An Overview of the GridWay Metascheduler

GridWay

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Contents

1. What is GridWay?
2. A Global Vision
3. Scheduling Policies
4. Scheduling Infrastructures
5. The GridWay Project
What is GridWay?

GridWay is a Globus Toolkit component for meta-scheduling, creating a scheduler virtualization layer on top of Globus services (GRAM, MDS & GridFTP)

- For **project and infrastructure directors**
  - GridWay is an open-source community project, adhering to Globus philosophy and guidelines for collaborative development.

- For **system integrators**
  - GridWay is highly modular, allowing adaptation to different grid infrastructures, and supports several OGF standards.

- For **system managers**
  - GridWay gives a scheduling framework similar to that found on local LRM systems, supporting resource accounting and the definition of state-of-the-art scheduling policies.

- For **application developers**
  - GridWay implements the OGF standard DRMAA API (C and JAVA bindings), assuring compatibility of applications with LRM systems that implement the standard, such as SGE, Condor, Torque,…

- For **end users**
  - GridWay provides a LRM-like CLI for submitting, monitoring, synchronizing and controlling jobs, that could be described using the OGF standard JSDL.
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A Global Vision

Global Architecture of a Computational Grid

Applications
- Standard API (OGF DRMAA)
- Command Line Interface

Grid Meta-Scheduler
- open source
- job execution management
- resource brokering

GridWay
- open source
- job execution management
- resource brokering

Globus
- Globus services
- Standard interfaces
- end-to-end (e.g. TCP/IP)

Infrastructure
- highly dynamic & heterogeneous
- high fault rate

Applications
- .C, .java

GridWay
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A Global Vision

Benefits

Integration of non-interoperable computational platforms (Organization)

• Establishment of a uniform and flexible infrastructure
• Achievement of greater utilization of resources and higher application throughput

Support for the existing platforms and LRM Systems (Sys. Admin.)

• Allocation of grid resources according to management specified policies
• Analysis of trends in resource usage
• Monitoring of user behavior

Familiar CLI and standard APIs (End Users & Developers)

• High Throughput Computing Applications
• Workflows
A Global Vision

Features

Workload Management

• Advanced (Grid-specific) scheduling policies
• Fault detection & recovery
• Accounting
• Array jobs and DAG workflows

User Interface

• OGF standards: JSDL & DRMAA (C and JAVA)
• Analysis of trends in resource usage
• Command line interface, similar to that found on local LRM Systems

Integration

• Straightforward deployment as new services are not required
• Interoperability between different infrastructures
GridWay Internals

A Global Vision

GridWay

GridWay Core

DRMAA library

CLI

Job Pool

Host Pool

Request Manager

Dispatcher Manager

Scheduler

Transfer Manager

Execution Manager

Information Manager

GridFTP

RFT

pre-WS GRAM

WS GRAM

MDS2

MDS2 GLUE

MDS4

Grid File Transfer Services

Grid Execution Services

Grid Information Services

Job Submission

Job Monitoring

Job Control

Job Migration

Job Preparation

Job Termination

Job Migration

Resource Discovery

Resource Monitoring
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Scheduling Policies

Grid Scheduling = Job + Resource Policies

Resource Policies
- Rank Expressions
- Fixed Priority
- User Usage History
- Failure Rate

Job Policies
- Fixed Priority
- Urgent Jobs
- User Share
- Deadline
- Waiting Time

Pending Jobs
Matching Resources for each job (user)
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GridWay

Scheduling Infrastructures

Centralized
Coupled

• Network Links
• Administration
• Homogeneity

Decentralized
Decoupled

SMP (Symmetric Multi-processors)
MPP (Massive Parallel Processors)
Clusters
Network Systems Intranet/Internet

Grid Infrastructures

High Performance Computing

High Throughput Computing
Enterprise Grid Infrastructures

Characteristics

• “Small” scale infrastructures (campus/enterprise) with one meta-scheduler instance providing access to resources within the same administration domain that may be running different DRMS and be geographically distributed

Goal & Benefits

• Integrate multiple systems, that could be heterogeneous, in an uniform/centralized infrastructure
• Decoupling of applications and resources
• Improve return of IT investment
• Performance/Usage maximization

Scheduling

• Centralized meta-scheduler that allows the enforcement of Grid-wide policies (e.g. resource usage) and provides centralized accounting
Scheduling Infrastructures

Enterprise Grids: Deployment with GridWay

GridWay

- GridWay
- Users
- Applications
- Middleware
- Infrastructure

- Users
- GridWay
- Applications
  - DRMAA interface
  - Portal and/or CLI access
- Services: MDS, GRAM, GridFTP
- One scheduling instance
- Grid-wide policies

Infrastructure

- Could be heterogeneous and geographically distributed

Services:
- SGE Cluster
- PBS Cluster
- LSF Cluster
- Globus

• Could be heterogeneous and geographically distributed
Enterprise Grids: Examples

**European Space Astronomy Center**

- Data Analysis from space missions (DRMAA)
- Site-level meta-scheduler
- Several clusters
Scheduling Infrastructures

Enterprise Grids: Examples

UABGrid, University of Alabama at Birmingham

- Bioinformatics applications
- Campus-level meta-scheduler
- 3 resources (PBS, SGE and Condor)
Characteristics

• “Large” scale infrastructures with one or several meta-scheduler instances providing access to resources that belong to different administrative domains (different organizations or partners)

Goal & Benefits

• Large-scale, secure and reliable sharing of resources between partners or supply-chain participants
• Support collaborative projects
• Access to higher computing power to satisfy peak demands

Scheduling

• Decentralized scheduling system that allows the enforcement of organization-wide policies
Partner Grids: Deployment with GridWay

- Multiple Admin. Domains
- Multiple Organizations
- Services: MDS, GRAM, GridFTP
- Multiple scheduling instances
- (V) Organization-wide policies
- DRMAA interface
- Science Gateways

Applications

Middleware

Infrastructure

SGE Cluster  PBS Cluster  LSF Cluster
AstroGrid-D, German Astronomy Community Grid

- Collaborative management of supercomputing resources & astronomy-specific resources
- Grid-level meta-scheduler (GRAM interface)
- 22 resources @ 5 sites, 800 CPUs
Partner Grids: Examples

- Fusion
  - Users
  - GridWay
  - gLite
  - SGE Cluster

- Biomed
  - Users
  - GridWay
  - gLite
  - PBS Cluster

- Services: BDII, GRAM, GridFTP
- EGEE Resource Broker
- DRMAA interface
- VO Schedulers

Massive Ray Tracing

CD-HIT workflow
Scheduling Infrastructures

A Tool for Interoperability

- Different Middlewares (e.g. WS and pre-WS)
- Different Data/Execution architectures
- Different Information models
- Integration through adapters
- Global DN’s
- Demo in June 2007, TeraGrid07
Characteristics

• Multiple meta-scheduler layers in a hierarchical structure
• Resource provision in a utility fashion (provider/consumer)

Goal & Benefits

• Supply resources on-demand, making resource provision more adaptive
• Access to unlimited computational capacity
• Transform IT costs from fixed to variable
• Seamless integration of different Grids (The Grid)

Scheduling

• Each Grid is handled as any other resource
• Characterization of a Grid as a single resource
• Use standard interfaces to virtualize a Grid infrastructure
Scheduling Infrastructures

Deploying Utility Grid Infrastructures with GridWay

- Globus
- SGE Cluster
- PBS Cluster
- LSF Cluster

Users

GridWay

Virtualization of a Grid

GRID-GATEWAY

Globus

Globus

Globus

Globus

Globus

Globus

Access to Outsourced Resources

globus-job-run, Condor/G, Nimrod/G …

Utility Grid
Scheduling Infrastructures

Utility Grids: Example

- Access to different infrastructures with the same adapters
- EGEE managed as other resource
- Delegate identity/ "VO" certificates
- In-house/provider gateway
- Regional infrastructure
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The GridWay Project

Some Projects and Infrastructures

- IRISGrid
- Politecnico di Torino
- CABGrid (Centro de Astrobiología)
- C2VO (Universidad de Castilla La Mancha)
- Grid en ESAC (Agencia Espacial Europea)
- CRO-GRID (Croacia)
- Sun Microsystems Solution Center World Grid
- Infraestructura EGEE
- Proyecto BeinGRID
- GridX1 (Canadian Grid for HEP applications)
- Universidade do Porto
- Madras Institute of Technology
- National Center for High-Performance Computing

More at: http://www.gridway.org/ (Success Stories)

Some Application Porting Areas

- Life-Sciences
- Aerospace
- Fusion Physics
- Computational Chemistry
The GridWay Project

History of the Project

• Started in **2002**, first releases were only distributed on request in binary format
• First open source release (v4.0) in **January 2005** (Apache license v2.0)
• Adhering to Globus philosophy and guidelines for **collaborative development**
• In June 2007 GridWay became part of the **Globus Toolkit**
• Since January 2005, more than **1000 downloads from 80 different countries**, 25% are private companies and 75% are universities and research centers.
• Best-effort support provided (contract support is also available)
  • Based on a strong open source community
The GridWay Project

Development Process

- **Community** – Open Source Project. Globus Development Philosophy

- **Development Infrastructure** (thanks to Globus Project!)
  - Mailing Lists
  - Bugzilla
  - CVS

- **You are very welcome to contribute:**
  - Reporting Bugs (gridway-user@globus.org)
  - Making feature requests for the next GridWay release (gridway-user@globus.org)
  - Contributing your own developments (bug fixes, new features, documentation)

- Detailed **Roadmap:**
  - **GridWay Campaigns** at bugzilla.mcs.anl.gov/globus/query.cgi
  - www-unix.mcs.anl.gov/~bacon/cgi-bin/big-roadmap.cgi#Gridway
Thank you for your attention!