

# DRMAA for Torque/PBS Professional

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Date: 2010-07-07  
Version: 1.0.3  
Revision: 386  
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## Abstract

This document describes installation, configuration and usage of  
**‘DRMAA for Torque/PBS Pro’** library (PBS DRMAA for short).

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## Introduction

DRMAA for Torque/PBS Pro is implementation of [Open Grid Forum DRMAA](#) (Distributed Resource Management Application API) [specification](#) for submission and control jobs to [PBS](#) systems: [PBS Professional](#), [Torque](#) and [OpenPBS](#). Using DRMAA, grid applications builders, portal developers and ISVs can use the same high-level API to link their software with different cluster/resource management systems.

This software also enables the integration of ‘[SMOA Computing](#)’ - with the underlying Torque/PBS Pro system for remote multi-user job submission and control over Web Services.

This manual can be found in HTML and PDF formats in doc directory.

## Installation

To compile the library just go to main source directory and type:

```
$ ./configure [--prefix=/installation/directory] && make
```

If you had installed PBS in a non standard directory pass it in --with-pbs configure parameter. There are no unusual requirements for basic usage of library: ANSI C compiler and standard make should suffice (if linking against PBS Professional you will need also the OpenSSL library). If you have taken sources directly from SVN repository you would need additional [developer tools](#). For further information regarding GNU build system see the INSTALL file.

For [Torque](#) it is advised to configure queues so jobs are leaved after the completion. To achieve this simply type the following command for all queues which are intended to use with PBS DRMAA:

```
# qmgr -c "set queue QUEUE_NAME keep_completed = 60"
```

The value of the keep\_completed parameter denotes a number of seconds jobs will have to wait in the queue after the completion (and should be greater then pool\_delay value in PBS DRMAA [configuration](#)). It enables the DRMAA library to retrieve the information about finished jobs.

Alternatively you can configure the DRMAA library to use Torque server daemon logs as information source for terminated jobs (consult next section for details)

## Configuration

During DRMAA session initialization (`drmaa_init`) library tries to read its configuration parameters from locations: `/etc/pbs_drmaa.conf`, `~/.pbs_drmaa.conf` and from file given in `PBS_DRMAA_CONF` environment variable (if set to non-empty string). If multiple configuration sources are present then all configurations are merged with values from user-defined files taking precedence (in following order: `$PBS_DRMAA_CONF`, `~/.pbs_drmaa.conf`, `/etc/pbs_drmaa.conf`).

Currently recognized configuration parameters are:

`pool_delay` Amount of time (in seconds) between successive checks of unfinished job(s).

Type: integer, Default: 5

`wait_thread` Value 1 enables single “wait thread” for updating jobs status. With `pbs_home` set enables `wait_thread` which reads PBS log files (instead of polling PBS daemons).

Type: integer, Default: 0

`pbs_home` Path to Torque/PBS Pro spool directory that contains server logs (e.g.: `/var/spool/pbs`).

Type: string, Default: not set

`job_categories` Dictionary of job categories. It’s keys are job categories names mapped to [native specification](#) strings. Attributes set by job category can be overridden by corresponding DRMAA attributes or native specification. Special category name default is used when `drmaa.job.category` job attribute was not set.

`cache_job_state` According to the DRMAA specification every `drmaa.job.ps()` call should query DRM system for job state. With this option one may optimize communication with DRM. If set to positive integer `drmaa.job.ps()` returns remembered job state without communicating with DRM for `cache_job_state` seconds since last update. By default library conforms to specification (no caching will be performed).

Type: integer, default: 0

Table 1: Different modes of operation

| <code>wait_thread</code> | <code>pbs_home</code> | mode      | keep_completed needed | comments                          |
|--------------------------|-----------------------|-----------|-----------------------|-----------------------------------|
| 0                        | not set               | polling   | yes                   | default configuration             |
| 1                        | not set               | polling   | yes                   | more effective than above         |
| 1                        | set                   | triggered | no                    | read access to server logs needed |

## Configuration file syntax

Configuration file is in form a dictionary. Dictionary is set of zero or more key-value pairs. Key is a string while value could be a string, an integer or another dictionary.

```
configuration: dictionary — dictionary_body
dictionary: '{' dictionary_body '}'
dictionary_body: (string ':' value ',')*
value: integer — string — dictionary
string: unquoted-string — single-quoted-string — double-quoted-string
unquoted-string: [^\t\n\r;0-9][^\t\n\r;]*
single-quoted-string: '['*
double-quoted-string: '"'*
integer: [0-9]+
```

## Configuration file example

```
# pbs.drmaa.conf - Sample pbs.drmaa configuration file.

wait_thread: 0,

#pool_delay: 5,

job_categories: {
  #default: "-k n", # delete output files from execution hosts
  longterm: "-p -100 -l nice=5",
  amd64: "-l arch=amd64",
  python: "-l software=python",
  java: "-l software=java,vmem=500mb -v PATH=/opt/sun-jdk-1.6:/usr/bin:/bin",
  #test: "-u test -q testing",
},
```

## Native specification

DRMAA interface allows to pass DRM dependant job submission options. Those options may be specified by settings `drmaa_native_specification`. `drmaa_native_specification` accepts space delimited `qsub`. `qsub` options which does not set job attributes (`-b`, `-z`, `-C`) as well as meant for submission of interactive jobs (`-I`, `-X`) or to specify directories (`-d`, `-D`) are not supported. Also instead of `-W` option following long options are accepted within native specification: `--depend`, `--group-list`, `--stagein` and `--stageout`. For detailed description of each option see PBS documentation.

Attributes set in native specification overrides corresponding DRMAA job attributes.

Table 2: Native specification strings with corresponding DRMAA attributes.

| DRMAA attribute                 | PBS attribute   | PBS re-source | native specification |
|---------------------------------|-----------------|---------------|----------------------|
| Attributes which get overridden |                 |               |                      |
| drmaa_job_name                  | Job_Name        |               | -N job name          |
| drmaa_output_path               | Output_Path     |               | -o output path       |
| drmaa_error_path                | Error_Path      |               | -e error path        |
| drmaa_join_files                | Join_Path       |               | -j join options      |
| drmaa_block_email               | Mail_Points     |               | -m mail options      |
| drmaa_start_time                | Execution_Time  |               | -a start time        |
| drmaa_js_state                  | Hold_Types      |               | -h                   |
|                                 | Account_Name    |               | -A account string    |
|                                 | Checkpoint      |               | -c interval          |
|                                 | Keep_Files      |               | -k keep              |
|                                 | Priority        |               | -p priority          |
|                                 | destination     |               | -q queue             |
|                                 | Rerunable       |               | -r y/n               |
|                                 | Shell_Path_List |               | -S path list         |
|                                 | User_List       |               | -u user list         |
|                                 | group_list      |               | --group_list=groups  |
| drmaa_v_env                     | Variable_List   |               | -v variable list     |
|                                 | Variable_List   |               | -V                   |
| drmaa_v_email                   | Mail_Users      |               | -M user list         |
| drmaa_duration_hlimit           | Resource_List   | cput          | -l cput=limit        |
| drmaa_wct_hlimit                | Resource_List   | walltime      | -l walltime=limit    |
|                                 | Resource_List   |               | -l resources         |
|                                 | depend          |               | --depend=dependency  |
|                                 | stagein         |               | --stagein=stagein    |
|                                 | stageout        |               | --stageout=stageout  |

## Release notes

### Changes in 1.0.5 release

- make drmaa tolerant to torque restarts
- now one can use 'lmem' in native specification attribute

### Changes in 1.0.4 release

- fix “mtime” date parsing ('triggered' mode)
- fix “submit\_args” attribute bug (PBS Professional only)

### Changes in 1.0.3 release

- new implementation of the “wait thread” which reads PBS log files (increased scalability)
- support for native specification attribute
- memleak fixes
- testsuite passed on PBS Pro 10
- exit codes 126-127 cause the `drmaa_wifaborted()` to return true
- other bug fixes

### Changes in 1.0.2 release

- automatic reconnect on PBS connection errors
- static linkage with DRMAA utilities
- other bug fixes

### Changes in 1.0.1 release

- number of attributes implemented:
  - `drmaa_start_time`
  - `drmaa_duration_hlimit`
  - `drmaa_wct_hlimit`
  - `drmaa_native_specification`
  - `drmaa_job_category`
- configuration file(s)
- separate wait thread
- lot of bug fixes
- more robust code
- separated DRMAA utilities library
- Python driven test-suite

### Known bugs and limitations

Library covers nearly all DRMAA 1.0 [specification](#) with exceptions listed below. It passes the [official DRMAA test-suite](#) except of tests which require job termination status. All mandatory and some optional job attributes (namely: transfer files, wall clock time hard limit, job run duration hard limit) are implemented.

Known limitations imposed by PBS API:

- With [PBS Pro](#) (and [OpenPBS](#)) retrieving of job termination status is impossible. For this DRM finished jobs are marked as done with 0 return code unless job was terminated through library when they are treated as aborted and killed after receiving SIGTERM.

- Library accepts job identifiers only of those jobs which were submitted under current session (specification says it should also accept job identifiers from previous sessions and even of jobs submitted in former execution of DRMAA enabled application). This could only be partially fixed as job state needs to be kept by library in order to cope with PBS shortcomings.
- Job termination (when job is running) is realized by PBS by sending SIGTERM and/or SIGKILL therefore retrieving those signals cannot be distinguished from abort using `drmaa_control(DRMAA_CONTROL_TERMINATE)`. Then job termination state is marked as “aborted” and “signaled” whatever is the state.
- `drmaa_wcoredump()` always returns false.
- Waiting functions (`drmaa_wait()` and `drmaa_synchronize()`) must pool DRM to find out whether job finished.

### Test-suite

The DRMAA for Torque/PBS Pro library was successfully tested with [PBS Pro 10](#) (10.0.0.82981) and [Torque 2.5.1](#) on Linux OS. Following table presents results of tests from [Official DRMAA test-suite](#) (originally developed for Sun Grid Engine).

Table 3: Mode - Polling

| Test name                                   | PBS Pro 10 | Torque 2.5.1 |
|---|------------|--------------|
| test_mt_exit_during_submit                  | passed     | passed       |
| test_mt_exit_during_submit_or_wait          | passed     | passed       |
| test_mt_submit_before_init_wait             | passed     | passed       |
| test_mt_submit_mt_wait                      | passed     | passed       |
| test_mt_submit_wait                         | passed     | passed       |
| test_st_attribute_change                    | passed     | passed       |
| test_st_bulk_singlesubmit_wait_individual   | passed     | passed       |
| test_st_bulk_submit_in_hold_session_delete  | passed     | passed       |
| test_st_bulk_submit_in_hold_session_release | passed     | passed       |
| test_st_bulk_submit_in_hold_single_delete   | passed     | passed       |
| test_st_bulk_submit_in_hold_single_release  | passed     | passed       |
| test_st_bulk_submit_wait                    | passed     | passed       |
| test_st_contact                             | passed     | passed       |
| test_st_drm_system                          | passed     | passed       |
| test_st_drmaa_impl                          | passed     | passed       |
| test_st_empty_session_control               | passed     | passed       |
| test_st_empty_session_synchronize_dispose   | passed     | passed       |
| test_st_empty_session_synchronize_nodispose | passed     | passed       |

... continued on next page

Table 3: Mode - Polling (... continued)

| Test name                                      | PBS Pro 10          | Torque 2.5.1 |
|--|---------------------|--------------|
| test_st_empty_session_wait                     | passed              | passed       |
| test_st_error_file_failure                     | FAILED <sup>1</sup> | passed       |
| test_st_exit_status                            | FAILED <sup>1</sup> | passed       |
| test_st_input_file_failure                     | FAILED <sup>1</sup> | passed       |
| test_st_mult_exit                              | passed              | passed       |
| test_st_mult_init                              | passed              | passed       |
| test_st_output_file_failure                    | FAILED <sup>1</sup> | passed       |
| test_st_submit_in_hold_delete                  | passed              | passed       |
| test_st_submit_in_hold_release                 | passed              | passed       |
| test_st_submit_kill_sig                        | FAILED <sup>1</sup> | passed       |
| test_st_submit_polling_synchronize_timeout     | passed              | passed       |
| test_st_submit_polling_synchronize_zerotimeout | passed              | passed       |
| test_st_submit_polling_wait_timeout            | passed              | passed       |
| test_st_submit_polling_wait_zerotimeout        | passed              | passed       |
| test_st_submit_suspend_resume_wait             | passed              | passed       |
| test_st_submit_wait                            | passed              | passed       |
| test_st_submitmixture_sync_all_dispose         | passed              | passed       |
| test_st_submitmixture_sync_all_nodispose       | passed              | passed       |
| test_st_submitmixture_sync_allids_dispose      | passed              | passed       |
| test_st_submitmixture_sync_allids_nodispose    | passed              | passed       |
| test_st_supported_attr                         | passed              | passed       |
| test_st_supported_vattr                        | passed              | passed       |
| test_st_usage_check                            | passed              | passed       |
| test_st_version                                | passed              | passed       |

Table 4: Mode - Triggered

| Test name                                 | PBS Pro 10 | Torque 2.5.1 |
|---|------------|--------------|
| test_mt_exit_during_submit                | passed     | passed       |
| test_mt_exit_during_submit_or_wait        | passed     | passed       |
| test_mt_submit_before_init_wait           | passed     | passed       |
| test_mt_submit_mt_wait                    | passed     | passed       |
| test_mt_submit_wait                       | passed     | passed       |
| test_st_attribute_change                  | passed     | passed       |
| test_st_bulk_singlesubmit_wait_individual | passed     | passed       |

... continued on next page

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<sup>1</sup>Due to unavailability of job termination status.



Table 4: Mode - Triggered (... continued)

| Test name                                      | PBS Pro 10 | Torque 2.5.1 |
|--|------------|--------------|
| test_st_bulk_submit_in_hold_session_delete     | passed     | passed       |
| test_st_bulk_submit_in_hold_session_release    | passed     | passed       |
| test_st_bulk_submit_in_hold_single_delete      | passed     | passed       |
| test_st_bulk_submit_in_hold_single_release     | passed     | passed       |
| test_st_bulk_submit_wait                       | passed     | passed       |
| test_st_contact                                | passed     | passed       |
| test_st_drm_system                             | passed     | passed       |
| test_st_drmaa_impl                             | passed     | passed       |
| test_st_empty_session_control                  | passed     | passed       |
| test_st_empty_session_synchronize_dispose      | passed     | passed       |
| test_st_empty_session_synchronize_nodispose    | passed     | passed       |
| test_st_empty_session_wait                     | passed     | passed       |
| test_st_error_file_failure                     | passed     | passed       |
| test_st_exit_status                            | passed     | passed       |
| test_st_input_file_failure                     | passed     | passed       |
| test_st_mult_exit                              | passed     | passed       |
| test_st_mult_init                              | passed     | passed       |
| test_st_output_file_failure                    | passed     | passed       |
| test_st_submit_in_hold_delete                  | passed     | passed       |
| test_st_submit_in_hold_release                 | passed     | passed       |
| test_st_submit_kill_sig                        | passed     | passed       |
| test_st_submit_polling_synchronize_timeout     | passed     | passed       |
| test_st_submit_polling_synchronize_zerotimeout | passed     | passed       |
| test_st_submit_polling_wait_timeout            | passed     | passed       |
| test_st_submit_polling_wait_zerotimeout        | passed     | passed       |
| test_st_submit_suspend_resume_wait             | passed     | passed       |
| test_st_submit_wait                            | passed     | passed       |
| test_st_submitmixture_sync_all_dispose         | passed     | passed       |
| test_st_submitmixture_sync_all_nodispose       | passed     | passed       |
| test_st_submitmixture_sync_allids_dispose      | passed     | passed       |
| test_st_submitmixture_sync_allids_nodispose    | passed     | passed       |
| test_st_supported_attr                         | passed     | passed       |
| test_st_supported_vattr                        | passed     | passed       |
| test_st_usage_check                            | passed     | passed       |
| test_st_version                                | passed     | passed       |

## Developers

Core functionality of DRMAA is put into `drmaa_utils` library. This library was created in order to keep consistent common functionality of ‘DRMAA for Torque/PBS Pro’ and other DRMAA libraries. As it is independent from any particular DRM you may find this library useful for developing other DRMAAs.

### Developer tools

Although not needed for library user the following tools may be required if you intend to develop DRMAA for Torque/PBS Pro library or run tests:

- GNU autotools (`autoconf`, `automake`, `libtool`),
- [Bison](#) parser generator,
- [gperf](#) perfect hash function generator,
- [Python](#) (with development files) for [Docutils](#) and running test-suite (at least 2.5 version but not Python 3.\* which will introduce incompatibilities),
- [Pyrex](#) a Language for writing Python extension modules ( $\geq 0.9.6$ ),
- [Docutils](#) for processing this README,
- [LaTeX](#) for creating documentation in PDF format,
- [Doxygen](#) for generating code documentation.

## Contact

The DRMAA library for Torque and PBSPro is currently maintained by [Poznan Supercomputing and Networking Center](#). Please send your comments, questions and bug reports to:

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Version 3, 29 June 2007

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- d) Convey the object code by offering access from a designated place (gratis or for a charge), and offer equivalent access to the Corresponding Source in the same way through the same place at no further charge. You need not require recipients to copy the Corresponding Source along with the object code. If the place to copy the object code is a network server, the Corresponding Source may be on a different server (operated by you or a third party) that supports equivalent copying facilities, provided you maintain clear directions next to the object code saying where to find the Corresponding Source. Regardless of what server hosts the Corresponding Source, you remain obligated to ensure that it is available for as long as needed to satisfy these requirements.
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```
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```

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## Docutils System Messages

system-message

**ERROR/3** in ../README, line 14

Unknown target name: “drmaa for torque/pbs pro”.

system-message

**ERROR/3** in ../README, line 38

Unknown target name: “smoa computing”.

system-message

**ERROR/3** in ../README, line 425

Unknown target name: “drmaa for torque/pbs pro”.