DRMAA: Distributed Resource Management Application API

Andre Merzky

on behalf of

Peter Tröger
Hasso-Plattner-Institute (HPI) @ University of Potsdam

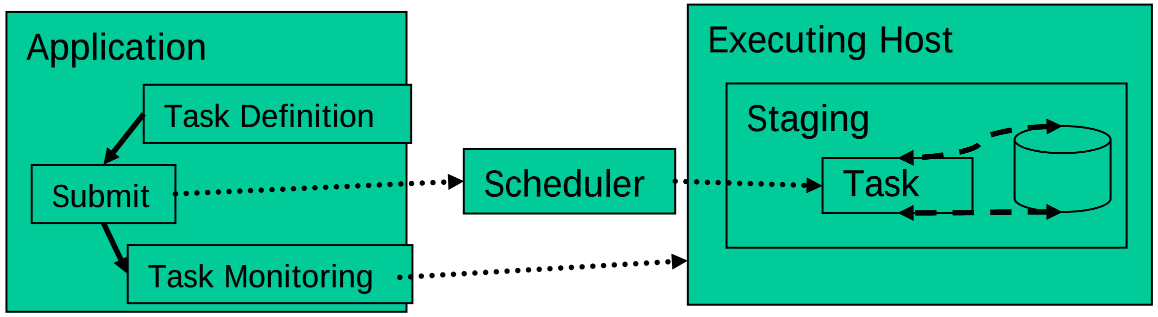
GGF 17 - Tokyo, May 10-12, 2006

Scope: Run a Job API

(Steps from: Ten Actions when SuperScheduling", GGF SchedWD 8.5, J.M. Schopf, July 2001)

- **Phase 1: Resource Discovery**
  - Step 1 Authorization Filtering
  - Step 2 Application requirement definition
  - Step 3 Minimal requirement filtering
- **Phase 2 System Selection**
  - Step 4 Gathering information (query)
  - Step 5 Select the system(s) to run on
- **Phase 3 Run job**
  - Step 6 (optional) Make an advance reservation
  - **Step 7 Submit job to resources** ⬅
  - Step 8 Preparation Tasks
  - **Step 9 Monitor progress (maybe go back to 4)** ⬅
  - **Step 10 Find out Job is done** ⬅
  - Step 11 Completion tasks

Resource Management Systems Differ Across Each Component



	Interface Format	Execution Environment
LSF	Has API plus Batch Utilities via "LSF Scripts"	User: Local disk exported System: Remote initialized (option)
Grid Engine	GDI API Interface plus Command line interface	System: Remote initialized, with SGE local variables exported
PBS	API (script option) Batch Utilities via "PBS Scripts"	System: Remote initialized, with PBS local variables exported
DataSynapse	Proprietary API.	User: Remote initialized

DRMAA Charter

- Develop an API specification for **the submission and control of jobs** to one or more Distributed Resource Management (DRM) systems.
- The scope of this specification is all the high level functionality which is necessary for an application to consign a job to a DRM system including **common operations on jobs** like termination or suspension.
- The objective is to **facilitate the direct interfacing of applications to today's DRM systems** by application's builders, portal builders, and Independent Software Vendors (ISVs).

DRMAA History

- BOF at GGF 3 in Frascati, Oct 2001
- WG status at GGF 4, Toronto, February 2002

- Participation from Altair (PBS), Sun Microsystems (SGE), Intel, IBM (LoadLeveler), University of Wisconsin (Condor), Cadence (Rocks system), Globus project

- Sideline engagement from EnFuzion, Entropia, Platform (LSF), GridIron project, United Devices

- June 2004: DRMAA 1.0 document accepted as *proposed recommendation* by GFSC

- Until today: Work on implementations and integration of user-provided feedback, new DRMAA compliance test suite

What have been the Issues?

- **General features**
  - Session concept
  - Asynchronous job monitoring
  - Scalability
  - Native features
- **Language bindings**
  - C/C++
  - Perl, Python
  - Fortran, Java
- **Libraries**
  - Serial / thread safe
  - Tracing / diagnosis
- **Advanced features**
  - Debugging support
  - File staging
  - Security
  - Job categories

Submit, control & monitor, and query status of jobs

DRMAA API Function Groups

- - Init / Exit
- - Job template handling
  - - Allocation / Deletion
  - - Job template parameter setter/getter routines
- - Job submission
  - - Individual jobs
    - - One time
    - - Multiple times – just re-adjust the job template (parameter sweep)
  - - Bulk jobs - implicit parameterization
- - Job monitoring and control
- - Auxiliary or system routines
  - - Error message routines
  - - Informational interfaces

Job Template

- - Description of all job requirements / parameters
- - Mandatory and optional parameters
- - Same intention as JSDL, but designed as ‘smallest
- common denominator’ between possible backend’s
- - Functions to create/delete job templates
  - `job_template *drmaa_allocate_job_template (void)`
  - `void drmaa_delete_job_template (job_template *jt)`
- - Setter/getter job template routines (scalar/vector)

```
– int drmaa_set_attribute   (job_template *jt,
–                             char *name,
–                             char *value);
– char* drmaa_get_attribute (job_template *jt,
–                             char *name);
```

Job Submission

- - Jobs submitted to the DRM system are
- identified via an opaque job identifier (char*)
- - Single job identifiers are returned by
  - `int drmaa_run_job (job_template *jt, char *job_id )`
- - Bulk job submissions return multiple job
- identifiers
  - `int drmaa_run_bulk_job (char **job_ids,`
  - `job_template *jt,`
  - `int start, int end, int incr);`

Job Monitoring, Control, and Status

- - Monitoring/Control functions

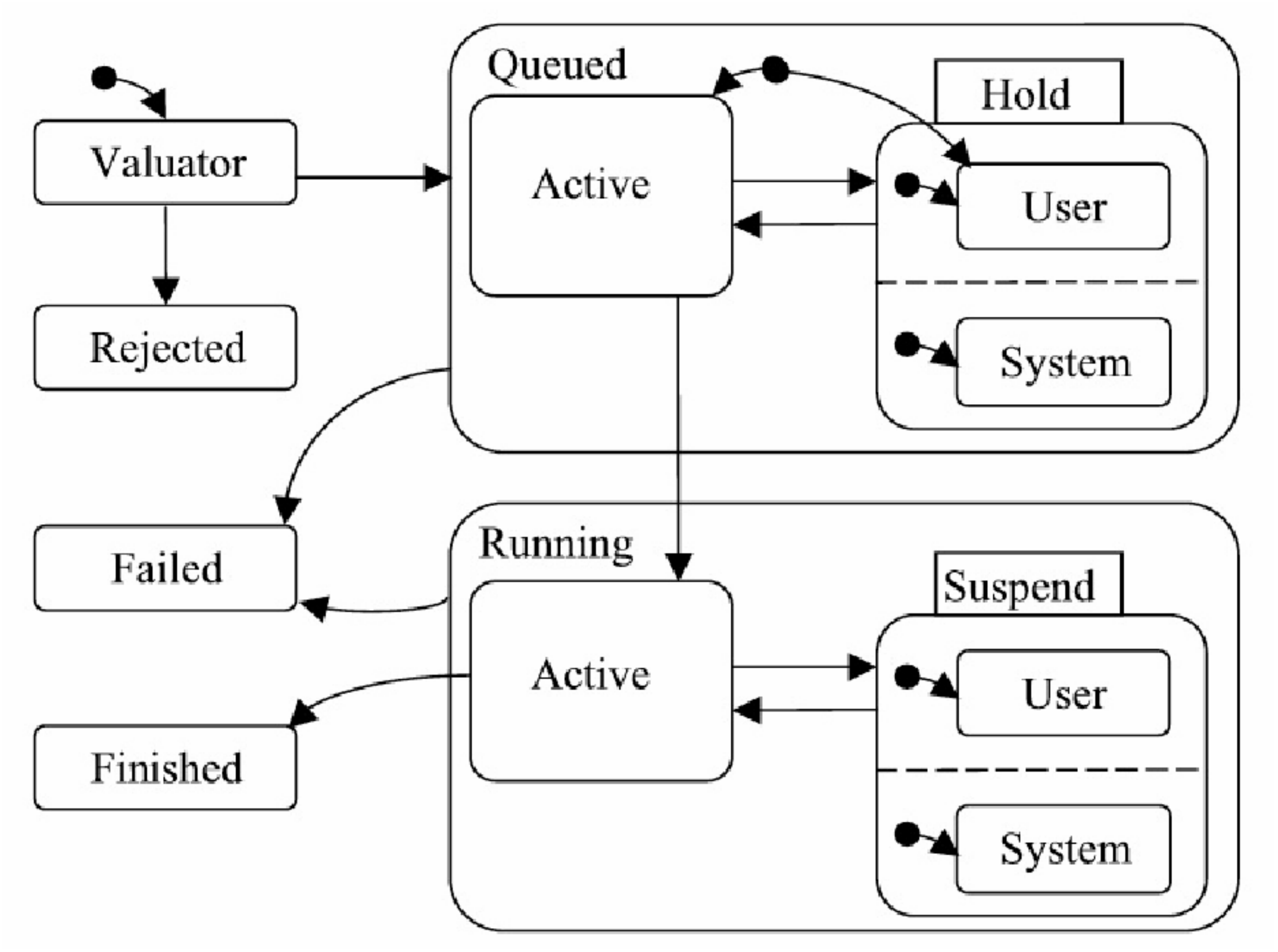
```
– int drmaa_control    (char  *job_id,
–                       int    action);
– int drmaa_synchronize(char **job_ids);
– int drmaa_job_ps     (char  *job_id,
–                       int   *remote_ps );
```

- - Blocking and non-blocking waiting for one or
- more jobs to finish (like POSIX wait4(2))

```
– char *drmaa_wait(char *jobid, int *status,
  int timeout, char **rusage);
```

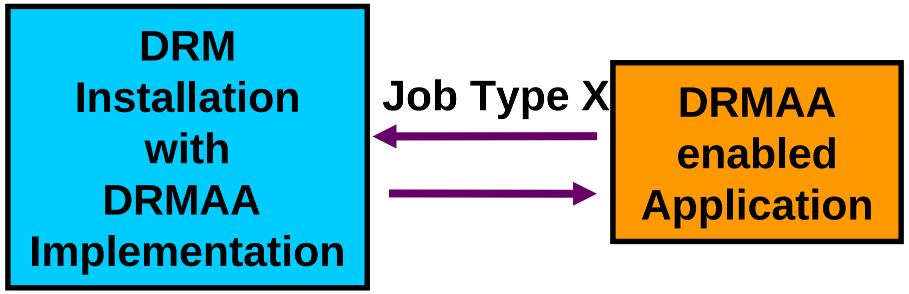
  – drmaa_wif[exited|signaled|aborted] and friends to get more information about failed jobs

Job State Transition



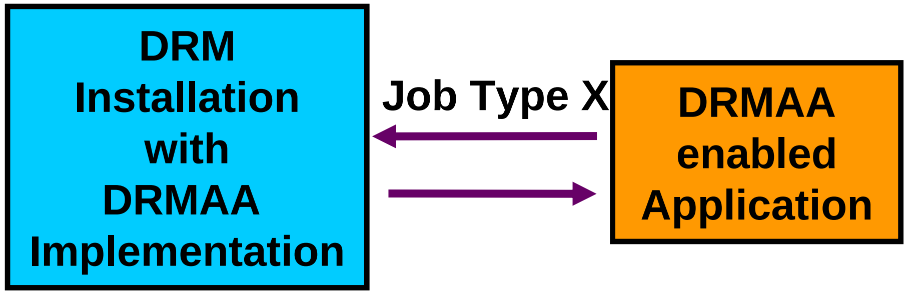
Job Categories

Site A


DRM Installation with DRMAA Implementation
Job Type X
DRMAA enabled Application

- Cluster consists of machines where X jobs run and others where they don’t run

Site B


DRM Installation with DRMAA Implementation
Job Type X
DRMAA enabled Application

- X jobs run at all machines in cluster

Native DRMS Options

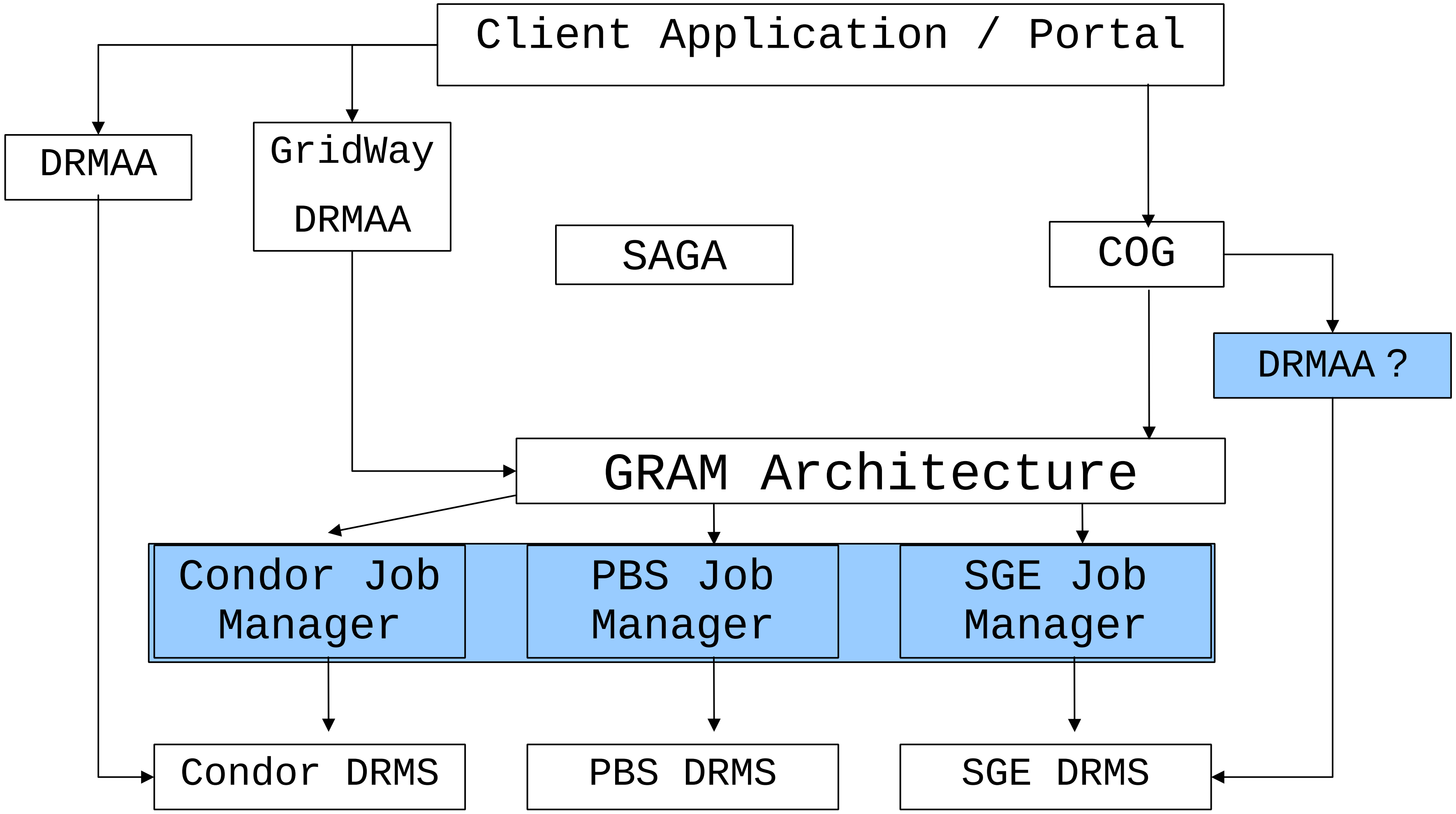
- - The end user interacts with the DRMS via
- native_specification parameter
  - - Simple solution
  - - DRMAA implementation ignores the DRMAA DRMS
  - implicitly used and disallowed options
  - - Dist. Appls. Developers and DRMS vendors are not involved
  - in the local environment spec.
  - - The burden is on the end users to define the execution
  - environment
    - - Need to know DRM
    - - Need to know the remote application installation

DRMAA Placement

- - Realized:
  - - On top of DRM systems
  - - On top of Globus
  - - Beneath GRAM
  - - Interfaced by a Portal, application, shell

- - Also possible:
  - - UNICORE TSI interface to DRMSs
  - - CoG adapter
  - - On top of CoG
  - - Portable command line utilities (qsub, qstat)

A World of Submission API's



DRMAA in Practice

- - Multiple implementations since 2004
  - - Product implementation in Sun Grid Engine 6
    - - C- and Java-binding implementation
  - - Complete implementation in Condor 6.7 series
    - - C-binding implementation
  - - CPAN Perl DRMAA module (Tim Harsch)
    - - On-top-of DRMAA C-library
  - - Complete implementation in GridWay
    - - Allows DRMAA on-top-of Globus
  - - Prototype for Globus 3 DRMAA job manager (HPI)
    - - Based on DRMAA Perl implementation
- - Tutorials, programming examples, test suites
  - - http://gridengine.sunsource.net
  - - http://www.dcl.hpi.uni-potsdam.de/research/drmaa
  - - GGF12 tutorial, JavaOne 05 tutorial materials

Latest Improvements

- - Feedback from practical usage of available
- implementation(s) went back into spec
  - - Just look at the GridForge tracker and the SGE / Condor
  - mailing lists
- - Some details were under-specified
  - - Behavior in multi-threaded environments
- - C-centric style makes it hard to develop conformant
- object-oriented bindings
  - - Massive feedback from Java and .NET language binding
  - specification work
- - Several missing error codes fixed
- - But: Keep the API as small as it is !!!

The Future - DRMAA IDL Spec

- - Started work in early 2005
- - Based on Java- and .NET-binding experiences
- - Specification through standardized OMG Interface
- Definition Language (IDL)
  - - No, that does not mean CORBA ;-)
  - - Example: W3C DOM specification
  - - DRMAA language bindings will (and should) **not** rely on IDL
  - language bindings from OMG
    - - Complicated, weired semantics
    - - Simple custom binding by specifying consistent mapping rules
    - - Examples for Java in the IDL-spec
  - - Usage of IDL avoids wording issues (i.e. ‚attribute‘ vs. ‚property‘)
  - - Allows for true language-independent description of
  - namespaces, enumerations, constants, and time values

The Future - DRMAA IDL Spec (contd.)

- - Improved, more consistent description text for all
- functions
  - - More details regarding advanced OO-specific features
  - (multiple session objects, exception hierarchies)
  - - Consider languages with introspection functionalities
  - - Some details about RPC-DRMAA scenarios (SOAP, RMI, ...)
- - More parameter placeholders (e.g. for job ID)
- - A lot more possible error codes for the operations

The Future - Backward Compatibility

- - C- and Java bindings in their current state can be mostly
-   derived also from the IDL spec
  - - Demand for consistent name mapping might change one or two
  -   method names in the C-binding
  - - Introduction of new job state / error codes does not break
  -   existing applications
  - - DRMAA has already a notion of versioning
- - .NET binding will be re-designed based on the IDL spec
- - No official binding documents for Perl and Python so far

DRMAA Documents and Tools

- - Updated DRMAA GFD-P-R
  - - Will be submitted to GFSG during the next weeks
  - - Three additional experience reports for Sun’s N1GE, Condor and GridWay
- - DRMAA GFD-P-R or GFD.22 document
  - - Since June 2004
- - C binding v1.0
  - - Ready for submission to GFSG
- - Java binding 0.6.1
  - - Fairly complete
- - .NET binding v0.2
  - - Needs a sync
- - IDL document v0.35
  - - Nearly feature complete, needs to be augmented with latest DRMAA spec
  - - Will be submitted as a new, standalone GFD-P-R doc (might become DRMAA 2.0)
- - DRMAA Test Suite
  - - Hosted by Condor DRMAA CVS at Sourceforge: http://sf.net/projects/condor-ext
- - DRMAA Wiki
  - - Share your experience : http://drmaa.org/wiki

Next Steps

- - Submitting final document + experience reports
- - Continuous improvement of the test suite
- - Start work on next DRMAA version,
-   based on IDL spec
- - Collaboration with SAGA, JSDL, and OGSA-BES for
-   identifying synergy effects
- - More implementations, more languages, more
-   applications …

Conclusion

- - Please take part in the discussion
  - Bi-weekly con calls
    - Toll Free: (866)545-5198 Code: 6898552
    - Regular: (865)521-8904
  - GridForge tracker
  - E-mail: *drmaa-wg@gridforum.org*
  - Archive: Use the link at *http://drmaa.org*
- - Please implement DRMAA and tell us your
- experience
  - It‘s easy, Dan did it 4 times ;-) ...

Thank you !