Tcl is not being used, full display for each job consists of the header line:

```
Job Id: job identifier
```

Followed by one line per job attribute of the form:

```
attribute_name = value
```

If any of the options **-a**, **-i**, **-r**, **-u**, **-n**, **-s**, **-G**, or **-M** are provided, the alternative display format for jobs is used. The following items are displayed on a single line, in the specified order, separated by white space:

- the job identifier assigned by PBS
- the job owner
- the queue in which the job currently resides
- the job name given by the submitter
- the session id (if the job is running)
- the number of nodes requested by the job
- the number of cpus or tasks requested by the job
- the amount of memory requested by the job
- either the cpu time, if specified, or wall time requested by the job, (hh:mm)
- the jobs current state
- the amount of cpu time or wall time used by the job (hh:mm)

If the **-r** option is provided, the line contains:

- the job identifier assigned by PBS
- the job owner
- the queue in which the job currently resides
- the number of nodes requested by the job
- the number of cpus or tasks requested by the job
- the amount of memory requested by the job
- either the cpu time or wall time requested by the job
- the jobs current state
- the amount of cpu time or wall time used by the job
- the amount of SRFS space requested on the big file system
- the amount of SRFS space requested on the fast file system
- the amount of space requested on the parallel I/O file system

The last three fields may not contain useful information at all sites or on all systems

### Displaying queue status

If queue status is being displayed and the **-f** option was not specified, the following items are displayed on a single line, in the specified order, separated by white space:

- the queue name
- the maximum number of jobs that may be run in the queue concurrently
- the total number of jobs in the queue
- the enable or disabled status of the queue

- the started or stopped status of the queue
- for each job state, the name of the state and the number of jobs in the queue in that state
- the type of queue, execution or routing

If queue status is being displayed and the `-f` option is specified, the output will depend on whether `qstat` was compiled to use a Tcl interpreter. See the configuration section for details. If Tcl is not being used, the full display for each queue consists of the header line:

```
Queue: queue_name
```

Followed by one line per queue attribute of the form:

```
attribute_name = value
```

If the `-Q` option is specified, queue information is displayed in the alternative format: The following information is displayed on a single line:

- the queue name
- the maximum amount of memory a job in the queue may request
- the maximum amount of cpu time a job in the queue may request
- the maximum amount of wall time a job in the queue may request
- the maximum amount of nodes a job in the queue may request
- the number of jobs in the queue in the running state
- the number of jobs in the queue in the queued state
- the maximum number (limit) of jobs that may be run in the queue concurrently
- the state of the queue given by a pair of letters:
  - either the letter *E* if the queue is Enabled or *D* if Disabled
  - and
  - either the letter *R* if the queue is Running (started) or *S* if Stopped.

## Displaying server status

If batch server status is being displayed and the `-f` option is not specified, the following items are displayed on a single line, in the specified order, separated by white space:

- the server name
- the maximum number of jobs that the server may run concurrently
- the total number of jobs currently managed by the server
- the status of the server
- for each job state, the name of the state and the number of jobs in the server in that state

If server status is being displayed and the `-f` option is specified, the output will depend on whether `qstat` was compiled to use a Tcl interpreter. See the configuration section for details. If Tcl is not being used, the full display for the server consists of the header line:

Server: server name

Followed by one line per server attribute of the form:

```
attribute_name = value
```

## Standard error

The `qstat` command will write a diagnostic message to standard error for each error occurrence.

## Configuration

If `qstat` is compiled with an option to include a Tcl interpreter, using the `-f` flag to get a full display causes a check to be made for a script file to use to output the requested information. The first location checked is `$HOME/.qstatrc`. If this does not exist, the next location checked is administrator configured. If one of these is found, a Tcl interpreter is started and the script file is passed to it along with three global variables. The command line arguments are split into two variable named flags and operands. The status information is passed in a variable named objects. All of these variables are Tcl lists. The flags list contains the name of the command (usually "qstat") as its first element. Any other elements are command line option flags with any options they use, presented in the order given on the command line. They are broken up individually so that if two flags are given together on the command line, they are separated in the list. For example, if the user typed:

```
qstat -QfWbigdisplay
```

the flags list would contain

```
qstat -Q -f -W bigdisplay
```

The operands list contains all other command line arguments following the flags. There will always be at least one element in operands because if no operands are typed by the user, the default destination or server name is used. The objects list contains all the information retrieved from the server(s) so the Tcl interpreter can run once to format the entire output. This list has the same number of elements as the operands list. Each element is another list with two elements.

The first element is a string giving the type of objects to be found in the second. The string can take the values "server", "queue", "job" or "error".

The second element will be a list in which each element is a single batch status object of the type given by the string discussed above. In the case of "error", the list will be empty. Each object is again a list. The first element is the name of the object. The second is a list of attributes.

The third element will be the object text.

All three of these object elements correspond with fields in the structure `batch_status` which is described in detail for each type of object by the man pages for `pbs_statjob(3)`, `pbs_statque(3)`, and `pbs_statserver(3)`. Each attribute in the second element list whose elements correspond with the `attr1` structure. Each will be a list with two elements. The first will be the attribute name and the second will be the attribute value.

## Exit status

Upon successful processing of all the operands presented to the `qstat` command, the exit status will be a value of zero.

If the `qstat` command fails to process any operand, the command exits with a value greater than zero.

### Related topics

- [qalter](#)(1B)
- [qsub](#)(1B)

### Non-Adaptive Computing topics

- [pbs\\_alterjob](#)(3B)
- [pbs\\_statjob](#)(3B)
- [pbs\\_statque](#)(3B)
- [pbs\\_statserver](#)(3B)
- [pbs\\_submit](#)(3B)
- [pbs\\_job\\_attributes](#)(7B)
- [pbs\\_queue\\_attributes](#)(7B)
- [pbs\\_server\\_attributes](#)(7B)
- `qmgr query_other_jobs` parameter (allow non-admin users to see other users' jobs)
- [pbs\\_resources\\_\\*](#)(7B) where \* is system type
- PBS ERS

## qsub

Submit PBS job.

### Synopsis

```
qsub [-a date_time] [-A account_string] [-b secs] [-c checkpoint_options]
[-C directive_prefix] [-d path] [-D path] [-e path] [-f] [-F] [-h]
[-I ] [-j join ] [-k keep ] [-l resource_list ]
[-m mail_options] [-M user_list] [-n] [-N name] [-o path]
[-p priority] [-P user[:group]] [-q destination] [-r c] [-S path_to_shell(s)]
[-t array_request] [-u user_list]
[-v variable_list] [-V] [-W additional_attributes] [-x] [-X] [-z] [script]
```

### Description

To create a job is to submit an executable script to a batch server. The batch server will be the default server unless the `-q` option is specified. The command parses a script prior to the actual script execution; it does not execute a script itself. All script-writing rules remain in effect, including the `"#"` at the head of the file (see discussion of `PBS_DEFAULT` under [Environment variables on page 220](#)). Typically, the script is a shell script which will be executed by a command shell such as `sh` or `csh`.

Options on the `qsub` command allow the specification of attributes which affect the behavior of the job.

The `qsub` command will pass certain environment variables in the `Variable_List` attribute of the job. These variables will be available to the job. The value for the following variables will be taken from the environment of the `qsub` command: `HOME`, `LANG`, `LOGNAME`, `PATH`, `MAIL`, `SHELL`, and `TZ`. These values



will be assigned to a new name which is the current name prefixed with the string "PBS\_O\_". For example, the job will have access to an environment variable named PBS\_O\_HOME which have the value of the variable HOME in the `qsub` command environment.



In addition to the above, the following environment variables will be available to the batch job:

Variable	Description
<b>PBS_O_HOST</b>	The name of the host upon which the <code>qsub</code> command is running.
<b>PBS_SERVER</b>	The hostname of the <code>pbs_server</code> which <code>qsub</code> submits the job to.
<b>PBS_O_QUEUE</b>	The name of the original queue to which the job was submitted.
<b>PBS_O_WORKDIR</b>	The absolute path of the current working directory of the <code>qsub</code> command.
<b>PBS_ARRAYID</b>	Each member of a job array is assigned a unique identifier (see <code>-t</code> option).
<b>PBS_ENVIRONMENT</b>	Set to <code>PBS_BATCH</code> to indicate the job is a batch job, or to <code>PBS_INTERACTIVE</code> to indicate the job is a PBS interactive job (see <code>-I</code> option).
<b>PBS_GPUIFILE</b>	The name of the file containing the list of assigned GPUs. For more information about how to set up TORQUE with GPUS, see the <a href="#">Moab Workload Manager accelerators documentation</a> .
<b>PBS_JOBID</b>	The job identifier assigned to the job by the batch system. It can be used in the stdout and stderr paths. TORQUE replaces <code>\$(PBS_JOBID)</code> with the job's jobid (for example, <code>#PBS -o /tmp/\$(PBS_JOBID).output</code> ).
<b>PBS_JOBNAME</b>	The job name supplied by the user.
<b>PBS_NODEFILE</b>	The name of the file contains the list of nodes assigned to the job (for parallel and cluster systems).
<b>PBS_QUEUE</b>	The name of the queue from which the job is executed.


## Options

Option	Name	Description
<b>-a</b>	date_time	<p>Declares the time after which the job is eligible for execution.</p> <p>The <code>date_time</code> argument is in the form:  <code>[ [ [CC] YY] MM] DD] hhmm [ . SS ]</code></p> <p>where <i>CC</i> is the first two digits of the year (the century), <i>YY</i> is the second two digits of the year, <i>MM</i> is the two digits for the month, <i>DD</i> is the day of the month, <i>hh</i> is the hour, <i>mm</i> is the minute, and the optional <i>SS</i> is the seconds.</p> <p>If the month (<i>MM</i>) is not specified, it will default to the current month if the specified day (<i>DD</i>) is in the future. Otherwise, the month will be set to next month. Likewise, if the day (<i>DD</i>) is not specified, it will default to today if the time (<i>hhmm</i>) is in the future. Otherwise, the day will be set to tomorrow.</p> <p>For example, if you submit a job at 11:15 am with a time of <code>-a 1110</code>, the job will be eligible to run at 11:10 am tomorrow.</p>
<b>-A</b>	account_string	<p>Defines the account string associated with the job. The <code>account_string</code> is an undefined string of characters and is interpreted by the server which executes the job. See section 2.7.1 of the PBS ERS.</p>
<b>-b</b>	seconds	<p>Defines the maximum number of seconds <code>qsub</code> will block attempting to contact <code>pbs_server</code>. If <code>pbs_server</code> is down, or for a variety of communication failures, <code>qsub</code> will continually retry connecting to <code>pbs_server</code> for job submission.</p> <p>This value overrides the <code>CLIENTRETRY</code> parameter in <code>torque.cfg</code>. This is a non-portable TORQUE extension. Portability-minded users can use the <code>PBS_CLIENTRETRY</code> environmental variable. A negative value is interpreted as infinity. The default is 0.</p>


Option	Name	Description
<b>-c</b>	checkpoint_options	<p>Defines the options that will apply to the job. If the job executes upon a host which does not support checkpoint, these options will be ignored.</p> <p>Valid checkpoint options are:</p> <ul style="list-style-type: none"> <li>• <i>none</i> – No checkpointing is to be performed.</li> <li>• <i>enabled</i> – Specify that checkpointing is allowed but must be explicitly invoked by either the <a href="#">ghold</a> or <a href="#">gchkpt</a> commands.</li> <li>• <i>shutdown</i> – Specify that checkpointing is to be done on a job at pbs_mom shutdown.</li> <li>• <i>periodic</i> – Specify that periodic checkpointing is enabled. The default interval is 10 minutes and can be changed by the \$checkpoint_interval option in the MOM config file or by specifying an interval when the job is submitted</li> <li>• <i>interval=minutes</i> – Checkpointing is to be performed at an interval of minutes, which is the integer number of minutes of wall time used by the job. This value must be greater than zero.</li> <li>• <i>depth=number</i> – Specify a number (depth) of checkpoint images to be kept in the checkpoint directory.</li> <li>• <i>dir=path</i> – Specify a checkpoint directory (default is /var/spool/torque/checkpoint).</li> </ul>
<b>-C</b>	directive_prefix	<p>Defines the prefix that declares a directive to the qsub command within the script file. (See the paragraph on script directives under <a href="#">Extended description on page 221</a>.)</p> <p>If the -C option is presented with a directive_prefix argument that is the null string, qsub will not scan the script file for directives.</p>
<b>-d</b>	path	<p>Defines the working directory path to be used for the job. If the -d option is not specified, the default working directory is the home directory. This option sets the environment variable PBS_O_INITDIR.</p>
<b>-D</b>	path	<p>Defines the root directory to be used for the job. This option sets the environment variable PBS_O_ROOTDIR.</p>

Option	Name	Description
<b>-e</b>	path	<p>Defines the path to be used for the standard error stream of the batch job. The path argument is of the form:</p> <pre>[hostname:]path_name</pre> <p>where <i>hostname</i> is the name of a host to which the file will be returned, and <i>path_name</i> is the path name on that host in the syntax recognized by POSIX.</p> <div style="border: 1px solid #ccc; border-radius: 10px; padding: 5px; margin: 10px 0;">  When specifying a directory for the location you need to include a trailing slash. </div> <p>The argument will be interpreted as follows:</p> <ul style="list-style-type: none"> <li>• <i>path_name</i> – where <i>path_name</i> is not an absolute path name, then the <code>qsub</code> command will expand the path name relative to the current working directory of the command. The command will supply the name of the host upon which it is executing for the hostname component.</li> <li>• <i>hostname:path_name</i> – where <i>path_name</i> is not an absolute path name, then the <code>qsub</code> command will not expand the path name relative to the current working directory of the command. On delivery of the standard error, the path name will be expanded relative to the user's home directory on the hostname system.</li> <li>• <i>path_name</i> – where <i>path_name</i> specifies an absolute path name, then the <code>qsub</code> will supply the name of the host on which it is executing for the hostname.</li> <li>• <i>hostname:path_name</i> – where <i>path_name</i> specifies an absolute path name, the path will be used as specified.</li> </ul> <p>If the <code>-e</code> option is not specified, the default file name for the standard error stream will be used. The default name has the following form:</p> <ul style="list-style-type: none"> <li>• <i>job_name.esquence_number</i> – where <i>job_name</i> is the name of the job (see the <code>-n</code> name option) and <i>sequence_number</i> is the job number assigned when the job is submitted.</li> </ul>
<b>-f</b>	---	<p>Job is made fault tolerant. Jobs running on multiple nodes are periodically polled by mother superior. If one of the nodes fails to report, the job is canceled by mother superior and a failure is reported. If a job is fault tolerant, it will not be canceled based on failed polling (no matter how many nodes fail to report). This may be desirable if transient network failures are causing large jobs not to complete, where ignoring one failed polling attempt can be corrected at the next polling attempt.</p> <div style="border: 1px solid #ccc; border-radius: 10px; padding: 5px; margin: 10px 0;">  If TORQUE is compiled with <code>PBS_NO_POSIX_VIOLATION</code> (there is no config option for this), you have to use <code>-W fault_tolerant=true</code> to mark the job as fault tolerant. </div>

Option	Name	Description
<b>-F</b>	---	<p>Specifies the arguments that will be passed to the job script when the script is launched. The accepted syntax is:</p> <pre>qsub -F "myarg1 myarg2 myarg3=myarg3value" myscript2.sh</pre> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>i</b> Quotation marks are required. <code>qsub</code> will fail with an error message if the argument following <code>-F</code> is not a quoted value. The <code>pbs_mom</code> server will pass the quoted value as arguments to the job script when it launches the script.</p> </div>
<b>-h</b>	---	Specifies that a user hold be applied to the job at submission time.
<b>-i</b>	---	<p>Declares that the job is to be run "interactively". The job will be queued and scheduled as any PBS batch job, but when executed, the standard input, output, and error streams of the job are connected through <code>qsub</code> to the terminal session in which <code>qsub</code> is running. Interactive jobs are forced to not rerunable. See <a href="#">Extended description on page 221</a> for additional information of interactive jobs.</p>
<b>-j</b>	join	<p>Declares if the standard error stream of the job will be merged with the standard output stream of the job.</p> <p>An option argument value of <code>oe</code> directs that the two streams will be merged, intermixed, as standard output. An option argument value of <code>eo</code> directs that the two streams will be merged, intermixed, as standard error.</p> <p>If the join argument is <code>n</code> or the option is not specified, the two streams will be two separate files.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p><b>i</b> If using either the <code>-e</code> or the <code>-o</code> option and the <code>-j eo oe</code> option, the <code>-j</code> option takes precedence and all standard error and output messages go to the chosen output file.</p> </div>

Option	Name	Description
<b>-k</b>	keep	<p>Defines which (if either) of standard output or standard error will be retained on the execution host. If set for a stream, this option overrides the path name for that stream. If not set, neither stream is retained on the execution host.</p> <p>The argument is either the single letter "e" or "o", or the letters "e" and "o" combined in either order. Or the argument is the letter "n".</p> <ul style="list-style-type: none"> <li>• <i>e</i> – The standard error stream is to be retained on the execution host. The stream will be placed in the home directory of the user under whose user id the job executed. The file name will be the default file name given by: <code>job_name.esquence</code> where <i>job_name</i> is the name specified for the job, and <i>sequence</i> is the sequence number component of the job identifier.</li> <li>• <i>o</i> – The standard output stream is to be retained on the execution host. The stream will be placed in the home directory of the user under whose user id the job executed. The file name will be the default file name given by: <code>job_name.osequence</code> where <i>job_name</i> is the name specified for the job, and <i>sequence</i> is the sequence number component of the job identifier.</li> <li>• <i>eo</i> – Both the standard output and standard error streams will be retained.</li> <li>• <i>oe</i> – Both the standard output and standard error streams will be retained.</li> <li>• <i>n</i> – Neither stream is retained.</li> </ul>
<b>-l</b>	resource_list	<p>Defines the resources that are required by the job and establishes a limit to the amount of resource that can be consumed. If not set for a generally available resource, such as CPU time, the limit is infinite. The <b>resource_list</b> argument is of the form: <code>resource_name [= [value]] [, resource_name [= [value]] , ...]</code></p> <div style="border: 1px solid #0070C0; border-radius: 10px; padding: 10px; background-color: #E6F2FF;"> <p> In this situation, you should request the more inclusive resource first. For example, a request for procs should come before a gres request.</p> </div> <p>In TORQUE 3.0.2 or later, <code>qsub</code> supports the mapping of <code>-l gpus=X</code> to <code>-l gres=gpus:X</code>. This allows users who are using NUMA systems to make requests such as <code>-l ncpus=20:gpus=5</code> indicating they are not concerned with the GPUs in relation to the NUMA nodes they request, they only want a total of 20 cores and 5 GPUs.</p> <p>For more information, see <a href="#">Requesting resources on page 42</a>.</p> <p>For information on specifying multiple types of resources for allocation, see "Multi-Req Support" under "General Job Policies" in the <a href="#">Moab Workload Manager</a> documentation.</p>

Option	Name	Description
<b>-m</b>	mail_options	<p>Defines the set of conditions under which the execution server will send a mail message about the job. The mail_options argument is a string which consists of either the single character "n", or one or more of the characters "a", "b", and "e".</p> <p>If the character "n" is specified, no normal mail is sent. Mail for job cancels and other events outside of normal job processing are still sent.</p> <p>For the letters "a", "b", and "e":</p> <ul style="list-style-type: none"> <li>• <i>a</i> – Mail is sent when the job is aborted by the batch system.</li> <li>• <i>b</i> – Mail is sent when the job begins execution.</li> <li>• <i>e</i> – Mail is sent when the job terminates.</li> </ul> <p>If the <code>-m</code> option is not specified, mail will be sent if the job is aborted.</p>
<b>-M</b>	user_list	<p>Declares the list of users to whom mail is sent by the execution server when it sends mail about the job.</p> <p>The user_list argument is of the form:</p> <pre>user[@host] [, user[@host] , ... ]</pre> <p>If unset, the list defaults to the submitting user at the qsub host, i.e. the job owner.</p>
<b>-n</b>	node-exclusive	<p>Allows a user to specify an exclusive-node access/allocation request for the job. This affects only cpusets and compatible schedulers (see <a href="#">Linux cpuset support on page 72</a>).</p>
<b>-N</b>	name	<p>Declares a name for the job. The name specified may be an unlimited number of characters in length. It must consist of printable, nonwhite space characters with the first character alphabetic.</p> <p>If the <code>-N</code> option is not specified, the job name will be the base name of the job script file specified on the command line. If no script file name was specified and the script was read from the standard input, then the job name will be set to STDIN.</p>

Option	Name	Description
<b>-o</b>	path	<p>Defines the path to be used for the standard output stream of the batch job. The path argument is of the form:</p> <pre>[hostname:]path_name</pre> <p>where <i>hostname</i> is the name of a host to which the file will be returned, and <i>path_name</i> is the path name on that host in the syntax recognized by POSIX.</p> <div style="border: 1px solid black; border-radius: 10px; padding: 5px; margin: 10px 0;">  When specifying a directory for the location you need to include a trailing slash. </div> <p>The argument will be interpreted as follows:</p> <ul style="list-style-type: none"> <li>• <i>path_name</i> – where <i>path_name</i> is not an absolute path name, then the <code>qsub</code> command will expand the path name relative to the current working directory of the command. The command will supply the name of the host upon which it is executing for the hostname component.</li> <li>• <i>hostname:path_name</i> – where <i>path_name</i> is not an absolute path name, then the <code>qsub</code> command will not expand the path name relative to the current working directory of the command. On delivery of the standard output, the path name will be expanded relative to the user's home directory on the hostname system.</li> <li>• <i>path_name</i> – where <i>path_name</i> specifies an absolute path name, then the <code>qsub</code> will supply the name of the host on which it is executing for the hostname.</li> <li>• <i>hostname:path_name</i> where <i>path_name</i> specifies an absolute path name, the path will be used as specified.</li> </ul> <p>If the <code>-o</code> option is not specified, the default file name for the standard output stream will be used. The default name has the following form:</p> <ul style="list-style-type: none"> <li>• <i>job_name.osequence_number</i> – where <i>job_name</i> is the name of the job (see the <a href="#">-n</a> name option) and <i>sequence_number</i> is the job number assigned when the job is submitted.</li> </ul>
<b>-p</b>	priority	<p>Defines the priority of the job. The priority argument must be a integer between -1024 and +1023 inclusive. The default is no priority which is equivalent to a priority of zero.</p>
<b>-P</b>	user [:group]	<p>Allows a root user or manager to submit a job as another user. TORQUE treats proxy jobs as though the jobs were submitted by the supplied username. This feature is available in TORQUE 2.4.7 and later, however, TORQUE 2.4.7 does not have the ability to supply the <code>[:group]</code> option; it is available in TORQUE 2.4.8 and later.</p>



Option	Name	Description
<b>-q</b>	destination	<p>Defines the destination of the job. The destination names a queue, a server, or a queue at a server.</p> <p>The <code>qsub</code> command will submit the script to the server defined by the destination argument. If the destination is a routing queue, the job may be routed by the server to a new destination.</p> <p>If the <code>-q</code> option is not specified, the <code>qsub</code> command will submit the script to the default server. (See <a href="#">Environment variables on page 220</a> and the PBS ERS section 2.7.4, "Default Server".)</p> <p>If the <code>-q</code> option is specified, it is in one of the following three forms:</p> <ul style="list-style-type: none"> <li>• queue</li> <li>• @server</li> <li>• queue@server</li> </ul> <p>If the destination argument names a queue and does not name a server, the job will be submitted to the named queue at the default server.</p> <p>If the destination argument names a server and does not name a queue, the job will be submitted to the default queue at the named server.</p> <p>If the destination argument names both a queue and a server, the job will be submitted to the named queue at the named server.</p>
<b>-r</b>	y/n	<p>Declares whether the job is rerunnable (see the <a href="#">qrerun</a> command). The option argument is a single character, either y or n.</p> <p>If the argument is "y", the job is rerunnable. If the argument is "n", the job is not rerunnable. The default value is y, rerunnable.</p>
<b>-S</b>	path_list	<p>Declares the path to the desired shell for this job.</p> <pre>qsub script.sh -S /bin/tcsh</pre> <p>If the shell path is different on different compute nodes, use the following syntax:</p> <pre>path[@host] [,path[@host], ...]</pre> <pre>qsub script.sh -S /bin/tcsh@node1,/usr/bin/tcsh@node2</pre> <p>Only one path may be specified for any host named. Only one path may be specified without the corresponding host name. The path selected will be the one with the host name that matched the name of the execution host. If no matching host is found, then the path specified without a host will be selected, if present.</p> <p>If the <code>-S</code> option is not specified, the option argument is the null string, or no entry from the <code>path_list</code> is selected, the execution will use the user's login shell on the execution host.</p>

Option	Name	Description
<b>-t</b>	array_request	<p>Specifies the task ids of a job array. Single task arrays are allowed.</p> <p>The <code>array_request</code> argument is an integer id or a range of integers. Multiple ids or id ranges can be combined in a comma delimited list. Examples: <code>-t 1-100</code> or <code>-t 1,10,50-100</code></p> <p>An optional <i>slot limit</i> can be specified to limit the amount of jobs that can run concurrently in the job array. The default value is unlimited. The slot limit must be the last thing specified in the <code>array_request</code> and is delimited from the array by a percent sign (%).</p> <pre>qsub script.sh -t 0-299%5</pre> <p>This sets the slot limit to 5. Only 5 jobs from this array can run at the same time.</p> <p>You can use <a href="#">qalter</a> to modify slot limits on an array. The server parameter <a href="#">max_slot_limit</a> can be used to set a global slot limit policy.</p>
<b>-u</b>	user_list	<p>Defines the user name under which the job is to run on the execution system.</p> <p>The <code>user_list</code> argument is of the form:</p> <pre>user[@host] [,user[@host],...]</pre> <p>Only one user name may be given per specified host. Only one of the user specifications may be supplied without the corresponding host specification. That user name will be used for execution on any host not named in the argument list. If unset, the user list defaults to the user who is running <code>qsub</code>.</p>
<b>-v</b>	variable_list	<p>Expands the list of environment variables that are exported to the job.</p> <p>In addition to the variables described in the "Description" section above, <code>variable_list</code> names environment variables from the <code>qsub</code> command environment which are made available to the job when it executes. The <code>variable_list</code> is a comma separated list of strings of the form <code>variable</code> or <code>variable=value</code>. These variables and their values are passed to the job. Note that <code>-v</code> has a higher precedence than <code>-V</code>, so identically named variables specified via <code>-v</code> will provide the final value for an environment variable in the job.</p>
<b>-V</b>	---	<p>Declares that all environment variables in the <code>qsub</code> commands environment are to be exported to the batch job.</p>

Option	Name	Description
-W	additional_attributes	<p>The <code>-W</code> option allows for the specification of additional job attributes. The general syntax of <code>-W</code> is in the form:</p> <pre>-W attr_name=attr_value.</pre> <p>You can use multiple <code>-W</code> options with this syntax:</p> <pre>-W attr_name1=attr_value1 -W attr_name2=attr_value2.</pre> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p><b>i</b> If white space occurs anywhere within the option argument string or the equal sign, "=", occurs within an attribute_value string, then the string must be enclosed with either single or double quote marks.</p> </div> <p>PBS currently supports the following attributes within the <code>-W</code> option:</p> <ul style="list-style-type: none"> <li>• <code>depend=dependency_list</code> – Defines the dependency between this and other jobs. The <code>dependency_list</code> is in the form: <pre>type[:argument[:argument...]][,type:argument...]</pre> <p>The argument is either a numeric count or a PBS job id according to type. If argument is a count, it must be greater than 0. If it is a job id and not fully specified in the form <code>seq_number.server.name</code>, it will be expanded according to the default server rules which apply to job IDs on most commands. If argument is null (the preceding colon need not be specified), the dependency of the corresponding type is cleared (unset). For more information, see <a href="#">depend=dependency_list valid dependencies on page 216</a>.</p> </li> <li>• <code>group_list=g_list</code> – Defines the group name under which the job is to run on the execution system. The <code>g_list</code> argument is of the form: <pre>group[@host][,group[@host],...]</pre> <p>Only one group name may be given per specified host. Only one of the group specifications may be supplied without the corresponding host specification. That group name will used for execution on any host not named in the argument list. If not set, the <code>group_list</code> defaults to the primary group of the user under which the job will be run.</p> </li> <li>• <code>interactive=true</code> – If the interactive attribute is specified, the job is an interactive job. The <code>-I</code> option is an alternative method of specifying this attribute.</li> <li>• <code>job_radix=&lt;int&gt;</code> – To be used with parallel jobs. It directs the Mother Superior of the job to create a distribution radix of size <code>&lt;int&gt;</code> between sisters. See <a href="#">Managing multi-node jobs on page 42</a>.</li> <li>• <code>stagein=file_list</code></li> <li>• <code>stageout=file_list</code> – Specifies which files are staged (copied) in before job start or staged out after the job completes execution. On completion of the job, all staged-in and staged-out files are removed from the execution system. The <code>file_list</code> is in the form: <pre>local_file@hostname:remote_file[,...]</pre> <p>regardless of the direction of the copy. The name <code>local_file</code> is the name of the file on the system where the job executed. It may be an absolute path or relative to the home directory of the user. The name <code>remote_file</code> is the destination name on the host specified by <code>hostname</code>. The name may be</p> </li> </ul>

Option	Name	Description
		<p>absolute or relative to the user's home directory on the destination host. The use of wildcards in the file name is not recommended. The file names map to a remote copy program (rcp) call on the execution system in the follow manner:</p> <ul style="list-style-type: none"> <li>◦ For stagein: <code>rcp hostname:remote_file local_file</code></li> <li>◦ For stageout: <code>rcp local_file hostname:remote_file</code></li> </ul> <p>Data staging examples:</p> <pre>-W stagein=/tmp/input.txt@headnode:/home/user/input.txt -W stageout=/tmp/output.txt@headnode:/home/user/output.txt</pre> <p>If TORQUE has been compiled with wordexp support, then variables can be used in the specified paths. Currently only \$PBS_JOBID, \$HOME, and \$TMPDIR are supported for stagein.</p> <ul style="list-style-type: none"> <li>• <code>umask=XXX</code> – Sets umask used to create stdout and stderr spool files in pbs_mom spool directory. Values starting with 0 are treated as octal values, otherwise the value is treated as a decimal umask value.</li> </ul>
<b>-x</b>	---	<p>By default, if you submit an interactive job with a script, the script will be parsed for PBS directives but the rest of the script will be ignored since it's an interactive job. The <code>-x</code> option allows the script to be executed in the interactive job and then the job completes. For example:</p> <pre>script.sh #!/bin/bash ls ---end script---</pre> <pre>qsub -I script.sh qsub: waiting for job 5.napali to start dbeer@napali:~# &lt;displays the contents of the directory, because of the ls command&gt; qsub: job 5.napali completed</pre>
<b>-X</b>	---	Enables X11 forwarding. The DISPLAY environment variable must be set.
<b>-z</b>	---	Directs that the <code>qsub</code> command is not to write the job identifier assigned to the job to the commands standard output.

## depend=dependency\_list valid dependencies



For job dependencies to work correctly, you must set the [keep\\_completed](#) on page 234 server parameter.

Dependency	Description
<code>synccount:count</code>	This job is the first in a set of jobs to be executed at the same time. Count is the number of additional jobs in the set.
<code>syncwith:jobid</code>	This job is an additional member of a set of jobs to be executed at the same time. In the above and following dependency types, jobid is the job identifier of the first job in the set.
<code>after:jobid[:jobid...]</code>	This job may be scheduled for execution at any point after jobs jobid have started execution.
<code>afterok:jobid[:jobid...]</code>	This job may be scheduled for execution only after jobs jobid have terminated with no errors. See the csh warning under <a href="#">Extended description on page 221</a> .
<code>afternotok:jobid[:jobid...]</code>	This job may be scheduled for execution only after jobs jobid have terminated with errors. See the csh warning under <a href="#">Extended description on page 221</a> .
<code>afterany:jobid[:jobid...]</code>	This job may be scheduled for execution after jobs jobid have terminated, with or without errors.
<code>on:count</code>	This job may be scheduled for execution after count dependencies on other jobs have been satisfied. This form is used in conjunction with one of the "before" forms (see below).
<code>before:jobid[:jobid...]</code>	When this job has begun execution, then jobs jobid... may begin.
<code>beforeok:jobid[:jobid...]</code>	If this job terminates execution without errors, then jobs jobid... may begin. See the csh warning under <a href="#">Extended description on page 221</a> .
<code>beforenotok:jobid[:jobid...]</code>	If this job terminates execution with errors, then jobs jobid... may begin. See the csh warning under <a href="#">Extended description on page 221</a> .

Dependency	Description
beforeany:jobid[:jobid...]	<p>When this job terminates execution, jobs jobid... may begin.</p> <p>If any of the before forms are used, the jobs referenced by jobid must have been submitted with a dependency type of on.</p> <p>If any of the before forms are used, the jobs referenced by jobid must have the same owner as the job being submitted. Otherwise, the dependency is ignored.</p>
<p><b>i</b> Array dependencies make a job depend on an array or part of an array. If no count is given, then the entire array is assumed. For examples, see <a href="#">Dependency examples on page 219</a>.</p>	
afterstartarray:arrayid[count]	<p>After this many jobs have started from arrayid, this job may start.</p>
afterokarray:arrayid[count]	<p>This job may be scheduled for execution only after jobs in arrayid have terminated with no errors.</p>
afternotokarray:arrayid[count]	<p>This job may be scheduled for execution only after jobs in arrayid have terminated with errors.</p>
afteranyarray:arrayid[count]	<p>This job may be scheduled for execution after jobs in arrayid have terminated, with or without errors.</p>
beforestartarray:arrayid[count]	<p>Before this many jobs have started from arrayid, this job may start.</p>
beforeokarray:arrayid[count]	<p>If this job terminates execution without errors, then jobs in arrayid may begin.</p>
beforenotokarray:arrayid[count]	<p>If this job terminates execution with errors, then jobs in arrayid may begin.</p>
beforeanyarray:arrayid[count]	<p>When this job terminates execution, jobs in arrayid may begin.</p> <p>If any of the before forms are used, the jobs referenced by arrayid must have been submitted with a dependency type of on.</p> <p>If any of the before forms are used, the jobs referenced by arrayid must have the same owner as the job being submitted. Otherwise, the dependency is ignored.</p>

Dependency	Description
<p><b>i</b> Error processing of the existence, state, or condition of the job on which the newly submitted job is a deferred service, i.e. the check is performed after the job is queued. If an error is detected, the new job will be deleted by the server. Mail will be sent to the job submitter stating the error.</p>	

## Dependency examples

```
qsub -W depend=afterok:123.big.iron.com /tmp/script
qsub -W depend=before:234.hunk1.com:235.hunk1.com
/tmp/script
qsub script.sh -W depend=afterokarray:427 []
```

(This assumes every job in array 427 has to finish successfully for the dependency to be satisfied.)

```
qsub script.sh -W depend=afterokarray:427 [] [5]
```

(This means that 5 of the jobs in array 427 have to successfully finish in order for the dependency to be satisfied.)

## Operands

The `qsub` command accepts a script operand that is the path to the script of the job. If the path is relative, it will be expanded relative to the working directory of the `qsub` command.

If the script operand is not provided or the operand is the single character "-", the `qsub` command reads the script from standard input. When the script is being read from Standard Input, `qsub` will copy the file to a temporary file. This temporary file is passed to the library interface routine `pbs_submit`. The temporary file is removed by `qsub` after `pbs_submit` returns or upon the receipt of a signal which would cause `qsub` to terminate.

## Standard input

The `qsub` command reads the script for the job from standard input if the script operand is missing or is the single character "-".

## Input files

The script file is read by the `qsub` command. `qsub` acts upon any directives found in the script.

When the job is created, a copy of the script file is made and that copy cannot be modified.

## Standard output

Unless the `-z` option is set, the job identifier assigned to the job will be written to standard output if the job is successfully created.

## Standard error

The `qsub` command will write a diagnostic message to standard error for each error occurrence.

## Environment variables

The values of some or all of the variables in the `qsub` commands environment are exported with the job (see the `-v` and `-V` options).

The environment variable `PBS_DEFAULT` defines the name of the default server. Typically, it corresponds to the system name of the host on which the server is running. If `PBS_DEFAULT` is not set, the default is defined by an administrator established file.

The environment variable `PBS_DPREFIX` determines the prefix string which identifies directives in the script.

The environment variable `PBS_CLIENTRETRY` defines the maximum number of seconds `qsub` will block (see the `-b` option). Despite the name, currently `qsub` is the only client that supports this option.

## torque.cfg

The `torque.cfg` file, located in `PBS_SERVER_HOME` (`/var/spool/torque` by default) controls the behavior of the `qsub` command. This file contains a list of parameters and values separated by whitespace.

- `QSUBSLEEP` – takes an integer operand which specifies time to sleep when running `qsub` command. Used to prevent users from overwhelming the scheduler.
- `SUBMITFILTER` – specifies the path to the submit filter used to pre-process job submission. The default path is `libexecdir/qsub_filter`, which falls back to `/usr/local/sbin/torque_submitfilter` for backwards compatibility. This `torque.cfg` parameter overrides this default.
- `SERVERHOST`
- `QSUBHOST`
- `QSUBSENDUID`
- `XAUTHPATH`
- `CLIENTRETRY`
- `VALIDATEGROUP`
- `DEFAULTCKPT`
- `VALIDATEPATH`
- `RERUNNABLEBYDEFAULT`

For example:

```
QSUBSLEEP 2
```

```
RERUNNABLEBYDEFAULT false
```



## Extended description

### Script Processing:

A job script may consist of PBS directives, comments and executable statements. A PBS directive provides a way of specifying job attributes in addition to the command line options. For example:

```
:
#PBS -N Job_name
#PBS -l walltime=10:30,mem=320kb
#PBS -m be
#
step1 arg1 arg2
step2 arg3 arg4
```

The `qsub` command scans the lines of the script file for directives. An initial line in the script that begins with the characters `"#!"` or the character `":"` will be ignored and scanning will start with the next line. Scanning will continue until the first executable line, that is a line that is not blank, not a directive line, nor a line whose first nonwhite space character is `"#"`. If directives occur on subsequent lines, they will be ignored.

A line in the script file will be processed as a directive to `qsub` if and only if the string of characters starting with the first nonwhite space character on the line and of the same length as the directive prefix matches the directive prefix.

The remainder of the directive line consists of the options to `qsub` in the same syntax as they appear on the command line. The option character is to be preceded with the `"-"` character.

If an option is present in both a directive and on the command line, that option and its argument, if any, will be ignored in the directive. The command line takes precedence.

If an option is present in a directive and not on the command line, that option and its argument, if any, will be processed as if it had occurred on the command line.

The directive prefix string will be determined in order of preference from:

- The value of the `-c` option argument if the option is specified on the command line.
- The value of the environment variable `PBS_DPREFIX` if it is defined.
- The four character string `#PBS`.

If the `-c` option is found in a directive in the script file, it will be ignored.

### User Authorization:

When the user submits a job from a system other than the one on which the PBS Server is running, the name under which the job is to be executed is selected according to the rules listed under the `-u` option. The user submitting the job must be authorized to run the job under the execution user name. This authorization is provided if:

- The host on which `qsub` is run is trusted by the execution host (see `/etc/hosts.equiv`).
- The execution user has an `.rhosts` file naming the submitting user on the submitting host.

## C-Shell .logout File:

The following warning applies for users of the c-shell, csh. If the job is executed under the csh and a `.logout` file exists in the home directory in which the job executes, the exit status of the job is that of the `.logout` script, not the job script. This may impact any inter-job dependencies. To preserve the job exit status, either remove the `.logout` file or place the following line as the first line in the `.logout` file:

```
set EXITVAL = $status
```

and the following line as the last executable line in `.logout`:

```
exit $EXITVAL
```

## Interactive Jobs:

If the `-I` option is specified on the command line or in a script directive, or if the "interactive" job attribute declared true via the `-W` option, `-W interactive=true`, either on the command line or in a script directive, the job is an interactive job. The script will be processed for directives, but will not be included with the job. When the job begins execution, all input to the job is from the terminal session in which `qsub` is running.

When an interactive job is submitted, the `qsub` command will not terminate when the job is submitted. `qsub` will remain running until the job terminates, is aborted, or the user interrupts `qsub` with an SIGINT (the control-C key). If `qsub` is interrupted prior to job start, it will query if the user wishes to exit. If the user response "yes", `qsub` exits and the job is aborted.

Once the interactive job has started execution, input to and output from the job pass through `qsub`. Keyboard generated interrupts are passed to the job. Lines entered that begin with the tilde (~) character and contain special sequences are escaped by `qsub`. The recognized escape sequences are:

Sequence	Description
<code>~.</code>	<code>qsub</code> terminates execution. The batch job is also terminated.
<code>~susp</code>	Suspend the <code>qsub</code> program if running under the C shell. "susp" is the suspend character (usually CNTL-Z).
<code>~asusp</code>	Suspend the input half of <code>qsub</code> (terminal to job), but allow output to continue to be displayed. Only works under the C shell. "asusp" is the auxiliary suspend character, usually CNTL-Y.

## Exit status

Upon successful processing, the `qsub` exit status will be a value of zero.

If the `qsub` command fails, the command exits with a value greater than zero.

## Related topics

- [galter\(1B\)](#)
- [qdel\(1B\)](#)

- [qhold](#)(1B)
- [qrls](#)(1B)
- [qsig](#)(1B)
- [qstat](#)(1B)
- [pbs\\_server](#)(8B)

## Non-Adaptive Computing topics

- [pbs\\_connect](#)(3B)
- [pbs\\_job\\_attributes](#)(7B)
- [pbs\\_queue\\_attributes](#)(7B)
- [pbs\\_resources\\_iris5](#)(7B)
- [pbs\\_resources\\_sp2](#)(7B)
- [pbs\\_resources\\_sunos4](#)(7B)
- [pbs\\_resources\\_unicos8](#)(7B)
- [pbs\\_server\\_attributes](#)(7B)
- [qselect](#)(1B)
- [qmove](#)(1B)
- [qmsg](#)(1B)
- [qrerun](#)(1B)

## qterm

Terminate processing by a PBS batch server.

### Synopsis


```
qterm [-t type] [server...]
```

### Description

The `qterm` command terminates a batch server. When a server receives a terminate command, the server will go into the "Terminating" state. No new jobs will be allowed to be started into execution or enqueued into the server. The impact on jobs currently being run by the server depends

In order to execute `qterm`, the user must have PBS Operation or Manager privileges.

## Options

Option	Name	Description
<b>-t</b>	type	<p>Specifies the type of shut down. The types are:</p> <ul style="list-style-type: none"><li>• <i>immediate</i> – If checkpointing is supported, all running jobs are to immediately stop execution. If checkpointing is supported, running jobs that can be checkpointed are checkpointed, terminated, and requeued. If checkpoint is not supported or the job cannot be checkpointed, running jobs are requeued if the rerunable attribute is true. Otherwise, jobs are killed.</li><li>• <i>delay</i> – If checkpointing is supported, running jobs that can be checkpointed are checkpointed, terminated, and requeued. If a job cannot be checkpointed, but can be rerun, the job is terminated and requeued. Otherwise, running jobs are allowed to continue to run.</li></ul> <div style="border: 1px solid #005596; border-radius: 10px; padding: 5px;"><p> Note, the operator or administrator may use the <a href="#">qrerun</a> and <a href="#">qdel</a> commands to remove running jobs.</p></div> <ul style="list-style-type: none"><li>• <i>quick</i> – This is the default action if the <code>-t</code> option is not specified. This option is used when you wish that running jobs be left running when the server shuts down. The server will cleanly shutdown and can be restarted when desired. Upon restart of the server, jobs that continue to run are shown as running; jobs that terminated during the server's absence will be placed into the exiting state.</li></ul>

## Operands

The server operand specifies which servers are to shut down. If no servers are given, then the default server will be terminated.

## Standard error

The `qterm` command will write a diagnostic message to standard error for each error occurrence.

## Exit status

Upon successful processing of all the operands presented to the `qterm` command, the exit status will be a value of zero.

If the `qterm` command fails to process any operand, the command exits with a value greater than zero.

## Related topics(non-Adaptive Computing topics)

- [pbs\\_server\(8B\)](#)
- [qmgr\(8B\)](#)
- [pbs\\_resources\\_aix4\(7B\)](#)
- [pbs\\_resources\\_iris5\(7B\)](#)
- [pbs\\_resources\\_sp2\(7B\)](#)
- [pbs\\_resources\\_sunos4\(7B\)](#)
- [pbs\\_resources\\_unicos8\(7B\)](#)

# trqauthd

(TORQUE authorization daemon)

## Synopsis

```
trqauthd -D  
trqauthd -d
```

## Description

The `trqauthd` daemon, introduced in TORQUE 4.0.0, replaced the `pbs_iff` authentication process. When users connect to `pbs_server` by calling one of the TORQUE utilities or by using the TORQUE APIs, the new user connection must be authorized by a trusted entity which runs as root. The advantage of `trqauthd`'s doing this rather than `pbs_iff` is that `trqauthd` is resident, meaning you do not need to be loaded every time a connection is made; multi-threaded; scalable; and more easily adapted to new functionality than `pbs_iff`.

Beginning in TORQUE 4.2.6, `trqauthd` can remember the currently active `pbs_server` host, enhancing high availability functionality. Previously, `trqauthd` tried to connect to each host in the `$TORQUE_HOME/<server_name>` file until it could successfully connect. Because it now remembers the active server, it tries to connect to that server first. If it fails to connect, it will go through the `<server_name>` file and try to connect to a host where an active `pbs_server` is running.

## Options

-D — Debug	
<b>Format</b>	---
<b>Default</b>	---
<b>Description</b>	Run <code>trqauthd</code> in debug mode.
<b>Example</b>	<code>trqauthd -D</code>

-d — Terminate	
<b>Format</b>	---
<b>Default</b>	---
<b>Description</b>	Terminate <code>trqauthd</code> .

**-d — Terminate**

**Example**

```
trqauthd -d
```

# Server parameters

TORQUE server parameters are specified using the [qmgr](#) command. The `set` subcommand is used to modify the **server** object. For example:

```
> qmgr -c 'set server default_queue=batch'
```

## Parameters

acl_hosts	
<b>Format</b>	<HOST>[,<HOST>]... <i>or</i> <HOST>[range] <i>or</i> <HOST*> where the asterisk (*) can appear anywhere in the host name
<b>Default</b>	(Only the host running <code>pbs_server</code> may submit jobs.)
<b>Description</b>	<p>Specifies a list of hosts from which jobs may be submitted. Hosts in the server nodes file located at <code>\$TORQUE/server_priv/nodes</code> cannot be added to the list using the <code>acl_hosts</code> parameter (see <a href="#">Server node file configuration on page 27</a>). To submit batch or interactive jobs (see <a href="#">Server configuration on page 21</a>) through hosts that are specified in the server nodes file, use the <a href="#">submit_hosts</a> parameter.</p> <pre>Qmgr: set queue batch acl_hosts = "hostA,hostB" Qmgr: set queue batch acl_hosts += "hostE,hostF,hostG"</pre> <p>In version 2.5 and later, the wildcard (*) character can appear anywhere in the host name, and ranges are supported; these specifications also work for managers and operators.</p> <pre>Qmgr: set server acl_hosts = "galaxy*.tom.org" Qmgr: set server acl_hosts += "galaxy[0-50].tom.org" Qmgr: set server managers+=tom@galaxy[0-50].tom.org</pre>


acl_host_enable	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	When set to <code>TRUE</code> , specifies that the <a href="#">acl_hosts</a> value is enabled.

## acl\_logic\_or

<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	When set to <code>TRUE</code> , the user and group queue ACL's are logically OR'd. When set to <code>FALSE</code> , they are AND'd.

## allow\_node\_submit

<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	When set to <code>TRUE</code> , specifies that users can submit jobs directly from any trusted compute host directly or from within batch jobs (see <a href="#">Configuring job submission hosts on page 22</a> ).

 When you enable `allow_node_submit`, you must also enable the [allow\\_proxy\\_user on page 228](#) parameter to allow user proxying when submitting and running jobs.

## allow\_proxy\_user

<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	When set to <code>TRUE</code> , specifies that users can proxy from one user to another. Proxy requests will be either validated by <code>ruserok()</code> or by the scheduler (see <a href="#">Job submission on page 39</a> ).

## auto\_node\_np

<b>Format</b>	<BOOLEAN>
<b>Default</b>	DISABLED
<b>Description</b>	When set to <code>TRUE</code> , automatically configures a node's <code>np</code> (number of processors) value based on the <code>ncpus</code> value from the status update. Requires full manager privilege to set or alter.



## automatic\_requeue\_exit\_code

**Format** <LONG>

**Default** ---

**Description** This is an exit code, defined by the admin, that tells pbs\_server to requeue the job instead of considering it as completed. This allows the user to add some additional checks that the job can run meaningfully, and if not, then the job script exits with the specified code to be requeued.

## checkpoint\_defaults

**Format** <STRING>

**Default** ---

**Description** Specifies for a queue the default checkpoint values for a job that does not have checkpointing specified. The checkpoint\_defaults parameter only takes effect on execution queues.

```
set queue batch checkpoint_defaults="enabled, periodic, interval=5"
```

## clone\_batch\_delay

**Format** <INTEGER>

**Default** 1

**Description** Specifies the delay (in seconds) between clone batches (see [clone\\_batch\\_size](#)).



## clone\_batch\_size

**Format** <INTEGER>

**Default** 256

**Description** Job arrays are created in batches of size *X*. *X* jobs are created, and after the [clone\\_batch\\_delay](#), *X* more are created. This repeats until all are created.

## copy\_on\_rerun

<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	<p>When set to <code>TRUE</code>, TORQUE will copy the output and error files over to the user-specified directory when the <code>grerun</code> command is executed (i.e. a job preemption). Output and error files are only created when a job is in running state before the preemption occurs.</p> <p> <code>pbs_server</code> and <code>pbs_mom</code> need to be on the same version.</p> <p> When you change the value, you must perform a <code>pbs_server</code> restart for the change to effect.</p>

## cray\_enabled

<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	<p>When set to <code>TRUE</code>, specifies that this instance of <code>pbs_server</code> has Cray hardware that reports to it. See <a href="#">Installation Notes for Moab and TORQUE for Cray</a> in the Moab Workload Manager documentation.</p>

## default\_queue


<b>Format</b>	<STRING>
<b>Default</b>	---
<b>Description</b>	Indicates the queue to assign to a job if no queue is explicitly specified by the submitter.

## disable\_server\_id\_check

<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE

## disable\_server\_id\_check

**Description** When set to `TRUE`, makes it so the user for the job doesn't have to exist on the server. The user must still exist on all the compute nodes or the job will fail when it tries to execute.


 If you have `disable_server_id_check` set to `TRUE`, a user could request a group to which they do not belong. Setting `VALIDATEGROUP` to `TRUE` in the `torque.cfg` file prevents such a scenario (see "[torque.cfg](#)" configuration file on page 295).

## display\_job\_server\_suffix

**Format** <BOOLEAN>

**Default** `TRUE`

**Description** When set to `TRUE`, TORQUE will display both the job ID and the host name. When set to `FALSE`, only the job ID will be displayed.

 If set to `FALSE`, the environment variable `NO_SERVER_SUFFIX` must be set to `TRUE` for `pbs_track` to work as expected.

## interactive\_jobs\_can\_roam

**Format** <BOOLEAN>

**Default** `FALSE`

**Description** By default, interactive jobs run from the login node that they submitted from. When `TRUE`, interactive jobs may run on login nodes other than the one where the jobs were submitted to. See "[Installation Notes for Moab and TORQUE for Cray](#)" in the *Moab Workload Manager Administrator Guide* for more information.

## job\_exclusive\_on\_use

**Format** <BOOLEAN>

**Default** `FALSE`

**Description** When `job_exclusive_on_use` is set to `TRUE`, `pbsnodes` will show job-exclusive on a node when there's at least one of its processors running a job. This differs with the default behavior which is to show job-exclusive on a node when all of its processors are running a job.

## job\_exclusive\_on\_use

### Example

```
set server job_exclusive_on_use=TRUE
```

## job\_force\_cancel\_time

### Format

<INTEGER>

### Default

Disabled

### Description

If a job has been deleted and is still in the system after  $x$  seconds, the job will be purged from the system. This is mostly useful when a job is running on a large number of nodes and one node goes down. The job cannot be deleted because the MOM cannot be contacted. The `qdel` fails and none of the other nodes can be reused. This parameter can be used to remedy such situations.

## job\_log\_file\_max\_size

### Format

<INTEGER>

### Default

---

### Description

This specifies a soft limit (in kilobytes) for the job log's maximum size. The file size is checked every five minutes and if the *current day* file size is greater than or equal to this value, it is rolled from `<filename>` to `<filename.1>` and a new empty log is opened. If the current day file size exceeds the maximum size a second time, the `<filename.1>` log file is rolled to `<filename.2>`, the current log is rolled to `<filename.1>`, and a new empty log is opened. Each new log causes all other logs to roll to an extension that is one greater than its current number. Any value less than 0 is ignored by `pbs_server` (meaning the log will not be rolled).

## job\_log\_file\_roll\_depth

### Format

<INTEGER>

### Default

---

### Description

This sets the maximum number of new log files that are kept in a day if the [job\\_log\\_file\\_max\\_size](#) parameter is set. For example, if the roll depth is set to 3, no file can roll higher than `<filename.3>`. If a file is already at the specified depth, such as `<filename.3>`, the file is deleted so it can be replaced by the incoming file roll, `<filename.2>`.

## job\_log\_keep\_days

<b>Format</b>	<INTEGER>
<b>Default</b>	---
<b>Description</b>	This maintains logs for the number of days designated. If set to 4, any log file older than 4 days old is deleted.

## job\_nanny

<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	When set to <code>TRUE</code> , enables the experimental "job deletion nanny" feature. All job cancels will create a repeating task that will resend <code>KILL</code> signals if the initial job cancel failed. Further job cancels will be rejected with the message "job cancel in progress." This is useful for temporary failures with a job's execution node during a job delete request.

## job\_stat\_rate

<b>Format</b>	<INTEGER>
<b>Default</b>	45 (30 in TORQUE 1.2.0p5 and earlier)
<b>Description</b>	Specifies the maximum age of MOM level job data which is allowed when servicing a <code>qstat</code> request. If data is older than this value, the <code>pbs_server</code> daemon will contact the MOMs with stale data to request an update. For large systems, this value should be increased to 5 minutes or higher.

## job\_start\_timeout

<b>Format</b>	<INTEGER>
<b>Default</b>	---
<b>Description</b>	Specifies the <code>pbs_server</code> to <code>pbs_mom</code> TCP socket timeout in seconds that is used when the <code>pbs_server</code> sends a job start to the <code>pbs_mom</code> . It is useful when the MOM has extra overhead involved in starting jobs. If not specified, then the <a href="#">tcp_timeout</a> parameter is used.

## job\_sync\_timeout

**Format** <INTEGER>

**Default** 60

**Description** When a stray job is reported on multiple nodes, the server sends a kill signal to one node at a time. This timeout determines how long the server waits between kills if the job is still being reported on any nodes.

## keep\_completed

**Format** <INTEGER>

**Default** ---

 If you ran `torque.setup` on TORQUE installation, the default is 300.

**Description** The amount of time a job will be kept in the queue after it has entered the completed state. `keep_completed` *must* be set for job dependencies to work. For more information, see [Keeping completed jobs on page 52](#).

## lock\_file

**Format** <STRING>

**Default** `torque/server_priv/server.lock`

**Description** Specifies the name and location of the lock file used to determine which high availability server should be active. If a full path is specified, it is used verbatim by TORQUE. If a relative path is specified, TORQUE will prefix it with `torque/server_priv`.

## lock\_file\_update\_time

**Format** <INTEGER>

### lock\_file\_update\_time

<b>Default</b>	3
<b>Description</b>	Specifies how often (in seconds) the thread will update the lock file.

### lock\_file\_check\_time

<b>Format</b>	<INTEGER>
<b>Default</b>	9
<b>Description</b>	Specifies how often (in seconds) a high availability server will check to see if it should become active.

### log\_events

<b>Format</b>	Bitmap
<b>Default</b>	---
<b>Description</b>	<p>By default, all events are logged. However, you can customize things so that only certain events show up in the log file. These are the bitmaps for the different kinds of logs:</p> <pre>#define PBSEVENT_ERROR 0x0001 /* internal errors */ #define PBSEVENT_SYSTEM 0x0002 /* system (server) events */ #define PBSEVENT_ADMIN 0x0004 /* admin events */ #define PBSEVENT_JOB 0x0008 /* job related events */ #define PBSEVENT_JOB_USAGE 0x0010 /* End of Job accounting */ #define PBSEVENT_SECURITY 0x0020 /* security violation events */ #define PBSEVENT_SCHED 0x0040 /* scheduler events */ #define PBSEVENT_DEBUG 0x0080 /* common debug messages */ #define PBSEVENT_DEBUG2 0x0100 /* less needed debug messages */ #define PBSEVENT_FORCE 0x8000 /* set to force a message */</pre>

If you want to log only error, system, and job information, use `qmgr` to set `log_events` to 11:

```
set server log_events = 11
```

### log\_file\_max\_size

<b>Format</b>	<INTEGER>
---------------	-----------

## log\_file\_max\_size

**Default**

0

**Description**

Specifies a soft limit, in kilobytes, for the server's log file. The file size is checked every 5 minutes, and if the *current day* file size is greater than or equal to this value then it will be rolled from *X* to *X.1* and a new empty log will be opened. Any value less than or equal to 0 will be ignored by `pbs_server` (the log will not be rolled).

## log\_file\_roll\_depth

**Format**

<INTEGER>

**Default**

1

**Description**

Controls how deep the current day log files will be rolled, if `log_file_max_size` is set, before they are deleted.

## log\_keep\_days

**Format**

<INTEGER>

**Default**

0

**Description**

Specifies how long (in days) a server or MOM log should be kept.

## log\_level

**Format**

<INTEGER>

**Default**

0

**Description**

Specifies the `pbs_server` logging verbosity. Maximum value is 7.

## mail\_body\_fmt

**Format**

A printf-like format string

**Default**

PBS Job Id: %i Job Name: %j Exec host: %h %m %d



## mail\_body\_fmt

<b>Description</b>	Override the default format for the body of outgoing mail messages. A number of printf-like format specifiers and escape sequences can be used: \n new line \t tab \ backslash ' single quote " double quote %d details concerning the message %h PBS host name %i PBS job identifier %j PBS job name %m long reason for message %r short reason for message %% a single %
--------------------	--

## mail\_domain

<b>Format</b>	<STRING>
<b>Default</b>	---
<b>Description</b>	Override the default domain for outgoing mail messages. If set, emails will be addressed to <user->@<hostdomain>. If unset, the job's Job_Owner attribute will be used. If set to never, TORQUE will never send emails.

## mail\_from

<b>Format</b>	<STRING>
<b>Default</b>	adm
<b>Description</b>	Specify the name of the sender when TORQUE sends emails.

## mail\_subject\_fmt

<b>Format</b>	A printf-like format string
<b>Default</b>	PBS JOB %i

## mail\_subject\_fmt

<b>Description</b>	Override the default format for the subject of outgoing mail messages. A number of printf-like format specifiers and escape sequences can be used: \n new line \t tab \ backslash \ ' single quote \ " double quote %d details concerning the message %h PBS host name %i PBS job identifier %j PBS job name %m long reason for message %r short reason for message %% a single %
--------------------	---

## managers

<b>Format</b>	<user>@<host.sub.domain>[,<user>@<host.sub.domain>...]
<b>Default</b>	root@localhost
<b>Description</b>	List of users granted batch administrator privileges. The host, sub-domain, or domain name may be wildcarded by the use of an asterisk character (*). Requires full manager privilege to set or alter.

## max\_job\_array\_size

<b>Format</b>	<INTEGER>
<b>Default</b>	Unlimited
<b>Description</b>	Sets the maximum number of jobs that can be in a single job array.

## max\_slot\_limit

<b>Format</b>	<INTEGER>
<b>Default</b>	Unlimited

## max\_slot\_limit

<b>Description</b>	<p>This is the maximum number of jobs that can run concurrently in any job array. Slot limits can be applied at submission time with <a href="#">qsub</a>, or it can be modified with <a href="#">qalter</a>.</p> <pre>qmgr -c 'set server max_slot_limit=10'</pre> <p>No array can request a slot limit greater than 10. Any array that does not request a slot limit receives a slot limit of 10. Using the example above, slot requests greater than 10 are rejected with the message: "Requested slot limit is too large, limit is 10."</p>
--------------------	---

## max\_threads

<b>Format</b>	<INTEGER>
<b>Default</b>	The value of min_threads $((2 * \text{the number of procs listed in } /proc/cpuinfo) + 1) * 10$
<b>Description</b>	This is the maximum number of threads that should exist in the thread pool at any time.

## max\_user\_queuable

<b>Format</b>	<INTEGER>
<b>Default</b>	Unlimited
<b>Description</b>	When set, max_user_queuable places a system-wide limit on the amount of jobs that an individual user can queue.

```
qmgr -c 'set server max_user_queuable=500'
```

## min\_threads

<b>Format</b>	<INTEGER>
<b>Default</b>	$(2 * \text{the number of procs listed in } /proc/cpuinfo) + 1$ . If TORQUE is unable to read <code>/proc/cpuinfo</code> , the default is 10.
<b>Description</b>	This is the minimum number of threads that should exist in the thread pool at any time.

## moab\_array\_compatible

**Format** <BOOLEAN>

**Default** TRUE

**Description** This parameter places a hold on jobs that exceed the [slot limit](#) in a job array. When one of the active jobs is completed or deleted, one of the held jobs goes to a queued state.

## mom\_job\_sync

**Format** <BOOLEAN>

**Default** TRUE

**Description** When set to TRUE, specifies that the pbs\_server will synchronize its view of the job queue and resource allocation with compute nodes as they come online. If a job exists on a compute node, it will be automatically cleaned up and purged. (Enabled by default in TORQUE 2.2.0 and higher.) Jobs that are no longer reported by the mother superior are automatically purged by pbs\_server. Jobs that pbs\_server instructs the MOM to cancel have their processes killed in addition to being deleted (instead of leaving them running as in versions of TORQUE prior to 4.1.1).

## next\_job\_number

**Format** <INTEGER>

**Default** ---

**Description** Specifies the ID number of the next job. If you set your job number too low and TORQUE repeats a job number that it has already used, the job will fail. Before setting next\_job\_number to a number lower than any number that TORQUE has already used, you must clear out your .e and .o files.

**i** If you use Moab Workload Manager and have configured it to synchronize job IDs with TORQUE (See [Synchronizing Job IDs in TORQUE and Moab](#) in the Moab Workload Manager Administrator Guide for more information.), then Moab will generate the job ID and next\_job\_number will have no effect on the job ID.

## node\_check\_rate

**Format** <INTEGER>

## node\_check\_rate

**Default**

600

**Description**

Specifies the minimum duration (in seconds) that a node can fail to send a status update before being marked down by the `pbs_server` daemon.

## node\_pack

**Format**

&lt;BOOLEAN&gt;

**Default**

---

**Description**

Controls how multiple processor nodes are allocated to jobs. If this attribute is set to `TRUE`, jobs will be assigned to the multiple processor nodes with the fewest free processors. This packs jobs into the fewest possible nodes leaving multiple processor nodes free for jobs which need many processors on a node. If set to `FALSE`, jobs will be scattered across nodes reducing conflicts over memory between jobs. If unset, the jobs are packed on nodes in the order that the nodes are declared to the server (in the nodes file). Default value: unset - assigned to nodes in order that were declared.

## node\_ping\_rate

**Format**

&lt;INTEGER&gt;

**Default**

300

**Description**

Specifies the maximum interval (in seconds) between successive "pings" sent from the `pbs_server` daemon to the `pbs_mom` daemon to determine node/daemon health.

## no\_mail\_force

**Format**

&lt;BOOLEAN&gt;

**Default**

FALSE

**Description**

When set to `TRUE`, eliminates all e-mails when `mail_options` (see [qsub on page 204](#)) is set to "n". The job owner won't receive e-mails when a job is deleted by a different user or a job failure occurs. If `no_mail_force` is unset or is `FALSE`, then the job owner receives e-mails when a job is deleted by a different user or a job failure occurs.

## np\_default

**Format** <INTEGER>

**Default** ---

**Description** Allows the administrator to unify the number of processors (np) on all nodes. The value can be dynamically changed. A value of 0 tells pbs\_server to use the value of np found in the nodes file. The maximum value is 32767.

## operators

**Format** <user>@<host.sub.domain>[,<user>@<host.sub.domain>...]

**Default** root@localhost

**Description** List of users granted batch operator privileges. Requires full manager privilege to set or alter.

## poll\_jobs

**Format** <BOOLEAN>

**Default** TRUE (FALSE in TORQUE 1.2.0p5 and earlier)

**Description** If set to TRUE, pbs\_server will poll job info from MOMs over time and will not block on handling requests which require this job information. If set to FALSE, no polling will occur and if requested job information is stale, pbs\_server may block while it attempts to update this information. For large systems, this value should be set to TRUE.

## query\_other\_jobs

**Format** <BOOLEAN>

**Default** FALSE

**Description** When set to TRUE, specifies whether or not non-admin users may view jobs they do not own.

## record\_job\_info

**Format** <BOOLEAN>

**Default** FALSE

**Description** This must be set to `TRUE` in order for job logging to be enabled.

## record\_job\_script

**Format** <BOOLEAN>

**Default** FALSE

**Description** If set to `TRUE`, this adds the contents of the script executed by a job to the log.



For `record_job_script` to take effect, [record\\_job\\_info](#) on page 243 must be set to `TRUE`.

## resources\_available

**Format** <STRING>

**Default** ---

**Description** Allows overriding of detected resource quantity limits (see [Assigning queue resource limits on page 87](#)). `pbs_server` must be restarted for changes to take effect. Also, `resources_available` is constrained by the smallest of `queue.resources_available` and the `server.resources_available`.

## scheduling

**Format** <BOOLEAN>

**Default** ---

**Description** Allows `pbs_server` to be scheduled. When `FALSE`, `pbs_server` is a resource manager that works on its own. When `TRUE`, TORQUE allows a scheduler, such as Moab or Maui, to dictate what `pbs_server` should do.

## submit\_hosts

**Format** "<HOSTNAME>[,<HOSTNAME>]..."

**Default** ---

**Description** Indicates which hosts included in the server nodes file located at `$TORQUE/server_priv/nodes` (see [Server node file configuration on page 27](#)) can submit batch or interactive jobs (see [Configuring job submission hosts on page 22](#)). For more information on adding hosts that are not included in the first nodes file, see the [acl\\_hosts](#) parameter.

## tcp\_timeout

**Format** <INTEGER>

**Default** 300

**Description** Specifies the timeout for idle TCP connections. If no communication is received by the server on the connection after the timeout, the server closes the connection. There is an exception for connections made to the server on port 15001 (default); timeout events are ignored on the server for such connections established by a client utility or scheduler. Responsibility rests with the client to close the connection first (See [Large cluster considerations on page 273](#) for additional information.).



If you use Moab Workload Manager, prevent communication errors by giving `tcp_timeout` at least twice the value of the Moab `RMPOLLINTERVAL`.

## thread\_idle\_seconds

**Format** <INTEGER>

**Default** 300

**Description** This is the number of seconds a thread can be idle in the thread pool before it is deleted. If threads should not be deleted, set to `-1`. TORQUE will always maintain at least [min\\_threads](#) number of threads, even if all are idle.



# Node manager (MOM) configuration

Under TORQUE, MOM configuration is accomplished using the `mom_priv/config` file located in the PBS directory on each execution server. You must create this file and insert any desired lines in a text editor (blank lines are allowed). When you modify the `mom_priv/config` file, you must restart `pbs_mom`.

The following examples demonstrate two methods of modifying the `mom_priv/config` file:

```
> echo "$loglevel 3" >> /var/spool/torque/mom_priv/config
> vim /var/spool/torque/mom_priv/config
...
$loglevel 3
```

For details, see these topics:

- [Parameters on page 245](#)
- [Node features and generic consumable resource specification on page 261](#)
- [Command-line arguments on page 261](#)

## Related topics

- [Commands overview on page 145](#)
- [Prologue and epilogue scripts on page 281](#)

## Parameters

### arch

**Format**

<STRING>

**Description**

Specifies the architecture of the local machine. This information is used by the scheduler only.

**Example**


arch ia64

### \$attempt\_to\_make\_dir


**Format**

<BOOLEAN>

## \$attempt\_to\_make\_dir

<b>Description</b>	When set to <i>TRUE</i> , specifies that you want TORQUE to attempt to create the output directories for jobs if they do not already exist. Default is <i>FALSE</i> . <div style="border: 1px solid #004a87; border-radius: 10px; padding: 5px; margin-top: 10px;"> TORQUE uses this parameter to make the directory as the <i>user</i> and not as <i>root</i>. TORQUE will create the directory (or directories) <b>ONLY</b> if the user has permissions to do so.</div>
<b>Example</b>	<code>\$attempt_to_make_dir true</code>

## \$clienthost


<b>Format</b>	<STRING>
<b>Description</b>	Specifies the machine running pbs_server. <div style="border: 1px solid #c00000; border-radius: 10px; padding: 5px; margin-top: 10px;"> This parameter is deprecated. Use <a href="#">\$pbsserver</a>.</div>
<b>Example</b>	<code>\$clienthost node01.teracluster.org</code>

## \$check\_poll\_time

<b>Format</b>	<STRING>
<b>Description</b>	Amount of time between checking running jobs, polling jobs, and trying to resend obituaries for jobs that haven't sent successfully. Default is 45 seconds.
<b>Example</b>	<code>\$check_poll_time 90</code>

## \$configversion

<b>Format</b>	<STRING>
<b>Description</b>	Specifies the version of the config file data.
<b>Example</b>	<code>\$configversion 113</code>

\$cputmult	
<b>Format</b>	<FLOAT>
<b>Description</b>	CPU time multiplier. <div style="border: 1px solid #0070C0; border-radius: 10px; padding: 5px; margin-top: 10px;">  If set to 0.0, MOM level cputime enforcement is disabled.           </div>
<b>Example</b>	<code>\$cputmult 2.2</code>

\$exec_with_exec	
<b>Format</b>	<BOOLEAN>
<b>Description</b>	pbs_mom uses the <code>exec</code> command to start the job script rather than the TORQUE default method, which is to pass the script's contents as the input to the shell. This means that if you trap signals in the job script, they will be trapped for the job. Using the default method, you would need to configure the shell to also trap the signals. Default is FALSE.
<b>Example</b>	<code>\$exec_with_exec true</code>

\$ext_pwd_retry	
<b>Format</b>	<INTEGER>
<b>Description</b>	<i>(Available in TORQUE 2.5.10, 3.0.4, and later.)</i> Specifies the number of times to retry checking the password. Useful in cases where external password validation is used, such as with LDAP. The default value is 3 retries.
<b>Example</b>	<code>\$ext_pwd_retry = 5</code>

\$ideal_load	
<b>Format</b>	<FLOAT>
<b>Description</b>	Ideal processor load.
<b>Example</b>	<code>\$ideal_load 4.0</code>

### `$igncpu`

**Format** <BOOLEAN>

**Description** Ignores limit violation pertaining to CPU time. Default is FALSE.

**Example** `$igncpu true`

### `$ignmem`

**Format** <BOOLEAN>

**Description** Ignores limit violations pertaining to physical memory. Default is FALSE.

**Example** `$ignmem true`

### `$ignvmem`

**Format** <BOOLEAN>

**Description** Ignores limit violations pertaining to virtual memory. Default is FALSE.

**Example** `$ignvmem true`

### `$ignwalltime`

**Format** <BOOLEAN>

**Description** Ignore walltime (do not enable MOM based walltime limit enforcement).

**Example** `$ignwalltime true`

### `$job_exit_wait_time`

**Format** <INTEGER>

## \$job\_exit\_wait\_time

**Description** This is the timeout to clean up parallel jobs after one of the sister nodes for the parallel job goes down or is otherwise unresponsive. The MOM sends out all of its kill job requests to sisters and marks the time. Additionally, the job is placed in the substate `JOB_SUBSTATE_EXIT_WAIT`. The MOM then periodically checks jobs in this state and if they are in this state for more than the specified time, death is assumed and the job gets cleaned up. Default is 10 minutes.

**Example** `$job_exit_wait_time 300`

## \$job\_output\_file\_unmask

**Format** <STRING>

**Description** Uses the specified umask when creating job output and error files. Values can be specified in base 8, 10, or 16; leading 0 implies octal and leading 0x or 0X hexadecimal. A value of "userdefault" will use the user's default umask. This parameter is in version 2.3.0 and later.

**Example** `$job_output_file_umask 027`

## \$job\_starter

**Format** <STRING>

**Description** Specifies the fully qualified pathname of the job starter. If this parameter is specified, instead of executing the job command and job arguments directly, the MOM will execute the job starter, passing the job command and job arguments to it as its arguments. The job starter can be used to launch jobs within a desired environment.

**Example**

```
$job_starter /var/torque/mom_priv/job_starter.sh
> cat /var/torque/mom_priv/job_starter.sh
#!/bin/bash
export FOOHOME=/home/foo
ulimit -n 314
$*
```

## \$log\_directory

**Format** <STRING>

## \$log\_directory

<b>Description</b>	Changes the log directory. Default is TORQUE_HOME/mom_logs/. TORQUE_HOME default is /var/spool/torque/ but can be changed in the ./configure script. The value is a string and should be the full path to the desired MOM log directory.
--------------------	--

<b>Example</b>	<code>\$log_directory /opt/torque/mom_logs/</code>
----------------	--

## \$log\_file\_suffix

<b>Format</b>	<STRING>
---------------	----------

<b>Description</b>	Optional suffix to append to log file names. If %h is the suffix, pbs_mom appends the hostname for where the log files are stored if it knows it, otherwise it will append the hostname where the MOM is running.
--------------------	---

<b>Example</b>	<code>\$log_file_suffix %h = 20100223.mybox</code> <code>\$log_file_suffix foo = 20100223.foo</code>
----------------	---

## \$logevent

<b>Format</b>	<STRING>
---------------	----------

<b>Description</b>	Specifies a bitmap for event types to log.
--------------------	--

<b>Example</b>	<code>\$logevent 255</code>
----------------	-----------------------------

## \$loglevel

<b>Format</b>	<INTEGER>
---------------	-----------

<b>Description</b>	Specifies the verbosity of logging with higher numbers specifying more verbose logging. Values may range between 0 and 7.
--------------------	---

<b>Example</b>	<code>\$loglevel 4</code>
----------------	---------------------------

## \$log\_file\_max\_size

<b>Format</b>	<INTEGER>
---------------	-----------

## `$log_file_max_size`

<b>Description</b>	Soft limit for log file size in kilobytes. Checked every 5 minutes. If the log file is found to be greater than or equal to <code>log_file_max_size</code> the current log file will be moved from X to X.1 and a new empty file will be opened.
--------------------	--

<b>Example</b>	<code>\$log_file_max_size = 100</code>
----------------	--

## `$log_file_roll_depth`

<b>Format</b>	<INTEGER>
---------------	-----------

<b>Description</b>	Specifies how many times a log file will be rolled before it is deleted.
--------------------	--

<b>Example</b>	<code>\$log_file_roll_depth = 7</code>
----------------	--

## `$log_keep_days`

<b>Format</b>	<INTEGER>
---------------	-----------

<b>Description</b>	Specifies how many days to keep log files. <code>pbs_mom</code> deletes log files older than the specified number of days. If not specified, <code>pbs_mom</code> won't delete log files based on their age.
--------------------	--

<b>Example</b>	<code>\$log_keep_days 10</code>
----------------	---------------------------------

## `$max_conn_timeout_micro_sec`

<b>Format</b>	<INTEGER>
---------------	-----------

<b>Description</b>	Specifies how long <code>pbs_mom</code> should wait for a connection to be made. Default value is 10000 (.1 sec).
--------------------	---

<b>Example</b>	<code>\$max_conn_timeout_micro_sec 30000</code> This sets the connection timeout on the MOM to .3 seconds..
----------------	--

## `$max_join_job_wait_time`

<b>Format</b>	<INTEGER>
---------------	-----------

## \$max\_join\_job\_wait\_time

**Description** The interval to wait for jobs stuck in a prerun state before deleting them from the MOMs and requeueing them on the server. Default is 10 minutes.

**Example** `$max_join_job_wait_time 300`

## \$max\_load

**Format** <FLOAT>

**Description** Maximum processor load.

**Example** `$max_load 4.0`

## \$memory\_pressure\_duration

**Format** <INTEGER>

**Description** *(Applicable in version 3.0 and later.)* Memory pressure duration sets a limit to the number of times the value of `memory_pressure_threshold` can be exceeded before a process is terminated. This can only be used with [\\$memory\\_pressure\\_threshold](#).

**Example** `$memory_pressure_duration 5`

## \$memory\_pressure\_threshold

**Format** <INTEGER>

**Description** *(Applicable in version 3.0 and later.)* The `memory_pressure` of a cpuset provides a simple per-cpuset running average of the rate that the processes in a cpuset are attempting to free up in-use memory on the nodes of the cpuset to satisfy additional memory requests. The `memory_pressure_threshold` is an integer number used to compare against the reclaim rate provided by the `memory_pressure` file. If the threshold is exceeded and `memory_pressure_duration` is set, then the process terminates after exceeding the threshold by the number of times set in `memory_pressure_duration`. If `memory_pressure` duration is not set, then a warning is logged and the process continues. `memory_pressure_threshold` is only valid with `memory_pressure` enabled in the root cpuset.

To enable, log in as the super user and execute the command `echo 1 >> /dev/cpuset/memory_pressure_enabled`. See the cpuset man page for more information concerning memory pressure.



## \$memory\_pressure\_threshold

<b>Example</b>	<code>\$memory_pressure_threshold 1000</code>
----------------	---

## \$mom\_hierarchy\_retry\_time

<b>Format</b>	<SECONDS>
---------------	-----------

<b>Description</b>	Specifies the amount of time that a MOM waits to retry a node in the hierarchy path after a failed connection to that node. The default is 90 seconds.
--------------------	--

<b>Example</b>	<code>\$mom_hierarchy_retry_time 30</code>
----------------	--

## \$node\_check\_script

<b>Format</b>	<STRING>
---------------	----------

<b>Description</b>	Specifies the fully qualified pathname of the health check script to run (see <a href="#">Compute node health check on page 134</a> for more information).
--------------------	--

<b>Example</b>	<code>\$node_check_script /opt/batch_tools/nodecheck.pl</code>
----------------	--

## \$node\_check\_interval

<b>Format</b>	<STRING>
---------------	----------

<b>Description</b>	Specifies the number of MOM intervals between subsequent executions of the specified health check. This value default to 1 indicating the check is run every MOM interval (see <a href="#">Compute node health check on page 134</a> for more information).
--------------------	---

\$node\_check\_interval has two special strings that can be set:

- *jobstart* – makes the node health script run when a job is started.
- *jobend* – makes the node health script run after each job has completed on a node.

<b>Example</b>	<code>\$node_check_interval 5</code>
----------------	--------------------------------------

## \$nodefile\_suffix

<b>Format</b>	<STRING>
---------------	----------

## \$nodefile\_suffix

**Description** Specifies the suffix to append to a host names to denote the data channel network adapter in a multi-homed compute node.

**Example** `$nodefile_suffix i`  
with the suffix of "i" and the control channel adapter with the name *node01*, the data channel would have a hostname of *node01i*.

## \$nospool\_dir\_list


**Format** <STRING>

**Description** If this is configured, the job's output is spooled in the working directory of the job or the specified output directory.

Specify the list in full paths, delimited by commas. If the job's working directory (or specified output directory) is in one of the paths in the list (or a subdirectory of one of the paths in the list), the job is spooled directly to the output location. `$nospool_dir_list *` is accepted.

The user that submits the job must have write permission on the folder where the job is written, and read permission on the folder where the file is spooled.

Alternatively, you can use the `$spool_as_final_name` parameter to force the job to spool directly to the final output.

 This should generally be used only when the job can run on the same machine as where the output file goes, or if there is a shared filesystem. If not, this parameter can slow down the system or fail to create the output file.

**Example** `$nospool_dir_list /home/mike/jobs/,/var/tmp/spool/`

## opsys

**Format** <STRING>

**Description** Specifies the operating system of the local machine. This information is used by the scheduler only.

**Example** `opsys RHEL3`


## \$pbsclient

**Format** <STRING>

## \$pbsclient

<b>Description</b>	Specifies machines which the MOM daemon will trust to run resource manager commands via <a href="#">momctl</a> . This may include machines where monitors, schedulers, or admins require the use of this command.
<b>Example</b>	<code>\$pbsclient node01.teracluster.org</code>

## \$pbserver

<b>Format</b>	<STRING>
<b>Description</b>	Specifies the machine running pbs_server. <div style="border: 1px solid #0070C0; border-radius: 10px; padding: 5px; margin-top: 10px;"> This parameter replaces the deprecated parameter <a href="#">\$clienthost</a>.</div>
<b>Example</b>	<code>\$pbserver node01.teracluster.org</code>

## \$prologalarm

<b>Format</b>	<INTEGER>
<b>Description</b>	Specifies maximum duration (in seconds) which the MOM will wait for the job prologue or job epilogue to complete. The default value is 300 seconds (5 minutes). The maximum value is 300 and when set to anything higher than that, it is treated as 300.
<b>Example</b>	<code>\$prologalarm 60</code>

## \$rcpcmd

<b>Format</b>	<STRING>
<b>Description</b>	Specifies the full path and optional additional command line args to use to perform remote copies.
<b>Example</b>	<code>mom_priv/config: \$rcpcmd /usr/local/bin/scp -i /etc/sshauth.dat</code>

## `$remote_reconfig`

<b>Format</b>	<STRING>
<b>Description</b>	Enables the ability to remotely reconfigure pbs_mom with a new config file. Default is disabled. This parameter accepts various forms of true, yes, and 1. For more information on how to reconfigure MOMs, see <a href="#">momctl-r</a> .
<b>Example</b>	<code>\$remote_reconfig true</code>

## `$reduce_prolog_checks`

<b>Format</b>	<STRING>
<b>Description</b>	If enabled, TORQUE will only check if the file is a regular file and is executable, instead of the normal checks listed on the prologue and epilogue page. Default is FALSE.
<b>Example</b>	<code>\$reduce_prolog_checks true</code>

## `$reject_job_submission`

<b>Format</b>	<BOOLEAN>
<b>Description</b>	If set to <b>TRUE</b> , jobs will be rejected and the user will receive the message, "Jobs cannot be run on mom %s." Default is FALSE.
<b>Example</b>	<code>\$reject_job_submission job01</code>

## `$resend_join_job_wait_time`

<b>Format</b>	<INTEGER>
<b>Description</b>	This is the timeout for the Mother Superior to re-send the join job request if it didn't get a reply from all the sister MOMs. The resend happens only once. Default is 5 minutes.
<b>Example</b>	<code>\$resend_join_job_wait_time 120</code>

\$restricted	
<b>Format</b>	<STRING>
<b>Description</b>	Specifies hosts which can be trusted to access MOM services as non-root. By default, no hosts are trusted to access MOM services as non-root.
<b>Example</b>	<code>\$restricted *.teracluster.org</code>

\$rpp_throttle	
<b>Format</b>	<INTEGER>
<b>Description</b>	This integer is in microseconds and causes a sleep after every RPP packet is sent. It is for systems that experience job failures because of incomplete data.
<b>Example</b>	<code>\$rpp_throttle 100</code> (will cause a 100 microsecond sleep)

size[fs=<FS>]	
<b>Format</b>	N/A
<b>Description</b>	<p>Specifies that the available and configured disk space in the &lt;FS&gt; filesystem is to be reported to the pbs_server and scheduler.</p> <div style="border: 1px solid #0070C0; border-radius: 5px; padding: 5px; margin-bottom: 5px;"> <p><b>i</b> To request disk space on a per job basis, specify the file resource as in <code>qsub -l nodes=1, file=1000kb</code>.</p> </div> <div style="border: 1px solid #0070C0; border-radius: 5px; padding: 5px;"> <p><b>i</b> Unlike most MOM config options, the <i>size</i> parameter is not preceded by a "\$" character.</p> </div>
<b>Example</b>	<code>size[fs=/localscratch]</code> The available and configured disk space in the /localscratch filesystem will be reported.

\$source_login_batch	
<b>Format</b>	<STRING>

## `$source_login_batch`

<b>Description</b>	Specifies whether or not MOM will source the <code>/etc/profile</code> , etc. type files for <i>batch</i> jobs. Parameter accepts various forms of true, false, yes, no, 1 and 0. Default is TRUE. This parameter is in version 2.3.1 and later.
<b>Example</b>	<pre>\$source_login_batch False</pre> MOM will bypass the sourcing of <code>/etc/profile</code> , etc. type files.

## `$source_login_interactive`

<b>Format</b>	<STRING>
<b>Description</b>	Specifies whether or not MOM will source the <code>/etc/profile</code> , etc. type files for <i>interactive</i> jobs. Parameter accepts various forms of true, false, yes, no, 1 and 0. Default is TRUE. This parameter is in version 2.3.1 and later.
<b>Example</b>	<pre>\$source_login_interactive False</pre> MOM will bypass the sourcing of <code>/etc/profile</code> , etc. type files.

## `$spool_as_final_name`

<b>Format</b>	<BOOLEAN>
<b>Description</b>	This makes the job write directly to its output destination instead of a spool directory. This allows users easier access to the file if they want to watch the jobs output as it runs.
<b>Example</b>	<pre>\$spool_as_final_name true</pre>

## `$status_update_time`

<b>Format</b>	<INTEGER>
<b>Description</b>	Specifies the number of seconds between subsequent MOM-to-server update reports. Default is 45 seconds.
<b>Example</b>	<pre>status_update_time: \$status_update_time 120</pre> MOM will send server update reports every 120 seconds.

## \$thread\_unlink\_calls

<b>Format</b>	<BOOLEAN>
<b>Description</b>	Threads calls to unlink when deleting a job. Default is false. If it is set to TRUE, pbs_mom will use a thread to delete the job's files.
<b>Example</b>	thread_unlink_calls: \$thread_unlink_calls true

## \$timeout


<b>Format</b>	<INTEGER>
<b>Description</b>	Specifies the number of seconds before a TCP connection on the MOM will timeout. Default is 300 seconds. In version 3.x and earlier, this specifies the number of seconds before MOM-to-MOM messages will timeout if RPP is disabled. Default is 60 seconds.
<b>Example</b>	\$timeout 120 A TCP connection will wait up to 120 seconds before timing out. For 3.x and earlier, MOM-to-MOM communication will allow up to 120 seconds before timing out.

## \$tmpdir


<b>Format</b>	<STRING>
<b>Description</b>	Specifies a directory to create job-specific scratch space (see <a href="#">Creating Per-Job Temporary Directories</a> ).
<b>Example</b>	\$tmpdir /localscratch

## \$usecp

<b>Format</b>	<HOST>:<SRCDIR> <DSTDIR>
<b>Description</b>	Specifies which directories should be staged (see <a href="#">NFS and other networked filesystems on page 110</a> )
<b>Example</b>	\$usecp *.fte.com:/data /usr/local/data

\$use_smt	
<b>Format</b>	<BOOLEAN>
<b>Description</b>	<p>Indicates that the user would like to use SMT. If set, each logical core inside of a physical core will be used as a normal core for cpusets. This parameter is on by default.</p> <div style="border: 1px solid #0070C0; border-radius: 10px; padding: 5px; background-color: #D9E1F2;"> <p> If SMT is used, you will need to set the <i>np</i> attribute so that each logical processor is counted.</p> </div>
<b>Example</b>	<code>\$use_smt false</code>

\$varattr	
<b>Format</b>	<INTEGER> <STRING>
<b>Description</b>	<p>Provides a way to keep track of dynamic attributes on nodes.</p> <p>&lt;INTEGER&gt; is how many seconds should go by between calls to the script to update the dynamic values. If set to -1, the script is read only one time.</p> <p>&lt;STRING&gt; is the script path. This script should check for whatever dynamic attributes are desired, and then output lines in this format:</p> <pre>name=value</pre> <p>Include any arguments after the script's full path. These features are visible in the output of <a href="#">pbsnodes -a</a></p> <pre>varattr=Matlab=7.1;Octave=1.0.</pre> <p>For information about using \$varattr to request dynamic features in Moab, see <a href="#">Configuring dynamic features in TORQUE and Moab</a> in the <i>Moab Workload Manager Administrator Guide</i>.</p>
<b>Example</b>	<code>\$varattr 25 /usr/local/scripts/nodeProperties.pl arg1 arg2 arg3</code>

\$wallmult	
<b>Format</b>	<FLOAT>
<b>Description</b>	<p>Sets a factor to adjust walltime usage by multiplying a default job time to a common reference system. It modifies real walltime on a per-MOM basis (MOM configuration parameters). The factor is used for walltime calculations and limits in the same way that cputmult is used for cpu time.</p> <div style="border: 1px solid #0070C0; border-radius: 10px; padding: 5px; background-color: #D9E1F2;"> <p> If set to 0.0, MOM level walltime enforcement is disabled.</p> </div>
<b>Example</b>	<code>\$wallmult 2.2</code>



## Related topics

- [Node manager \(MOM\) configuration on page 245](#)

# Node features and generic consumable resource specification

Node features (a.k.a. "node properties") are opaque labels which can be applied to a node. They are not consumable and cannot be associated with a value. (Use generic resources described below for these purposes). Node features are configured within the nodes file on the [pbs\\_server](#) head node. This file can be used to specify an arbitrary number of node features.

Additionally, per node consumable generic resources may be specified using the format "<ATTR> <VAL>" with no leading dollar ("\$\$") character. When specified, this information is routed to the scheduler and can be used in scheduling decisions. For example, to indicate that a given host has two tape drives and one node-locked matlab license available for batch jobs, the following could be specified:

mom\_priv/config:

```
$clienthost 241.13.153.7
tape 2
matlab 1
```

Dynamic consumable resource information can be routed in by specifying a path preceded by an exclamation point. (!) as in the example below. If the resource value is configured in this manner, the specified file will be periodically executed to load the effective resource value.

mom\_priv/config:

```
$clienthost 241.13.153.7
tape !/opt/rm/gettapecount.pl
matlab !/opt/tools/getlicensecount.pl
```

## Related topics

- [Node manager \(MOM\) configuration on page 245](#)

# Command-line arguments

Below is a table of `pbs_mom` command-line startup flags.

Flag	Description
<b>a</b> <integer>	Alarm time in seconds.
<b>c</b> <file>	Config file path.

Flag	Description
<b>C</b> <dir-ectory>	Checkpoint path.
<b>d</b> <dir-ectory>	Home directory.
<b>L</b> <file>	Log file.
<b>M</b> <integer>	MOM port to listen on.
<b>p</b>	Perform 'poll' based job recovery on restart (jobs persist until associated processes terminate).
<b>P</b>	On restart, deletes all jobs that were running on MOM (Available in 2.4.X and later).
<b>q</b>	On restart, requeues all jobs that were running on MOM (Available in 2.4.X and later).
<b>r</b>	On restart, kills all processes associated with jobs that were running on MOM, and then requeues the jobs.
<b>R</b> <integer>	MOM 'RM' port to listen on.
<b>S</b> <integer>	pbs_server port to connect to.
<b>v</b>	Display version information and exit.
<b>x</b>	Disable use of privileged port.
<b>?</b>	Show usage information and exit.

For more details on these command-line options, see [pbs\\_mom on page 151](#).

### Related topics

- [Node manager \(MOM\) configuration on page 245](#)

# Diagnostics and error codes

TORQUE has a diagnostic script to assist you in giving TORQUE Support the files they need to support issues. It should be run by a user that has access to run all TORQUE commands and access to all TORQUE directories (this is usually root).

The script (`contrib/diag/tdiag.sh`) is available in TORQUE 2.3.8, TORQUE 2.4.3, and later. The script grabs the node file, server and MOM log files, and captures the output of `qmgr -c 'p s'`. These are put in a tar file.

The script also has the following options (this can be shown in the command line by entering `./tdiag.sh -h`):

USAGE: `./torque_diag [-d DATE] [-h] [-o OUTPUT_FILE] [-t TORQUE_HOME]`

- *DATE* should be in the format YYYYmmdd. For example, "20091130" would be the date for November 30th, 2009. If no date is specified, today's date is used.
- *OUTPUT\_FILE* is the optional name of the output file. The default output file is `torque_diag<today's_date>.tar.gz`. *TORQUE\_HOME* should be the path to your TORQUE directory. If no directory is specified, `/var/spool/torque` is the default.

Table D-1: TORQUE error codes

Error code name	Number	Description
PBSE_FLOOR	15000	No error
PBSE_UNKJOBID	15001	Unknown job ID error
PBSE_NOATTR	15002	Undefined attribute
PBSE_ATTRRO	15003	Cannot set attribute, read only or insufficient permission
PBSE_IVALREQ	15004	Invalid request
PBSE_UNKREQ	15005	Unknown request
PBSE_TOOMANY	15006	Too many submit retries

Error code name	Number	Description
PBSE_PERM	15007	Unauthorized Request
PBSE_IFF_NOT_FOUND	15008	trqauthd unable to authenticate
PBSE_MUNGE_NOT_FOUND	15009	Munge executable not found, unable to authenticate
PBSE_BADHOST	15010	Access from host not allowed, or unknown host
PBSE_JOBEXIST	15011	Job with requested ID already exists
PBSE_SYSTEM	15012	System error
PBSE_INTERNAL	15013	PBS server internal error
PBSE_REGROUTE	15014	Dependent parent job currently in routing queue
PBSE_UNKSIG	15015	Unknown/illegal signal name
PBSE_BADATVAL	15016	Illegal attribute or resource value for
PBSE_MODATTRUN	15017	Cannot modify attribute while job running
PBSE_BADSTATE	15018	Request invalid for state of job
PBSE_UNKQUE	15020	Unknown queue
PBSE_BADCRED	15021	Invalid credential
PBSE_EXPIRED	15022	Expired credential
PBSE_QUNOENB	15023	Queue is not enabled
PBSE_QACCESS	15024	Access to queue is denied
PBSE_BADUSER	15025	Bad UID for job execution
PBSE_HOPCOUNT	15026	Job routing over too many hops
PBSE_QUEEXIST	15027	Queue already exists

Error code name	Number	Description
PBSE_ATTRTYPE	15028	Incompatible type
PBSE_QUEBUSY	15029	Cannot delete busy queue
PBSE_QUENBIG	15030	Queue name too long
PBSE_NOSUP	15031	No support for requested service
PBSE_QUENOEN	15032	Cannot enable queue, incomplete definition
PBSE_PROTOCOL	15033	Batch protocol error
PBSE_BADATLST	15034	Bad attribute list structure
PBSE_NOCONNECTS	15035	No free connections
PBSE_NOSERVER	15036	No server specified
PBSE_UNKRESC	15037	Unknown resource type
PBSE_EXCQRESC	15038	Job exceeds queue resource limits
PBSE_QUENODFLT	15039	No default queue specified
PBSE_NORERUN	15040	Job is not rerunnable
PBSE_ROUTEREJ	15041	Job rejected by all possible destinations (check syntax, queue resources, ...)
PBSE_ROUTEEXPD	15042	Time in Route Queue Expired
PBSE_MOMREJECT	15043	Execution server rejected request
PBSE_BADSCRIPT	15044	(qsub) cannot access script file
PBSE_STAGEIN	15045	Stage-in of files failed
PBSE_RESCUNAV	15046	Resource temporarily unavailable

Error code name	Number	Description
PBSE_BADGRP	15047	Bad GID for job execution
PBSE_MAXQUED	15048	Maximum number of jobs already in queue
PBSE_CKPBSY	15049	Checkpoint busy, may retry
PBSE_EXLIMIT	15050	Resource limit exceeds allowable
PBSE_BADACCT	15051	Invalid Account
PBSE_ALRDYEXIT	15052	Job already in exit state
PBSE_NOCOPYFILE	15053	Job files not copied
PBSE_CLEANEOUT	15054	Unknown job id after clean init
PBSE_NOSYNCMSTR	15055	No master found for sync job set
PBSE_BADDEPEND	15056	Invalid Job Dependency
PBSE_DUPLIST	15057	Duplicate entry in list
PBSE_DISPROTO	15058	Bad DIS based Request Protocol
PBSE_EXECTHERE	15059	Cannot execute at specified host because of checkpoint or stagein files
PBSE_SISREJECT	15060	Sister rejected
PBSE_SISCOMM	15061	Sister could not communicate
PBSE_SVRDOWN	15062	Request not allowed: Server shutting down
PBSE_CKPSHORT	15063	Not all tasks could checkpoint
PBSE_UNKNODE	15064	Unknown node
PBSE_UNKNODEATR	15065	Unknown node-attribute

Error code name	Number	Description
PBSE_NONODES	15066	Server has no node list
PBSE_NODENBIG	15067	Node name is too big
PBSE_NODEEXIST	15068	Node name already exists
PBSE_BADNDATVAL	15069	Illegal value for
PBSE_MUTUALEX	15070	Mutually exclusive values for
PBSE_GMODERR	15071	Modification failed for
PBSE_NORELYMOM	15072	Server could not connect to MOM
PBSE_NOTSNODE	15073	No time-share node available
PBSE_JOBTYPE	15074	Wrong job type
PBSE_BADACLHOST	15075	Bad ACL entry in host list
PBSE_MAXUSERQUED	15076	Maximum number of jobs already in queue for user
PBSE_BADDISALLOWTYPE	15077	Bad type in disallowed_types list
PBSE_NOINTERACTIVE	15078	Queue does not allow interactive jobs
PBSE_NOBATCH	15079	Queue does not allow batch jobs
PBSE_NORERUNABLE	15080	Queue does not allow rerunable jobs
PBSE_NONONRERUNABLE	15081	Queue does not allow nonrerunable jobs
PBSE_UNKARRAYID	15082	Unknown Array ID
PBSE_BAD_ARRAY_REQ	15083	Bad Job Array Request
PBSE_BAD_ARRAY_DATA	15084	Bad data reading job array from file
PBSE_TIMEOUT	15085	Time out

Error code name	Number	Description
PBSE_JOBNOTFOUND	15086	Job not found
PBSE_NOFAULTTOLERANT	15087	Queue does not allow fault tolerant jobs
PBSE_NOFAULTINTOLERANT	15088	Queue does not allow fault intolerant jobs
PBSE_NOJOBARRAYS	15089	Queue does not allow job arrays
PBSE_RELAYED_TO_MOM	15090	Request was relayed to a MOM
PBSE_MEM_MALLOC	15091	Error allocating memory - out of memory
PBSE_MUTEX	15092	Error allocating controlling mutex (lock/unlock)
PBSE_THREADATTR	15093	Error setting thread attributes
PBSE_THREAD	15094	Error creating thread
PBSE_SELECT	15095	Error in socket select
PBSE_SOCKET_FAULT	15096	Unable to get connection to socket
PBSE_SOCKET_WRITE	15097	Error writing data to socket
PBSE_SOCKET_READ	15098	Error reading data from socket
PBSE_SOCKET_CLOSE	15099	Socket close detected
PBSE_SOCKET_LISTEN	15100	Error listening on socket
PBSE_AUTH_INVALID	15101	Invalid auth type in request
PBSE_NOT_IMPLEMENTED	15102	This functionality is not yet implemented
PBSE_QUEENOTAVAILABLE	15103	Queue is currently not available
PBSE_TMPDIFFOWNER	15104	tmpdir owned by another user
PBSE_TMPNOTDIR	15105	tmpdir exists but is not a directory



Error code name	Number	Description
PBSE_TMPNONAME	15106	tmpdir cannot be named for job
PBSE_CANTOPENSOCKET	15107	Cannot open demux sockets
PBSE_CANTCONTACTSISTERS	15108	Cannot send join job to all sisters
PBSE_CANTCREATETMPDIR	15109	Cannot create tmpdir for job
PBSE_BADMOMSTATE	15110	Mom is down, cannot run job
PBSE_SOCKET_INFORMATION	15111	Socket information is not accessible
PBSE_SOCKET_DATA	15112	Data on socket does not process correctly
PBSE_CLIENT_INVALID	15113	Client is not allowed/trusted
PBSE_PREMATURE_EOF	15114	Premature End of File
PBSE_CAN_NOT_SAVE_FILE	15115	Error saving file
PBSE_CAN_NOT_OPEN_FILE	15116	Error opening file
PBSE_CAN_NOT_WRITE_FILE	15117	Error writing file
PBSE_JOB_FILE_CORRUPT	15118	Job file corrupt
PBSE_JOB_RERUN	15119	Job can not be rerun
PBSE_CONNECT	15120	Can not establish connection
PBSE_JOBWORKDELAY	15121	Job function must be temporarily delayed
PBSE_BAD_PARAMETER	15122	Parameter of function was invalid
PBSE_CONTINUE	15123	Continue processing on job. (Not an error)
PBSE_JOBSTATE	15124	Current sub state does not allow transaction.
PBSE_CAN_NOT_MOVE_FILE	15125	Error moving file

Error code name	Number	Description
PBSE_JOB_RECYCLED	15126	Job is being recycled
PBSE_JOB_ALREADY_IN_QUEUE	15127	Job is already in destination queue.
PBSE_INVALID_MUTEX	15128	Mutex is NULL or otherwise invalid
PBSE_MUTEX_ALREADY_LOCKED	15129	The mutex is already locked by this object
PBSE_MUTEX_ALREADY_UNLOCKED	15130	The mutex has already been unlocked by this object
PBSE_INVALID_SYNTAX	15131	Command syntax invalid
PBSE_NODE_DOWN	15132	A node is down. Check the MOM and host
PBSE_SERVER_NOT_FOUND	15133	Could not connect to batch server
PBSE_SERVER_BUSY	15134	Server busy. Currently no available threads

# Considerations before upgrading

TORQUE is flexible in regards to how it can be upgraded. In most cases, a TORQUE "shutdown" followed by a *configure, make, make install* procedure as documented in this guide is all that is required (see [Installing TORQUE on page 2](#)). This process will preserve existing configuration and in most cases, existing workload.

A few considerations are included below:

- If upgrading from OpenPBS, PBSPro, or TORQUE 1.0.3 or earlier, queued jobs whether active or idle will be lost. In such situations, job queues should be completely drained of all jobs.
- If not using the [pbs\\_mom](#) `-r` or `-p` flag (see [Command-line arguments on page 261](#)), running jobs may be lost. In such cases, running jobs should be allowed to be completed or should be requeued before upgrading TORQUE.
- `pbs_mom` and `pbs_server` daemons of differing versions may be run together. However, not all combinations have been tested and unexpected failures may occur.
- `trqauthd` is an intermediary between client commands and `pbs_server`. It is recommended that when you upgrade `pbs_server` you also upgrade the client utilities and `trqauthd` to prevent unexpected failures when you execute client commands. Because no direct relationship exists between the MOMs and `trqauthd`, you can upgrade `trqauthd` without upgrading the MOMs.
- When upgrading from early versions of TORQUE (pre-4.0) and Moab, you may encounter a problem where Moab core files are regularly created in `/opt/moab`. This can be caused by old TORQUE library files used by Moab that try to authorize with the old TORQUE `pbs_iff` authorization daemon. You can resolve the problem by removing the old version library files from `/usr/local/lib`.

## To upgrade

1. Build new release (do not install).
2. Stop all TORQUE daemons (see [qterm](#) and [momctl](#) `-s`).
3. Install new TORQUE (use *make install*).
4. Start all TORQUE daemons.

## Rolling upgrade

If you are upgrading to a new point release of your current version (for example, from 4.2.2 to 4.2.3) and not to a new major release from your current version (for example, from 4.1 to 4.2), you can use the following procedure to upgrade TORQUE without taking your nodes offline.

**i** Because TORQUE version 4.1.4 changed the way that pbs\_server communicates with the MOMs, it is not recommended that you perform a rolling upgrade of TORQUE from version 4.1.3 to 4.1.4.

## To perform a rolling upgrade in TORQUE

1. Enable the [enablemomrestart](#) on [page 157](#) flag on the MOMs you want to upgrade. The `enablemomrestart` option causes a MOM to check if its binary has been updated and restart itself at a safe point when no jobs are running. You can enable this in the MOM configuration file, but it is recommended that you use `momctl` instead.

```
> momctl -q enablemomrestart=1 -h :ALL
```

*The `enablemomrestart` flag is enabled on all nodes.*

2. Replace the `pbs_mom` binary, located in `/usr/local/bin` by default. `pbs_mom` will continue to run uninterrupted because the `pbs_mom` binary has already been loaded in RAM.

```
> torque-package-mom-linux-x86_64.sh --install
```

The next time `pbs_mom` is in an idle state, it will check for changes in the binary. If `pbs_mom` detects that the binary on disk has changed, it will restart automatically, causing the new `pbs_mom` version to load.

After the `pbs_mom` restarts on each node, the `enablemomrestart` parameter will be set back to false (0) for that node.

**i** If you have cluster with high utilization, you may find that the nodes never enter an idle state so `pbs_mom` never restarts. When this occurs, you must manually take the nodes offline and wait for the running jobs to complete before restarting `pbs_mom`. To set the node to an offline state, which will allow running jobs to complete but will not allow any new jobs to be scheduled on that node, use `pbsnodes -o <nodeName>`. After the new MOM has started, you must make the node active again by running `pbsnodes -c <nodeName>`.

## Large cluster considerations

TORQUE has enhanced much of the communication found in the original OpenPBS project. This has resulted in a number of key advantages including support for:

- larger clusters.
- more jobs.
- larger jobs.
- larger messages.

In most cases, enhancements made apply to all systems and no tuning is required. However, some changes have been made configurable to allow site specific modification. The configurable communication parameters are: [node\\_check\\_rate](#), [node\\_ping\\_rate](#), and [tcp\\_timeout](#).

For details, see these topics:

- [Scalability guidelines](#) on page 273
- [End user command caching](#) on page 274
- [Moab and TORQUE configuration for large clusters](#) on page 276
- [Starting TORQUE in large environments](#) on page 277
- [Other considerations](#) on page 278

## Scalability guidelines

In very large clusters (in excess of 1,000 nodes), it may be advisable to tune a number of communication layer timeouts. By default, PBS MOM daemons timeout on inter-MOM messages after 60 seconds. In TORQUE 1.1.0p5 and higher, this can be adjusted by setting the timeout parameter in the `mom_priv/config` file (see, [Node manager \(MOM\) configuration](#) on page 245). If 15059 errors (cannot receive message from sisters) are seen in the MOM logs, it may be necessary to increase this value.

Client-to-server communication timeouts are specified via the [tcp\\_timeout](#) server option using the [qmgr](#) command.

**i** On some systems, *ulimit* values may prevent large jobs from running. In particular, the open file descriptor limit (i.e., `ulimit -n`) should be set to at least the maximum job size in procs + 20. Further, there may be value in setting the `fs.file-max` in `sysctl.conf` to a high value, such as:

```
/etc/sysctl.conf:  
fs.file-max = 65536
```

## Related topics

- [Large cluster considerations](#) on page 273

## End user command caching

### qstat

In a large system, users may tend to place excessive load on the system by manual or automated use of resource manager end user client commands. A simple way of reducing this load is through the use of client command wrappers which cache data. The example script below will cache the output of the command '[qstat](#) -f' for 60 seconds and report this info to end users.

```

#!/bin/sh

# USAGE: qstat $@

CMDPATH=/usr/local/bin/qstat
CACHETIME=60
TMPFILE=/tmp/qstat.f.tmp

if [ "$1" != "-f" ] ; then
    #echo "direct check (arg1=$1) "
    $CMDPATH $1 $2 $3 $4
    exit $?
fi

if [ -n "$2" ] ; then
    #echo "direct check (arg2=$2)"
    $CMDPATH $1 $2 $3 $4
    exit $?
fi

if [ -f $TMPFILE ] ; then
    TMPFILEMTIME=`stat -c %Z $TMPFILE`
else
    TMPFILEMTIME=0
fi

NOW=`date +%s`
AGE=$(( $NOW - $TMPFILEMTIME ))

#echo AGE=$AGE

for i in 1 2 3;do
    if [ "$AGE" -gt $CACHETIME ] ; then
        #echo "cache is stale "

        if [ -f $TMPFILE.1 ] ; then
            #echo someone else is updating cache

            sleep 5

            NOW=`date +%s`

            TMPFILEMTIME=`stat -c %Z $TMPFILE`

            AGE=$(( $NOW - $TMPFILEMTIME ))
        else
            break;
        fi
    fi
done

if [ -f $TMPFILE.1 ] ; then
    #echo someone else is hung

    rm $TMPFILE.1
fi

if [ "$AGE" -gt $CACHETIME ] ; then
    #echo updating cache

    $CMDPATH -f > $TMPFILE.1
mv $TMPFILE.1 $TMPFILE

fi

#echo "using cache"

```

```
cat $TMPFILE
exit 0
```

The above script can easily be modified to cache any command and any combination of arguments by changing one or more of the following attributes:

- script name
- value of \$CMDPATH
- value of \$CACHETIME
- value of \$TMPFILE

For example, to cache the command [pbsnodes](#) -a, make the following changes:

- Move original `pbsnodes` command to `pbsnodes.orig`.
- Save the script as 'pbsnodes'.
- Change \$CMDPATH to `pbsnodes.orig`.
- Change \$TMPFILE to `/tmp/pbsnodes.a.tmp`.

### Related topics

- [Large cluster considerations on page 273](#)

## Moab and TORQUE configuration for large clusters

There are a few basic configurations for Moab and TORQUE that can potentially improve performance on large clusters.

### Moab configuration

In the `moab.cfg` file, add:

1. `RMPOLLINTERVAL 30,30` - This sets the minimum and maximum poll interval to 30 seconds.
2. `RMCFG [<name>] FLAGS=ASYNCSTART` - This tells Moab not to block until it receives a confirmation that the job starts.
3. `RMCFG [<name>] FLAGS=ASYNCDELETE` - This tells Moab not to block until it receives a confirmation that the job was deleted.

### TORQUE configuration

1. Follow the [Starting TORQUE in large environments](#) recommendations.
2. Increase `job_start_timeout` on `pbs_server`. The default is `300` (5 minutes), but for large clusters the value should be changed to something like `600` (10 minutes). Sites running very large parallel jobs might want to set this value even higher.



3. Use a node health check script on all MOM nodes. This helps prevent jobs from being scheduled on bad nodes and is especially helpful for large parallel jobs.
4. Make sure that `ulimit -n` (maximum file descriptors) is set to *unlimited*, or a very large number, and not the default.
5. For clusters with a high job throughput it is recommended that the server parameter `max_threads` be increased from the default. The default is  $(2 * \text{number of cores} + 1) * 10$ .

### Related topics

- [Large cluster considerations on page 273](#)

## Starting TORQUE in large environments

If running TORQUE in a large environment, use these tips to help TORQUE start up faster.

### Fastest possible start up

1. Create a [MOM hierarchy](#), even if your environment has a one-level MOM hierarchy (meaning all MOMs report directly to `pbs_server`), and copy the file to the `mom_priv` directory on the MOMs.
2. Start `pbs_server` with the [-n option](#). This specifies that `pbs_server` won't send the hierarchy to the MOMs unless a MOM requests it.
3. Start the MOMs normally.

### If no daemons are running

1. Start `pbs_server` with the [-c option](#).
2. Start the MOMs without the `-w` option.

### If MOMs are running and just restarting `pbs_server`

1. Start `pbs_server` without the `-c` option.

### If restarting a MOM or all MOMs

1. Start `pbs_server` without the `-w` option. Starting it with `-w` causes the MOMs to appear to be down.

### Related topics

- [Large cluster considerations on page 273](#)

## Other considerations

### job\_stat\_rate


In a large system, there may be many users, many jobs, and many requests for information. To speed up response time for users and for programs using the API the [job\\_stat\\_rate](#) can be used to tweak when the pbs\_server daemon will query MOMs for job information. By increasing this number, a system will not be constantly querying job information and causing other commands to block.

### poll\_jobs

The [poll\\_jobs](#) parameter allows a site to configure how the pbs\_server daemon will poll for job information. When set to TRUE, the pbs\_server will poll job information in the background and not block on user requests. When set to FALSE, the pbs\_server may block on user requests when it has stale job information data. Large clusters should set this parameter to TRUE.

### Internal settings

On large, slow, and/or heavily loaded systems, it may be desirable to increase the pbs\_tcp\_timeout setting used by the pbs\_mom daemon in MOM-to-MOM communication. This setting defaults to 20 seconds and requires rebuilding code to adjust. For client-server based communication, this attribute can be set using the [qmgr](#) command. For MOM-to-MOM communication, a source code modification is required. To make this change, edit the \$TORQUEBUILDDIR/src/lib/Libifl/tcp\_dis.c file and set pbs\_tcp\_timeout to the desired maximum number of seconds allowed for a MOM-to-MOM request to be serviced.

 A system may be heavily loaded if it reports multiple 'End of File from addr' or 'Premature end of message' failures in the pbs\_mom or pbs\_server logs.

### Scheduler settings

If using Moab, there are a number of parameters which can be set on the scheduler which may improve TORQUE performance. In an environment containing a large number of short-running jobs, the JOBAGGREGATIONTIME parameter (see the "Parameters" section of the [Moab Workload Manager Administrator Guide](#)) can be set to reduce the number of workload and resource queries performed by the scheduler when an event based interface is enabled. If the pbs\_server daemon is heavily loaded and PBS API timeout errors (i.e. "Premature end of message") are reported within the scheduler, the "TIMEOUT" attribute of the RMCFG parameter may be set with a value of between 30 and 90 seconds.

### File system

TORQUE can be configured to disable file system blocking until data is physically written to the disk by using the --disable-filesync argument with *configure*. While having filesync enabled is more reliable, it may lead to server delays for sites with either a larger number of nodes, or a large number of jobs. Filesync is enabled by default.

## Network ARP cache

For networks with more than 512 nodes it is mandatory to increase the kernel's internal ARP cache size. For a network of ~1000 nodes, we use these values in `/etc/sysctl.conf` on all nodes and servers:

```
/etc/sysctl.conf

# Don't allow the arp table to become bigger than this
net.ipv4.neigh.default.gc_thresh3 = 4096
# Tell the gc when to become aggressive with arp table cleaning.
# Adjust this based on size of the LAN.
net.ipv4.neigh.default.gc_thresh2 = 2048
# Adjust where the gc will leave arp table alone
net.ipv4.neigh.default.gc_thresh1 = 1024
# Adjust to arp table gc to clean-up more often
net.ipv4.neigh.default.gc_interval = 3600
# ARP cache entry timeout
net.ipv4.neigh.default.gc_stale_time = 3600
```

Use `sysctl -p` to reload this file.

The ARP cache size on other Unixes can presumably be modified in a similar way.

An alternative approach is to have a static `/etc/ethers` file with all hostnames and MAC addresses and load this by `arp -f /etc/ethers`. However, maintaining this approach is quite cumbersome when nodes get new MAC addresses (due to repairs, for example).

### Related topics

- [Large cluster considerations on page 273](#)



## Prologue and epilogue scripts

TORQUE provides administrators the ability to run scripts before and/or after each job executes. With such a script, a site can prepare systems, perform node health checks, prepend and append text to output and error log files, cleanup systems, and so forth.

The following table shows which MOM runs which script. All scripts must be in the `TORQUE_HOME/mom_priv/` directory and be available on every compute node. The "Mother Superior" is the `pbs_mom` on the first node allocated for a job. While it is technically a sister node, it is not a "Sister" for the purposes of the following table.

 The execution directory for each script is `TORQUE_HOME/mom_priv/`.

Script	Execution location	Execute as	File permissions
<b>prologue</b>	Mother Superior	root	Readable and executable by root and NOT writable by anyone but root (e.g., <code>-r-x-----</code> )
<b>epilogue</b>		root	
<b>prologue.user</b>		user	Readable and executable by root and other (e.g., <code>-r-x--r-x</code> )
<b>epilogue.user</b>		user	
<b>prologue.parallel</b>	Sister	root	Readable and executable by root and NOT writable by anyone but root (e.g., <code>-r-x-----</code> )
<b>epilogue.parallel</b>		root	
<b>prologue.user.parallel</b>		user	Readable and executable by root and other (e.g., <code>-r-x--r-x</code> )
<b>epilogue.user.parallel</b>		user	
<b>epilogue.precancel</b>	Mother Superior This script runs after a job cancel request is received from <code>pbs_server</code> and before a kill signal is sent to the job process.	user	Readable and executable by root and other (e.g., <code>-r-x--r-x</code> )

**i** `epilogue.parallel` is available in version 2.1 and later.

This section contains these topics:

- [Script order of execution on page 282](#)
- [Script environment on page 282](#)
- [Per job prologue and epilogue scripts on page 284](#)
- [Prologue and epilogue scripts time out on page 285](#)
- [Prologue error processing on page 285](#)

## Script order of execution

When jobs start, the order of script execution is `prologue` followed by `prologue.user`. On job exit, the order of execution is `epilogue.user` followed by `epilogue` unless a job is canceled. In that case, `epilogue.precancel` is executed first. `epilogue.parallel` is executed only on the Sister nodes when the job is completed.

**i** The `epilogue` and `prologue` scripts are controlled by the system administrator. However, beginning in TORQUE version 2.4 a user `epilogue` and `prologue` script can be used on a per job basis. (See [Per job prologue and epilogue scripts on page 284](#) for more information.)

**i** Root squashing is now supported for `epilogue` and `prologue` scripts.

### Related topics

- [Prologue and epilogue scripts on page 281](#)

## Script environment

The `prologue` and `epilogue` scripts can be very simple. On most systems, the script must declare the execution shell using the `#!<SHELL>` syntax (for example, `#!/bin/sh`). In addition, the script may want to process context sensitive arguments passed by TORQUE to the script.

### Prologue Environment

The following arguments are passed to the `prologue`, `prologue.user`, and `prologue.parallel` scripts:

Argument	Description
<code>argv[1]</code>	job id

Argument	Description
<b>argv[2]</b>	job execution user name
<b>argv[3]</b>	job execution group name
<b>argv[4]</b>	job name (TORQUE 1.2.0p4 and higher only)
<b>argv[5]</b>	list of requested resource limits (TORQUE 1.2.0p4 and higher only)
<b>argv[6]</b>	job execution queue (TORQUE 1.2.0p4 and higher only)
<b>argv[7]</b>	job account (TORQUE 1.2.0p4 and higher only)

## Epilogue Environment

TORQUE supplies the following arguments to the `epilogue`, `epilogue.user`, `epilogue.precancel`, and `epilogue.parallel` scripts:

Argument	Description
<b>argv[1]</b>	job id
<b>argv[2]</b>	job execution user name
<b>argv[3]</b>	job execution group name
<b>argv[4]</b>	job name
<b>argv[5]</b>	session id
<b>argv[6]</b>	list of requested resource limits
<b>argv[7]</b>	list of resources used by job
<b>argv[8]</b>	job execution queue
<b>argv[9]</b>	job account
<b>argv[10]</b>	job exit code

The `epilogue.precancel` script is run after a job cancel request is received by the MOM and before any signals are sent to job processes. If this script exists, it is run whether the canceled job was active or idle.

**i** The cancel job command (`qdel`) will take as long to return as the `epilogue.precancel` script takes to run. For example, if the script runs for 5 minutes, it takes 5 minutes for `qdel` to return.

For all scripts, the environment passed to the script is empty. However, if you submit the job using `msub` rather than `qsub`, some Moab environment variables are available in the TORQUE prologue and epilogue script environment: `MOAB_CLASS`, `MOAB_GROUP`, `MOAB_JOBARRAYINDEX`, `MOAB_JOBARRAYRANGE`, `MOAB_JOBID`, `MOAB_JOBNAME`, `MOAB_MACHINE`, `MOAB_NODECOUNT`, `MOAB_NODELIST`, `MOAB_PARTITION`, `MOAB_PROCCOUNT`, `MOAB_QOS`, `MOAB_TASKMAP`, and `MOAB_USER`. For more information, see [msub -E](#) in the *Moab Workload Manager Administrator Guide*.

Also, standard input for both scripts is connected to a system dependent file. Currently, for all systems this is `/dev/null`. Except for epilogue scripts of an interactive job, `prologue.parallel`, `epilogue.precancel`, and `epilogue.parallel`, the standard output and error are connected to output and error files associated with the job. For an interactive job, since the pseudo terminal connection is released after the job completes, the standard input and error point to `/dev/null`. For `prologue.parallel` and `epilogue.parallel`, the user will need to redirect `stdout` and `stderr` manually.

## Related topics

- [Prologue and epilogue scripts on page 281](#)

## Per job prologue and epilogue scripts

TORQUE supports per job prologue and epilogue scripts when using the `qsub -l` option. The syntax is:

```
qsub -l prologue=<prologue_script_path> epilogue=<epilogue_script_path>
<script>.
```

The path can be either relative (from the directory where the job is submitted) or absolute. The files must be owned by the user with at least execute and read privileges, and the permissions must not be writeable by group or other.

```
/home/usertom/dev/
```

```
-r-x----- 1 usertom usertom 24 2009-11-09 16:11 prologue_script.sh
-r-x----- 1 usertom usertom 24 2009-11-09 16:11 epilogue_script.sh
```

### Example G-1:

```
$ qsub -l prologue=/home/usertom/dev/prologue_
script.sh,epilogue=/home/usertom/dev/epilogue_script.sh job14.pl
```

This job submission executes the prologue script first. When the prologue script is complete, `job14.pl` runs. When `job14.pl` completes, the epilogue script is executed.



## Related topics

- [Prologue and epilogue scripts on page 281](#)

## Prologue and epilogue scripts time out

TORQUE takes preventative measures against prologue and epilogue scripts by placing an alarm around the scripts execution. By default, TORQUE sets the alarm to go off after 5 minutes of execution. If the script exceeds this time, it will be terminated and the node will be marked down. This timeout can be adjusted by setting the `$prologalarm` parameter in the `mom_priv/config` file.

**i** While TORQUE is executing the `epilogue`, `epilogue.user`, or `epilogue.precancel` scripts, the job will be in the *E* (exiting) state.

If an `epilogue.parallel` script cannot open the `.OU` or `.ER` files, an error is logged but the script is continued.

## Related topics

- [Prologue and epilogue scripts on page 281](#)

## Prologue error processing

If the `prologue` script executes successfully, it should exit with a zero status. Otherwise, the script should return the appropriate error code as defined in the table below. The `pbs_mom` will report the script's exit status to `pbs_server` which will in turn take the associated action. The following table describes each exit code for the prologue scripts and the action taken.

Error	Description	Action
-4	The script timed out	Job will be requeued
-3	The <code>wait(2)</code> call returned an error	Job will be requeued
-2	Input file could not be opened	Job will be requeued
-1	Permission error (script is not owned by root, or is writable by others)	Job will be requeued
0	Successful completion	Job will run
1	Abort exit code	Job will be aborted
>1	other	Job will be requeued

### Example G-2:

Following are example prologue and epilogue scripts that write the arguments passed to them in the job's standard out file:

prologue	
<b>Script</b>	<pre>#!/bin/sh echo "Prologue Args:" echo "Job ID: \$1" echo "User ID: \$2" echo "Group ID: \$3" echo ""  exit 0</pre>
<b>stdout</b>	<pre>Prologue Args: Job ID: 13724.node01 User ID: user1 Group ID: user1</pre>

epilogue	
<b>Script</b>	<pre>#!/bin/sh echo "Epilogue Args:" echo "Job ID: \$1" echo "User ID: \$2" echo "Group ID: \$3" echo "Job Name: \$4" echo "Session ID: \$5" echo "Resource List: \$6" echo "Resources Used: \$7" echo "Queue Name: \$8" echo "Account String: \$9" echo ""  exit 0</pre>
<b>stdout</b>	<pre>Epilogue Args: Job ID: 13724.node01 User ID: user1 Group ID: user1 Job Name: script.sh Session ID: 28244 Resource List: neednodes=node01,nodes=1,walltime=00:01:00 Resources Used: cput=00:00:00,mem=0kb,vmem=0kb,walltime=00:00:07 Queue Name: batch Account String:</pre>

### Example G-3:

The Ohio Supercomputer Center contributed the following scripts:

"prologue creates a unique temporary directory on each node assigned to a job before the job begins to run, and epilogue deletes that directory after the job completes.

**i** Having a separate temporary directory on each node is probably not as good as having a good, high performance parallel filesystem.

```
prologue

#!/bin/sh
# Create TMPDIR on all the nodes
# Copyright 1999, 2000, 2001 Ohio Supercomputer Center
# prologue gets 3 arguments:
# 1 -- jobid
# 2 -- userid
# 3 -- grpuid
#
jobid=$1
user=$2
group=$3
nodefile=/var/spool/pbs/aux/$jobid
if [ -r $nodefile ] ; then
    nodes=$(sort $nodefile | uniq)
else
    nodes=localhost
fi
tmp=/tmp/pbstmp.$jobid
for i in $nodes ; do
    ssh $i mkdir -m 700 $tmp \&\& chown $user.$group $tmp
done
exit 0
```

```
epilogue

#!/bin/sh
# Clear out TMPDIR
# Copyright 1999, 2000, 2001 Ohio Supercomputer Center
# epilogue gets 9 arguments:
# 1 -- jobid
# 2 -- userid
# 3 -- grpuid
# 4 -- job name
# 5 -- sessionid
# 6 -- resource limits
# 7 -- resources used
# 8 -- queue
# 9 -- account
#
jobid=$1
nodefile=/var/spool/pbs/aux/$jobid
if [ -r $nodefile ] ; then
    nodes=$(sort $nodefile | uniq)
else
    nodes=localhost
fi
tmp=/tmp/pbstmp.$jobid
for i in $nodes ; do
    ssh $i rm -rf $tmp
done
exit 0
```

**i** `prologue`, `prologue.user`, and `prologue.parallel` scripts can have dramatic effects on job scheduling if written improperly.

### Related topics

- [Prologue and epilogue scripts on page 281](#)

# Running multiple TORQUE servers and MOMs on the same node

TORQUE can be configured to allow multiple servers and MOMs to run on the same node. This example will show how to configure, compile and install two different TORQUE servers and MOMs on the same node. For details, see these topics:

- [Configuring the first TORQUE on page 289](#)
- [Configuring the second TORQUE on page 289](#)
- [Bringing the first TORQUE server online on page 289](#)
- [Bringing the second TORQUE server online on page 290](#)

## Configuring the first TORQUE

```
./configure --with-server-home=/usr/spool/PBS1 --bindir=/usr/spool/PBS1/bin --  
sbindir=/usr/spool/PBS1/sbin
```

Then `make` and `make install` will place the first TORQUE into `/usr/spool/PBS1` with the executables in their corresponding directories.

## Configuring the second TORQUE

```
./configure --with-server-home=/usr/spool/PBS2 --bindir=/usr/spool/PBS2/bin --  
sbindir=/usr/spool/PBS2/sbin
```

Then `make` and `make install` will place the second TORQUE into `/usr/spool/PBS2` with the executables in their corresponding directories.

## Bringing the first TORQUE server online

Each command, including `pbs_server` and `pbs_mom`, takes parameters indicating which servers and ports to connect to or listen on (when appropriate). Each of these is documented in their corresponding man pages (configure with `--enable-docs`).

In this example the first TORQUE server will accept batch requests on port 35000, communicate with the MOMs on port 35001, and communicate via RPP on port 35002. The first TORQUE MOM will try to connect to the server on port 35000, it will listen for requests from the server on port 35001 and will communicate via RPP on port 35002. (Each of these command arguments is discussed in further details on the corresponding man page. In particular, `-t create` is only used the first time a server is run.)

```
> pbs_server -p 35000 -M 35001 -R 35002 -t create  
> pbs_mom -S 35000 -M 35001 -R 35002
```

Afterwards, when using a client command to make a batch request it is necessary to specify the server name and server port (35000):

```
> pbsnodes -a -s node01:35000
```

Submitting jobs can be accomplished using the `-q` option ([queue][@host[:port]]):

```
> qsub -q @node01:35000 /tmp/script.pbs
```

## Bringing the second TORQUE server online

In this example the second TORQUE server will accept batch requests on port 36000, communicate with the MOMS on port 36002, and communicate via RPP on port 36002. The second TORQUE MOM will try to connect to the server on port 36000, it will listen for requests from the server on port 36001 and will communicate via RPP on port 36002.

```
> pbs_server -p 36000 -M 36001 -R 36002 -t create  
> pbs_mom -S 36000 -M 36001 -R 36002
```

Afterward, when using a client command to make a batch request it is necessary to specify the server name and server port (36002):

```
> pbsnodes -a -s node01:36000  
> qsub -q @node01:36000 /tmp/script.pbs
```

## Security overview

The authorization model for TORQUE changed in version 4.0.0 from `pbs_iff` to a daemon called `trqauthd`. The job of the `trqauthd` daemon is the same as `pbs_iff`. The difference is that `trqauthd` is a resident daemon whereas `pbs_iff` is invoked by each client command. `pbs_iff` is not scalable and is prone to failure under even small loads. `trqauthd` is very scalable and creates the possibility for better security measures in the future.

### `trqauthd` and `pbs_iff` authorization theory

The key to security of both `trqauthd` and `pbs_iff` is the assumption that any host which has been added to the TORQUE cluster has been secured by the administrator. Neither `trqauthd` nor `pbs_iff` do authentication. They only do authorization of users. Given that the host system is secure the following is the procedure by which `trqauthd` and `pbs_iff` authorize users to `pbs_server`.

1. Client utility makes a connection to `pbs_server` on a dynamic port.
2. Client utility sends a request to `trqauthd` with the user name and port.
3. `trqauthd` verifies the user ID and then sends a request to `pbs_server` on a privileged port with the user ID and dynamic port to authorize the connection.
4. `trqauthd` reports results of the server to client utility.

Both `trqauthd` and `pbs_iff` use Unix domain sockets for communication from the client utility. Unix domain sockets have the ability to verify that a user is who they say they are by using security features that are part of the file system.





## Job submission filter ("qsub wrapper")

When a "submit filter" exists, TORQUE will send the command file (or contents of STDIN if piped to `qsub`) to that script/executable and allow it to evaluate the submitted request based on specific site policies. The resulting file is then handed back to `qsub` and processing continues. Submit filters can check user jobs for correctness based on site policies. They can also modify user jobs as they are submitted. Some examples of what a submit filter might evaluate and check for are:

- Memory Request - Verify that the job requests memory and rejects if it does not.
- Job event notifications - Check if the job does one of the following and rejects it if it:
  - explicitly requests no notification.
  - requests notifications but does not provide an email address.
- Walltime specified - Verify that the walltime is specified.
- Global Walltime Limit - Verify that the walltime is below the global max walltime.
- Test Walltime Limit - If the job is a test job, this check rejects the job if it requests a walltime longer than the testing maximum.

The script below reads the original submission request from STDIN and shows how you could insert parameters into a job submit request:

```
#!/bin/sh
# add default memory constraints to all requests
# that did not specify it in user's script or on command line
echo "#PBS -l mem=16MB"
while read i
do
echo $i
done
```

The same command line arguments passed to `qsub` will be passed to the submit filter and in the same order. It should be noted that as of TORQUE 2.2.0 extended attributes are not passed to the filter. Exit status of -1 will cause `qsub` to reject the submission with a message stating that it failed due to administrative policies.

The "submit filter" must be executable, must be available on each of the nodes where users may submit jobs, and by default must be located at `${libexecdir}/qsub_filter` (for version 2.1 and older: `/usr/local/sbin/torque_submitfilter`). At run time, if the file does not exist at this new preferred path then `qsub` will fall back to the old hard-coded path. The submit filter location can be customized by setting the `SUBMITFILTER` parameter inside the file (see ["torque.cfg" configuration file on page 295](#)), as in the following example:

```
torque.cfg:
```

```
SUBMITFILTER /opt/torque/submit.pl  
...
```

 Initial development courtesy of Oak Ridge National Laboratories.

## "torque.cfg" configuration file

CLIENTRETRY	
<b>Format</b>	<INT>
<b>Default</b>	0
<b>Description</b>	Seconds between retry attempts to talk to pbs_server.
<b>Example</b>	<pre>CLIENTRETRY 10</pre> <p><i>TORQUE waits 10 seconds after a failed attempt before it attempts to talk to pbs_server again.</i></p>

DEFAULTCKPT	
<b>For mat</b>	One of <i>None, Enabled, Shutdown, Periodic, Interval=minutes, depth=number, or dir=path</i>
<b>Default</b>	<i>None</i>
<b>Description</b>	<p>Default value for job's checkpoint attribute. For a description of all possible values, see the <a href="#">qsub -c</a> documentation.</p> <p><b>i</b> This default setting can be overridden at job submission with the <code>qsub -c</code> option.</p>
<b>Example</b>	<pre>DEFAULTCKPT Shutdown</pre> <p><i>By default, TORQUE checkpoints at pbs_mom shutdown.</i></p>

FAULT_TOLERANT_BY_DEFAULT	
<b>Format</b>	<BOOLEAN>

## FAULT\_TOLERANT\_BY\_DEFAULT

<b>Default</b>	FALSE
<b>Description</b>	Sets all jobs to fault tolerant by default. (See <a href="#">qsub -f</a> for more information on fault tolerance.)
<b>Example</b>	<pre>FAULT_TOLERANT_BY_DEFAULT TRUE</pre> <p><i>Jobs are fault tolerant by default. They will not be canceled based on failed polling, no matter how many nodes fail to report.</i></p>

## HOST\_NAME\_SUFFIX

<b>Format</b>	<STRING>
<b>Default</b>	---
<b>Description</b>	Specifies a hostname suffix. When <code>qsub</code> submits a job, it also submits the username of the submitter and the name of the host from which the user submitted the job. TORQUE appends the value of <code>HOST_NAME_SUFFIX</code> to the hostname. This is useful for multi-homed systems that may have more than one name for a host.
<b>Example</b>	<pre>HOST_NAME_SUFFIX -ib</pre> <p><i>When a job is submitted, the -ib suffix is appended to the host name.</i></p>

## QSUBHOST

<b>Format</b>	<HOSTNAME>
<b>Default</b>	---
<b>Description</b>	The hostname given as the argument of this option will be used as the <code>PBS_O_HOST</code> variable for job submissions. By default, <code>PBS_O_HOST</code> is the hostname of the submission host. This option allows administrators to override the default hostname and substitute a new name.
<b>Example</b>	<pre>QSUBHOST host1</pre> <p><i>The default hostname associated with a job is host1.</i></p>

QSUBSENDUID	
<b>Format</b>	N/A
<b>Default</b>	---
<b>Description</b>	Integer for job's PBS_OUID variable. Specifying the parameter name anywhere in the config file enables the feature. Removing the parameter name disables the feature.
<b>Example</b>	<pre>QSUBSENDUID</pre> <p><i>TORQUE assigns a unique ID to a job when it is submitted by qsub.</i></p>

QSUBSLEEP	
<b>Format</b>	<INT>
<b>Default</b>	0
<b>Description</b>	Specifies time, in seconds, to sleep between a user's submitting and TORQUE's starting a qsub command. Used to prevent users from overwhelming the scheduler.
<b>Example</b>	<pre>QSUBSLEEP 2</pre> <p><i>When a job is submitted with qsub, it will sleep for 2 seconds.</i></p>

RERUNNABLEBYDEFAULT	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	TRUE
<b>Description</b>	Specifies if a job is re-runnable by default. Setting this to false causes the re-runnable attribute value to be false unless the users specifies otherwise with the <a href="#">qsub -r</a> option. (New in TORQUE 2.4.)
<b>Example</b>	<pre>RERUNNABLEBYDEFAULT FALSE</pre> <p><i>By default, qsub jobs cannot be rerun.</i></p>

## SERVERHOST

<b>Format</b>	<STRING>
<b>Default</b>	localhost
<b>Description</b>	If set, the <a href="#">qsub on page 204</a> command will open a connection to the host specified by the SERVERHOST string.
<b>Example</b>	<pre>SERVERHOST orion15</pre> <p><i>The server will open socket connections and and communicate using serverhost orion15.</i></p>

## SUBMITFILTER

<b>Format</b>	<STRING>
<b>Default</b>	\${libexecdir}/qsub_filter (for version 2.1 and older: /usr/local/sbin/torque_submitfilter)
<b>Description</b>	Specifies the location of the submit filter (see <a href="#">Job submission filter ("qsub wrapper") on page 293</a> used to pre-process job submission.
<b>Example</b>	<pre>SUBMITFILTER /usr/local/sbin/qsub_filter</pre> <p><i>The location of the submit filter is specified as /usr/local/sbin/qsub_filter.</i></p>

## TRQ\_IFNAME

<b>Format</b>	<STRING>
<b>Default</b>	null
<b>Description</b>	Allows you to specify a specific network interface to use for outbound TORQUE requests. The string is the name of a network interface, such as <i>eth0</i> or <i>eth1</i> , depending on which interface you want to use.
<b>Example</b>	<pre>TRQ_IFNAME eth1</pre> <p><i>Outbound TORQUE requests are handled by eth1.</i></p>

VALIDATEGROUP	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	FALSE
<b>Description</b>	Validate submit user's group on <a href="#">qsub</a> commands. For TORQUE builds released after 2/8/2011, <i>VALIDATEGROUP</i> also checks any groups requested in <code>group_list</code> at the submit host. Set <i>VALIDATEGROUP</i> to "TRUE" if you set <a href="#">disable_server_id_check</a> to TRUE.
<b>Example</b>	<pre>VALIDATEGROUP TRUE</pre> <p><i>qsub verifies the submitter's group ID.</i></p>

VALIDATEPATH	
<b>Format</b>	<BOOLEAN>
<b>Default</b>	TRUE
<b>Description</b>	Validate local existence of '-d' working directory.
<b>Example</b>	<pre>VALIDATEPATH FALSE</pre> <p><i>qsub does not validate the path.</i></p>





# TORQUE Quick Start Guide

## Initial installation

TORQUE is now hosted at <https://github.com> under the adaptivecomputing organization. To download source, you will need to use the [git](#) utility. For example:

```
[root]# git clone https://github.com/adaptivecomputing.com/torque.git -b 4.2.9 4.2.9
```

To download a different version, replace each 4.2.9 with the desired version. After downloading a copy of the repository, you can list the current branches by typing `git branch -a` from within the directory of the branch you cloned.

**i** If you're checking source out from git, read the `README.building-40` file in the repository.

Extract and build the distribution on the machine that will act as the "TORQUE server" - the machine that will monitor and control all compute nodes by running the `pbs_server` daemon. See the example below:

```
> tar -xvzf torque.tar.gz
> cd torque
> ./configure
> make
> make install
```

**i** OSX 10.4 users need to change the `#define _TDARWIN` in `src/include/pbs_config.h` to `#define _TDARWIN_8`.

**i** After installation, verify you have PATH environment variables configured for `/usr/local/bin/` and `/usr/local/sbin/`. Client commands are installed to `/usr/local/bin` and server binaries are installed to `/usr/local/sbin`.

**i** In this document, `TORQUE_HOME` corresponds to where TORQUE stores its configuration files. The default is `/var/spool/torque`.

## Initialize/Configure TORQUE on the server (pbs\_server)

- Once installation on the TORQUE server is complete, configure the `pbs_server` daemon by executing the command `torque.setup <USER>` found packaged with the distribution source code, where `<USER>` is a username that will act as the TORQUE admin. This script will set up a

basic batch queue to get you started. If you experience problems, make sure that the most recent TORQUE executables are being executed, or that the executables are in your current PATH.

 If you are upgrading from TORQUE 2.5.9, run `pbs_server -u` before running `torque.setup`.

```
[root]# pbs_server -u
```

- If doing this step manually, be certain to run the command `pbs_server -t create` to create the new batch database. If this step is not taken, the `pbs_server` daemon will be unable to start.
- Proper server configuration can be verified by following the steps listed in Testing server configuration.

## Install TORQUE on the compute nodes

To configure a compute node do the following on each machine (see page 19, Section 3.2.1 of PBS Administrator's Manual for full details):

- Create the self-extracting, distributable packages with `make packages` (See the `INSTALL` file for additional options and features of the distributable packages) and use the parallel shell command from your cluster management suite to copy and execute the package on all nodes (i.e. `xCAT` users might do `prcp torque-package-linux-i686.sh main:/tmp/; psh main /tmp/torque-package-linux-i686.sh --install`). Optionally, distribute and install the clients package.

## Configure TORQUE on the compute nodes

- For each compute host, the MOM daemon must be configured to trust the `pbs_server` daemon. In TORQUE 2.0.0p4 and earlier, this is done by creating the `TORQUE_HOME/mom_priv/config` file and setting the `$pbsserver` parameter. In TORQUE 2.0.0p5 and later, this can also be done by creating the `TORQUE_HOME/server_name` file and placing the server hostname inside.
- Additional config parameters may be added to `TORQUE_HOME/mom_priv/config` (see [Node manager \(MOM\) configuration on page 245](#) for details).

## Configure data management on the compute nodes

Data management allows jobs' data to be staged in/out or to and from the server and compute nodes.

- For shared filesystems (i.e., NFS, DFS, AFS, etc.) use the `$usecp` parameter in the `mom_priv/config` files to specify how to map a user's home directory.  
(Example: `$usecp gridmaster.tmx.com:/home /home`)
- For local, non-shared filesystems, `rcp` or `scp` must be configured to allow direct copy without prompting for passwords (key authentication, etc.)

## Update TORQUE server configuration

On the TORQUE server, append the list of newly configured compute nodes to the `TORQUE_HOME/server_priv/nodes` file:

```
server_priv/nodes
computenode001.cluster.org
computenode002.cluster.org
computenode003.cluster.org
```

## Start the pbs\_mom daemons on compute nodes

- Next start the pbs\_mom daemon on each compute node by running the pbs\_mom executable.

Run the trqauthd daemon to run client commands (see [Configuring trqauthd for client commands on page 13](#)). This enables running client commands.

## Verifying correct TORQUE installation

The pbs\_server daemon was started on the TORQUE server when the torque.setup file was executed or when it was manually configured. It must now be restarted so it can reload the updated configuration changes.

```
# shutdown server
> qterm # shutdown server

# start server
> pbs_server

# verify all queues are properly configured
> qstat -q

# view additional server configuration
> qmgr -c 'p s'

# verify all nodes are correctly reporting
> pbsnodes -a

# submit a basic job
> echo "sleep 30" | qsub

# verify jobs display
> qstat
```

At this point, the job will not start because there is no scheduler running. The scheduler is enabled in the next step below.

## Enabling the scheduler

Selecting the cluster scheduler is an important decision and significantly affects cluster utilization, responsiveness, availability, and intelligence. The default TORQUE scheduler, pbs\_sched, is very basic and will provide poor utilization of your cluster's resources. Other options, such as [Maui Scheduler](#) or [Moab Workload Manager](#) are highly recommended. If using Maui/Moab, refer to the Moab-PBS Integration Guide. If using pbs\_sched, start this daemon now.

**i** If you are installing ClusterSuite, TORQUE and Moab were configured at installation for interoperability and no further action is required.

## Startup/Shutdown service script for TORQUE/Moab (OPTIONAL)

Optional startup/shutdown service scripts are provided as an example of how to run TORQUE as an OS service that starts at bootup. The scripts are located in the `contrib/init.d/` directory of the TORQUE tarball you downloaded. In order to use the script you must:

- Determine which `init.d` script suits your platform the best.
- Modify the script to point to TORQUE's install location. This should only be necessary if you used a non-default install location for TORQUE (by using the `--prefix` option of `./configure`).
- Place the script in the `/etc/init.d/` directory.
- Use a tool like `chkconfig` to activate the start-up scripts or make symbolic links (`S99moab` and `K15moab`, for example) in desired runtimes (`/etc/rc.d/rc3.d/` on Redhat, etc.).

### Related topics

- [Advanced configuration on page 14](#)

# BLCR acceptance tests

This section contains a description of the testing done to verify the functionality of the BLCR implementation. For details, see these topics:

- [Test environment on page 305](#)
- [Test 1 - Basic operation on page 305](#)
- [Test 2 - Persistence of checkpoint images on page 308](#)
- [Test 3 - Restart after checkpoint on page 308](#)
- [Test 4 - Multiple checkpoint/restart on page 309](#)
- [Test 5 - Periodic checkpoint on page 309](#)
- [Test 6 - Restart from previous image on page 310](#)

## Test environment

All these tests assume the following test program and shell script, `test.sh`.

```
#include
int main( int argc, char *argv[] )
{
  int i;

  for (i=0; i<100; i++)
  {
    printf("i = %d\n", i);
    fflush(stdout);
    sleep(1);
  }
}
#!/bin/bash
/home/test/test
```

### Related topics

- [BLCR acceptance tests on page 305](#)

## Test 1 - Basic operation

### Introduction

This test determines if the proper environment has been established.

## Test steps

Submit a test job and the issue a hold on the job.

```
> qsub -c enabled test.sh
999.xxx.yyy
> qhold 999
```

## Possible failures

Normally the result of `qhold` is nothing. If an error message is produced saying that `qhold` is not a supported feature then one of the following configuration errors might be present.

- The TORQUE images may have not be configured with `--enable-blcr`
- BLCR support may not be installed into the kernel with `insmod`.
- The config script in `mom_priv` may not exist with `$checkpoint_script` defined.
- The config script in `mom_priv` may not exist with `$restart_script` defined.
- The config script in `mom_priv` may not exist with `$checkpoint_run_exe` defined.
- The scripts referenced in the config file may not exist.
- The scripts referenced in the config file may not have the correct permissions.

## Successful results

If no configuration was done to specify a specific directory location for the checkpoint file, the default location is off of the TORQUE directory, which in my case is `/var/spool/torque/checkpoint`.

Otherwise, go to the specified directory for the checkpoint image files. This was done by either specifying an option on job submission, i.e. `-c dir=/home/test` or by setting an attribute on the execution queue. This is done with the command `qmgr -c 'set queue batch checkpoint_dir=/home/test'`.

Doing a directory listing shows the following.

```
# find /var/spool/torque/checkpoint
/var/spool/torque/checkpoint
/var/spool/torque/checkpoint/999.xxx.yyy.CK
/var/spool/torque/checkpoint/999.xxx.yyy.CK/ckpt.999.xxx.yyy.1205266630
# find /var/spool/torque/checkpoint |xargs ls -l
-r----- 1 root root 543779 2008-03-11 14:17
/var/spool/torque/checkpoint/999.xxx.yyy.CK/ckpt.999.xxx.yyy.1205266630


/var/spool/torque/checkpoint:
total 4
drwxr-xr-x 2 root root 4096 2008-03-11 14:17 999.xxx.yyy.CK

/var/spool/torque/checkpoint/999.xxx.yyy.CK:
total 536
-r----- 1 root root 543779 2008-03-11 14:17 ckpt.999.xxx.yyy.1205266630
```

Doing a `qstat -f` command should show the job in a held state, `job_state = H`. Note that the attribute `checkpoint_name` is set to the name of the file seen above.

If a checkpoint directory has been specified, there will also be an attribute *checkpoint\_dir* in the output of `qstat -f`.

```
$ qstat -f
Job Id: 999.xxx.yyy
Job_Name = test.sh
Job_Owner = test@xxx.yyy
resources_used.cput = 00:00:00
resources_used.mem = 0kb
resources_used.vmem = 0kb
resources_used.walltime = 00:00:06
job_state = H
queue = batch
server = xxx.yyy
Checkpoint = u
ctime = Tue Mar 11 14:17:04 2008
Error_Path = xxx.yyy:/home/test/test.sh.e999
exec_host = test/0
Hold_Types = u
Join_Path = n
Keep_Files = n
Mail_Points = a
mtime = Tue Mar 11 14:17:10 2008
Output_Path = xxx.yyy:/home/test/test.sh.o999
Priority = 0
qtime = Tue Mar 11 14:17:04 2008
Rerunable = True
Resource_List.nodect = 1
Resource_List.nodect = 1
Resource_List.nodes = 1
Resource_List.walltime = 01:00:00
session_id = 9402 substate = 20
Variable_List = PBS_O_HOME=/home/test,PBS_O_LANG=en_US.UTF-8,
                PBS_O_LOGNAME=test,
                PBS_O_PATH=/usr/local/perltests/bin:/home/test/bin:/usr/local/s
bin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin:/usr/games,
                PBS_O_SHELL=/bin/bash,PBS_SERVER=xxx.yyy,
                PBS_O_HOST=xxx.yyy,PBS_O_WORKDIR=/home/test,
                PBS_O_QUEUE=batch
euser = test
egroup = test
hashname = 999.xxx.yyy
queue_rank = 3
queue_type = E comment = Job started on Tue Mar 11 at 14:17
exit_status = 271
submit_args = test.sh
start_time = Tue Mar 11 14:17:04 2008
start_count = 1
checkpoint_dir = /var/spool/torque/checkpoint/999.xxx.yyy.CK
checkpoint_name = ckpt.999.xxx.yyy.1205266630
```

 The value of `Resource_List.*` is the amount of resources requested.

## Related topics

- [BLCR acceptance tests on page 305](#)

## Test 2 - Persistence of checkpoint images

### Introduction

This test determines if the checkpoint files remain in the default directory after the job is removed from the TORQUE queue.

Note that this behavior was requested by a customer but in fact may not be the right thing to do as it leaves the checkpoint files on the execution node. These will gradually build up over time on the node being limited only by disk space. The right thing would seem to be that the checkpoint files are copied to the user's home directory after the job is purged from the execution node.

### Test steps

Assuming the steps of Test 1 (see [Test 1 - Basic operation on page 305](#)), delete the job and then wait until the job leaves the queue after the completed job hold time. Then look at the contents of the default checkpoint directory to see if the files are still there.

```
> qsub -c enabled test.sh
999.xxx.yyy
> qhold 999
> qdel 999
> sleep 100
> qstat
>
> find /var/spool/torque/checkpoint
... files ...
```

### Possible failures

The files are not there, did Test 1 actually pass?

### Successful results

The files are there.

### Related topics

- [BLCR acceptance tests on page 305](#)

## Test 3 - Restart after checkpoint

### Introduction

This test determines if the job can be restarted after a checkpoint hold.

### Test steps

Assuming the steps of Test 1 (see [Test 1 - Basic operation on page 305](#)), issue a [qrls](#) command. Have another window open into the `/var/spool/torque/spool` directory and tail the job.



## Successful results

After the `qrls`, the job's output should resume.

### Related topics

- [BLCR acceptance tests on page 305](#)

## Test 4 - Multiple checkpoint/restart

### Introduction

This test determines if the checkpoint/restart cycle can be repeated multiple times.

### Test steps

Start a job and then while tailing the job output, do multiple [qhold/qrls](#) operations.

```
> qsub -c enabled test.sh
999.xxx.yyy
> qhold 999
> qrls 999
> qhold 999
> qrls 999
> qhold 999
> qrls 999
```

### Successful results

After each `qrls`, the job's output should resume. Also tried "while true; do `qrls 999`; `qhold 999`; done" and this seemed to work as well.

### Related topics

- [BLCR acceptance tests on page 305](#)

## Test 5 - Periodic checkpoint

### Introduction

This test determines if automatic periodic checkpoint will work.

### Test steps

Start the job with the option `-c enabled,periodic,interval=1` and look in the checkpoint directory for checkpoint images to be generated about every minute.

```
> qsub -c enabled,periodic,interval=1 test.sh
999.xxx.yyy
```

## Successful results

After each `qrls`, the job's output should resume. Also tried "while true; do `qrls 999`; `qhold 999`; done" and this seemed to work as well.

### Related topics

- [BLCR acceptance tests on page 305](#)

## Test 6 - Restart from previous image

### Introduction

This test determines if the job can be restarted from a previous checkpoint image.

### Test steps

Start the job with the option `-c enabled,periodic,interval=1` and look in the checkpoint directory for checkpoint images to be generated about every minute. Do a [qhold](#) on the job to stop it. Change the attribute `checkpoint_name` with the [qalter](#) command. Then do a [qrls](#) to restart the job.

```
> qsub -c enabled,periodic,interval=1 test.sh
999.xxx.yyy
> qhold 999
> qalter -W checkpoint_name=ckpt.999.xxx.yyy.1234567
> qrls 999
```

## Successful results

The job output file should be truncated back and the count should resume at an earlier number.

### Related topics

- [BLCR acceptance tests on page 305](#)