InterOperability among Grids: A Case Study with GARUDA & EGEE Grids

Shamjith K. V.
shamjithkv@cdacb.ernet.in

Asvija B., Sridharan R., Prahlada Rao BB., Mohanram N.

System Software Development Group (SSDG)
Centre for Development of Advanced Computing (C-DAC)
C-DAC Knowledge Park, Bangalore India
http://www.cdac.in
Outline

- Interoperability definition and needs
- Introduction to GARUDA
- Component comparisons: GARUDA Vs EGEE
- Interoperability frameworks
  - Security Interoperability
  - Information System Interoperability
  - Job Submission Interoperability
  - Data Management Interoperability
- Conclusion
Grid Interoperability

**Definition of Grid Interoperability**
- Ability of Components in a Grid to communicate and share, information and data to peer components in different Grids.

**Need for Grid Interoperability**
- Evolution of Customized Grid Middlewares
  - Globus Toolkit
  - Glite
  - Unicore
  - Gridbus
  - Legion
- Unifying Grids to address challenging scientific problems
  - Particle analysis, Disaster management & Protein folding
- Grid applications portability
  - Enforcing common standards (OGF)
GARUDA Grid
GARUDA Overview

• National Grid Computing initiative by the Dept. of IT, Govt. of India in November 2004

• Objectives
  – Create a test bed for the research & engineering of technologies, architectures, standards and applications in Grid Computing
  – Bring together all potential research, development and user groups to develop a national Grid Computing Infrastructure
  – Create the foundation for the next generation grids by addressing long term research issues in grid computing

• GARUDA Resources & Connectivity
  – More than 400 CPUs and 13TB of storage
  – Connects 45 organizations across 17 cities
  – Provide seamless & high speed access to the compute, data & other resources on the Grid
  – Scalable, secure and reliable network private network
GARUDA Grid Architecture

Submit node gridfs

GARUDA HeadNode
Bangalore

C-DAC Bangalore
AIX

Chennai
Linux

Pune
Linux

C-DAC
(Hyd)
Linux

IGIB
Linux

RRI-Bangalore
Linux

Cluster Head Node

Cluster Head Node

Cluster Head Node

Cluster Head Node

Cluster Head Node

Cluster Head Node

Compute Nodes

Compute Nodes
GARUDA Components

Management & Monitoring
- Paryaveekshanam

Resources
- Compute, Data Storage,
  Scientific Instruments,
  Softwares

Resource Management & Scheduling
- Moab from Cluster Resources
- Load Leveler, Torque, LSF, SGE
- Globus 2.4

Application (PoC)
- Disaster Management
- Bioinformatics

Access Methods
- Access Portal
- Problem Solving Environments

Data Management
- Storage Resource Broker

Development Environment
- DIViA for Grid
  GridIDE
GARUDA Access Methods

GARUDA Portal
- User-friendly web portal for GARUDA
- Support submission of Jobs such as
  - Sequential Applications
  - Homogeneous Parallel Applications
  - Heterogeneous Parallel Applications
- Facilitate seamless integration of the Grid Meta Scheduler, Middleware, and Data Grid solutions
- Satellite & Terrestrial Grid Integration APIs
- Facilitate Semantic Search

Tools Interface
- MOAB Grid Scheduler
- Globus Middleware
- Storage Resource Broker (SRB)

Program Solving Environments
- Supports the entire cycle of problem solving for specific application domains
- Currently Bio-informatics and Atmospheric Modelling PSEs
**Objectives**

- Monitor resources of GARUDA Grid & send alerts / notify for malfunctioning of resources.
- Resources are dynamic and critical in nature and
- Monitoring is an essential for heterogeneous distributed environment like GARUDA
- Paryavekshanam is a 24X7 grid-monitoring tool

**Paryavekshanam Features**

- Search facility for Resources & SW
- Parya Dashboard, Nodal, and Grid Overview pages
- GOC Desk page for the daily graphs
- Alert messages Gen for resource failure
- Addition of new sites is through web page
- Archival of Historical data
- Job monitoring & Accounting: jobs-running/cluster, job_id, job_name, state, Cpu_time, wall_time, memory used etc
- Archival of completed jobs
- SRB monitoring using APIs
- Home page with radar graph
- Nodal Information and grid overview page
- Network, data gallery, network monitoring
Grid Integrated Development Environment (GIDE)

Components of GridIDE
- Project Development and Management
- Resource Management
- Job Management
- Inbuilt source level Debugger
- Profiler
- Help

Features for next GridIDE
- Support web services
- Job submission through GARUDA Portal APIs
- Resource Management using GRIDMON database
- Accounting information
Applications Tested on GARUDA

- **Disaster Management Application**
  - Analyze disaster affected areas using SAR radar data, process it to take corrective actions.
  - Mosaic Data, and enable remote Visualization

- **Bio-informatics Application**
  - Smith-Waterman grid portal being deployed on GARUDA Grid
    - **Prototype tested across Bangalore, Pune, Hyderabad & Chennai Clusters**
  - Grid Enable popular applications like BLAST
GARUDA Grid Security

• Authentication
  - GARUDA Certificate
    • Subject Name
    • Public Key of the Subject
    • Identity of GARUDA CA
    • Digital Signature of GARUDA CA
  - Adheres to GSI
    • Credential Delegation
    • Single Sign-On

• Authorization
  - User Mapping
  - DN to Pool of Unix accounts

• MOAB
  - Uses GSI FTP for data transfer

• SRB
  - Relies on separate SRB credential
  - Not integrated with GSI

• GARUDA CA
  • Managed by C-DAC
    Bangalore
    - Key length 1024 bits
    - Not recognized by IGTF
    - Registration through PURSE
    - http://gridfs.ctsf.cdac.org.in/purse/

• Indian Grid CA
  - Preliminary document is under review and will be submitted to APGrid PMA
  - Key length 2048 bits
**GARUDA Information System (GIS)**

- Depends on Globus MDS
- Easy querying & publishing
  - Hierarchical approach
  - GRIS: Resource level
  - GIIS: At site level and Grid level
- Follows MDS Core schema, can support GLUE Schema
- Integrated with Ganglia
  - Cluster level information
- GARUDA Grid Monitoring (Paryavekshhanam)
  - Relies on data from MDS
GARUDA - Job Submission & Management

• Globus GRAM
  - Gatekeeper in GT 2.4
  - Supports Parallel MPI Jobs
    - DUROC Component
  - Integrates well with Torque, PBS

• Moab Workload Manager
  - A policy based job scheduler
  - Advanced Reservations
  - Uses GSI FTP : To support Data Transfers

• Local Schedulers-GARUDA
  - Torque - Linux Clusters
  - LSF - Linux clusters
  - Load Leveler- AIX Cluster
  - Torque-Aix Cluster (in progress)
  - SG Engine – Solaris Cluster
GARUDA - Data Grid Solutions

- **Storage Resource Broker (SRB)** - Data grid middleware
- **SRB Components**
  - **MCAT server:**
    - Main repository of the information about the SRB federation
    - Contains all the metadata about all the SRB objects
  - **SRB server (Agent):**
    - Simple daemon running at each site and manages the local resources to present them to SRB federations
    - Agent can process the requests after getting metadata from the MCAT server.
  - **SRB Clients:**
    - Web and Java clients, APIs (C & Java) & Command line utilities (Scommands)
  - **Gateways:**
    - NFS Gateway
    - GridFtp Gateway
    - SRB API
Overview of EGEE

• Project for **Enabling Grids for E-Science**
  – Facilitate collaboration among research & engineering communities world wide

• Funded by European Commission

• Target applications
  – High energy physics, life science, Geology, computational chemistry etc.

• Based on **Glite** Middleware
Glite - Service Components

**Access**

- **CLI**
- **API**

**Security Services**
- Authorization
- Authentication
- Auditing

**Data Services**
- Metadata Catalog
- File & Replica Catalog
- Storage Element
- Data Movement

**Accounting**
- Job Provenance
- Computing Element
- Package Manager
- Workload Management

**Information & Monitoring Services**
- Information & Monitoring
- Service Discovering
- Network Monitoring

**Job Management Services**
- Job Management

---

Middleware Components: GARUDA Vs EGEE

- **GARUDA INDIA**
  - GSI + gridmapfile
  - MDS
  - SRB

  **PORTAL**
  - MOAB
    - GLOBUS
    - GARUDA-CE (GT2 based)
  - WMS
    - lcg-CE (GT2 based)

  **UID**
  - BDII
  - GSI + VOMS
  - LFC
  - SRM

  **PBS, LSF, SGE, TORQUE**
  - WN-1
  - WN-2
  - WN-n

- **EGEE**
  - Lightware: Middleware for Grid Computing

- **GSI**

- **MOAB**

- **GLOBUS**

- **GARUDA-CE** (GT2 based)

- **WMS**
  - lcg-CE (GT2 based)

- **BDII**

- **GSI + VOMS**

- **LFC**

- **SRM**

- **Linux + AIX**
Security Components: GARUDA Vs EGEE

• GARUDA
  - GSI for authentication
  - Authorization based on Grid-map file
    • DN is mapped
  - Key length is 1024
  - CA not recognized internationally

• EGEE
  - GSI & VOMS for authentication
  - Authorization based on Grid-map file
    • VOMS Attrib is mapped
  - Key length is 2048
  - Recognized by IGTF
Access Methods: GARUDA Vs EGEE

• GARUDA
  - Through GARUDA Access portal
  - Job submission, monitoring and management interfaces
  - Browse GARUDA resources
  - Integrated with GARUDA Data Grid
  - Integrated with GARUDA PSE

• EGEE
  - Command line UI
  - Exposes client APIs
  - Support Grid Portals
    • GENIUS, P-GRADE
  - Job submission, monitoring & management commands
  - Commands to list & search resources
  - Integrated with EGEE Data Grid
Meta Schedulers: GARUDA Vs EGEE

**GARUDA**
- MOAB as the Meta Scheduler
- Resource Brokering & Scheduling
- Supported LRMS
  - PBS
  - Torque
  - Load Leveler
  - LSF
  - SGE
- Its own logging & book keeping

**EGEE**
- WMS as the Meta Scheduler
- Resource Brokering & Matchmaking
- Supported LRMS
  - PBS
  - Torque
  - SGE
  - LSF
- Logging & Book keeping
Computing Elements: GARUDA Vs EGEE

- **GARUDA**
  - Operating Systems
    - Linux (RHEL), AIX
  - LRMS
    - PBS, Torque, Load Leveler, LSF, SGE
  - LB Host – part of Moab
  - Software installed are published into IS.

- **EGEE**
  - Operating System
    - Scientific Linux
    - Initiatives to support to other OSs (Linux and non Linux)
  - LRMS
    - PBS, Torque, SGE, LSF
  - Software availability can be VO specific and advertised in IS
GARUDA Vs EGEE : Storage Element

**GARUDA**
- Storage Resource Broker (SRB)
  - Provide a unified name space across the grid
  - Require SRB credentials
  - Web, Java Clients
  - Exposes API’s (C, JAVA)
  - Command line interface
  - Supports file replication
- GridFTP can be used to transfer files

**EGEE**
- Storage Resource Manager (SRM)
  - Shared storage resource allocation
  - Integrated with GSI
  - Command line interfaces
  - Supports file replication
  - Exposes API’s (C, Perl)
- GridFTP is used to transfer files
- Namespace Management catalogs
  - LFC, AMGA
Information Service: GARUDA Vs EGEE

• GARUDA
  – Based on Globus MDS 2
  – GIIS at Site level & GRIS at resource level
  – Hierarchical approach
  – GLOBUS Schema, can support GLUE Schema v1.1
  – MDS APIs

• EGEE
  – Evolved version of Globus MDS
  – GRIS at resource level & GIIS at site and higher levels implemented through BDIIIs
  – Hierarchical approach
  – Follows GLUE Schema (v1.3)
  – BDII APIs
InterOperability Frameworks: GARUDA & EGEE

A possible advanced scenario
Security Interoperability : GARUDA & EGEE

- Both Grids follow GSI for security
- GARUDA users get certificates from Internationally recognized CAs
- Authentication
  - GARUDA can trust certificates signed by EGEE CAs
    - Proxy credential in the VOMS proxy can be used for Authenticating EGEE users in GARUDA
  - EGEE can recognize Garuda users as VO users (euindia)
- Authorization
  - GARUDA relies on grid-mapfile for authorization
    - EGEE users DN will be mapped to local users in GARUDA resources
  - EGEE Grid should authorize GARUDA users based on their roles
Information Systems Interoperability: EGEE & GARUDA

• GARUDA tools have to validate & extract information from BDII
  – Information specified in Glue Schema
  – Adapter for fetching & processing information from BDII (TBD)

• EGEE needs Info Fetch interface to access GARUDA resource information from GIS
  – GIS is based on GIIS
  – GIIS Information is specified in Glue Schema
  – Info Fetch Interface (TBD)
Job Submission Interoperability: GARUDA to EGEE

- Garuda users submit Job Request (JR) through Grid Portal.
- Grid Portal provide the JR to MOAB/GRAM.
- Match the JR to find suitable resources in EGEE.
  - Information Adapter for Moab to query BDII (TBD)
  - Information Adapter for GRAM to query BDII (TBD)
- Convert JR (with data staging information) to JDL.
  - MOAB/RSL script to JDL Adapter (JDLA-TBD)
- JDL Adapter submits JDL to WMS (TBD)
- Job identifier returned by WMS is taken to Grid Portal for:
  - Status-query and
  - Fetching Job output
Job Submission Interoperability: EGEE to GARUDA

• User makes job request (JR) through Glite UI
  – JDL Scripts
• Glite UI provides the JR to WMS
• WMS Match the JR to find suitable resources in GARUDA
  – Information Adapter for WMS + RB to query GARUDA Information System
• JDL to MOAB/RSL script converter: Generate MOAB/RSL script from JR with data staging information
  – JDL to MOAB/RSL Script Adapter (JMRS Adapter) need to be developed
• JMRS Adapter submits Job to MOAB/GRAM
• Job Details need to be updated in Logging & Book keeping
Data Management Interoperability: EGEE & GARUDA

- Data transfer using GridFTP
  - `globus-url-copy gsiftp://<GARUDA Node>/file`
  - `gsiftp://<EGEE Node>/file`

- Integrate Data Grids (SRB & SRM)
  - SRM interface to SRB (ASGC working)
Conclusion

- GARUDA & EGEE Adapt interOperability models based on OGF
- Adapters, and Converters for interoperability of GARUDA & EGEE (TBD)
  - Adapters for information fetching and converting job requirements
- Applications to be tried for demonstrating interoperability bet’n GARUDA & EGEE
THANK YOU