

GridLab Middleware and Tools

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Baltic Grid Conference, Vilnius, Lithuania, 6 October 2004



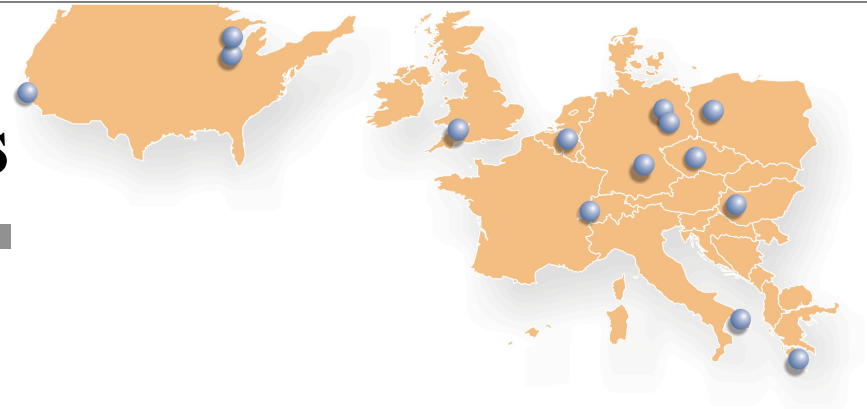
GridLab Project



- Funded by the EU (5+ M€), January 2002 – March 2005
 - Application and Testbed oriented
 - Cactus Code, Triana Workflow, all the other applications that want to be Grid-enabled
 - Main goal: to develop a Grid Application Toolkit (GAT) and set of grid middleware services and tools...:
 - resource management (GRMS),
 - data management,
 - monitoring,
 - adaptive components,
 - mobile user support,
 - security services,
 - portals,
- ... and test them on a real testbed with real applications



GridLab Members



- PSNC (Poznan) - coordination
- AEI (Potsdam)
- ZIB (Berlin)
- Univ. of Lecce
- Cardiff University
- Vrije Univ. (Amsterdam)
- SZTAKI (Budapest)
- Masaryk Univ. (Brno)
- NTUA (Athens)
- Sun Microsystems
- HP
- ANL (Chicago, I. Foster)
- ISI (LA, C.Kesselman)
- UoWisconsin (M. Livny)

collaborating with:

Users!

EU Astrophysics Network,

DFN TiKSL/GriKSL

NSF ASC Project

other Grid projects

Globus, Condor,

GrADS,

PROGRESS,

GriPhyn/iVDGL,

Most of the other European Grid Projects
(GRIDSTART)

GWEN

InteliGrid

Clusterix

SGI Grid

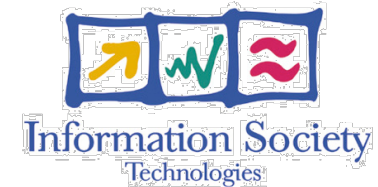
HPC-Europa

Canadian Grid Infrastructure

.....



GridLab's scope



- GridLab project is one of the biggest EU research and development undertakings in the development of application tools and middleware for Grid environments,
- It produces a set of **application-oriented Grid services and toolkits** providing capabilities such as **dynamic application scenarios, adaptive resource and data management, security** on the VO and resource level, **Grid portal framework** and more...
- Services are accessed using the Grid Application Toolkit (GAT)
 - GAT provides applications with access to various GridLab and third-party services, resources, specific libraries, tools, etc. in a way that the end-users and especially application developers can build and run applications on the Grid without needing to know details about the runtime environment in advance.



Vision



● Goals

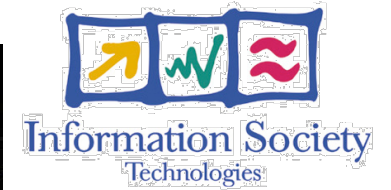
- Enable all Apps to take full advantage of Grids
- Develop
 - toolkits for non-Grid programmers to create these Apps
 - services to enable them
- Unlock innovative power of Grids with new paradigms
 - Automatic resource discovery, distribution of tasks, spawning, migration, reconfiguration, collaboration...many papers on subject

● Grid Application Toolkit (GAT)

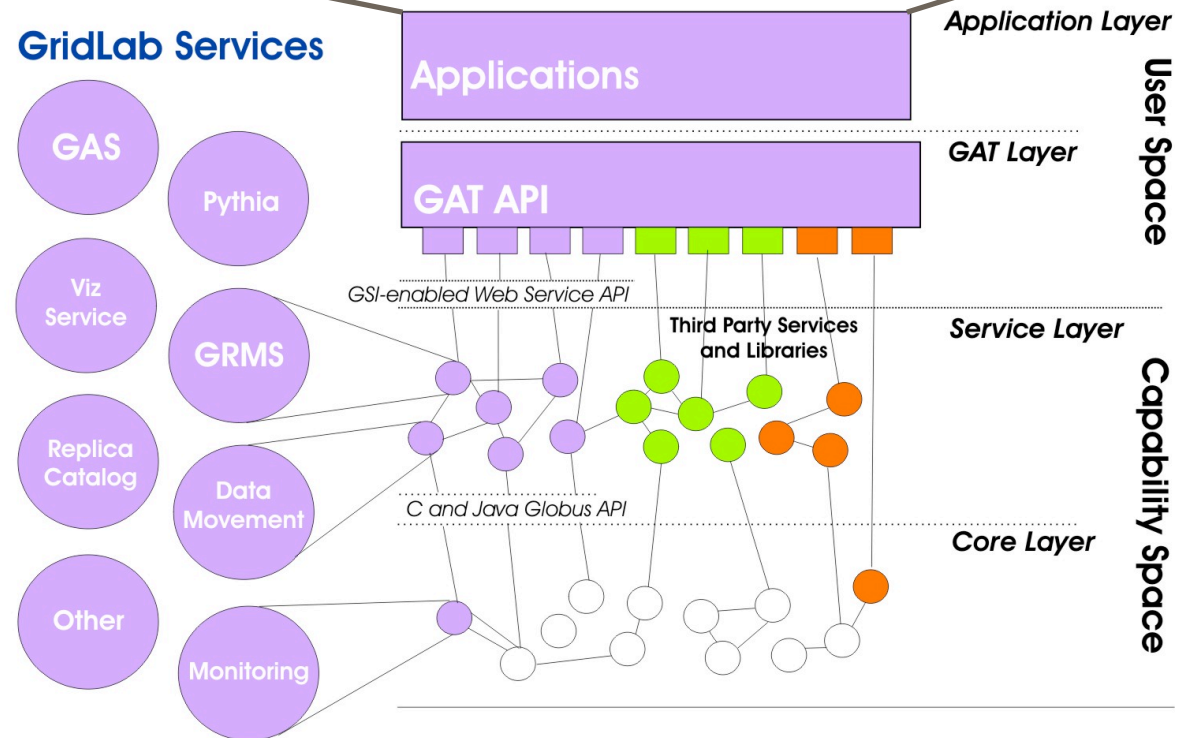
- Abstracts services at application level: simple
- Makes apps ind. of any infrastructure, endowed with grid capabilities
- Wide adoption: we expect to change the way computing is done

● Migration Scenario

- Innovative in its general implementation
- Building block (but complex!) for much more advanced scenarios

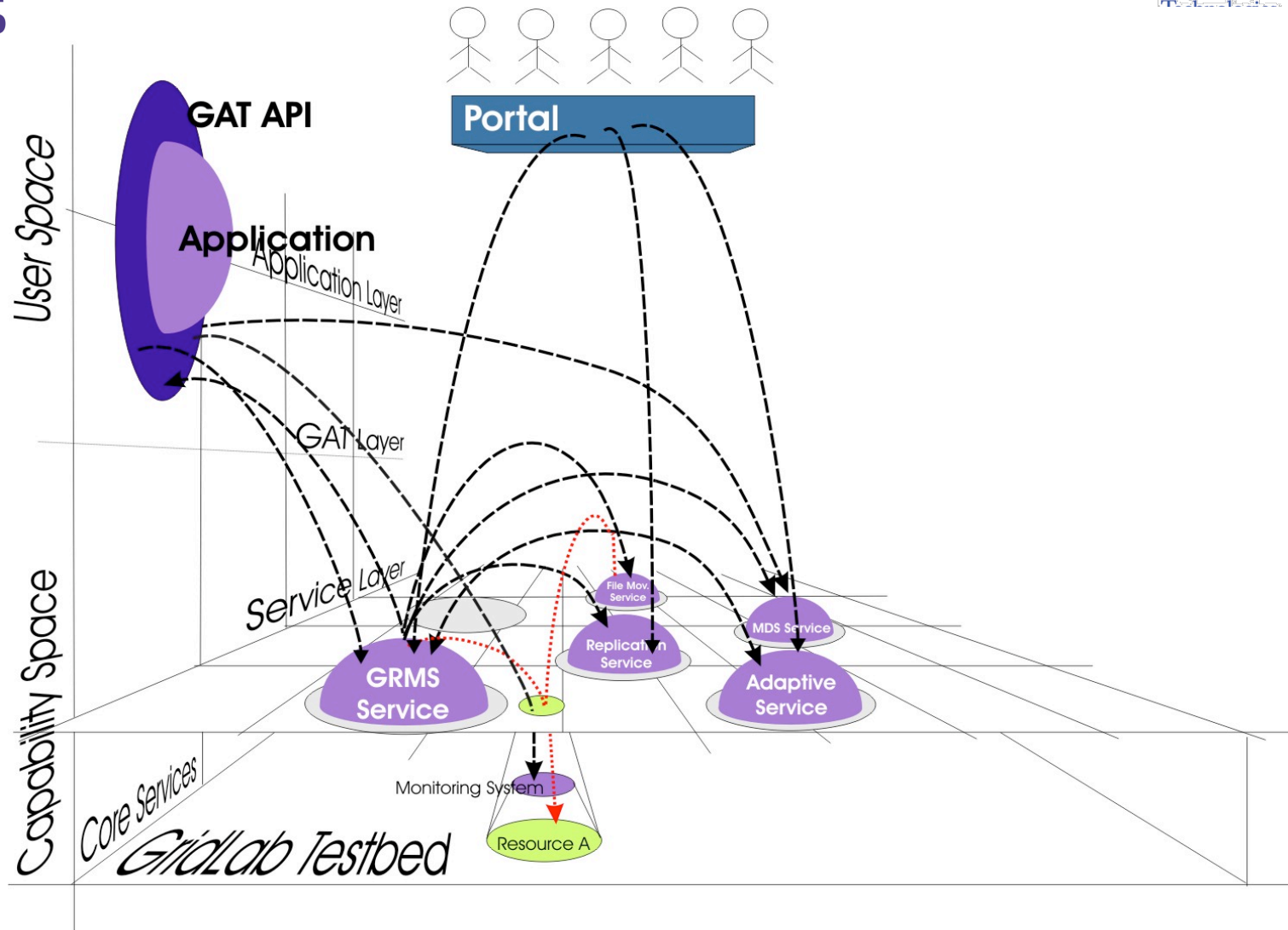


GridLab Architecture

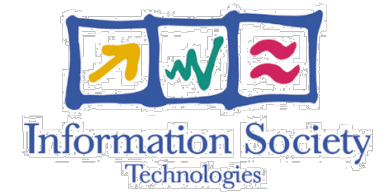




GridLab architecture (3D view)



Baltic Grid Conference, Vilnius, Lithuania, 6 October 2004



GridLab = GAT + Services

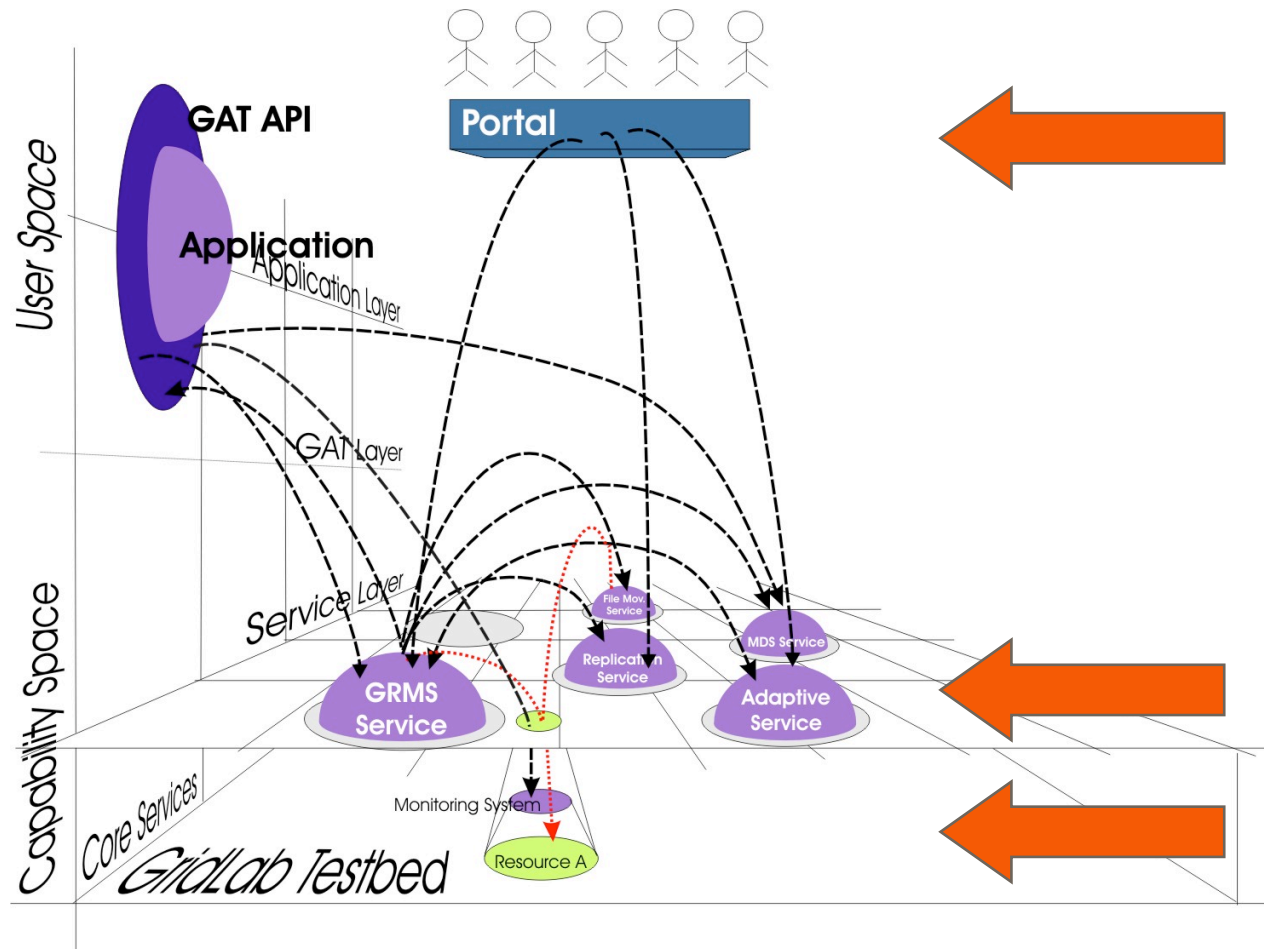


What are the GL services?



- Testbed Services (including testbed monitoring)
- Monitoring Services (***Mercury***)
- Adaptive Services (***Pythia*** and ***Delphoi***)
- Information Services (***iGrid*** information service)
- Data Management and Visualization Services
- Authorisation Service (***GAS***)
- Resource Management Services (***GRMS***)
- Portal Framework (***GridSphere***)
- Mobile User Support

Testbed Services





Testbed Services



machine	GIIS	MDS ext	GRIS	Gatekeeper	FTP	CA	mapfile	GSISsh	software	Jobmanagers	
skirit.ics.muni.cz	OK	OK	OK	OK	OK	OK	OK	OK	OK	jobmanager-fork	jobmanager-pbs
fs0.das2.cs.vu.nl	OK	OK	OK	OK	OK	OK	OK	OK	OK	jobmanager-fork	jobmanager-pbs
kiwi.zib.de	OK	fail	OK	OK	OK	OK	OK	OK	OK	jobmanager-fork	
sierra0.unile.it	OK	OK	OK	OK	OK	OK	OK	OK	fail		
origin.aei.mpg.de	OK	fail	OK	OK	OK	OK	OK	OK	fail	jobmanager	
n0.hpcc.sztaki.hu	OK	fail	OK	OK	OK	OK	OK	OK	fail		
onyx3.zib.de	OK	fail	OK	OK	OK	OK	OK	OK	fail	jobmanager	
gridentry.uni-paderborn.de	fail	fail	OK	OK	OK	OK	OK	OK	OK	jobmanager-ccs	
bouscat.cs.cf.ac.uk	fail	fail	OK	OK	OK	OK	OK	OK	fail	jobmanager-condor	jobmanager-fork
eltoro.pcz.pl	fail	fail	fail	OK	OK	OK	OK	fail	OK		prereq
grape.man.poznan.pl	OK	fail	OK	OK	OK	OK	fail	fail	fail		
sr8000.lrz-muenchen.de	fail	fail	fail	OK	OK	fail	fail	OK	fail		prereq
rage1.man.poznan.pl	fail	fail	timeout	fail	timeout	prereq	prereq	timeout	prereq		prereq
pclab120.telecom.ece.ntua.gr	fail	fail	fail	fail	fail	prereq	prereq	fail	prereq		prereq



Testbed Services



- Grid infrastructure status test/monitoring tools
- Centralized approach (one site starts all tests) and all results are available on the web page
- Both static and dynamic web pages supported
- Web service interface (SOAP over GSI-HTTP)
 - Can be used as a specific information service (GRMS)



Testbed Services



- Simple tests:
 - Globus 2 tests: GRIS, GridFTP, GSI-SSH (on port 2222),
 - Gatekeeper (including MPI job tests), *G/IS*
 - MPI C and MPI Fortran compilers availability
 - Job manager tests
 - Test normal and MPI jobs

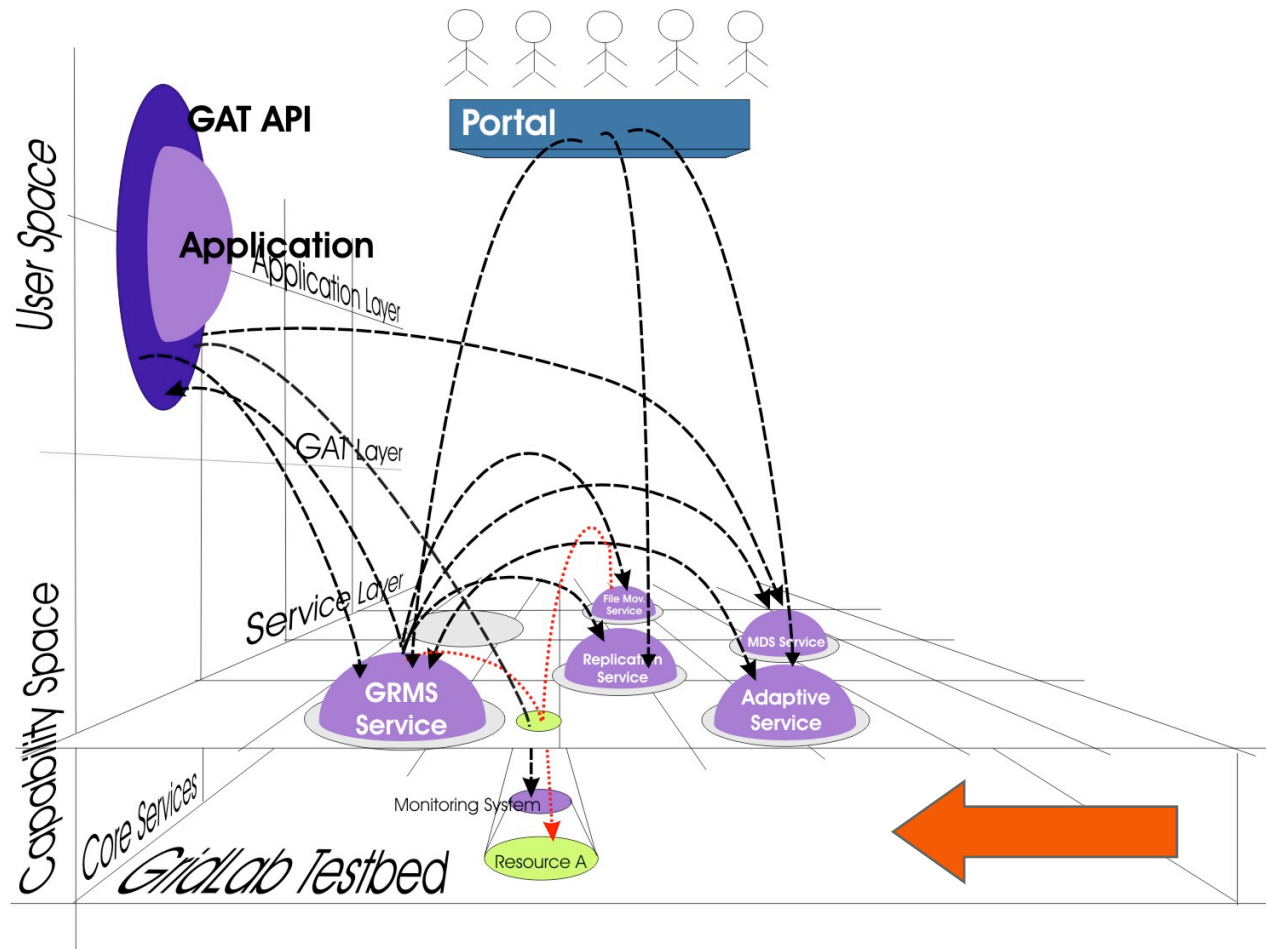


Testbed Services



- GridLab specific tests:
 - Accepted CAs
 - grid-mapfile integrity and completeness
 - GridLab Mercury
 - GridLab MDS Extensions and MDS web service
 - Required software installation and usability
 - Two stages: responsiveness and *functionality* of GridLab services:
 - getServiceDescription()
 - GRMS, Adaptive service, Meta-data service, Replica Catalog, *DataMovement*, Data Browsing, Authorization, Message Box Service, Testbed Status
 - matrix tests (Data Movement): N-to-N tests

Monitoring Services





Monitoring Services



- Monitoring is the most low-level service in GridLab
 - Provides instant information about the state of hosts, services and jobs
- Goal: generic monitoring framework for the grid
 - it provides monitoring data represented as metrics via both pull and push model data access semantics and also supports steering by controls.
 - Must support host, resource and application monitoring
 - Must be easily extensible
 - Based on the Grid Monitoring Architecture (GMA) as proposed by the GGF
 - Support application steering (SIGNALS)

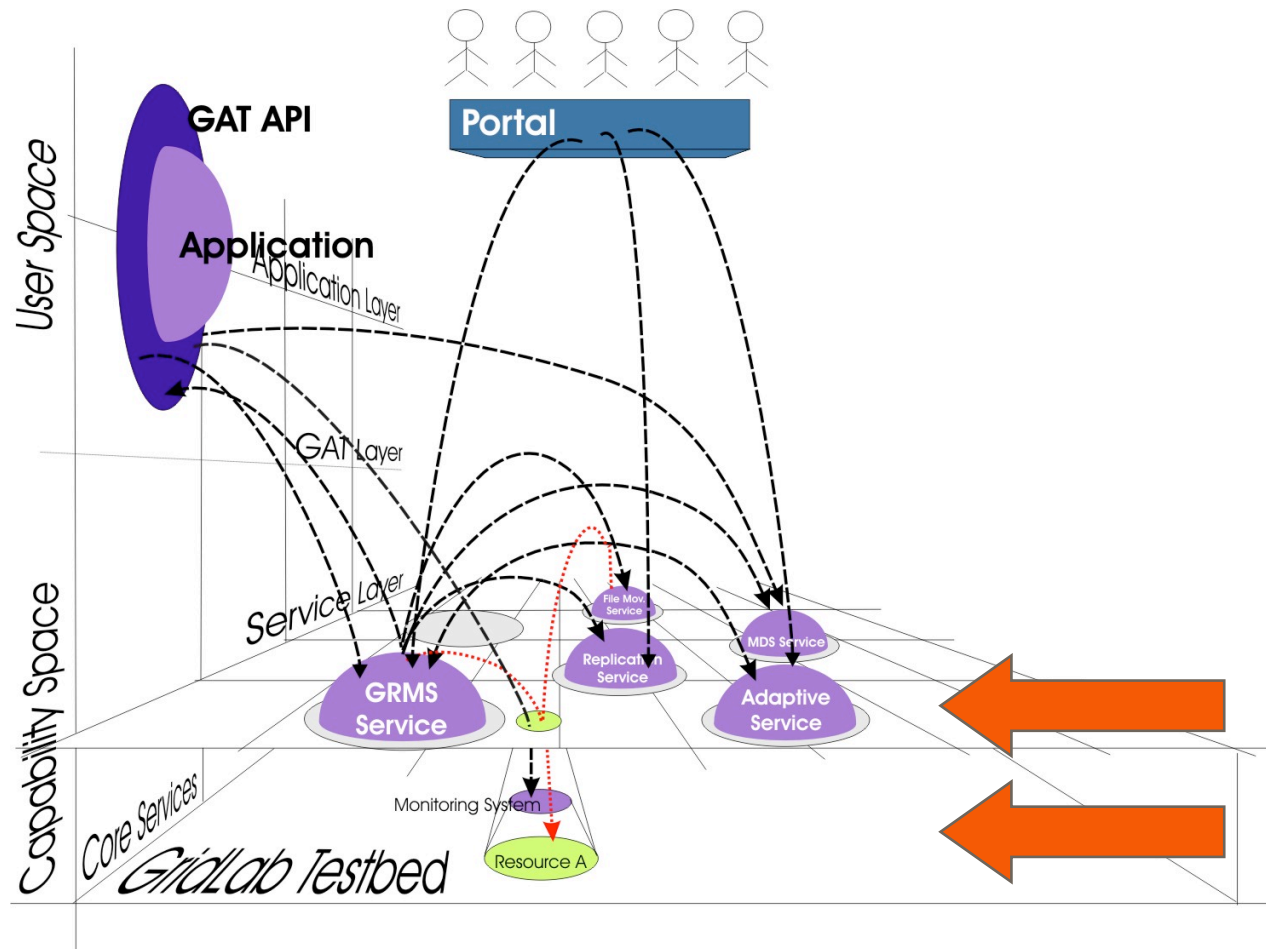


Monitoring Services

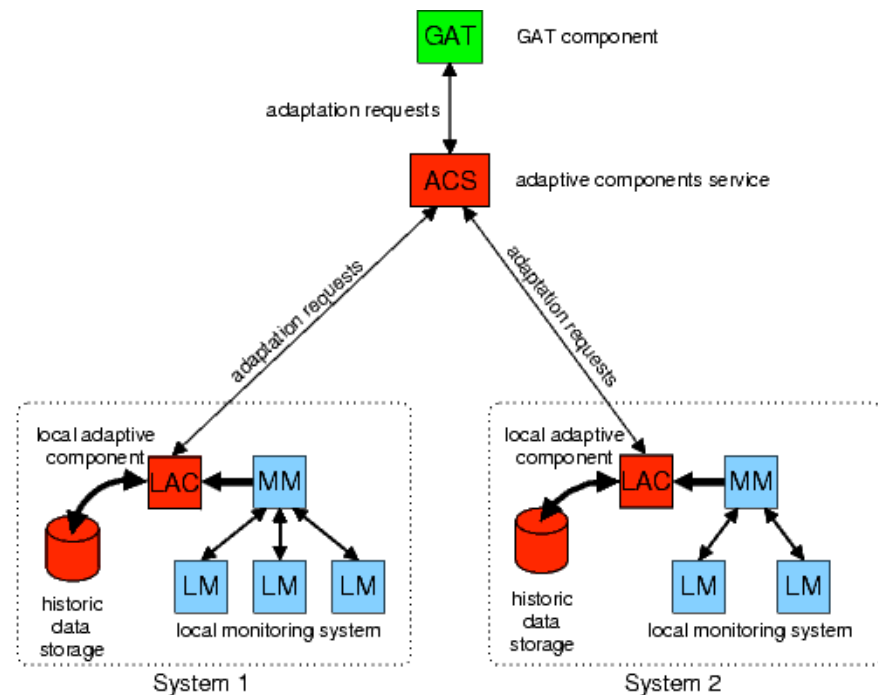


- Release 2.1.4 of the Mercury Monitoring System is installed on the GridLab testbed now
- Host monitoring is fully functional
 - Host are available for Linux, Irix, OSF/1, Darwin and Solaris
- Application monitoring is still under development

Adaptive Services

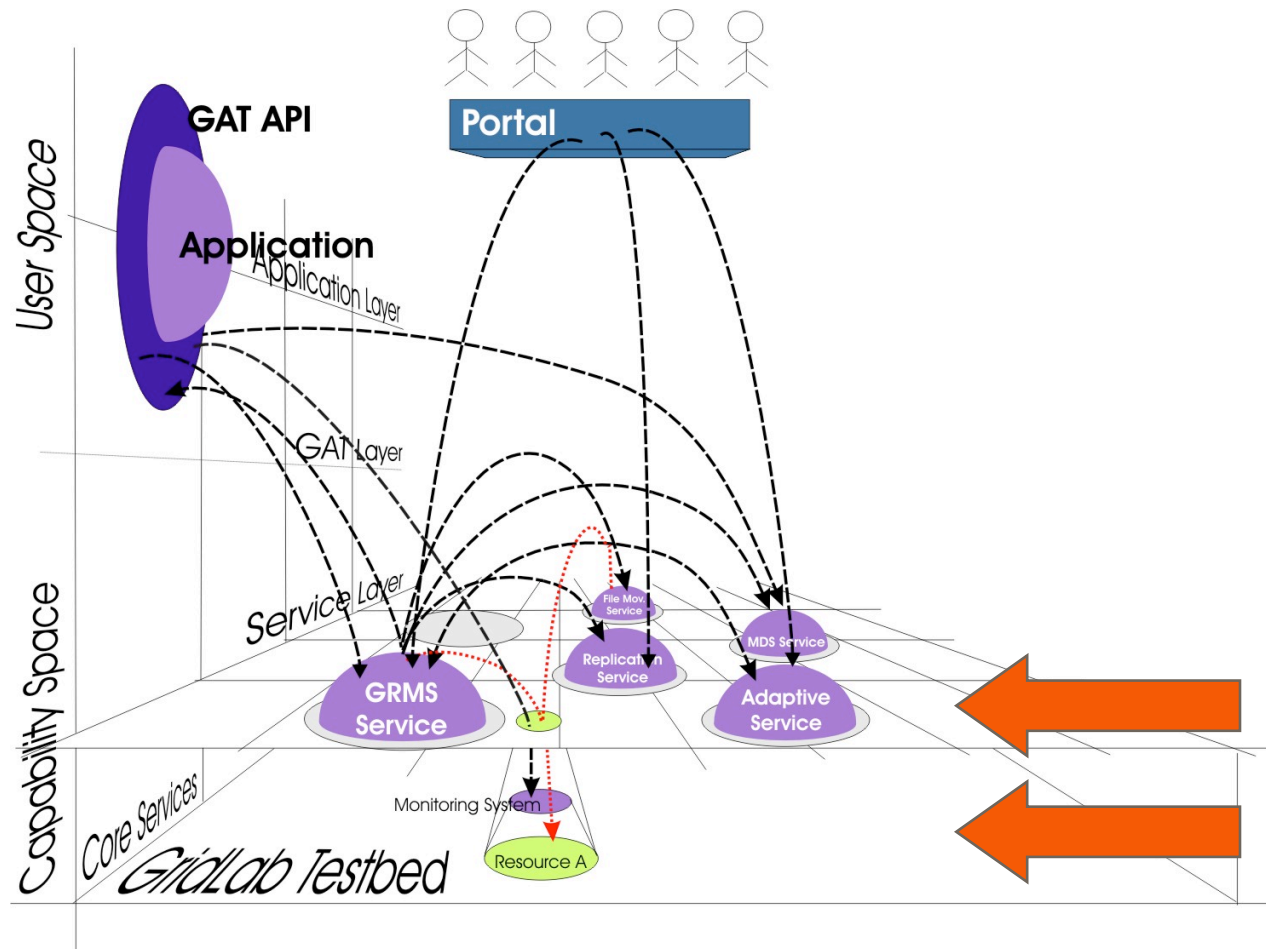
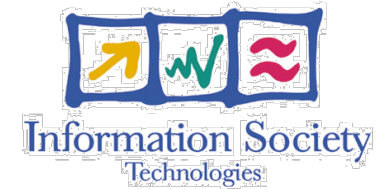


- Adaptive Components Service (ACS) and the Local Adaptive Components (LAC).
- ACS provides an interface to query the adaptive system. It currently supports calls to:
 - Useful statistics about queuing systems (PBS, SGE, Condor)
 - estimate transfer time
 - estimate usage (of some given metric)
- LAC uses the monitoring system (shown in blue), to continuously collect data about the resource and applications running on it (load information, queue lengths, network bandwidth to other machines, etc.).





Information Services (*iGrid*)





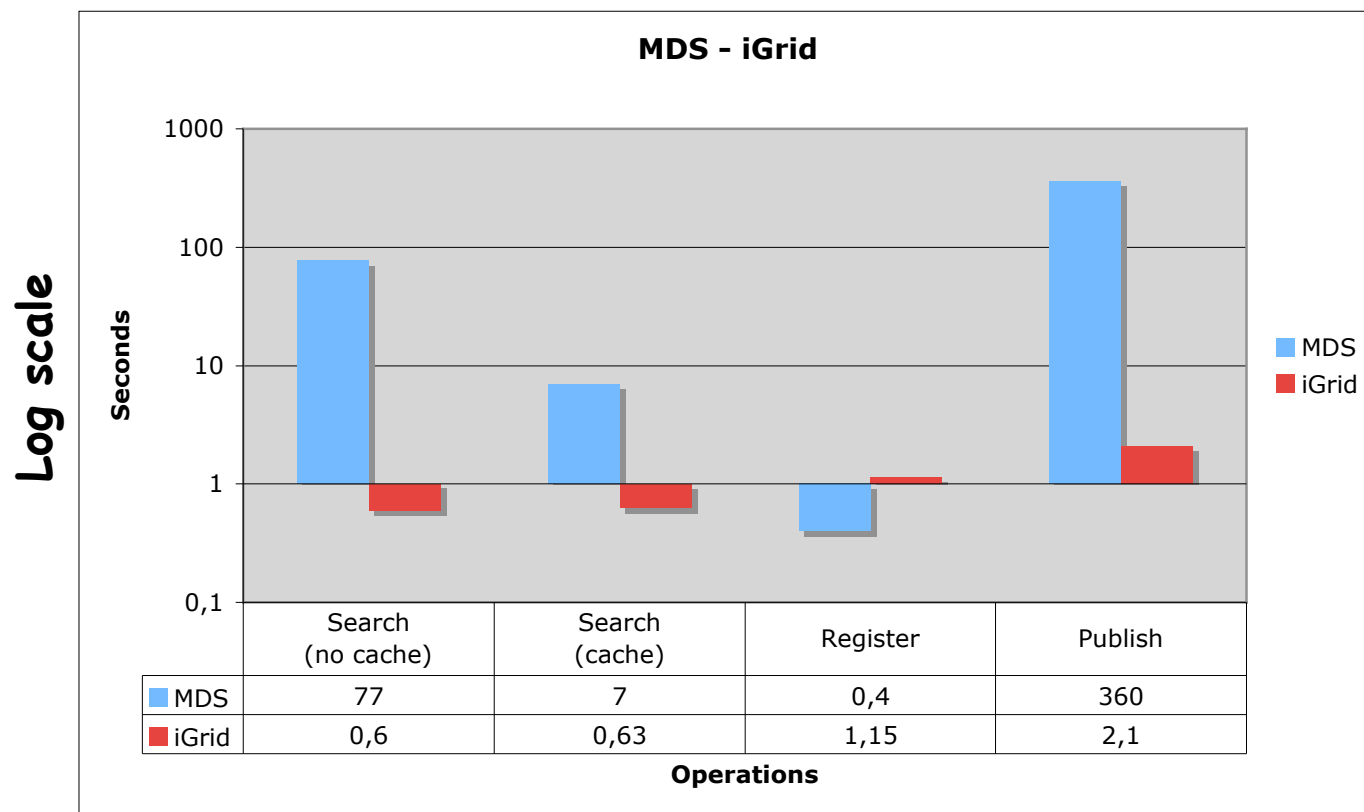
iGrid Features



- Web Service interface
- Support for Globus GSI security mechanism
 - Through our GSI Plugin for gSOAP Toolkit
- Distributed architecture
- Fault tolerant
- Based on relational DBMS
- Support for SSL binding to DBMS
- Support for heterogeneous DBMS
 - Through our GRelC library
- Easy to extend with new information providers
- Includes support for GAS authorization service (WP6)
- Includes support for logging service (WP11)
- Platforms: linux, Mac OS X, tru64, irix
- Extreme Performances

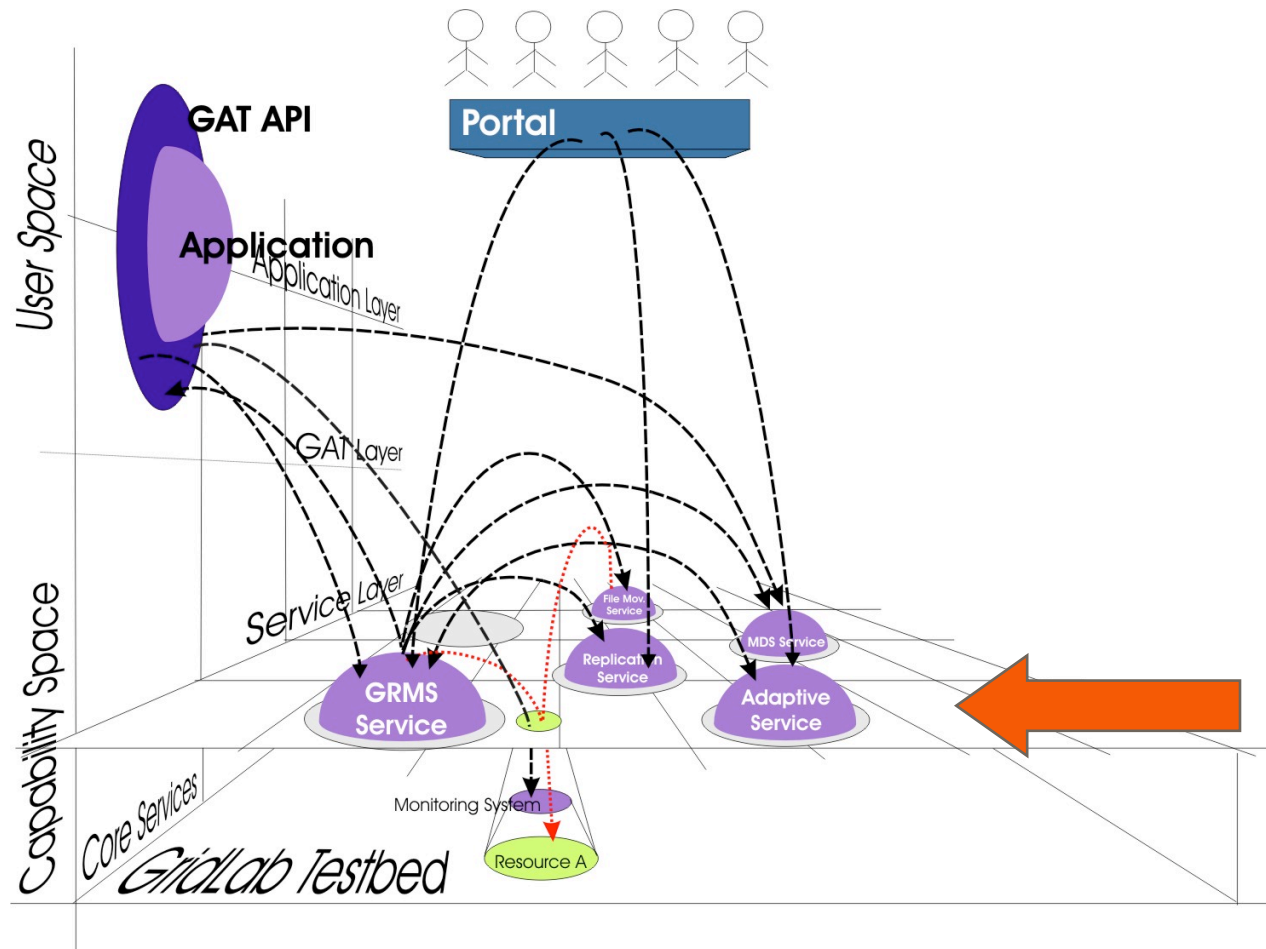
iGrid vs Globus MDS 2.4

Performance





Data Management and Viz Services

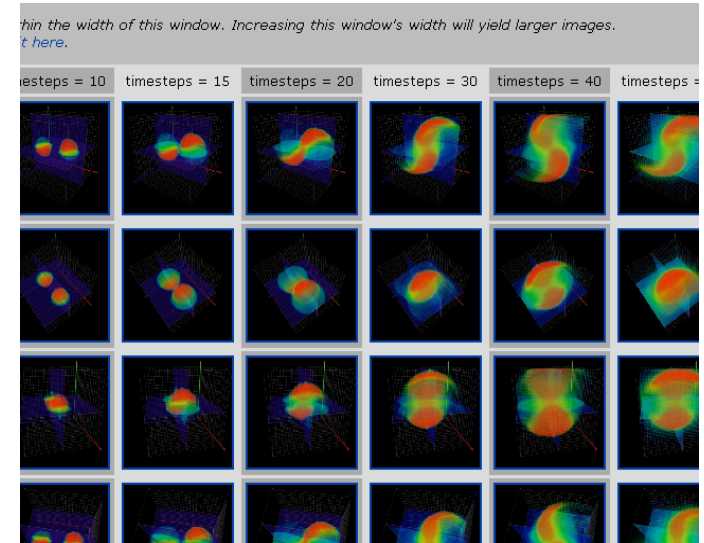


Visualization

- Access to grid resources from existing viz applications
- Access to existing viz applications from the grid

Mobile devices

- Access to viz services from mobile phones, PDAs
- Development of grid-enabled “mobile” viz devices





Visualization service

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Stop <http://litchi.zib.de:555/viz/service/job/3/> Search Print

BH param / GL test (6 Mar 2004)

core parameters

parameter file:	pi3-g0-b3.4a1p4-192.par
run date:	6 Mar 2004
user:	pollney
executable:	cactus_bh (24 Apr 2003)
machine:	platinum.ncsa.uiuc.edu
procs:	32
duration:	24:00:00, 65M, 2182 iterations
output:	platinum:/storage/pollney/pi3/pi3-g0-b3.4a1p4-192

viz links: ...jump ahead to...

1D:

2D:

3D:

initial data

position1:	(0, 1.8491, 0)
position2:	(0, -1.8491, 0)
momentum1:	(-0.2148, 0, 0)
momentum2:	(0.2148, 0, 0)
spin1:	(0, 0, 0)
spin2:	(0, 0, 0)

evolution parameters

system:	BSSN
method:	icn
fd order:	2
outer boundary:	newrad
excision boundary:	dtecopy

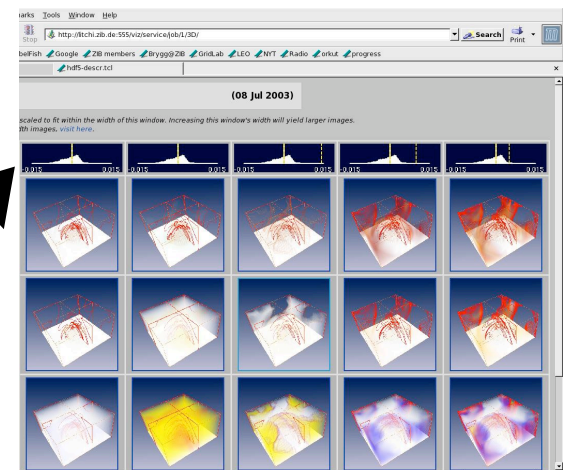
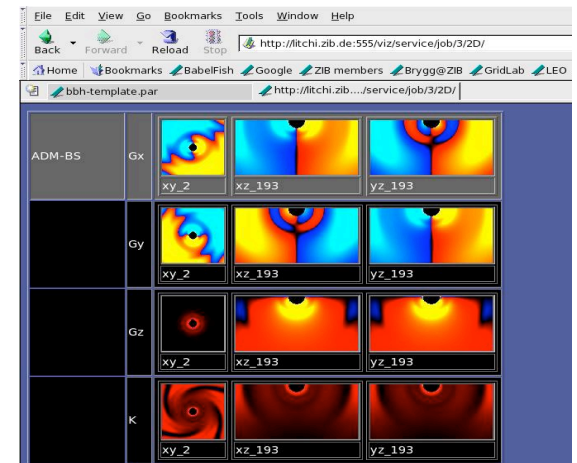
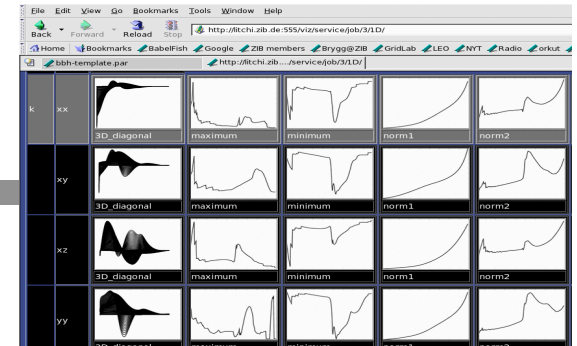
gauge

lapse:	1 + log	rotation W:	0.100876
initial lapse:	one	drift correct:	off
lapse Y power:	4	B driver:	4
lapse dissipation:	0.02	alpha power:	1
shift:	gamma0	Y power:	4
initial shift:	rotation		

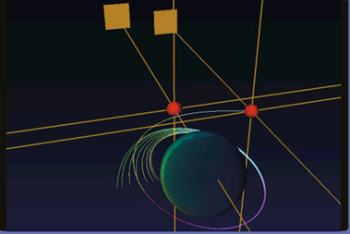
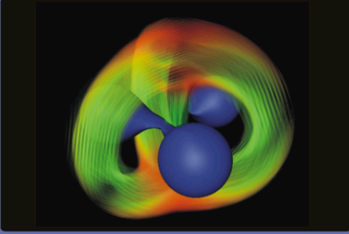
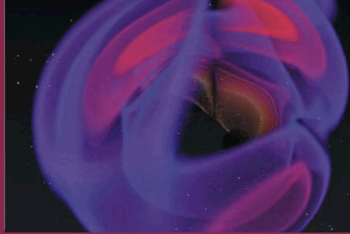
1D

2D

3D



Data cards

benger : bh influences 2/4 demo 	benger : numrel 4/4 demo 	normal : published 1/2 movie 
<ol style="list-style-type: none"> 1 kerr : star texture 2 kerr : galaxy texture 3 kerr : trajectories 4 kerr : crush ncc 5 bh : geodesics 6 bh : photon orbit <p style="font-size: small;">begun 2003-08-25 last modified 2003-08-26</p>	<ol style="list-style-type: none"> 1 kerr : particles 2 orbital colliding bh 3 3 colliding bh 4 5 6 <p style="font-size: small;">begun 2003-08-25 last modified 2003-08-26</p>	<ol style="list-style-type: none"> 1 discov : bh 2002 2 discov : 1st star 2002

- Represent online data, user credentials, remote users, parameters, etc.





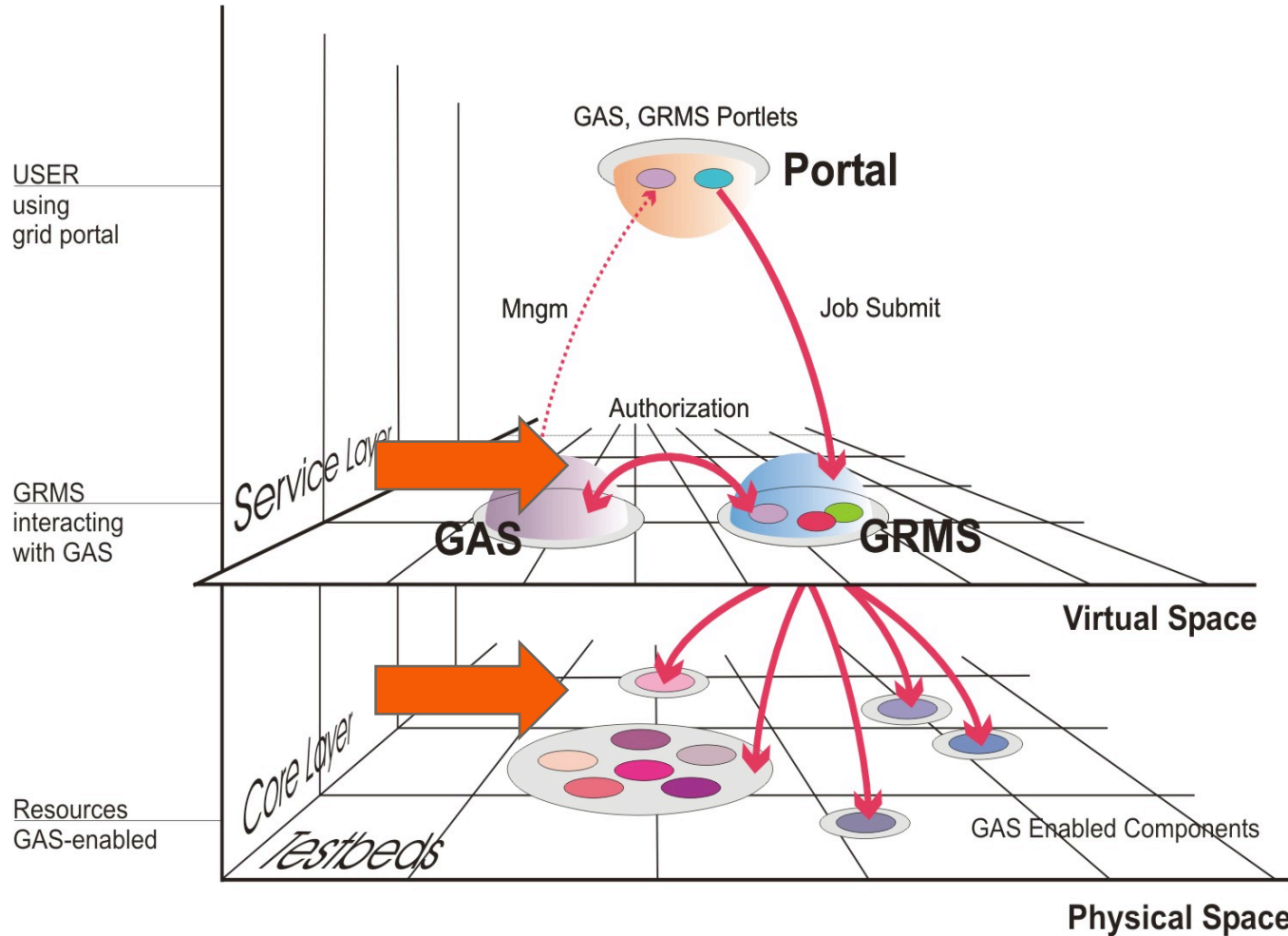
Replica Management Components



- **Replica catalog**
 - Supports hierarchical data organization
 - POSIX filesystem like interface
 - Uses C++ with SOAP/GSI interface
- **GAT-Adaptor**
 - Uses SOAP/GSI interface
- **File movement service**
 - Used for replication
 - Based on GridFTP
- **Adaptive service**
 - Ranks replica locations
 - Optimizes GridFTP parameters



GridLab Authorization Service



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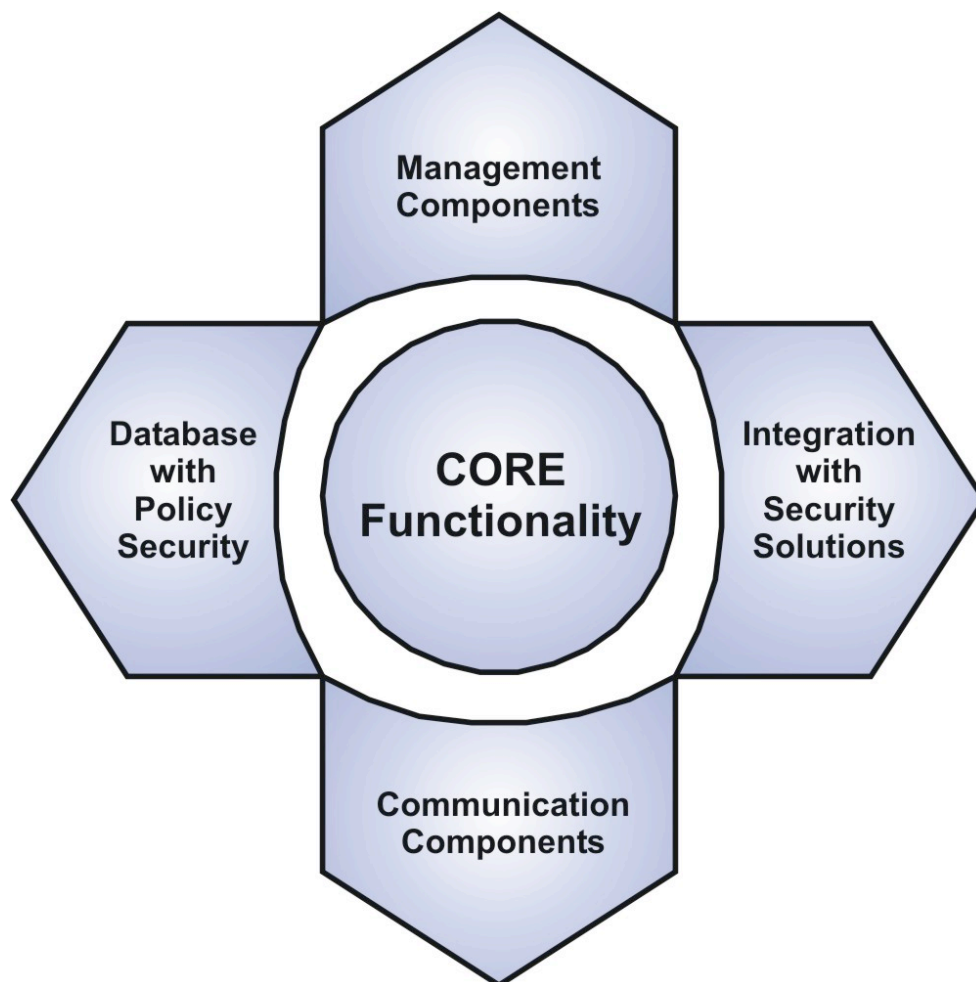
GridLab Authorization Service



- The GAS is designed in order to fulfill various requirements of complex grid-based computing environments.
- It is considered as an trusted single logical point for managing security policy for virtual organizations.
- Support for different scenarios of using GAS, with possibility to apply them simultaneously within single virtual organization.
- It is assumed to be independent from specific technologies applied to build any grid infrastructure.
- Modular structure allows to introduce new modules for communication, database support, service management, integration with external security solutions (e.g. GSI, WS-Policy)



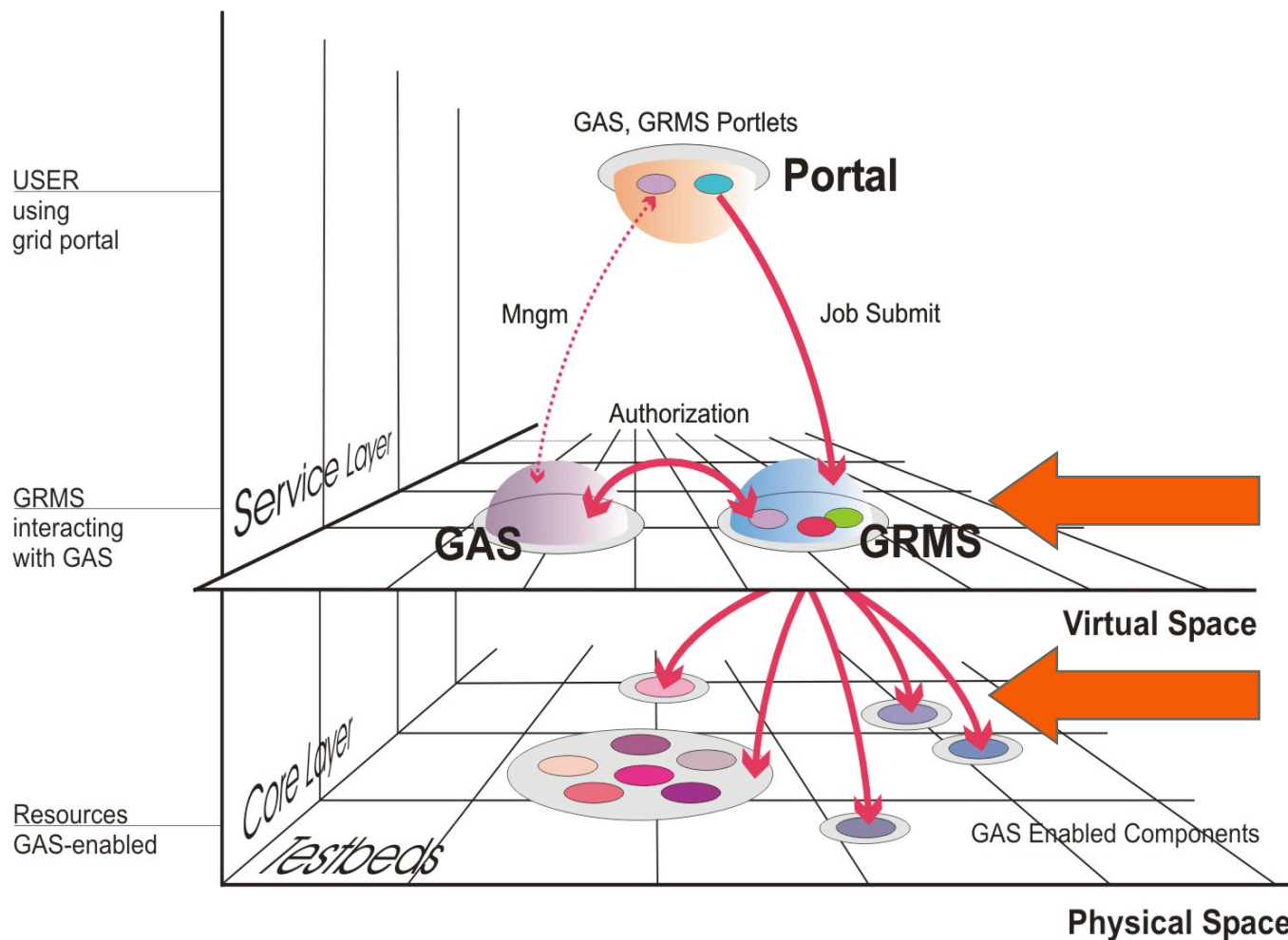
GridLab Authorization Service



- Management components
 - Administration of security policy (admin, user)
 - Security policy database
 - Storing of policy and maintaining its consistency
 - Communication Components
 - Communication with external services
- CORE Functionality
 - Generating full or partial security policy
 - Integration with security solutions



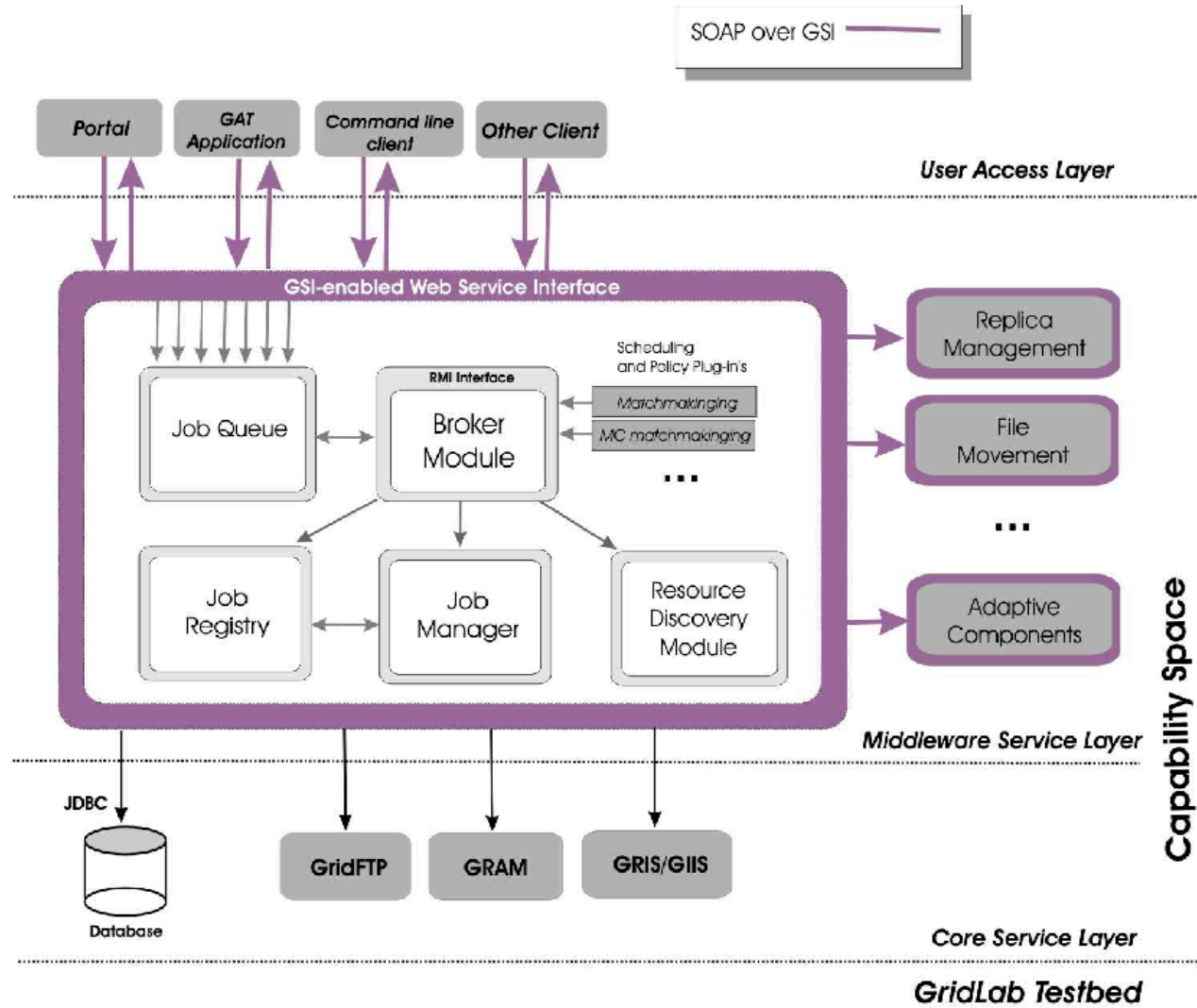
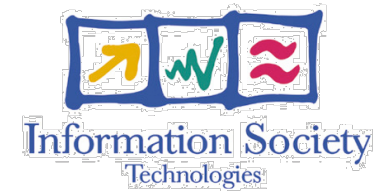
Resource Management Services (GRMS)



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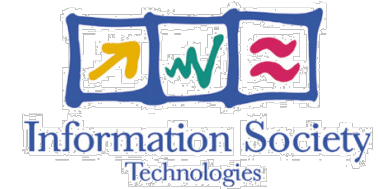


Resource Management Services (GRMS)





Resource Management Services (GRMS)



- Acts on behalf of users on resources and meet application requirements concerning resources and their environment,
- Stage-in and stage-out files required by jobs before and after executions using Core Services (GridFTP/GASS/FTP) or GridLab Middleware Services (Replica Catalog Service and Data Movement Service).
- Runs and controls precompiled batch jobs remotely,
- Runs and controls precompiled MPI batch jobs remotely,
- Runs Java applications remotely,
- Registers GAT applications and receive unique JOB IDs,
- Checkpoints GAT applications remotely,
- Migrates GAT applications remotely,
- Stores all historic information about job statuses and resources which have been used during a job submission process,
- Works with the Information Service to receive static and dynamic information about resources,
- Register GRMS in an Information Service,
- Works with Adaptive Components Service to get additional information about distributed resources and networks,



Resource Management Services (GRMS)



- List of jobs submitted by given user (information about jobs):
 - Job Description used for submission
 - Information about request progress
 - Name of host where the job is running
 - Submission time
 - Start time on resource
 - Finish time
 - History of job execution
- Due to a specific interface for registration of applications in the GRMS, more complex and more dynamic application scenarios are supported now.
- The functionality is available for all applications, in particular GAT enabled applications, which are able to register callback information in the GRMS and then wait for a checkpoint GRMS's call.



Resource Management Services (GRMS)



GridLab Architecture

Scenario I

GridLab Services

Application

Work-flow

Application Layer

User Space

Layer

Example Pegasus/Chimera work-flow

Service Layer

Capability Space

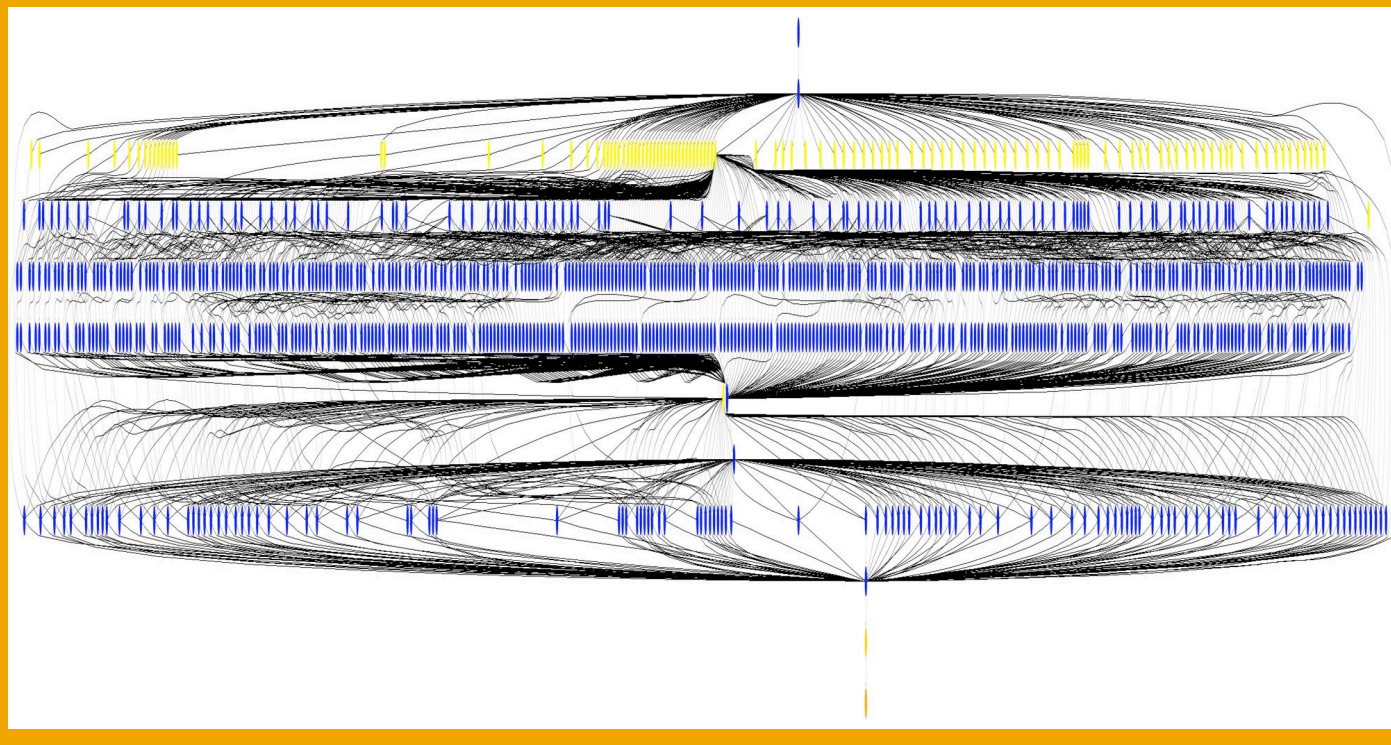
Resource Layer

AS

Apps Manager

Data Mgmt

Logging





Resource Management Services (GRMS) – Various clients



GridSphere Portal - Mozilla

http://elitoro.pcz.pl:8080/gridsphere/gridsphere?action=setJoblist&up=dTg&dTg_jobID=1078686598551%3Aappid%3A...

Welcome | GRMS Portlet and Services

GRMS Portlet

easy normal expert

Your identity : /C=PL/O=GRID/O=PSNC/CN=Juliusz Pukacki - (RemainingLifetime: 592381 s)

Job description		List of jobs																																			
Job description ID:	sleep-rage1																																				
Creation date:	Thursday, March 4, 2004 4:22:03 PM CET																																				
Last access:	Sunday, March 7, 2004 8:07:39 PM CET																																				
Last modified:	Thursday, March 4, 2004 5:07:54 PM CET																																				
<pre><gmsjob appid = "appid"> <simplejob> <resource> <hostname>rage1.man.poznan.pl/</hostname> </resource> <executable type="single" count="1"> <file name="sleep" type="in"> <urlfile:///bin/sleep/</url> </file> <arguments> <value>50</value> </arguments> </executable> </simplejob> </gmsjob></pre>		<input type="checkbox"/> autorefresh <input checked="" type="checkbox"/> job filtering <input type="button" value="set"/>																																			
		<input type="button" value="refresh"/> <input type="button" value="add notifications"/> <input type="button" value="reload"/>																																			
		<table border="1"> <thead> <tr> <th>JobID</th> <th>Info</th> <th>Migration</th> <th>Cancel</th> </tr> </thead> <tbody> <tr> <td>1078674364152:CGAT:1964</td> <td>show</td> <td>show</td> <td></td> </tr> <tr> <td>1078677301958:CGAT:8029</td> <td>show</td> <td>show</td> <td>cancel</td> </tr> <tr> <td>1078677370194:CGAT:8589</td> <td>show</td> <td>show</td> <td></td> </tr> <tr> <td>1078679867597:appid:8454</td> <td>show</td> <td>show</td> <td></td> </tr> <tr> <td>1078680268827:appid:6612</td> <td>show</td> <td>show</td> <td></td> </tr> <tr> <td>1078686483164:appid:2503</td> <td>show</td> <td>show</td> <td></td> </tr> <tr> <td>1078686598551:appid:0275</td> <td>hide</td> <td>show</td> <td></td> </tr> </tbody> </table>				JobID	Info	Migration	Cancel	1078674364152:CGAT:1964	show	show		1078677301958:CGAT:8029	show	show	cancel	1078677370194:CGAT:8589	show	show		1078679867597:appid:8454	show	show		1078680268827:appid:6612	show	show		1078686483164:appid:2503	show	show		1078686598551:appid:0275	hide	show	
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1078677301958:CGAT:8029	show	show	cancel																																		
1078677370194:CGAT:8589	show	show																																			
1078679867597:appid:8454	show	show																																			
1078680268827:appid:6612	show	show																																			
1078686483164:appid:2503	show	show																																			
1078686598551:appid:0275	hide	show																																			
<input type="button" value="save"/> <input type="button" value="load"/> <input type="button" value="new"/>		<table border="1"> <tr> <td>UserDN</td> <td>/C=PL/O=GRID/O=PSNC/CN=Juliusz Pukacki</td> </tr> <tr> <td>JobStatus</td> <td>CANCELED</td> </tr> <tr> <td>Submission time</td> <td>Sunday, March 7, 2004 8:09:58 PM CET</td> </tr> <tr> <td>RequestStatus</td> <td>JOB_CANCEL_DONE</td> </tr> <tr> <td>ReqNumStatus</td> <td>15</td> </tr> <tr> <td>ErrorDescription</td> <td>Job canceled</td> </tr> <tr> <td colspan="2">LATEST JOB HISTORY</td> </tr> <tr> <td>Hostname</td> <td>rage1.man.poznan.pl</td> </tr> <tr> <td>Start time</td> <td>Sunday, March 7, 2004 8:09:59 PM CET</td> </tr> <tr> <td>Local Start time</td> <td>Sunday, March 7, 2004 8:10:07 PM CET</td> </tr> <tr> <td>Latest Job Description</td> <td>show</td> </tr> <tr> <td>Full Job History</td> <td>show</td> </tr> </table>				UserDN	/C=PL/O=GRID/O=PSNC/CN=Juliusz Pukacki	JobStatus	CANCELED	Submission time	Sunday, March 7, 2004 8:09:58 PM CET	RequestStatus	JOB_CANCEL_DONE	ReqNumStatus	15	ErrorDescription	Job canceled	LATEST JOB HISTORY		Hostname	rage1.man.poznan.pl	Start time	Sunday, March 7, 2004 8:09:59 PM CET	Local Start time	Sunday, March 7, 2004 8:10:07 PM CET	Latest Job Description	show	Full Job History	show								
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Full Job History	show																																				
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<table border="1"> <thead> <tr> <th colspan="2">Last Action</th> </tr> </thead> <tbody> <tr> <td>Description:</td> <td>Canceling job 1078686598551:appid:0275.</td> </tr> <tr> <td>Status:</td> <td>OK</td> </tr> <tr> <td>Date:</td> <td>Sunday, March 7, 2004 8:10:23 PM CET</td> </tr> </tbody> </table>		Last Action		Description:	Canceling job 1078686598551:appid:0275.	Status:	OK	Date:	Sunday, March 7, 2004 8:10:23 PM CET																												
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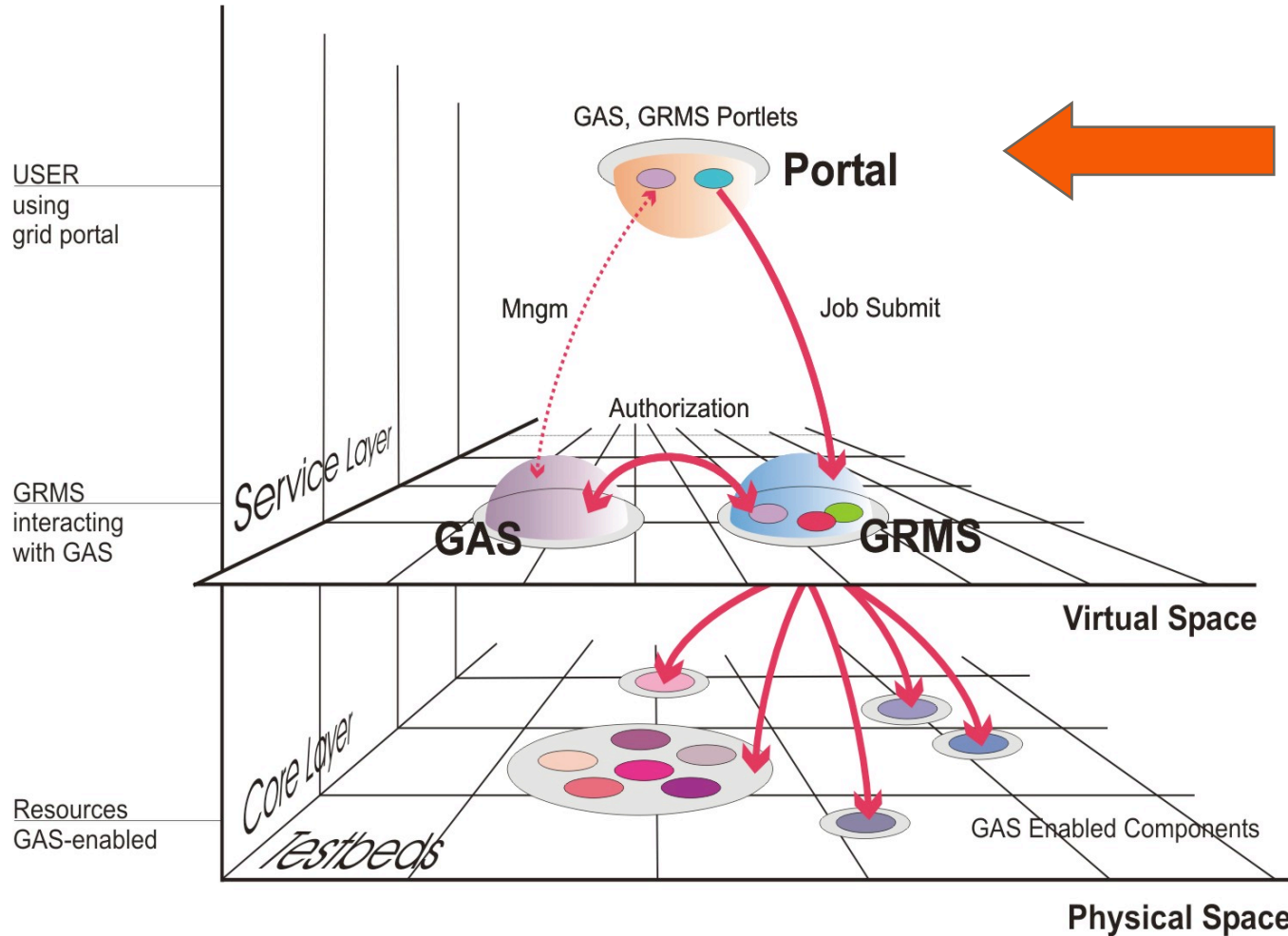
GRMSPortlet



```
C:\>
C:\>
C:\>
C:\>
C:\>java GRMSClient_
```

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Portals



- **Portlets:**
- Portlets define how to construct and deliver Web content as modular components within a Web page.
- Portlets can be “maximized” or “minimized” within a Web page.
- Portlets support various modes
 - View, Edit, Help, Configure
- Users can choose to which portlets they want to be “subscribed”.
- Users can modify their layout including placement of portlets within a tab, tab names, etc.



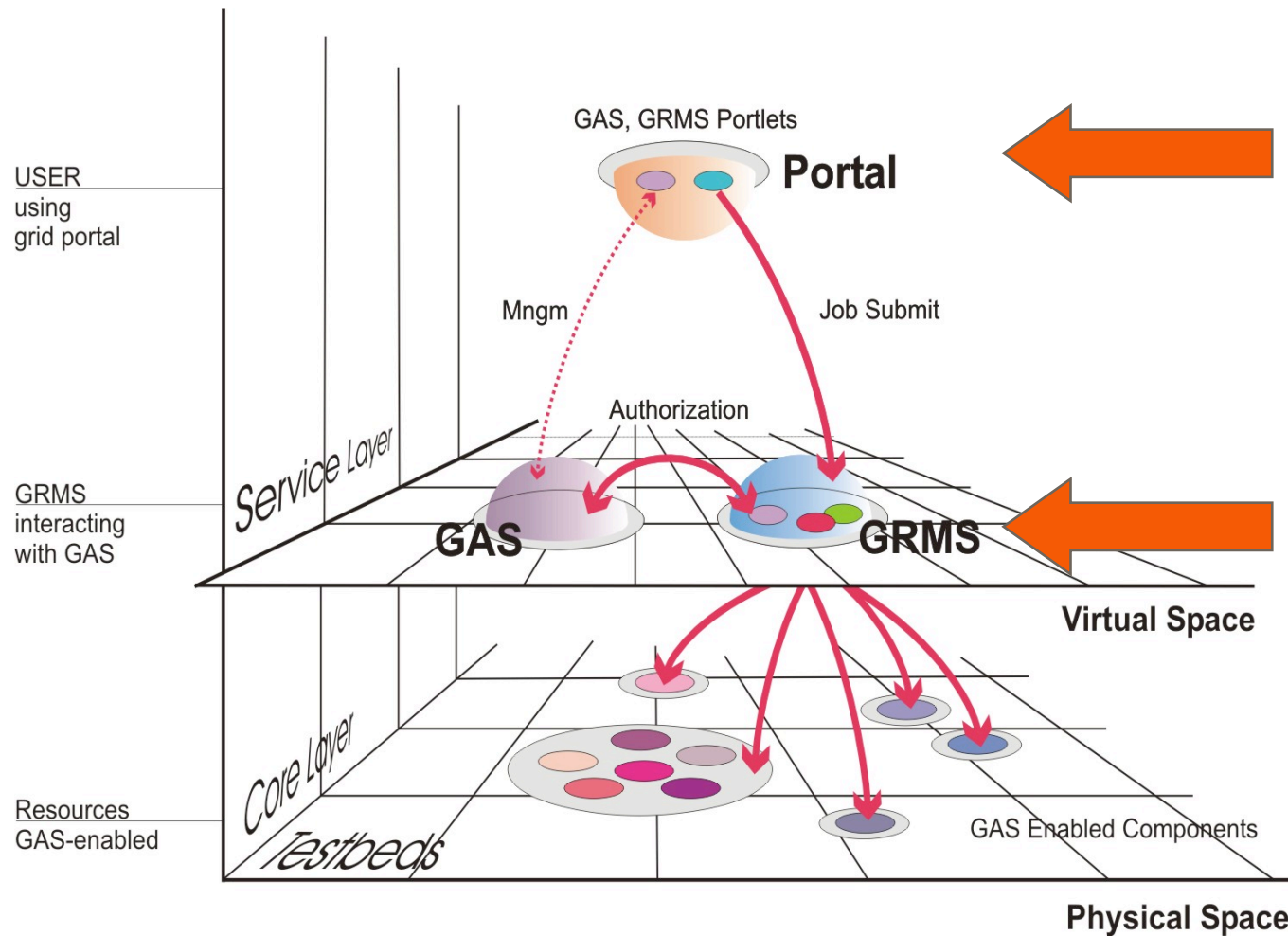
The screenshot displays the GridSphere Portal interface. At the top, there is a navigation bar with language selection options: English (UK), English (US), Czech, German, French, Hungarian, Polish, and Italian. The main header area includes the GridLab logo, the text "GridSphere Portal", a "Logout" link, and a welcome message: "Welcome, Root User". Below the header, there are several portlets. The "Notepad" portlet contains a search box and buttons for "Create a Note" and "Show all Notes". The "Text Messaging" portlet shows a "Send" form with a list of recipients: Michael Russell (aim), Oliver Wehrens (aim sms mail), and Root User (mail). The "File Manager" portlet includes a "File:" field with a "Browse..." button, an "Upload file" button, and a list of current files showing "empty directory".



Portals



- We have developed portlet-based GridSphere Framework (www.gridsphere.org)
- The GridSphere portal framework provides an advanced open-source portlet based Web portal.
- The GridSphere provides a sophisticated portal offering a completely customizable portal for a wide range of end users.
- The portlet model provides both users a flexible easy to use interface and portal developers a model to create pluggable and dynamic application support.



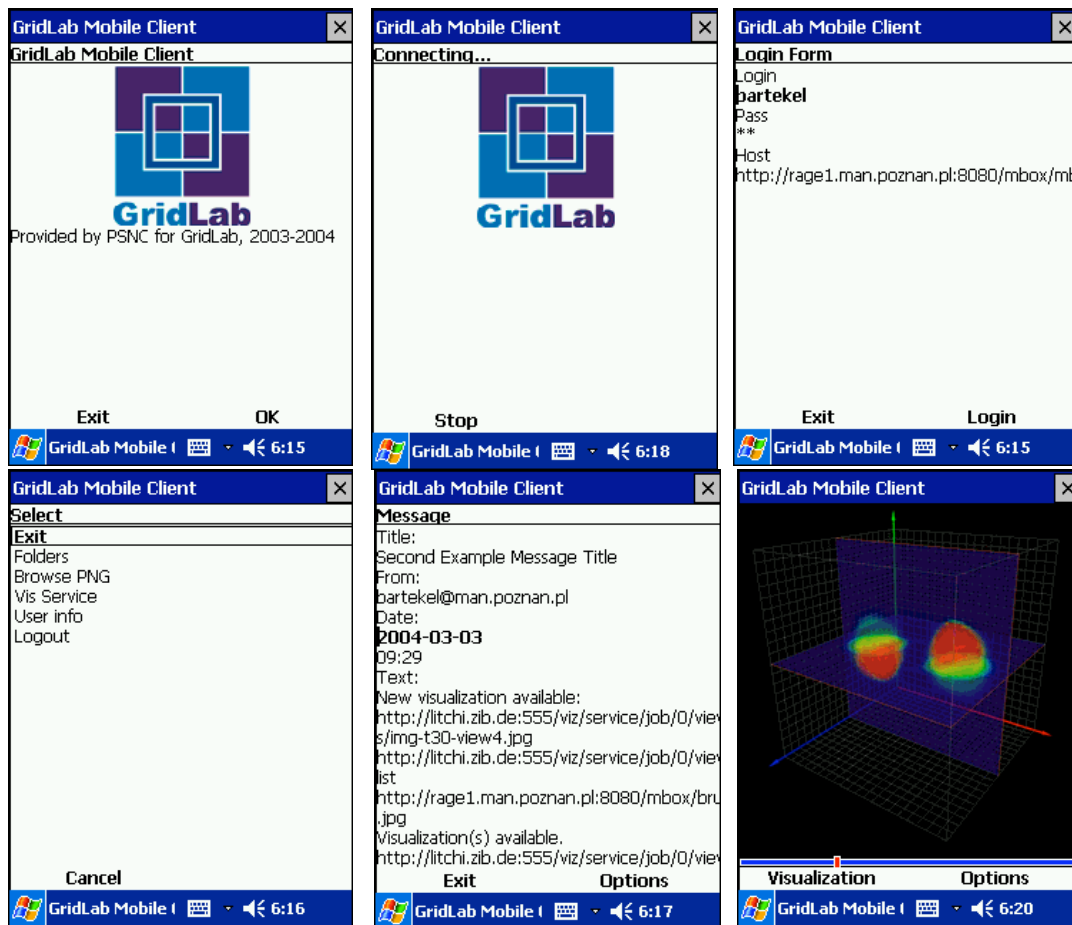


Mobile Services



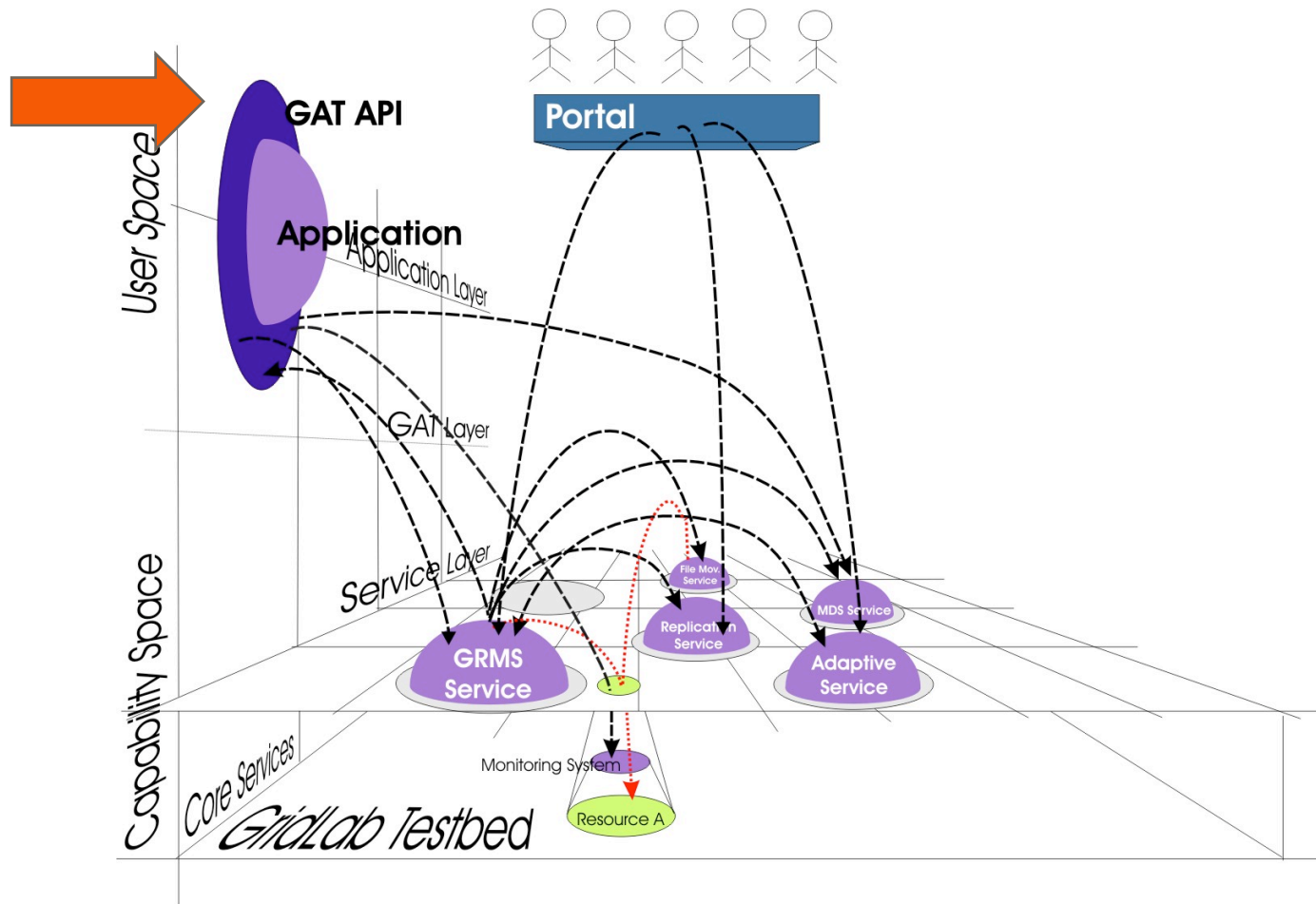
- **Mobile client**
 - J2ME midlet is running on mobile phones, PDAs and PC laptops
 - Features: browsing notification messages, displaying visualizations
- **Gateway**
 - Mobile Command Center acts as a gateway between mobile client and Grid services
 - Developed as a Gridsphere portlet
- **Notification**
 - Message Box is running as both a Java API and a Web/Grid service
 - Exploited by GRMS, Portal
- **Mobile visualisation**
 - J2ME midlet interacts via Mobile Command Center with GridLab Mobile Visualisation Service (developed by WP8)
- **Running the same mobile application on different platforms**
 - Mobile phone (network: GPRS)
 - PDA (network: wireless)
 - Laptop PC (network: either wireless or wired)

Some pictures (HP IPAQ screenshots)



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GAT & GAT APIs



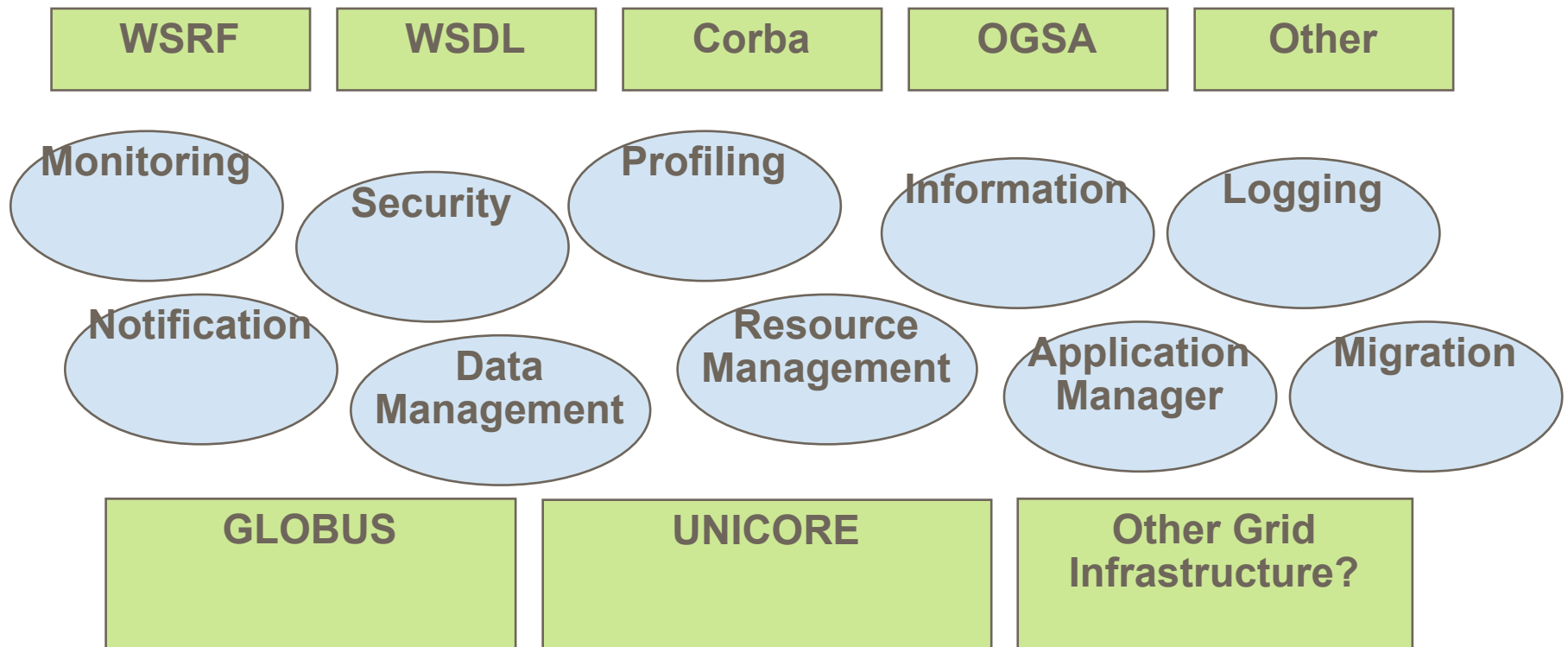


The Grid is complex ...



Application

“Is there a better resource I could be using?”



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...need to make it easier to use



Application

“Is there a better resource I could be using?”

GAT_FindResource()

GAT & GAT APIs

The Grid



The Same Application ...



Laptop

Application

GAT



No network!

Super Computer

Application

GAT



Firewall issues!

The Grid

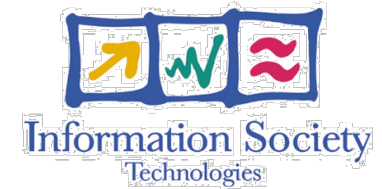
Application

GAT





GAT Philosophy



Application makes GAT API calls for operations which may be Grid-related.

Application links against the GAT Engine

Application runs irrespective of actual underlying infrastructure deployment

Engine loads adaptors which are valid in the environment extant when the application starts

Adaptors try to do Grid operations on request, on failure another adaptor provided function may be called.

Application can thus be compiled, linked and tested without any Grid services

Same application executable can run in a full Grid environment.



GAT Philosophy



- The GAT uses whatever underlying Grid infrastructure there is and that people have developed adaptors for,
- GAT is not about replacing already developed infrastructure, but instead to provide a simple, clear interface which can be used with many different infrastructures.
 - Different versions of Globus
 - Condor
 - Unicore
 - ...



The GAT Architecture



GAT: Grid Application Toolkit

API and Toolkit for developing portable Grid applications independently of the underlying Grid infrastructure and available services

- Implements the GAT-API

- Used by applications (different languages)

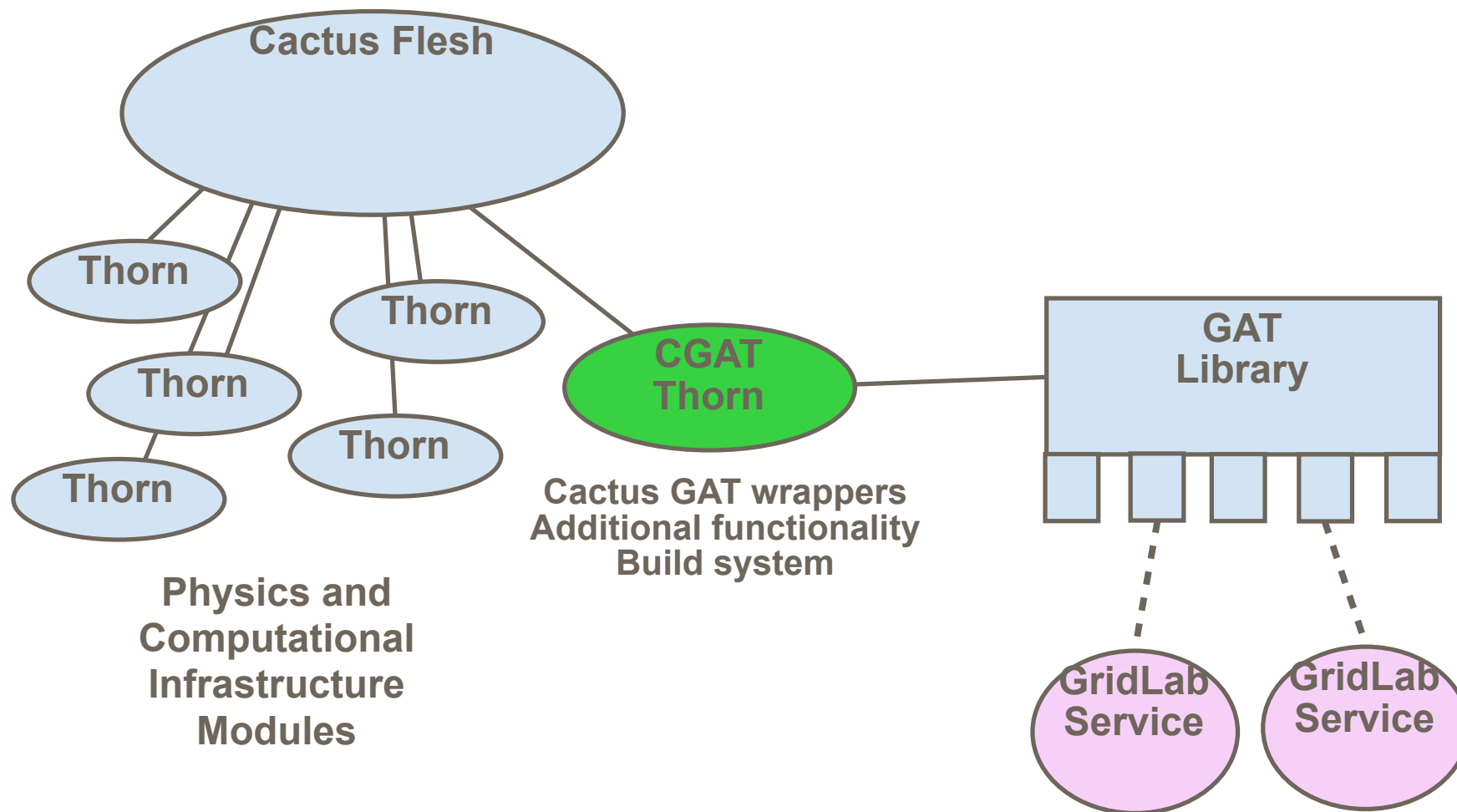
GAT Adaptors

- Connect to capabilities/services

GAT Engine

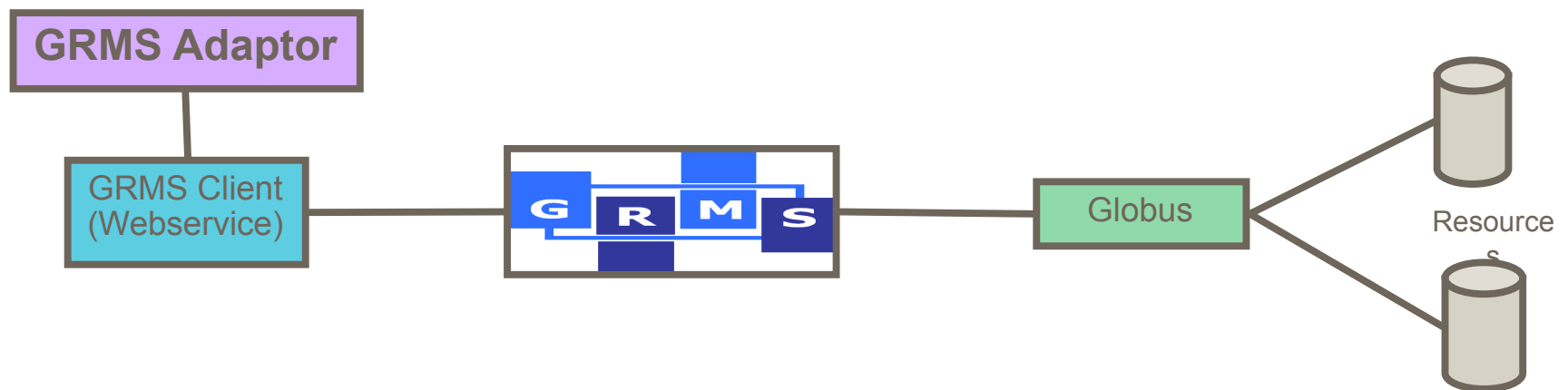
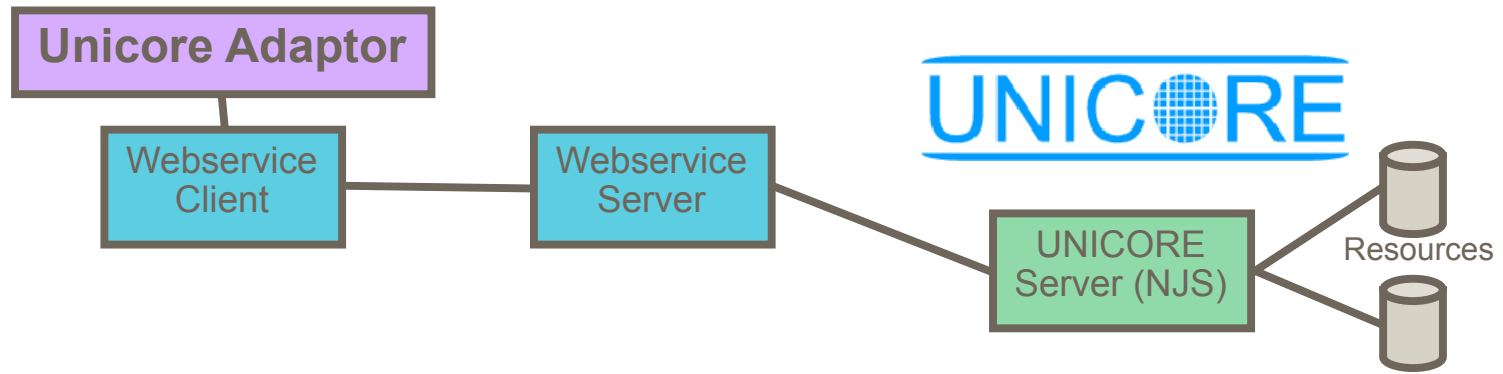
- Provides the function bindings for the GAT-API

Example Cactus/GAT Integration





Globus, Unicore and more



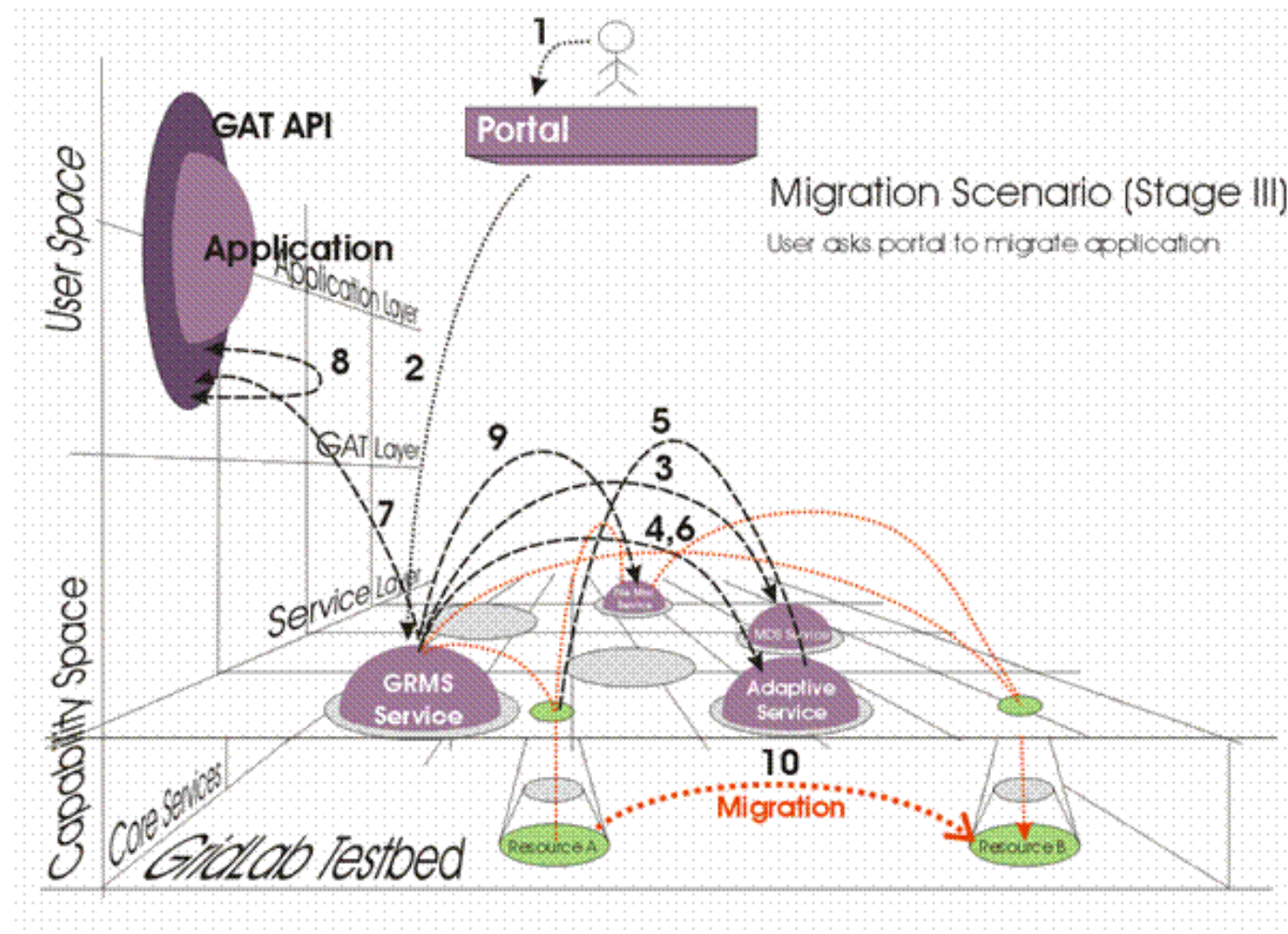


Migration Scenario

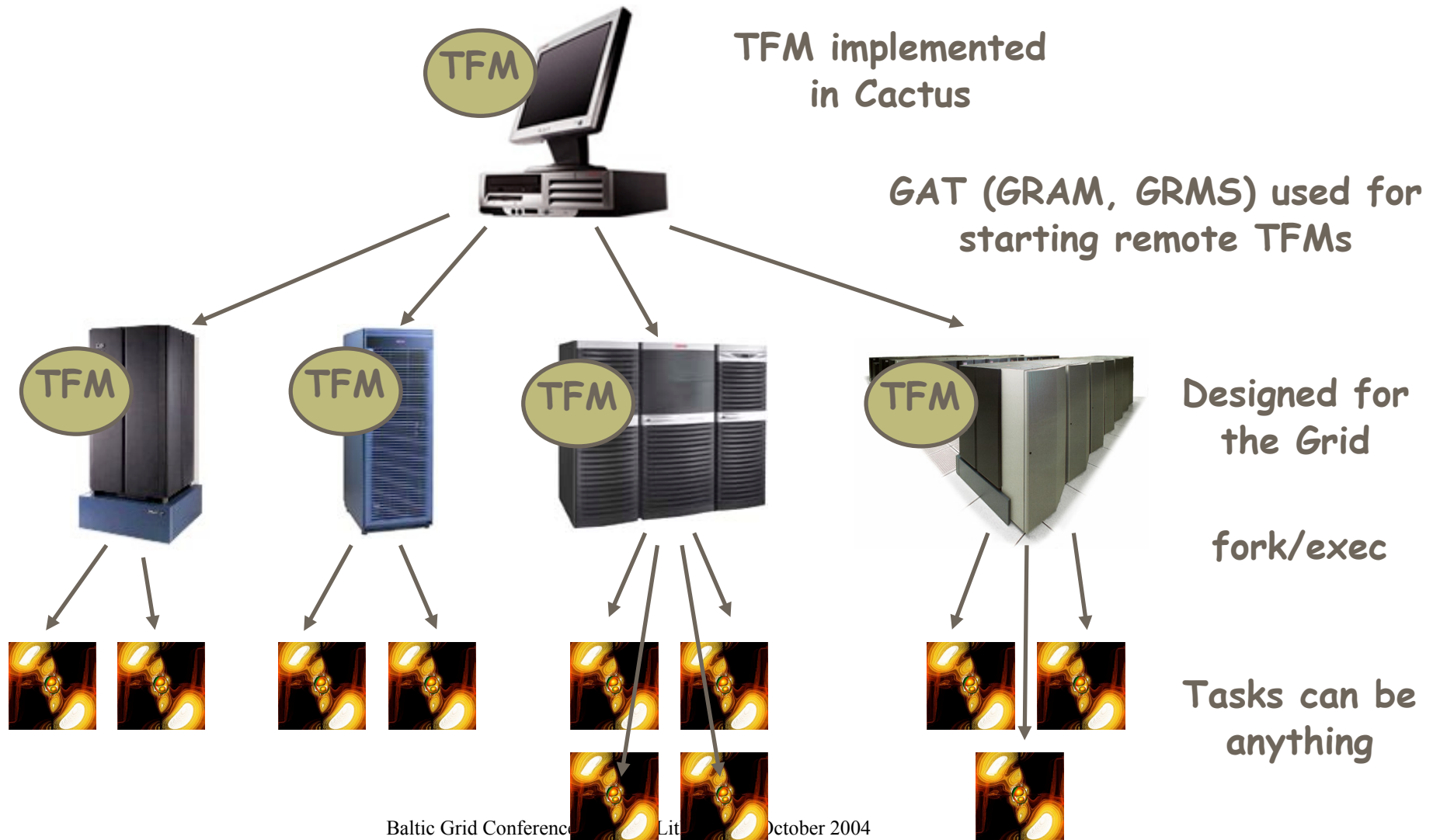


- Application migrates because of bad performance
- The Goal: Involve all the WPs and provide basis for more complex scenarios
 - GAT application
 - Portal
 - GRMS
 - Adaptive
 - Monitoring
 - GIS
 - Mobile user support
 - Security
 - Data mgmt
 - Testbed

Migration Scenario



Task Farming on the Grid





Legacy applications (example)

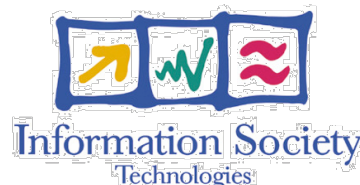


● PAM-CRASH

- Wrapped around with simple script taking care of checkpoint/migration and file stage-in and out, registration with GRMS,
 - MPI version of PAM CRASH run on the Grid
 - GRMS capable of taking care of the checkpoint files coming from all the processes and migrate the app if performance goes down (or triggered by any other event - e.g. machine to be down).
- Collaborate with ESI Group to Grid enable PAM-CRASH with the GAT and GridLab services
 - Demo at SC2004 in Pittsburgh
 - Other legacy applications to be demonstrated...



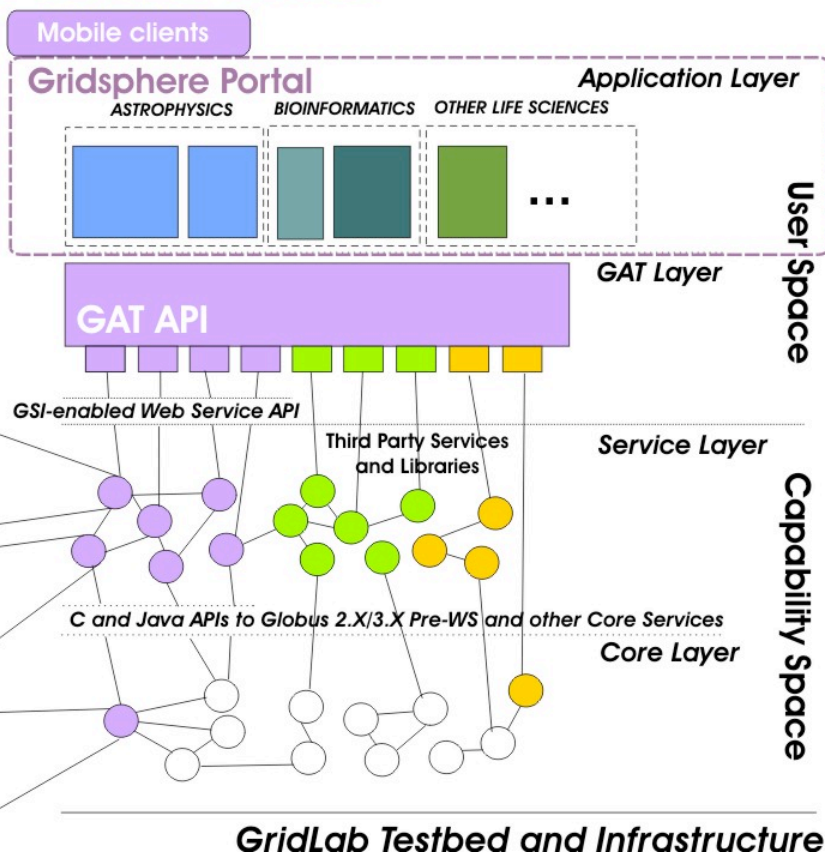
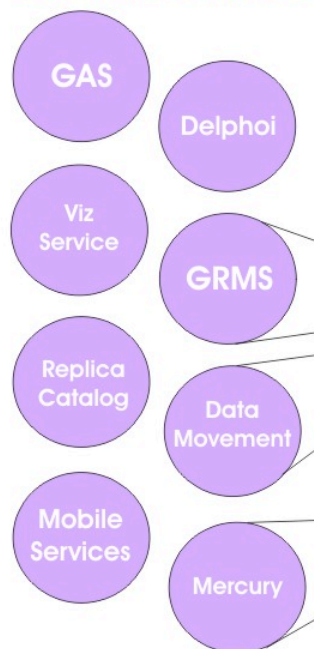
GridLab Summary



GridLab Architecture

GridLab
www.gridlab.org

GridLab Services



- More than just a prototype!
- Potentially infrastructure independent (adaptors available for Globus and Unicore),
- Integrated, almost complete Grid solution.
- Supports new dynamic scenarios.
- Fully open source!
- Productization by PSNC underway (with support) - GridSuite.
- Being deployed and extended in more than 20 other projects!
- Compliant with GGF standards (GRM, SAGA, GSA, ...).
- GridSphere is 100% JSR 168 compliant

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More Information / Summary



www.gridlab.org
www.gridsphere.org

Thank you!