

# An Interoperable & Optimal Data Grid Solution for Heterogeneous and SOA based Grid- GARUDA

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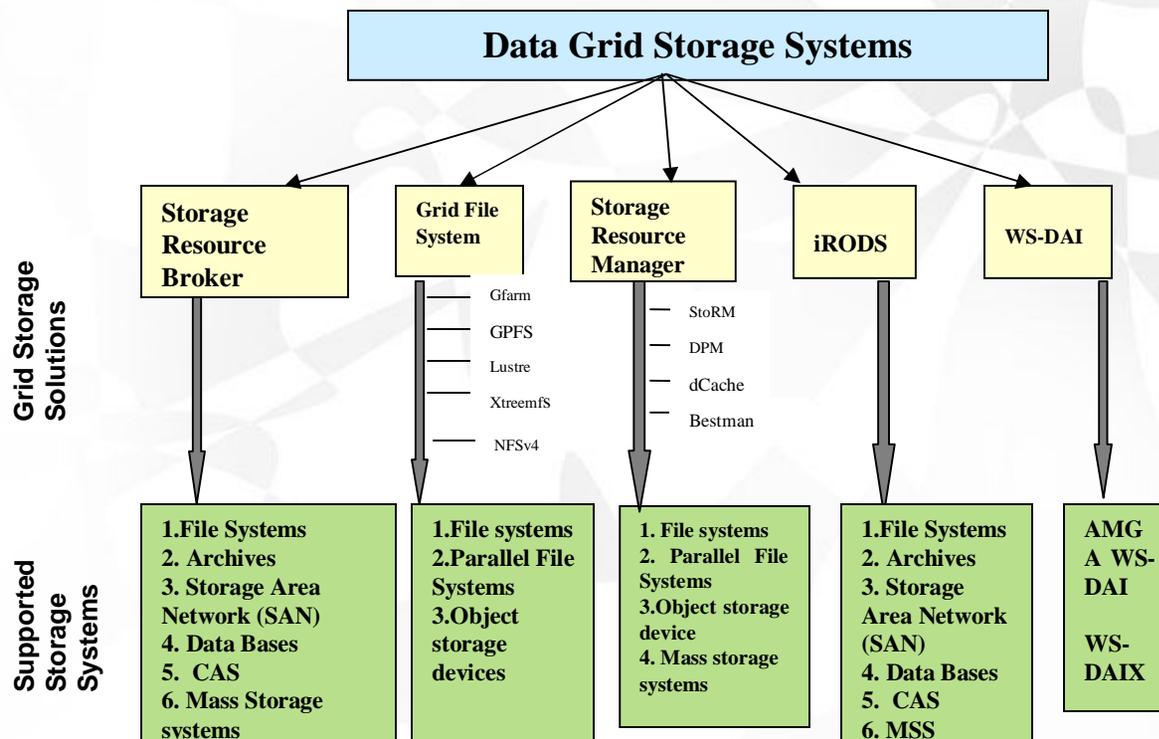
# Presentation Outline

- **Grid Storage Requirements**
- **Various Data Grid Solutions**
- **Comparision of Grid data Solutions**
- **Indian National Grid –GARUDA**
- **Data Management Challenges for GARUDA**
- **GARUDA Data Storage Solution - GSRM**
- **GSRM Highlights**
- **GSRM Architecture Integration with GARUDA middleware components**
- **GSRM Usage Scenario for Par. applications**
- **Conclusions**

# Grid Storage Requirements

- **Data Availability**
- **Security**
- **Performance & Latency**
- **Scalability**
- **Fault Tolerance**

# Data Grid Solutions & Supported Storage Systems



Hierarchy of Data Grid Solutions and Supported Storage Systems

# Survey of Data Grid Solutions

- **Storage Resource Broker (Nirvana SRB)**
- **iRODS (Integrated Rule Oriented Data System)**
- **GFS (Grid File Systems)**
- **WS-DAI (Web Service-data Access & Integration)**
- **SRM (Storage Resource manager)**

# Feature comparison of Grid Data Solutions



Features	SRB (Nirvana)	iRODS	SRM	GFS	WS-DAI
Organization	SDSC, Nirvana	SDSC	EGEE	GFS-WG (GGF)	OGSA group
Tool/ Spec	Tool	Tool	Spec	Spec	Spec
Storage Support	File system, MSS, Database, Object based	File system	File systems,, MSS,	File systems	database
Global Namespace	Yes	Yes	Yes	Yes	Yes
Security	GSI, Unix Auth, kerberos	GSI, Unix auth, kerberos	GSI, VOMS	GSI	WS-Security
Standardization	Proprietary tool	No	OGF	OGF	GGF
Interoperability	No	No	Yes		Yes
Space Management	No	No	Yes	No	No
Replication	yes	yes	yes		

# Indian National Grid Computing Initiative-GARUDA

HPGC Workshop, IEEE's IPDPS 2010, Atlanta

Website : [www.garudaindia.in](http://www.garudaindia.in)

- **Share High-end Computational Resources with the larger Scientific and Engineering community across India.**
- **Emerging High Performance Computing (HPC) Applications require integration of geographically distributed resources**
- **Collaborative Frameworks for solving applications that are interdisciplinary, experts participation from multiple domains and distributed locations**
- **Universal (location-independence, ubiquitous) access to resources**

# Components Evolution in GARUDA Project Phases

Phase \ Features	GARUDA PoC Phase	GARUDA Found Phase	GARUDA Main Phase
Middleware	Globus 2.4.3 (Stable release)	Globus 4.0.7 (Stable release)	Globus + Clouds
Web compliance	Pre WS	Web Service Based	Web Service Based
SOA Support	Not supported	Service Oriented Grid	Supported
Architecture	Centralized	Peer to Peer	Peer to Peer
Grid Meta Scheduler	Moab	Gridway	NA
QOS Compliance	Rudimentary	Advanced Reservation	Yes
Storage Solutions	SRB-Commercial	SRM- Open source S/W	NA
Virtual Community Support	Virtual Community Groups formed.	Enabling Virtual Communities through VOMS	Fully Supported

# GARUDA Partners (Currently -45)



- Institute of Plasma Research, Ahmedabad
- Physical Research Laboratory, Ahmedabad
- Space Applications Centre, Ahmedabad
- Harish Chandra Research Institute, Allahabad
- Motilal Nehru National Institute of Technology, Allahabad
- Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore
- Indian Institute of Astrophysics, Bangalore
- Indian Institute of Science, Bangalore
- Institute of Microbial Technology, Chandigarh
- Punjab Engineering College, Chandigarh
- Madras Institute of Technology, Chennai
- Indian Institute of Technology, Chennai
- Institute of Mathematical Sciences, Chennai
- Indian Institute of Technology, Delhi
- Jawaharlal Nehru University, Delhi
- Institute for Genomics and Integrative Biology, Delhi
- Indian Institute of Technology, Guwahati
- Guwahati University, Guwahati
- University of Hyderabad, Hyderabad
- Centre for DNA Fingerprinting and Diagnostics, Hyderabad
- Jawaharlal Nehru Technological University, Hyderabad
- Indian Institute of Technology, Kanpur
- Indian Institute of Technology, Kharagpur
- Saha Institute of Nuclear Physics, Kolkatta
- Central Drug Research Institute, Lucknow
- Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow
- Bhabha Atomic Research Centre, Mumbai
- Indian Institute of Technology, Mumbai
- Tata Institute of Fundamental Research, Mumbai
- IUCCA, Pune
- National Centre for Radio Astrophysics, Pune
- National Chemical Laboratory, Pune
- Pune University, Pune
- Indian Institute of Technology, Roorkee
- Regional Cancer Centre, Thiruvananthapuram
- Vikram Sarabhai Space Centre, Thiruvananthapuram
- Institute of Technology, Banaras Hindu University, Varanasi

# Cyber Infrastructure – Resources

- PARAM Padma (Aix, Bangalore), Linux Clusters at Pune, Hyderabad & Chennai
- Grid Labs have been setup at Bangalore, Pune & Hyderabad
- Fourteen of the partner institutions contributed resources including Satellite Terminals (compute aggregating to 1600+ CPUs)



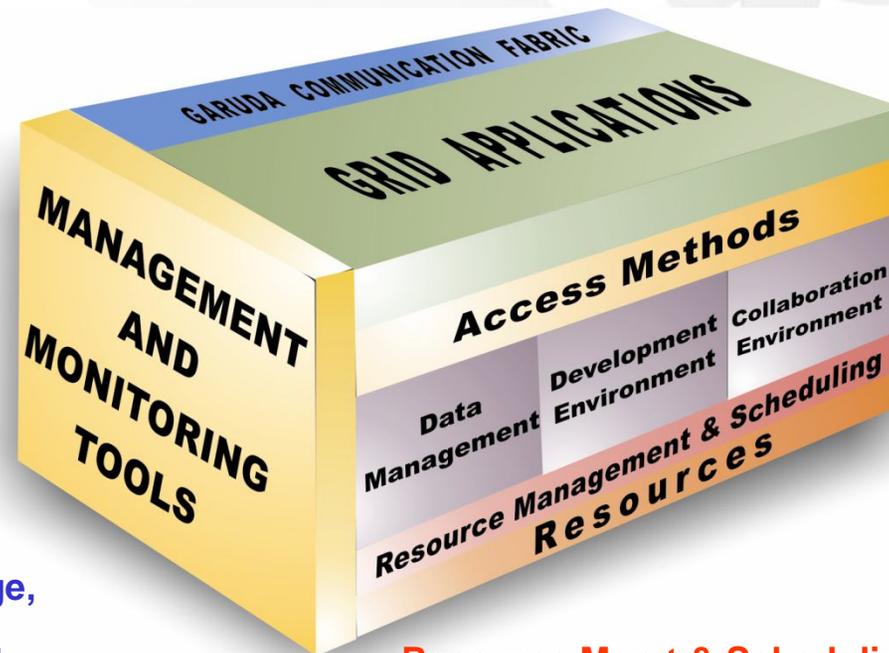
# GARUDA Component Architecture

## Management, Monitoring & Accounting

- Paryaveekshanam
- Web MDS
- GARUDA Information Service
- GARUDA Accounting

## GARUDA Resources

- Compute, Data, Storage,
- Scientific Instruments,
- Software,...



## Access Methods

- Access Portal for SOA
- Problem Solving Environments

## Security Framework

- IGCA Certificates
- MyProxy
- VOMS

## Resource Mgmt & Scheduling

- GridWay Meta-scheduler
- Resource Reservation
- Torque, Load Leveler
- Globus 4.x (WS Components)



# IGCA

Indian Grid Certification Authority

- *Indian Grid Certification Authority (IGCA):*  
Located at C-DAC, Knowledge Park, Bangalore, India.
- IGCA is the first **CA in India** for the purpose of **Grid** research.
- Managed by **GARUDA -Grid Operation Centre**.
- Issues **X.509** Certificates to support the secure environment in Grid (to institutes doing grid research in India and Internationally collaborating with GARUDA).

# GARUDA current Phase: Objectives

- Provide an Operational **Stable Cyber Infrastructure** with **Service oriented** technologies for scientific/ Commercial applications
- Deliver A **Service Level Architecture** ie usable by a wide range of scientific disciplines
- Integrate GARUDA with other International Grids
- Address long-term research issues in Grid Computing

## **Deliverables:**

- **Grid Technologies & Research**
- **SOA based Infrastructure**
- **Applications**
- **Capacity and Community Building**

# Grid Technologies & Research Works

- **Secure Access Methods**
  - **Grid Middleware-SOA and QOS**
  - **PSE & Program Devlp. Environmenrts**
  - **Data Management Solutions**
    - Managing Data Collection
    - Parallel File System
    - Parallel & Distributed DB systems
    - I/O Libraries
  - **Grid Monitoring & Management**
  - **Collaborative Environment**
- **Collaborative Environments**
    - Create & Manage Virtual Organizations
    - Multi-Comp Distr Application-building
    - Managing Resources through common Access methods
  - **Research Initiatives**
    - Scheduling
    - Rescheduling, Migration, Redistribution
    - Checkpointing
    - Fault tolerance
    - Application Specific MW Development
    - Performance Modelling of Applications

# GARUDA-Project Dissemination Mechanisms

- Website : [www.garudaindia.in](http://www.garudaindia.in)
- Workshops on Grid Computing
  - Held in collaboration with CERN at Bangalore, Delhi and Pune in February 2006
- Workshops on GARUDA deployment.
- National Workshops on Applications Enablement On Garuda (DAG).
- Internal Trainings on Grid Technologies & Tools
  - Moab Grid Scheduler by Cluster Resources, USA
  - Storage Resource Broker by Nirvana, USA
  - C-DAC GARUDA SIGMA for deployment at partner sites
- Workshops GARUDA Introduction at GARUDA partner locations.
- GARUDA Partner Meets: at regular intervals

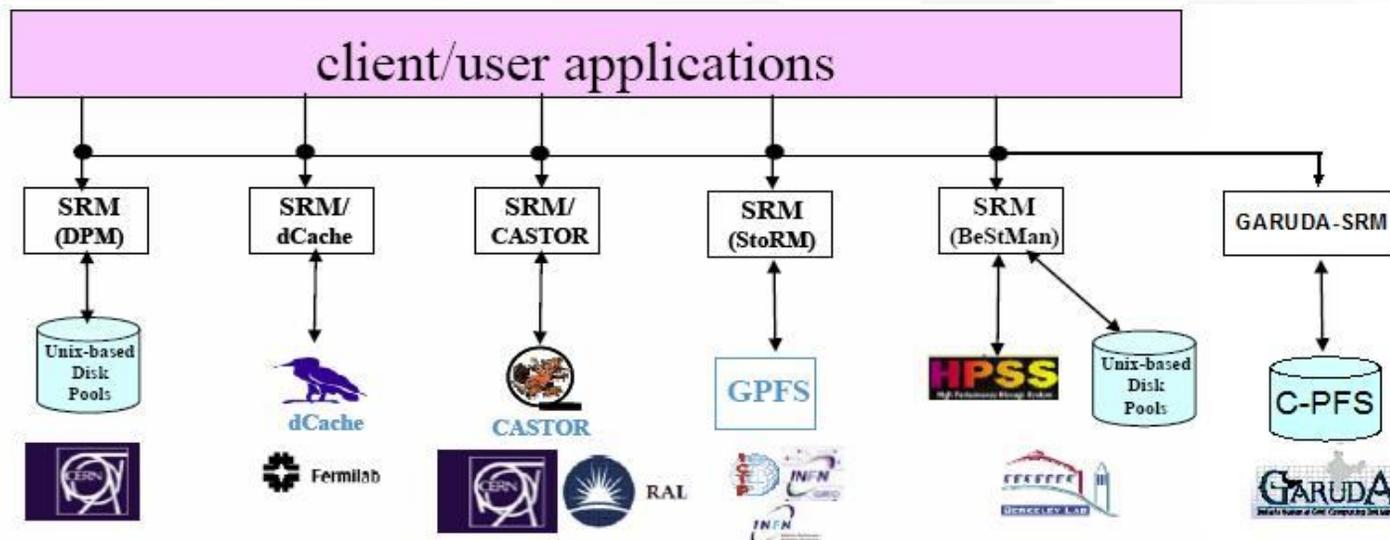
The screenshot shows the GARUDA India website interface. At the top, it says 'GARUDA INDIA The National Grid Computing Initiative'. There are navigation links for 'About C-DAC | Home | Downloads | Site Map | Contact Us'. Below that is a menu with 'Partner Information', 'Technology & Research', 'Computational Resources', 'Network Fabric', 'Collaborations', 'Events', and 'Related Links'. On the left side, there are buttons for 'Partners Login', 'New Content & Updates', and '2nd PARTNERS MEET'. The main content area features a 'PARAM Supercomputer' image and a 'Welcome to GARUDA [The National Grid Computing Initiative]' message. Below this, there is a text block describing GARUDA as a collaboration of science researchers and experimenters on a nation-wide grid of computational nodes, mass storage and scientific instruments. It also mentions that the Department of Information Technology (DIT), Government of India has funded the Centre for Development of Advanced Computing (C-DAC) to deploy the nation-wide computational grid 'GARUDA'. To the right of the text is a 3D diagram of a grid architecture with components like 'Grid Applications', 'Access Methods', 'Management and Monitoring Tools', 'Data Management', 'Development/Computation', 'Resource Management & Scheduling', and 'Resources'. Below the diagram, there are three bullet points: 'Objectives', 'Deliverables', and 'Component Architecture'. At the bottom of the page, there is a footer with the same navigation menu as the top.

# Data Management Challenges for GARUDA



- Unified access point for **distributed** and **heterogeneous** storage resources.
- **24x7 availability** of storage for jobs submitted to GARUDA with the support of storage reservation.
- **Dynamic Space Management** that enables efficient storage usage.
- **Adherence to international grid storage standards** to support **interoperability** with other grids like EU grid.
- **Scalability** to cater the huge IO storage requirements of data intensive scientific applications of fields like :
  - **Bioinformatics**
  - **Particle Physics**
  - **Biomedical informatics**
  - **Healthcare**
- **High performance IO access** to storage for Real Time parallel applications.
- Grid service as GARUDA is based on **service oriented architecture**.

- GARUDA is based on SOA adhering to OGSA model.
- SRM implementations are based on OGSA
- GSRM is based on open source Disk Pool Manager (DPM) SRM implementation
- GSRM services are available for users as web services.
- GSRM support high performance file systems.



The objective of this project is to develop a Storage Solution customized for GARUDA users requirements.

## Advantages of SRM in Garuda Grid:

- SRM works as a web service that adheres to OGF standards
- Easily integrates with GRID services like Information service , MDS , RLS .
- Provides space reservation for data intensive applications
- Provides security using GSI , VOMS
- Scalability
- Access to File systems, Mass storage systems
- Implementations are interoperable

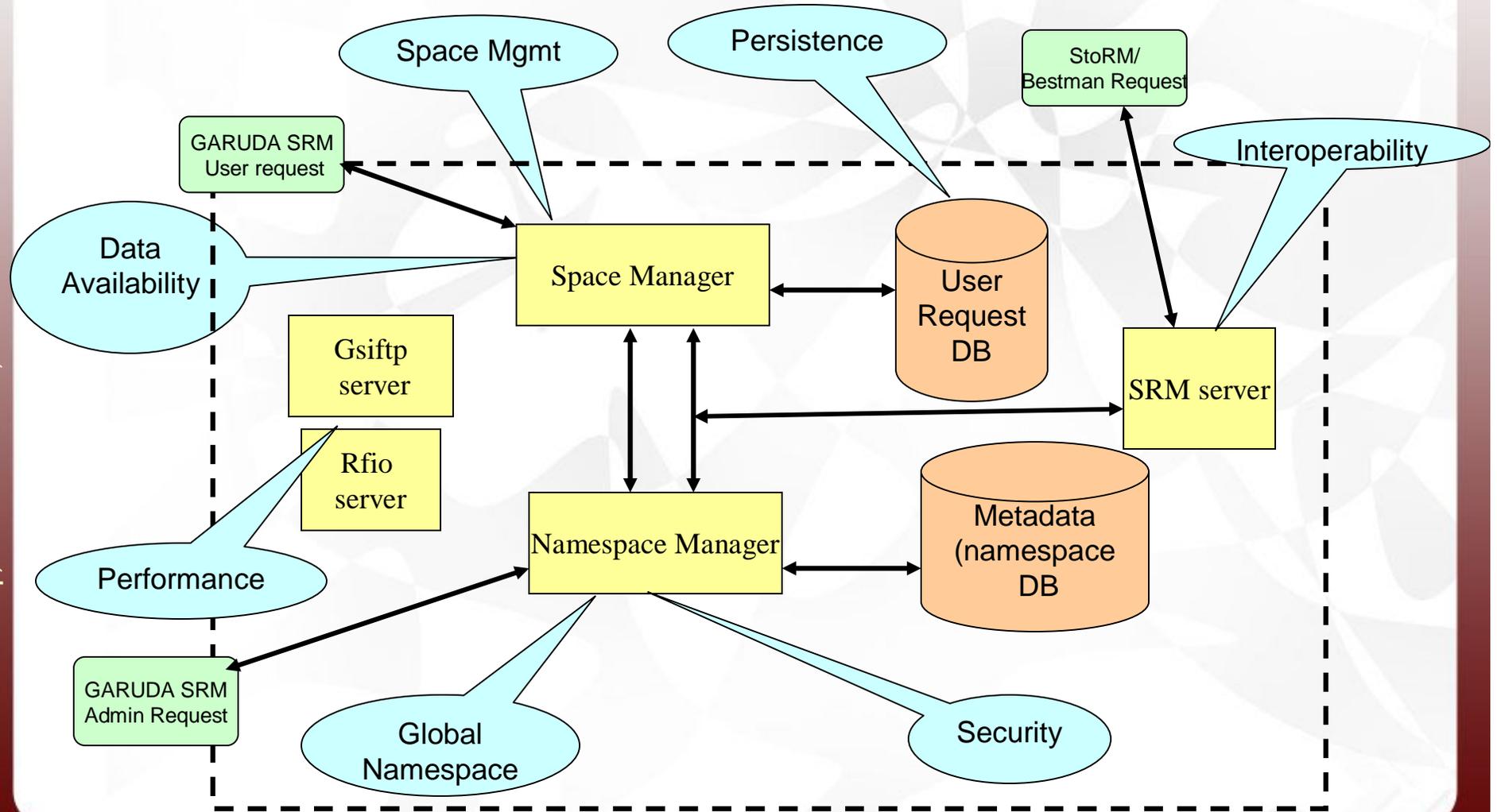
# Experiences with SRM Implementations

SRM Implementations	Pros	Cons
<b>StoRM</b>	<ul style="list-style-type: none"> <li>•GT4 support</li> <li>•Parallel file system support</li> </ul>	<ul style="list-style-type: none"> <li>•Strict binding with OS(SE &amp; RHEL4-update4)</li> <li>•only binary distribution is available through rpms, no source code availability</li> <li>•Space reservation is not working properly</li> <li>•XML-RPC Communication error</li> <li>•No support from storm team for troubleshooting</li> </ul>
<b>Bestman</b>	<ul style="list-style-type: none"> <li>•Works on all versions of linux</li> <li>•Easy installation &amp; maintenance</li> <li>•Space reservation working with cmd line</li> <li>•Provides support through chat group or email</li> <li>•Licensed source code available with nominal charges</li> </ul>	<ul style="list-style-type: none"> <li>•No support for GT4</li> <li>•Lack of complete set of BestMAN JAVA APIs</li> </ul>
<b>DPM</b>	<ul style="list-style-type: none"> <li>•Recommended platform :Scientific Linux but also works on Red Hat Linux</li> <li>•Easy installation &amp; maintenance</li> <li>•Most of the required functionalities working fine</li> <li>•Free Source code available</li> <li>•Data Replication facility inbuilt</li> <li>•Parallel file system support</li> </ul>	<ul style="list-style-type: none"> <li>•No Support for Mass storage system</li> </ul>

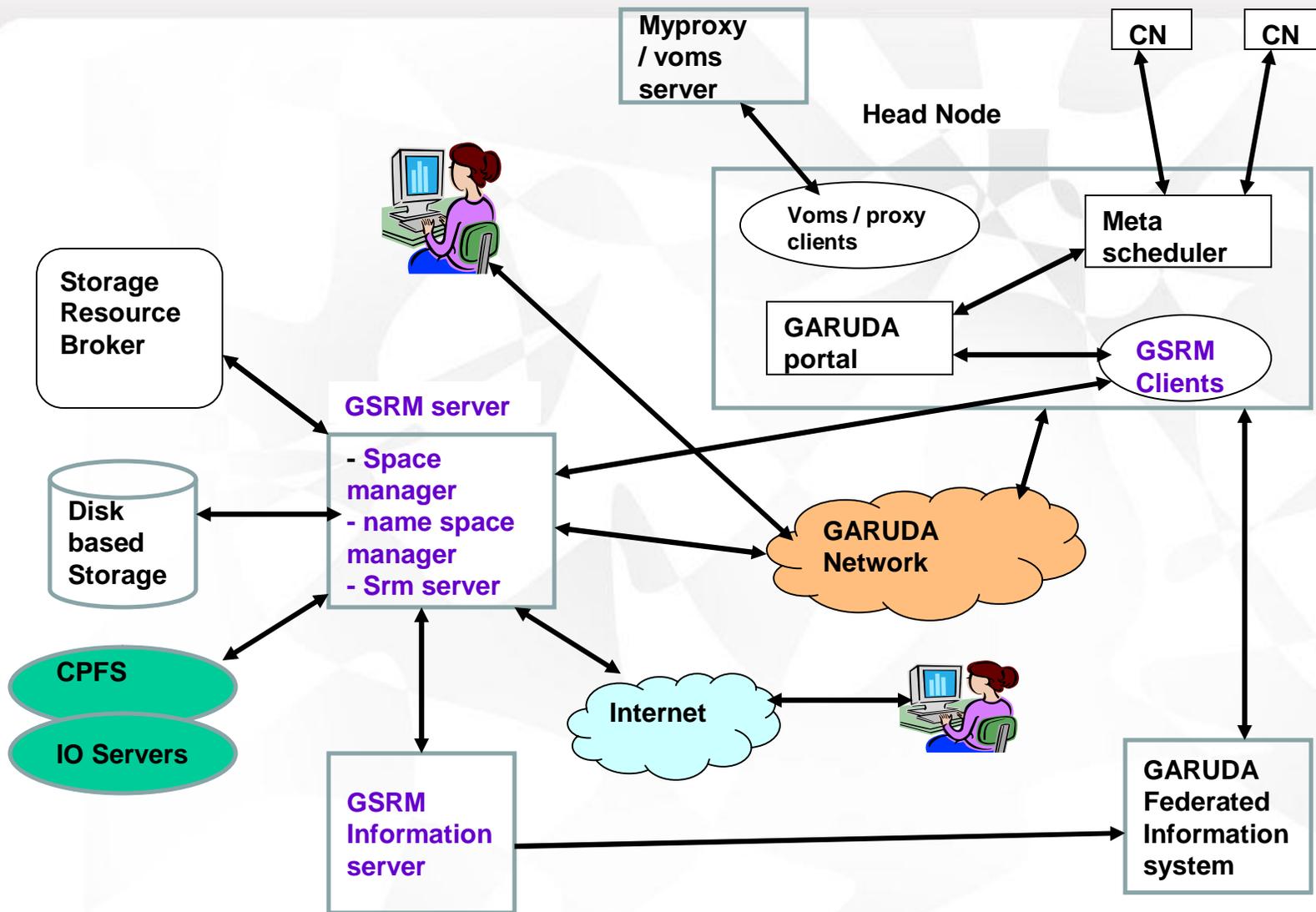
# GSRM Highlights

- **Global Namespace**
- **Availability**
- **Space Management**
- **Security**
- **Interoperability**
- **Performance**
- **Persistence**

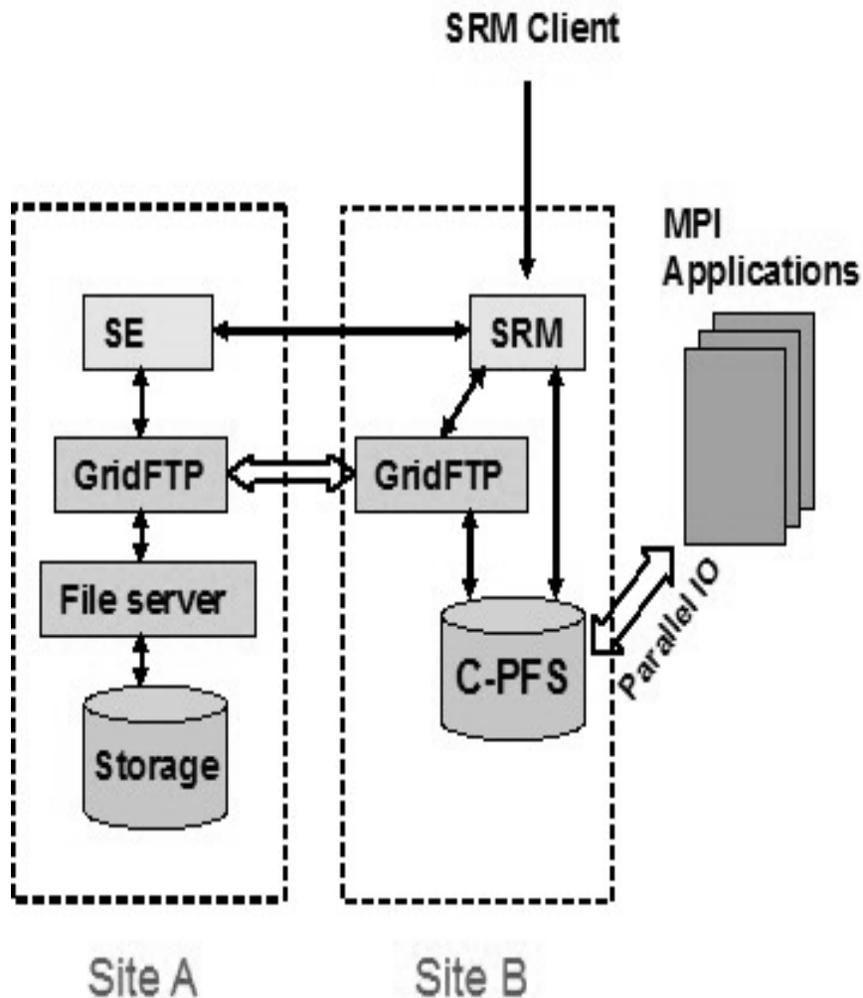
# GSRM Highlights & Components Mapping



# GSRM Architecture & Integration with other GARUDA middleware components

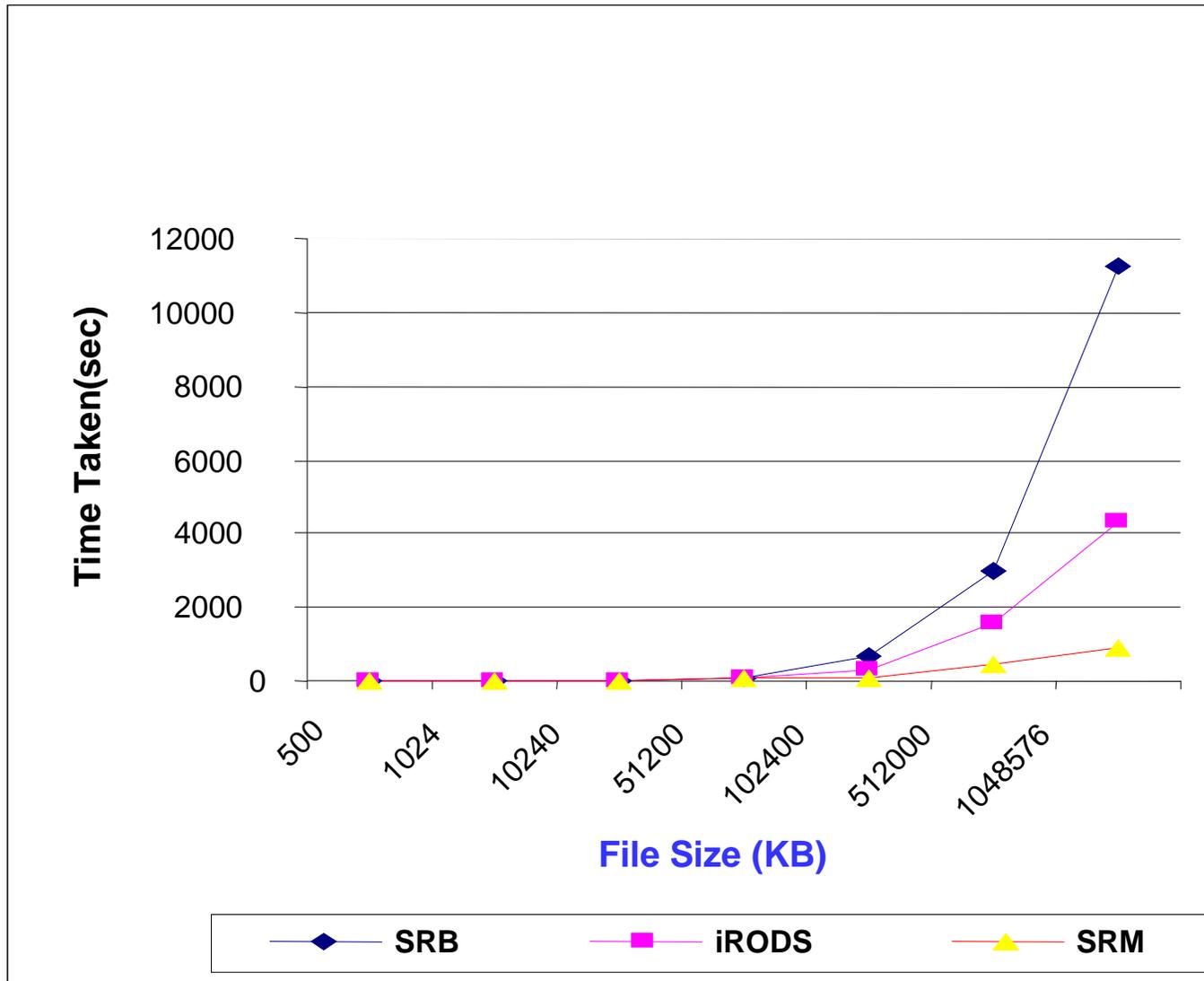


# Usage Scenario of GSRM By Parallel Applications



- Client initiates transfer of all the inputs files from the storage element (SE) using *srmPrepareToPut* command
- Client also specifies requisite parameters such as lifetime required for the files and **space token** received from *srmReserveSpace* command
- storage space is maintained by C-PFS with multiple IO servers with locally attached storage.
- actual file transfer can be carried out by GridFTP protocol using the **transfer URL (TURL)** returned by *srmPrepareToPut*.
- **file data is striped** across file servers and the backend C-PFS driver can issue request to reconstruct the files.

# Multisite Data transfer using SRB, SRM, iRODS



# Conclusions

- **GARUDA**: SOA based Grid Architecture providing distributed integrated environments to develop scientific applications.
- **SRM** is the optimal data grid solution for GARUDA
- **SRM based GARUDA Data Solution-GSRM**: adheres to grid open standards, support interoperability
- **Proposed GARUDA SRM (GSRM)** :
  - provides well-defined and interoperable interfaces
  - Integrate with High performance C-DAC parallel file systems
  - Facilitate high aggregate IO bandwidth for parallel applications.

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**Thank you!**

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