

# Grid Explorations

Marios D. Dikaiakos  
University of Cyprus

<http://www.cs.ucy.ac.cy/mdd>

## Talk Outline

- **From Parallel to Grid Computing**
- Grid Resource Characterization through Benchmarking
- Navigating and Searching the Grid Information Space
- Conclusions

## Parallel computing

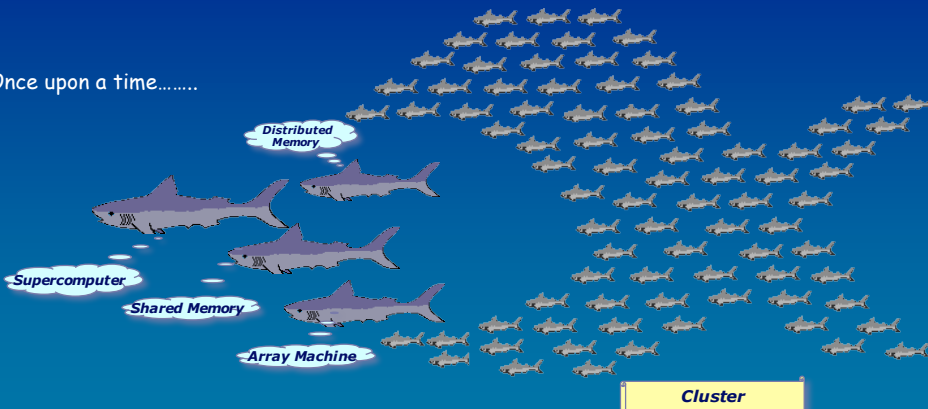
- Used to solve **large** problems, mainly from science/engineering.
- Different **parallel machine models** (SIMD, MIMD).
- A **large variety of parallel hardware** (Vector, Array Processors, Shared Memory and Distributed Memory Machines).
- Alternative **computing models**: data/task parallelism, SPMD.
- Lots of **parallel programming approaches**: implicit parallelism, shared-memory and/or message-passing semantics, high-level languages.
- Software **tools**: compilation, automatic parallelization, performance analysis & modeling, parallel debugging, application development.

## Parallel computing: implicit assumptions

- "Tightly coupled."
- **Homogeneous** processing elements and interconnection.
- Communication through a "**closed**" **interconnection** network (bounded latency, high bandwidth).
- Parallel computer under a **single administrative domain**.
- User needs **direct access** to the parallel machine.

## The Dead Supercomputer Society and the "killer micros"

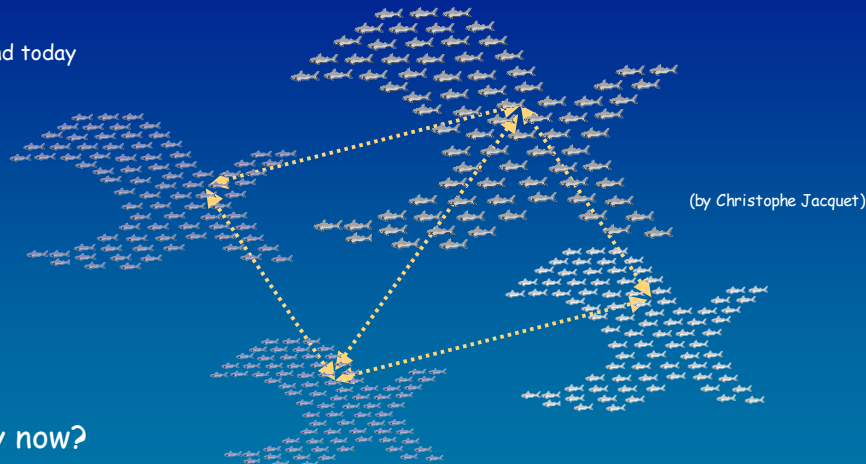
Once upon a time.....



(by Christophe Jacquet)

## The GRID distributed computing idea

...and today



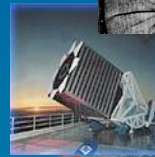
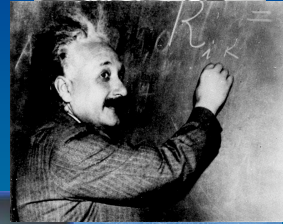
(by Christophe Jacquet)

Why now?

- Technological progress.
- Trends in Science.
- Internet Computing trends (e-Services, Overlays, P2P).

## Why Now...? From Science to e-Science

- In the past, science has been mainly **empirical** and **theoretical**.
- Recently, science is becoming **computational** (Data captured by instruments or data generated by simulators, processed by software, placed in databases / files. Scientists analyze database / files)
- Large Hadron Collider (LHC) at CERN:
  - 10 Petabytes/year of data.
  - ~100,000 of today's fastest PC processors.

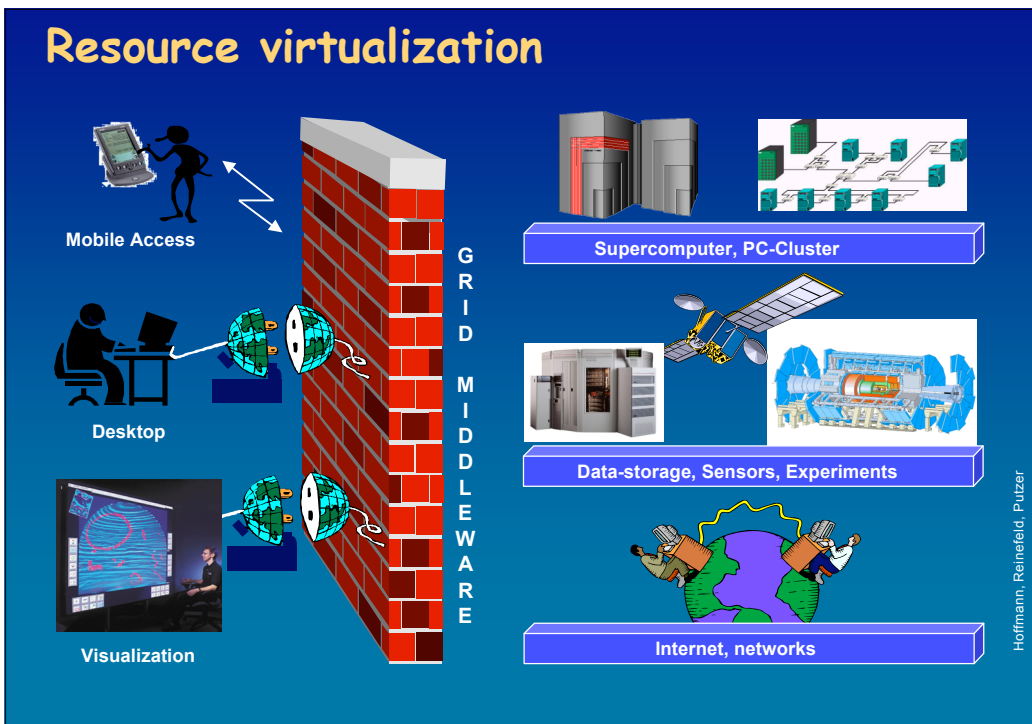


## The Grid

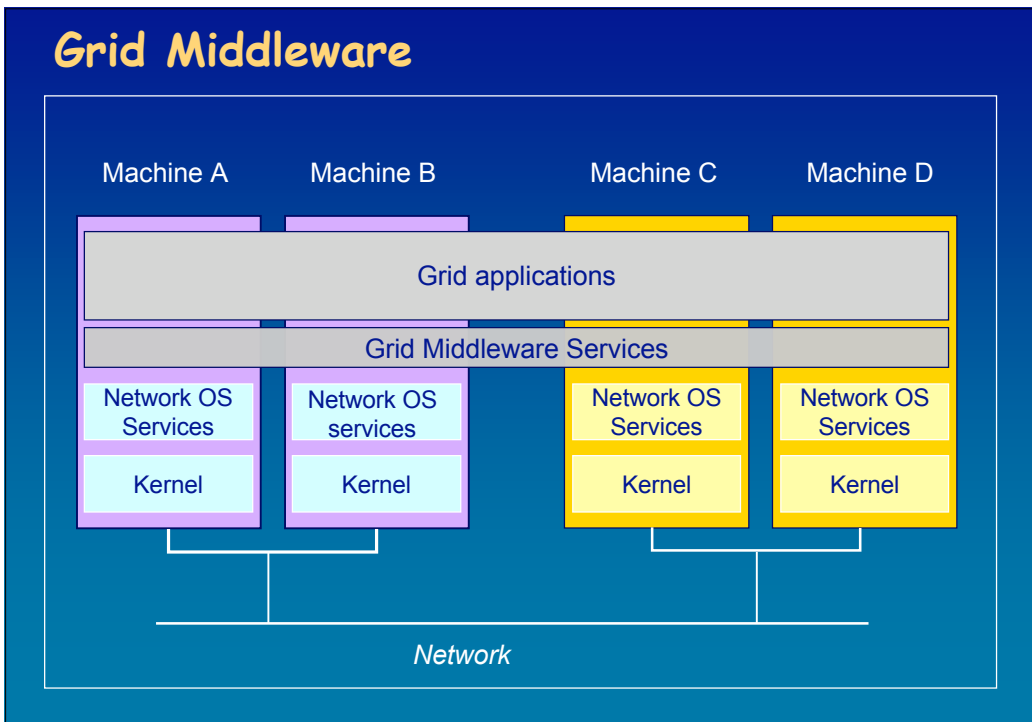
- Middleware infrastructure that enables flexible, secure, coordinated resource sharing among dynamic collections of individuals and institutions (Foster, Kesselman, Tuecke).
- Enables communities ("Virtual Organizations") to share geographically distributed resources as they pursue common goals --
- Key assumptions: **absence of...**
  - Homogeneity
  - Central location
  - Central control
  - Existing trust relationships



# Resource virtualization



# Grid Middleware



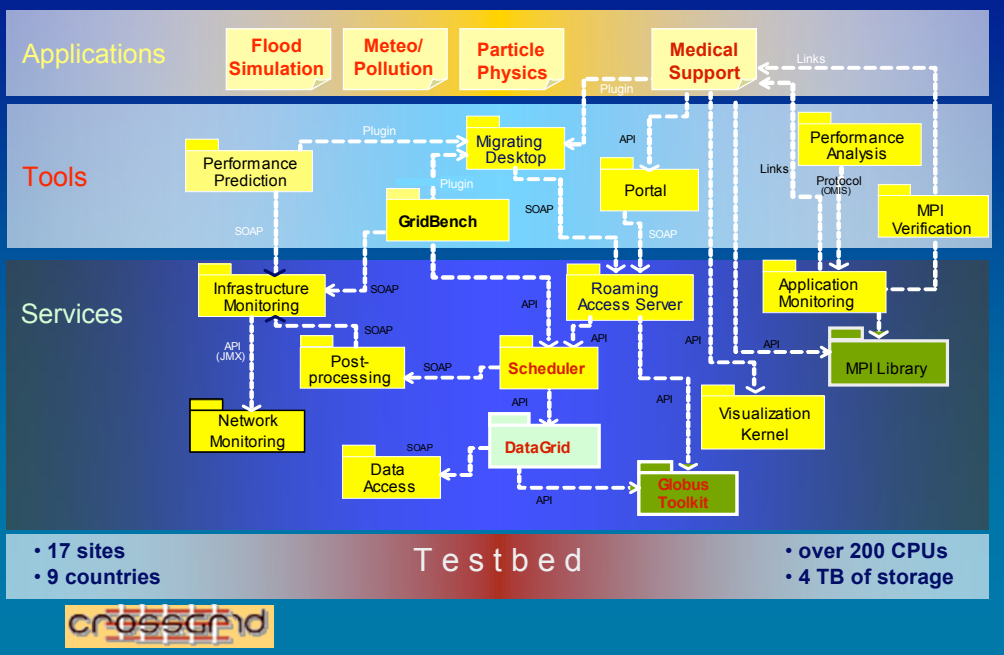
## Key Components... and challenges

- **Resource management:** discovery, monitoring, control, access, data management..
- **Job management:** definition, submission, control, Web-based access..
- **Administration:** configuration & policy management, security, fault discovery, software packaging and distribution..
- **Application development:** programming tools, new programming paradigms, higher-level abstractions..
- **Common protocols, standards, APIs, services.**

## Grid Middleware Systems

- **GLOBUS Toolkit (ANL,ISI/USC)**
  - GSI, GRAM, GridFTP, MDS, Grid Services.
- **Condor (Wisc)**
  - "Cycle-stealing," high-throughput computing, check-pointing and migration.
- **UNICORE (R.Z. Juelich)**
  - A "vertically integrated" Grid components supporting batch-job submission to distributed supercomputing sites.
- **EDG, CrossGrid, LCG2, GridLab, gLite (EU-IST)**
  - Toolkits using some components from several other projects, packaged and tested together.

# CrossGrid Middleware

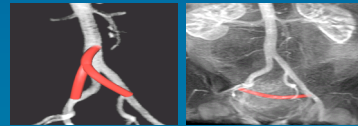
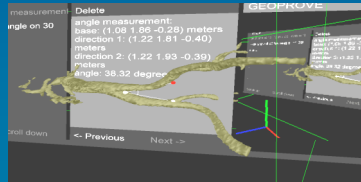
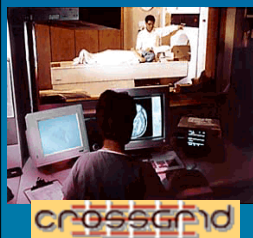


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## Vascular surgery planning: a Grid application

- Goal: support bypass surgical treatment of vascular diseases by simulating vascular reconstruction.
  - Examine **alternative scenarios** for bypass placement.
  - Improvements in **blood flow** determine which bypass is best.
  - **3D arterial model** presented to the surgeon in an **immersive environment**.
  - Parallel MPI code computes **blood flow properties**.



Source: P. Sloot, Univ. of Amsterdam & CrossGrid project

## Choosing Grid resources

Status for Resource Broker CERN\_xn1188: Thu Oct 7 07:46:29 BST 2004

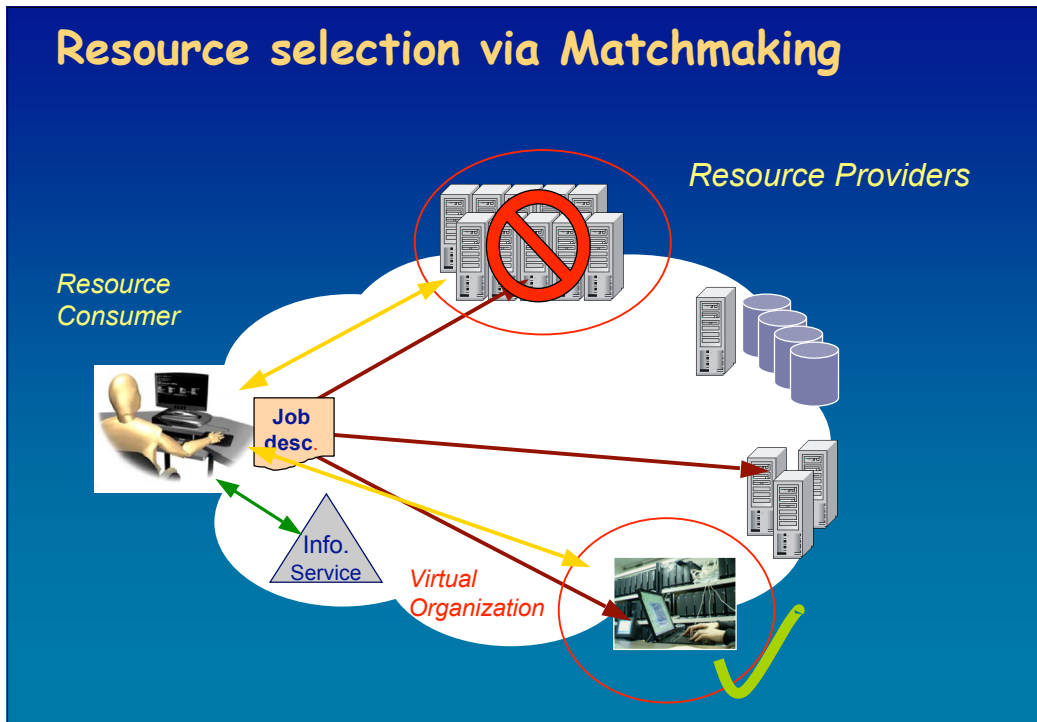
**crossgrid** **egee**

Enabling Grids for  
E-science in Europe

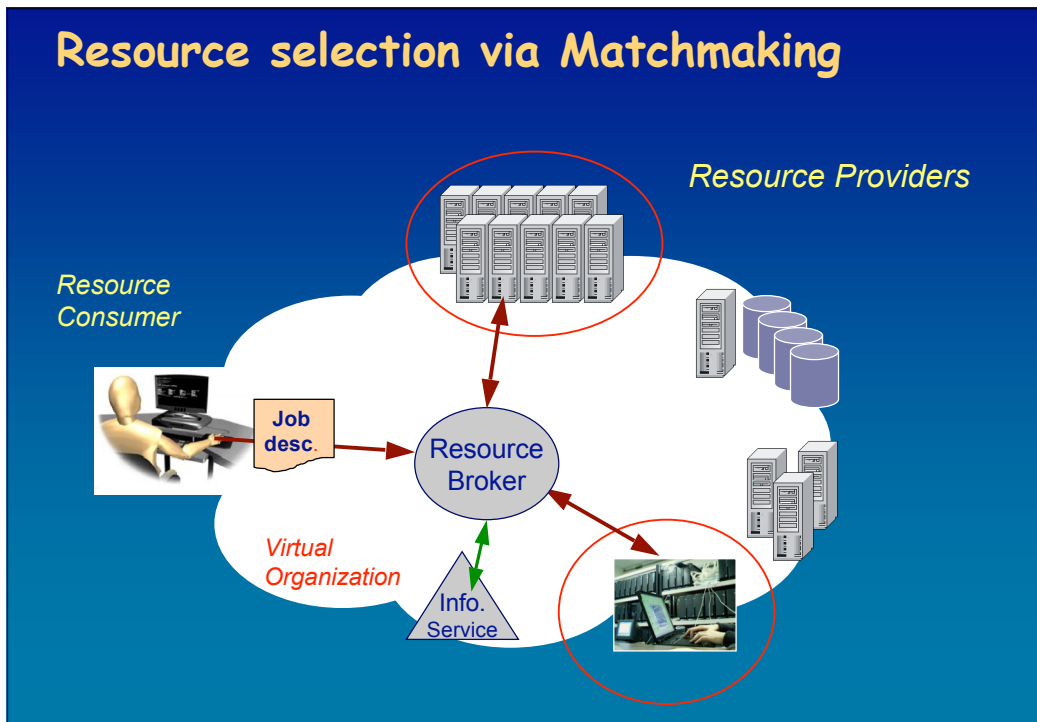
# TERAGRID



## Resource selection via Matchmaking



## Resource selection via Matchmaking



## Ask a Grid Information Service!

```
dn: GlueSubClusterUniqueID=cgce.ifca.org.es,
GlueClusterUniqueID=cgce.ifca.org.es,
dn: GlueCEUniqueID=cgce.ifca.org.es:2119/jobmanager-pbs-short,
Mds-Vo-name-ifcapro,mds-vo-name-local,o=grid

GlueChunkKey: GlueClusterUniqueID=cgce.ifca.org.es
GlueHostApplicationSoftwareRuntimeEnvironment: CC? 0 4
GlueCEUniqueID: cgce.ifca.org.es:2119/jobmanager-pbs-short
GlueCEInfoGatekeeperPort: 2119
GlueCEInfoHostName: cgce.ifca.org.es
GlueCEInfoLRMSType: pbs
GlueCEInfoLRMSVersion: OpenPBS_2.4
GlueCEInfoTotalCPUs: 20
GlueCEStateEstimatedResponseTime: 0
GlueCEStateFreeCPUs: 20
GlueCEStateRunningJobs: 0
GlueHostMainMemoryVirtualSize: 1144
GlueForeignKey: GlueClusterUniqueID=cgce.ifca.org.es
```

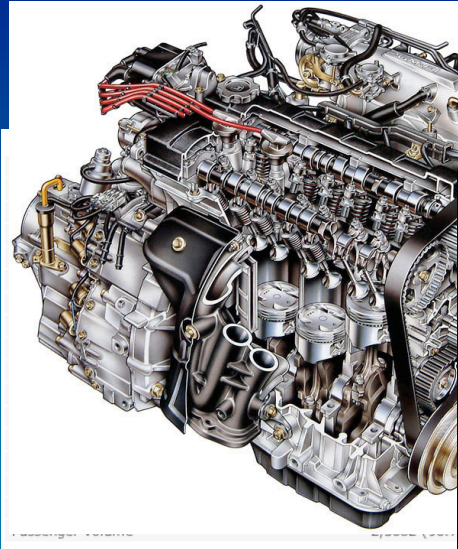
Annotations:

- dn: GlueSubClusterUniqueID=cgce.ifca.org.es, GlueClusterUniqueID=cgce.ifca.org.es: inserted manually
- dn: GlueCEUniqueID=cgce.ifca.org.es:2119/jobmanager-pbs-short, Mds-Vo-name-ifcapro,mds-vo-name-local,o=grid: inaccurate
- GlueHostApplicationSoftwareRuntimeEnvironment: CC? 0 4: obsolete
- GlueCEInfoGatekeeperPort: 2119: complete
- GlueCEInfoHostName: cgce.ifca.org.es: functional characteristics
- GlueCEInfoLRMSType: pbs: black holes, heterogeneity, availability
- GlueCEInfoLRMSVersion: OpenPBS\_2.4: Static Info
- GlueCEInfoTotalCPUs: 20: machine properties
- GlueCEStateEstimatedResponseTime: 0: Dynamic Info
- GlueCEStateFreeCPUs: 20: "end-to-end" representation

## Motivation and Focus

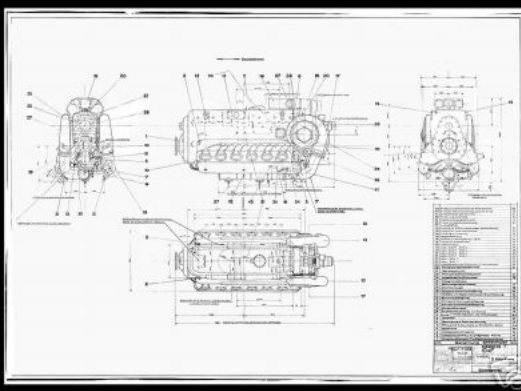
- How can we characterize the performance of Grid resources?
  - ⇒ Support more advanced criteria for matchmaking: performance, functionality, reliability, robustness, cost...
  - ⇒ Drive the design and configuration of Grid infrastructures.
  - ⇒ Open marketplaces based on performance negotiation.
  - ⇒ Developing models for performance prediction.
- "We have no real idea how the Grid and Grid applications could be characterized from the point of view of performance" (APART Working Group on Automatic Performance Analysis, Rackeve Workshop, 11/2003)
- Do this in an end-to-end fashion.

## Choosing an automobile



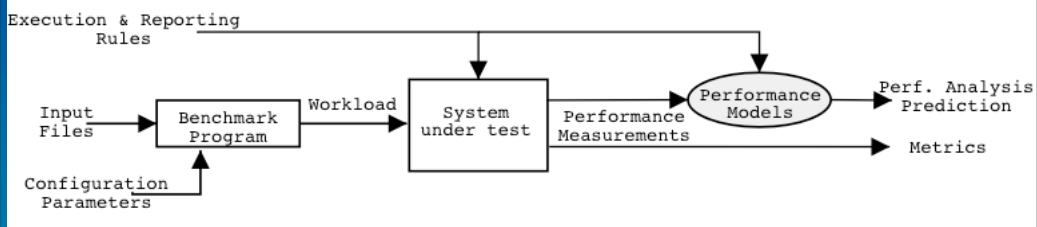
### Caractéristiques techniques

Version	1.4i	1.6i	1.8i	1.9i	2.0i	2.0i 16V	2.3i	2.5i	2.8i
Cylindres	4	4	4	4	4	4	4	4	4
Puissance (kW)	55	66	77	88	100	115	130	145	160
Puissance (CV)	75	90	105	120	136	156	180	199	218
Vitesse max (km/h)	170	185	195	205	215	225	235	245	255
Accélération 0-100 (s)	12.5	10.5	9.5	8.5	7.5	6.5	5.5	4.5	3.5
Consommation (l/100km) Cycle	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5
Consommation (l/100km) Cycle	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5
Consommation (l/100km) Cycle	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5



## Test-driving computers...

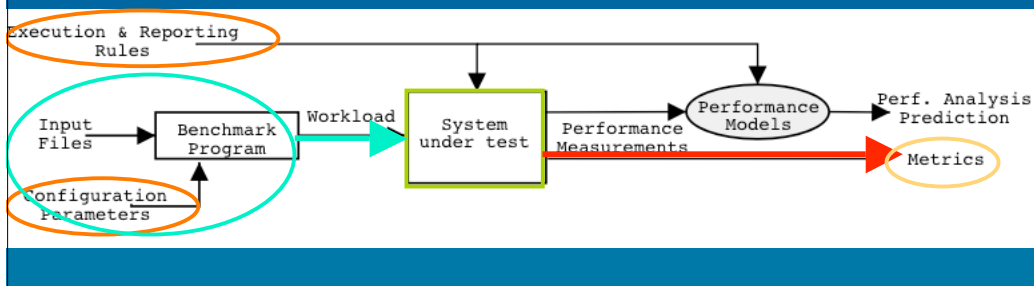
- **Benchmarks:** standardized programs designed or chosen to investigate performance properties of computer systems:
  - System characterization
  - Fair comparison
  - System design assessment
  - Supporting quantitative research



- Conditions of execution & measurement: **well-defined** and **publicly available**.
- Benchmarks are required to be: **portable**, **fair**, **relevant**, **easy to measure**, **easy to explain**.

## Key challenges for benchmarking Grids

- Measuring a fuzzy target
- Trusting our measurements
- Describing performance (metrics)
- Managing cost
- In search of relevance



## GridBench



- The GridBench Framework:
  - A software tool for characterizing the performance of Grids and Grid resources quantitatively, using benchmarks.
  - Supports the administration of Grid benchmarks, the archival, publication, browsing and analysis of metrics.
- GridBench Suite of Benchmarks:
  - A layered suite of benchmarks deployed on a Grid testbed.
  - Geared towards high-performance and high-throughput computing needs.



## Elements of the GridBench Framework

- An "ontology" of performance metrics.
- GBDL, a platform-independent XML language:
  - Specification of configuration.
  - Representation of results.
- A translator from GBDL to different Job Description Languages:
  - RSL (Globus)
  - JDL (Condor/DataGrid/CrossGrid/EGEE).
- A "user-friendly" administration tool and GUI.
- A database for archiving metrics.
- A performance analysis tool and GUI.

## GridBench software

- Implemented in JAVA + MySQL + Linux (ports to IRIX, AIX)
- Open Source Benchmarks in C/C++/Fortran + MPI
- Available for downloading: <http://grid.ucy.ac.cy/GridBench>
- Part of CrossGrid Middleware distribution 
- Adopted and in use by Grid Ireland 
- Working towards demonstrating it on EGEE 

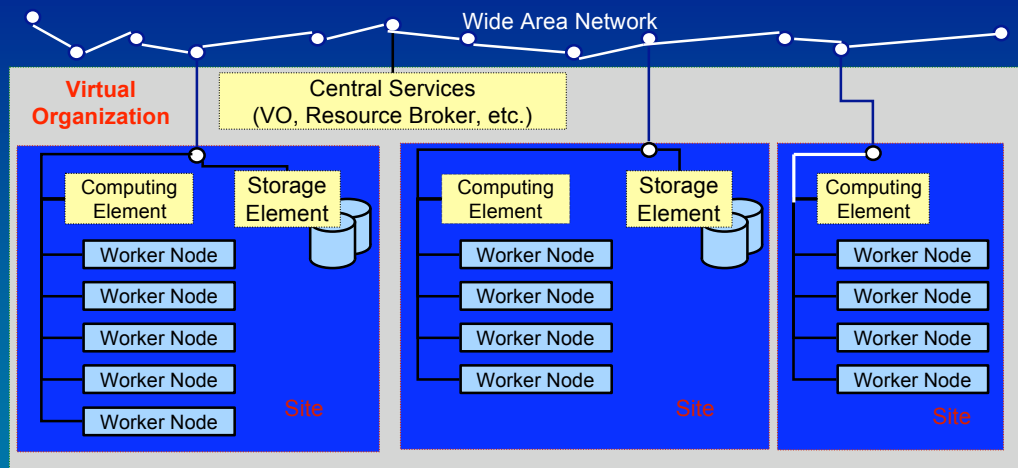
## Talk Outline

- From Parallel to *Grid* Computing
- **Grid Resource Characterization through Benchmarking**
  - **Metrics and Benchmarks.**
  - Filtering polluted measurements.
  - GridBench GUI and use.
- Navigating *Grids*
- Grid Search Engines
- Conclusions & Future Work

## An ontology of performance metrics

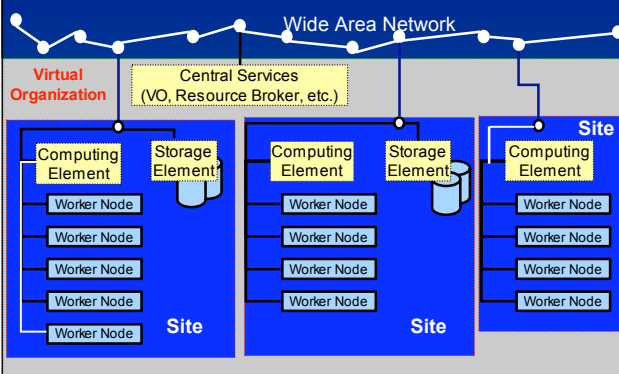
- Performance capacity of *Grid* infrastructure can be described by:
  - The performance of a **hierarchical collection** of measurable entities (CPUs, memory performance, computers, clusters, collections of clusters..)
- Thus:
  - Small sets of metrics **not adequate** for *Grids*.
  - Definition, organization, storage, and interpretation requires **advanced, open data models**, amenable to post-processing (statistical, data mining, AI).
- ...what about **interpretation of metrics?**

## A simple reference model

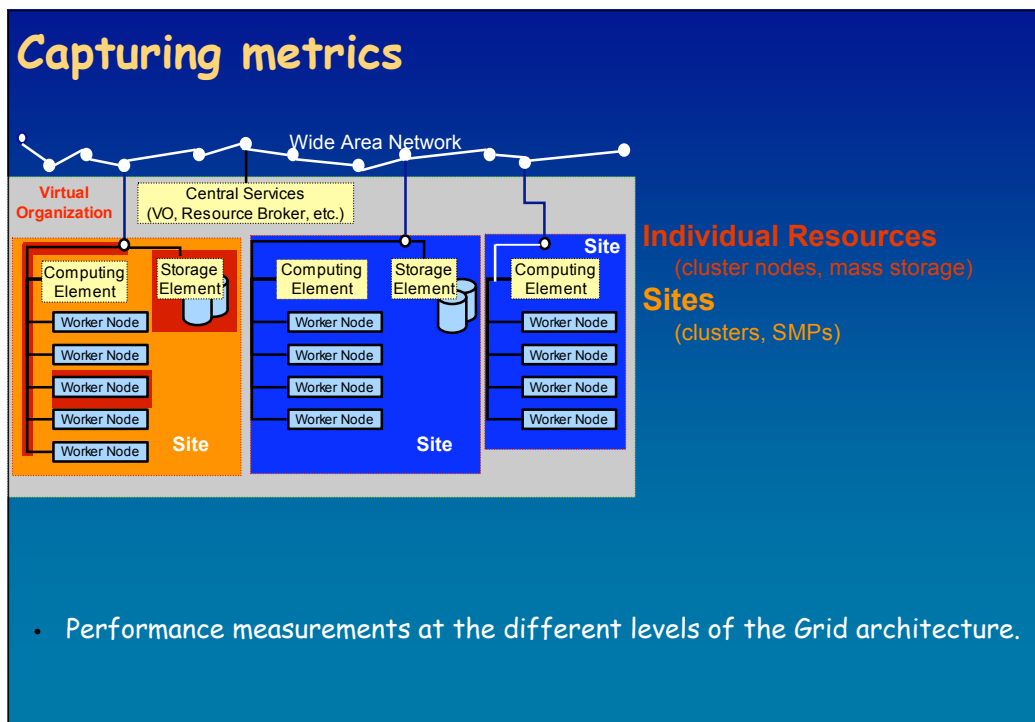
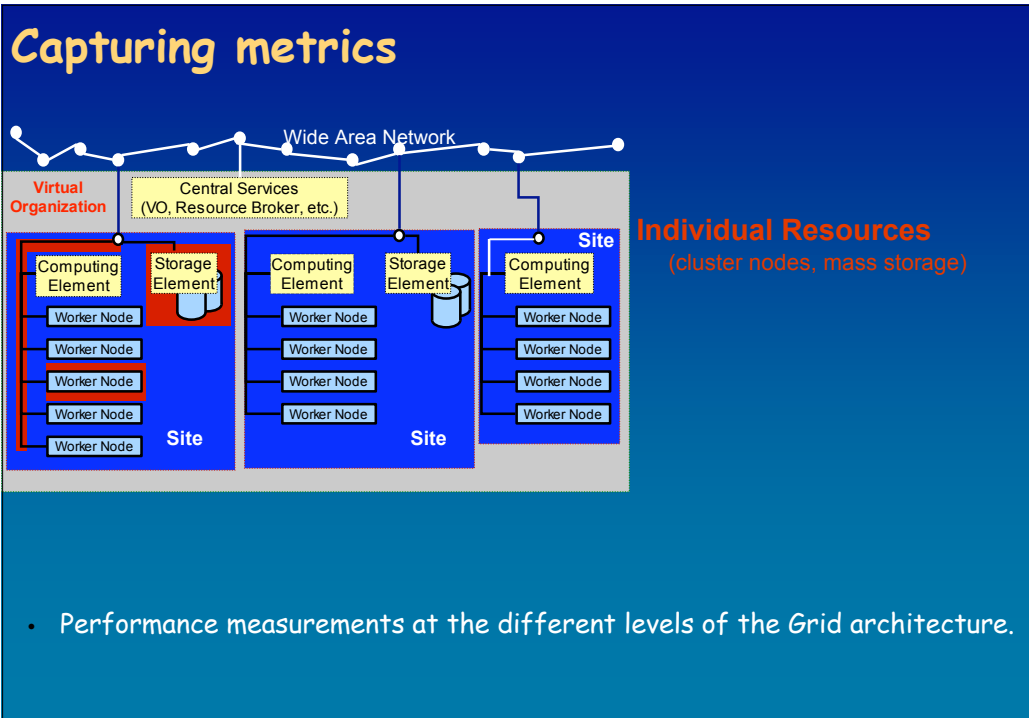


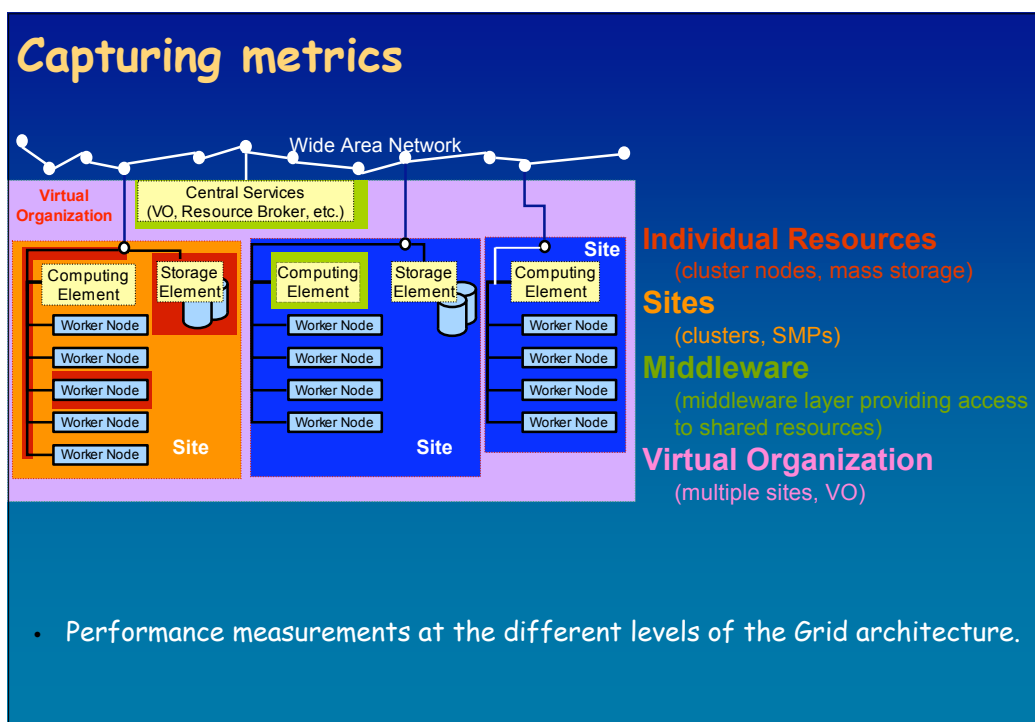
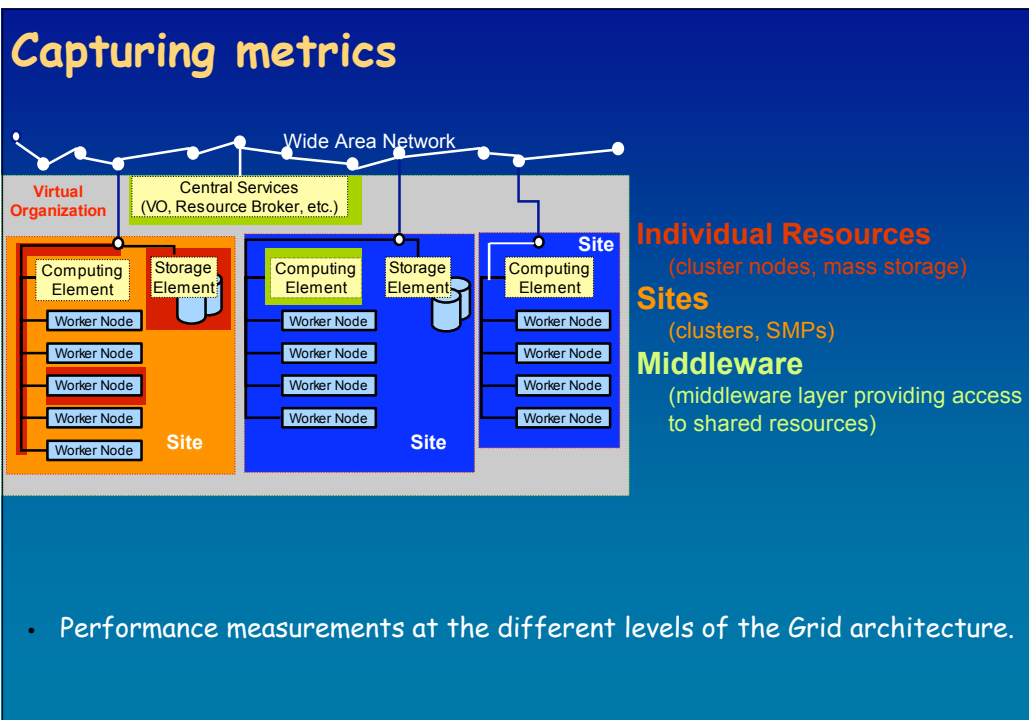
- ✓ Inspired by the DataGrid/CrossGrid/LCG architecture (Globus 2-based)
- ✓ Represented by the GLUE Schema.
- ✓ Necessary for defining benchmarking-targets and interpreting metrics.

## Capturing metrics

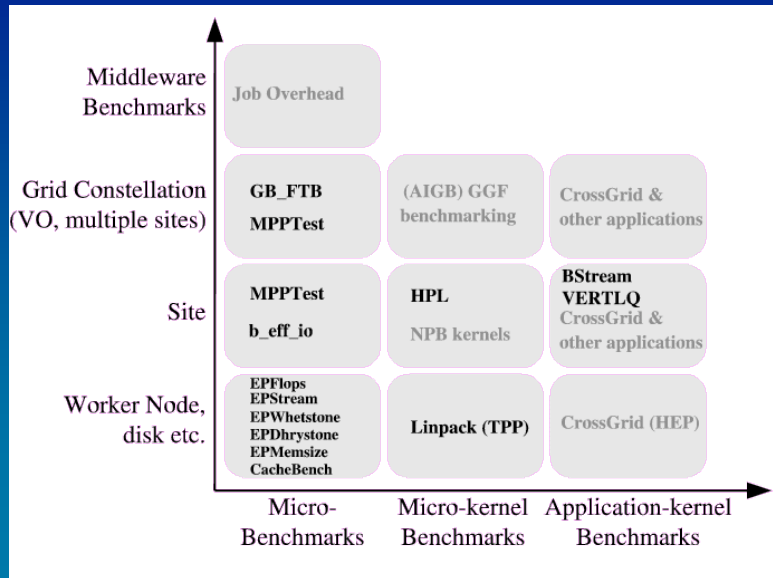


- Performance measurements at the different levels of the Grid architecture.





## The GridBench suite of benchmarks



## Outline

- From Parallel to Grid Computing
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  - Metrics and Benchmarks.
  - **Filtering polluted measurements.**
  - GridBench GUI and use.
- Navigating and Searching the Grid Information Space
- Conclusions & Future Work

## Identifying polluted measurements

- Often benchmark runs in co-location with other jobs:
  - "Fellow passengers:" co-allocated by the Resource Broker.
  - "Free-riders:" unauthorized users, unknown to the VO.
  - "Runaways:" O/S processes, zombies, etc.
- These jobs "pollute" measurements and can affect seriously the characterization accuracy.
- Their effect on metric accuracy can be:
  - Identified through **monitoring data**.
  - Reduced through **access control** (for fellow passengers) and **remote healing** (for runaways).

## Filtering polluted measurements

- GridBench retrieves monitoring information from **Grid monitoring services**, for a time-window encapsulating a benchmarking experiment.
- This is specified in the **GBDL document** describing a particular experiment:

```
<component name="data-transfer" ID="xfer01">...</component>
<monitor type="RGMA" source="ccwp71.in2p3.fr:3306"
  query="select * from NetworkTCPThroughput
        where NMIdSource='adc0003.cern.ch'
          and NMIdDestination='ccwp7.in2p3.fr'
  <parameter name="begin">comp-begin="xfer01"</parameter>
  <parameter name="end">comp-end="xfer01"</parameter>
</monitor>
```

- Retrieval from monitoring services is conducted via **monitoring-client plug-ins** called by GridBench.

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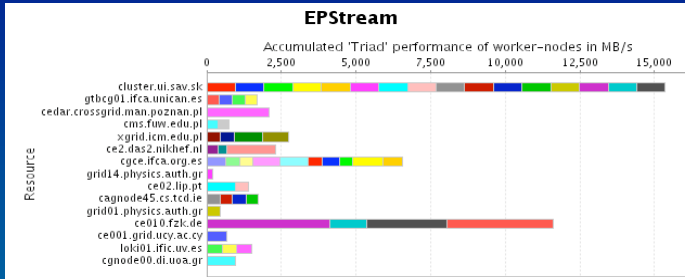
The screenshot displays the GridBench web interface. At the top, there are tabs for 'Templates', 'Resources', and 'Results'. The 'Resources' tab is active, showing a 'Resource List' for 'JMS on ce010.fzk.de'. This list includes various benchmarks like 'epcfcargos', 'ce010zzkde', 'clusterzaksavsk', 'zeus-24x3f-hr-zakugl', 'grid01.physics.zut.ac', 'unccegridlabuz', 'sgridimedeupl', and 'hkl01.zicavsk'. A 'Result Matrix' table is visible, showing performance metrics for different benchmarks across various resources. Below the resource list, there are several benchmark-specific graphs and data visualizations:

- EPStream 3:** A bar chart showing 'Accumulated Tritium performance of worker-nodes' for resources like 'cge.ifex.org.es' and 'ce010.fzk.de'.
- MPPTest 4:** A line graph showing 'Time (seconds)' vs 'Packet Size (bytes)' for 'Blocking cge.ifex.org.es (10 nodes)' and 'Blocking cge.ifex.org.es (10 nodes)'. The graph shows a linear increase in time with packet size.
- New epdhytone Benchmark:** A dialog box for defining a new benchmark, showing fields for 'definition', 'GBDL', 'globus', and 'edg'. The definition includes benchmark name, date, type, model, location, and various parameters like 'executable', 'execpath', 'stage\_executable', and 'nloops'.

At the bottom of the interface, there is a 'new parameter' section with a 'Description' field and a 'submit' button. The URL <http://grid.ucy.ac.cy/GridBench> is displayed at the bottom center.

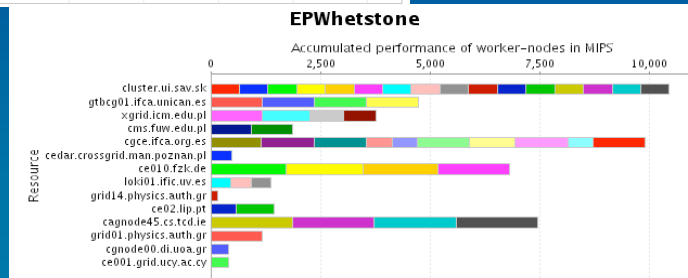


# Sample results

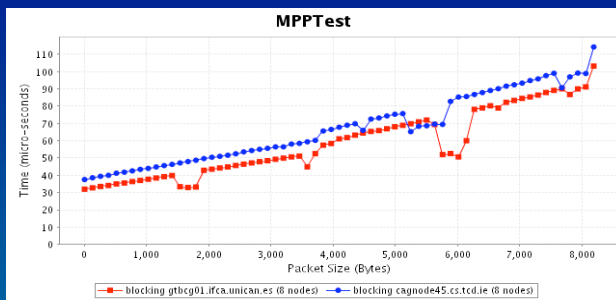


Memory Bandwidth

CPU Performance

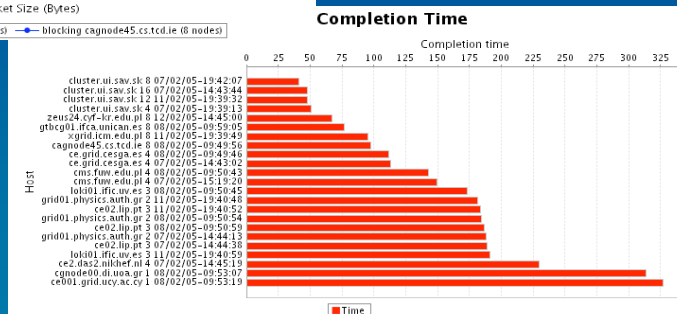


# Sample results



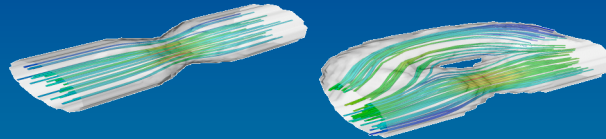
MPI Performance

Application-kernel Performance

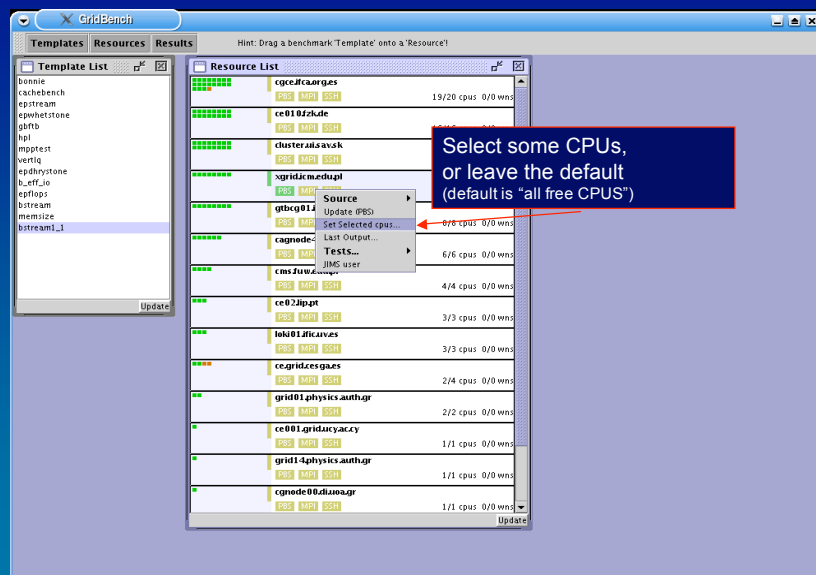


## Resource Selection with GridBench

- Where should I run my fluid-flow code for Surgical Planning?



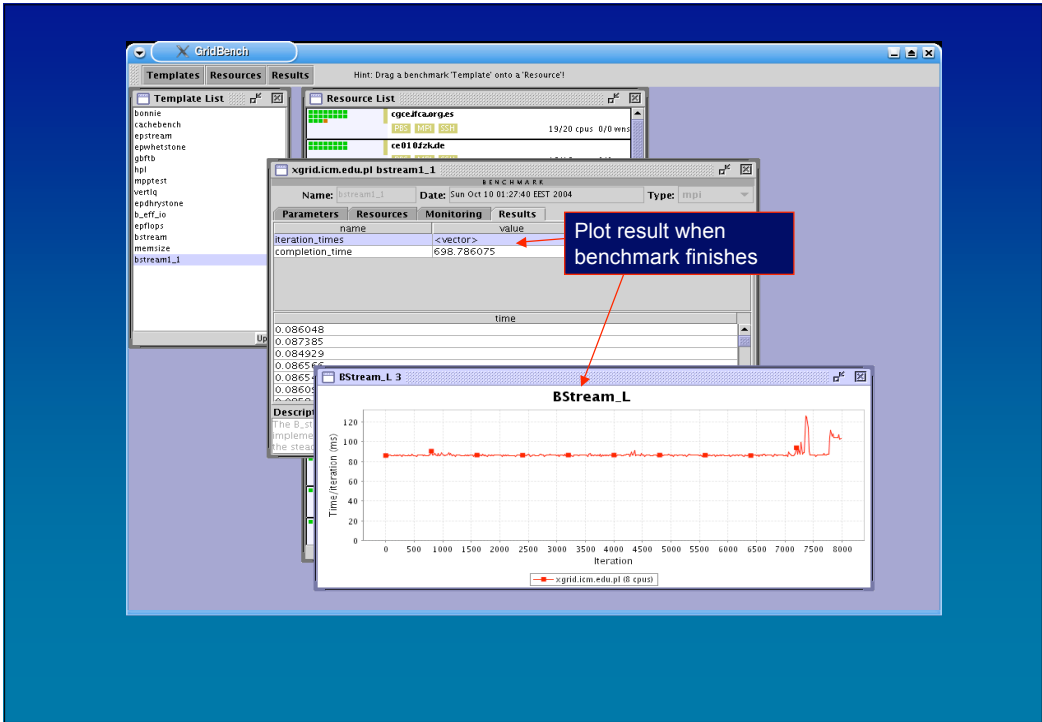
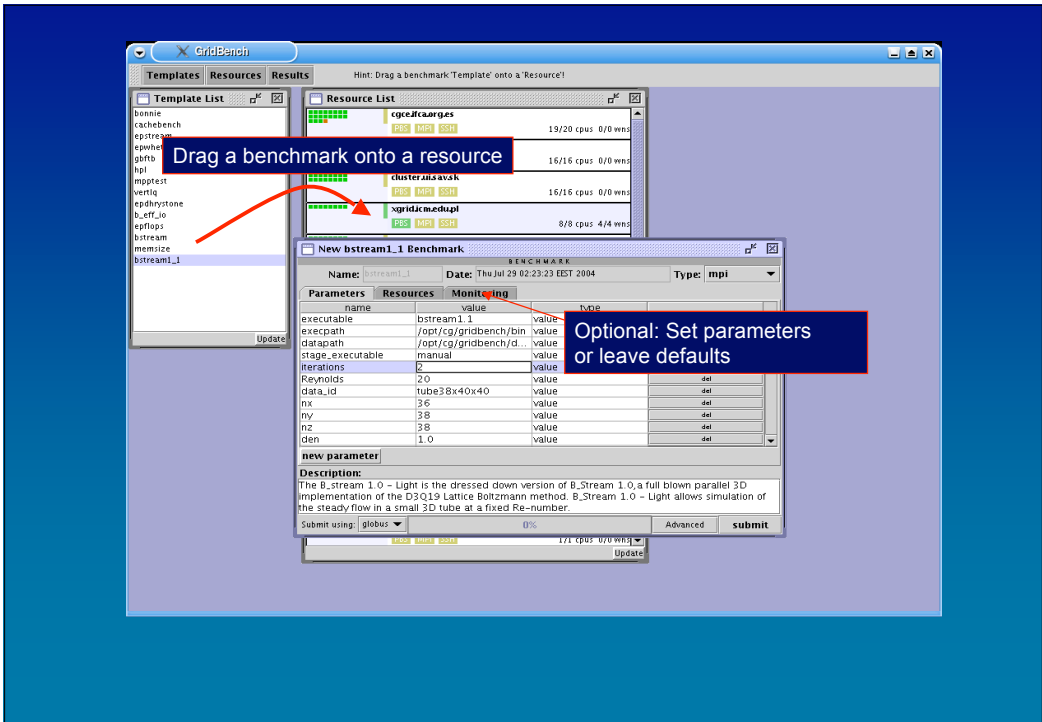
Simulated flows

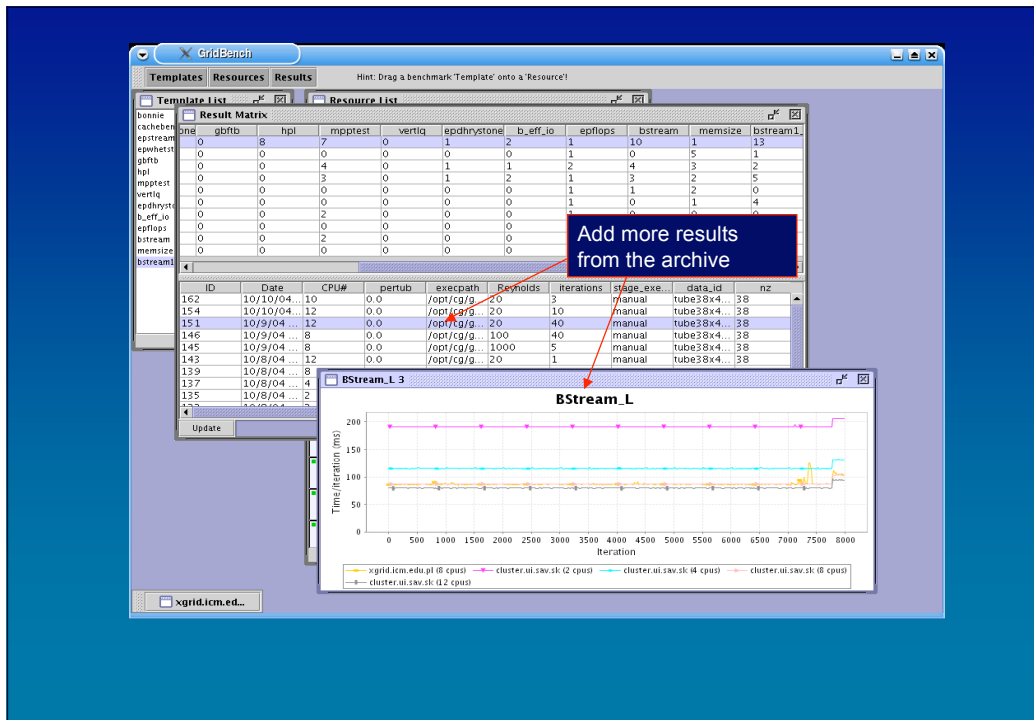


The screenshot shows the GridBench application window with the following components:

- Template List:** A list of benchmark templates including bonnie, cachebench, egstream, epwhetstone, gbfb, hpl, imptest, vertiq, epdmsstone, b\_eff\_io, eplfops, bstream, memsize, and bstream1\_1.
- Resource List:** A table of available resources with columns for resource name, status, and specifications. A context menu is open over the 'grbcg011' resource, showing options: 'Update IPBS', 'Set Selected cpus...', 'Last Output...', 'Test...', and 'JMS user'.
- Callout Box:** A blue box with white text that reads: "Select some CPUs, or leave the default (default is 'all free CPUS')". An arrow points from this box to the 'Set Selected cpus...' menu option.

Resource Name	Status	CPUs	WINS
cgcaifcaorges	Green	19/20	0/0
ce010zkate	Green	6/6	0/0
clusterasavash	Green	6/6	0/0
xgridcmadupl	Green	6/6	0/0
grbcg011	Green	6/6	0/0
cagnode	Green	6/6	0/0
cms4uw...	Green	4/4	0/0
ce02lippt	Green	3/3	0/0
lok01#icavuz	Green	3/3	0/0
ce.grid.ces.gaes	Green	2/4	0/0
grid01.physics.auth.gr	Green	2/2	0/0
ce001.grid.cyaxcy	Green	1/1	0/0
grid1_4.physics.auth.gr	Green	1/1	0/0
cgnode06.tuusa.gr	Green	1/1	0/0





## Remarks

- Virtualization and resource heterogeneity turn Grid Benchmarking into a:
  - Challenging and expensive process.
  - Necessary undertaking for performance-based decisions.
- Isolated metrics are of little use. We need instead ontologies of metrics.
- Virtualization and the lack of central control, put the accuracy of benchmarking measurements to question:
  - Need a combination of metrics and monitoring information to filter-out invalid measurements.

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## A Scenario for the Grid's future

- The Grid as a Wide-Scale Distributed System:
  - Millions of resources of different kinds.
  - Services and Policies in place.
  - Relationships (permanent and transient) between organizations, software, data, services, applications...
  - Different middleware platforms.
  - Common (?) protocols, standards and API's.
- The hope is that Grid will grow larger and will reach an acceptance as wide as the Web.

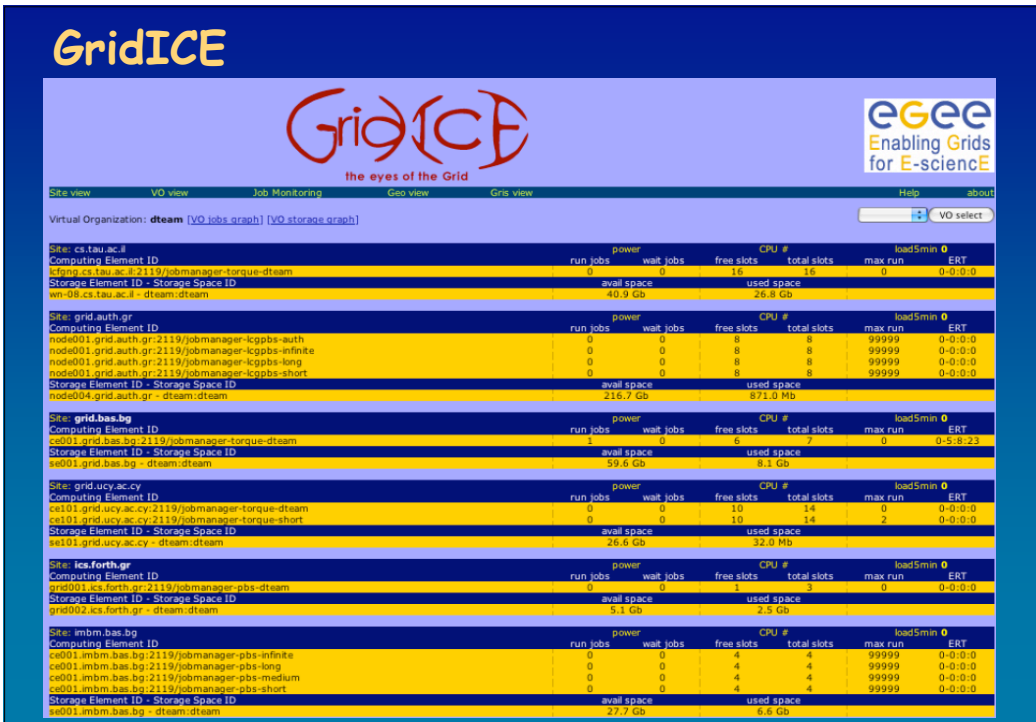
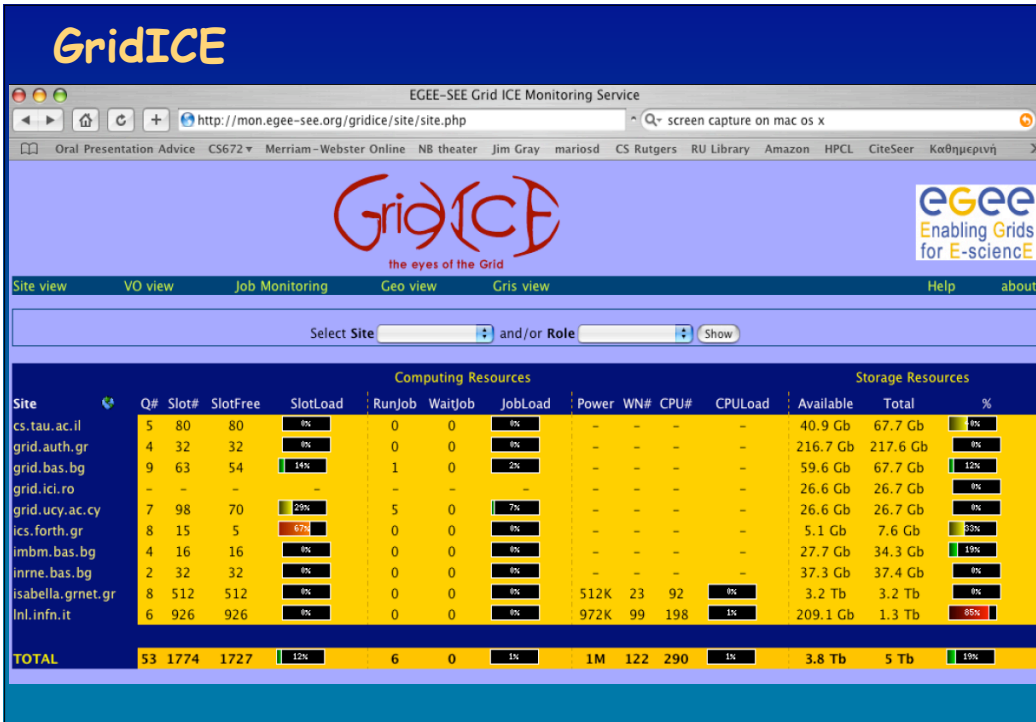
## The Grid information problem

- How are individuals and organizations going to harness the capabilities of a **fully deployed Grid**:
  - **Massive** and ever-expanding base of resources.
  - Huge corpus of available programs, services, and data.
- Users need **tools** to **discover** and **identify** information about resources that are:
  - **Interesting** (discovery)
  - **Relevant** (classification)
  - **Accessible** and **available** under known policies of use, cost (inquiry)

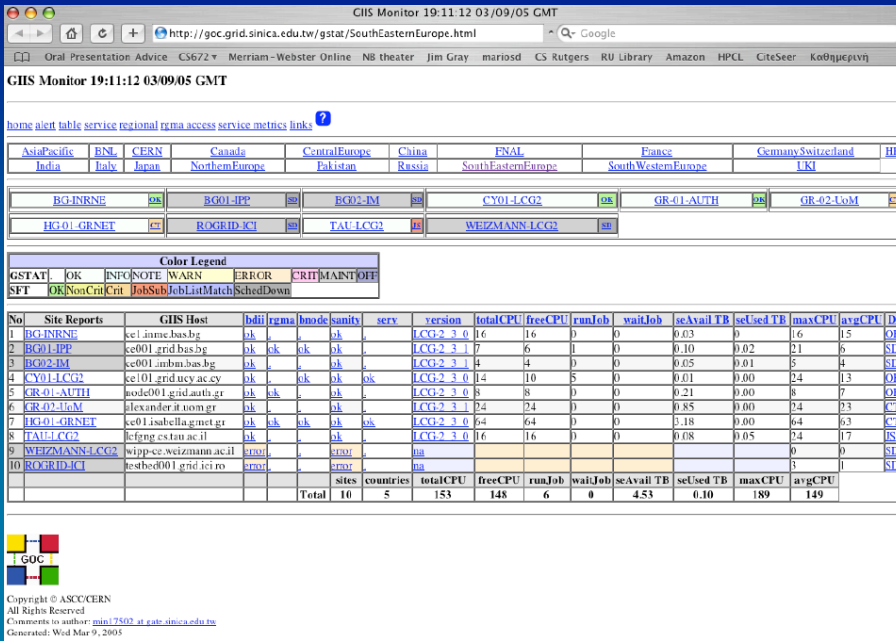
## Globus MDS

```
dn: GlueSubClusterUniqueID-cgce.ifca.org.es,  
    GlueClusterUniqueID-cgce.ifca.org.es,  
    Mds-Vo-name-ifcapro.mds-vo-name-local,o-grid  
objectClass: GlueClusterTop  
objectClass: GlueSubCluster  
objectClass: GlueSchemaVersion  
objectClass: GlueInformationService  
objectClass: GlueKey  
GlueSchemaVersionMajor: 1  
GlueSchemaVersionMinor: 1  
GlueChunkKey: GlueClusterUniqueID-cgce.ifca.org.es  
GlueHostApplicationSoftwareRunTimeEnvironment: CG2_0_4  
GlueHostApplicationSoftwareRunTimeEnvironment: CROSSGRID  
GlueHostApplicationSoftwareRunTimeEnvironment: LOG-2  
GlueHostApplicationSoftwareRunTimeEnvironment: MPICH  
GlueHostApplicationSoftwareRunTimeEnvironment: MPICH  
GlueHostApplicationSoftwareRunTimeEnvironment: MPICH-C2  
GlueHostArchitectureSMPSize: 2  
GlueHostBenchmarkSF00: 328  
GlueHostBenchmarkSI00: 409  
GlueHostMainMemoryRAMSize: 627  
GlueHostMainMemoryVirtualSize: 1144  
GlueHostNetworkAdapterInboundIP: FALSE  
GlueHostNetworkAdapterOutboundIP: TRUE  
GlueHostOperatingSystemName: Redhat  
GlueHostOperatingSystemRelease: 2.4.20-30.7.legacy.smp  
GlueHostOperatingSystemVersion: 1 SMP Fri Feb 20 10:12:55 2004  
GlueHostProcessorClockSpeed: 1261  
GlueHostProcessorModel: Intel(R) Pentium(R) III family 1266MHz  
GlueHostProcessorVendor: GenuineIntel  
GlueSubClusterName: cgce.ifca.org.es  
GlueSubClusterUniqueID: cgce.ifca.org.es
```

```
dn: GlueCEUniqueID-cgce.ifca.org.es:2119/jobmanager-pbs-short,  
    Mds-Vo-name-ifcapro.mds-vo-name-local,o-grid  
objectClass: GlueCETop  
objectClass: GlueCE  
objectClass: GlueSchemaVersion  
objectClass: GlueCEAccessControlBase  
objectClass: GlueCEInfo  
objectClass: GlueCEPolicy  
objectClass: GlueCEState  
objectClass: GlueInformationService  
objectClass: GlueKey  
GlueSchemaVersionMajor: 1  
GlueSchemaVersionMinor: 1  
GlueCEName: short  
GlueCEUniqueID: cgce.ifca.org.es:2119/jobmanager-pbs-short  
GlueCEInfoGatekeeperPort: 2119  
GlueCEInfoHostName: cgce.ifca.org.es  
GlueCEInfoLRMSType: pbs  
GlueCEInfoLRMSVersion: OpenPBS_2.4  
GlueCEInfoTotalCPUs: 20  
GlueCEStateEstimatedResponseTime: 0  
GlueCEStateFreeCPUs: 20  
GlueCEStateRunningJobs: 0  
GlueCEStateStatus: Production  
GlueCEStateTotalJobs: 0  
GlueCEStateWaitingJobs: 0  
GlueCEStateWorstResponseTime: 0  
GlueCEPolicyMaxCPUTime: 900  
GlueCEPolicyMaxRunningJobs: 2  
GlueCEPolicyMaxTotalJobs: 4  
GlueCEPolicyMaxWallClockTime: 7200  
GlueCEPolicyPriority: 1  
GlueCEAccessControlBaseRule: VO:cg  
GlueForeignKey: GlueClusterUniqueID-cgce.ifca.org.es
```



# MapCenter



GIHS Monitor 19:11:12 03/09/05 GMT

[home](#) [alert](#) [table](#) [service](#) [regional](#) [rma](#) [access](#) [service](#) [metrics](#) [links](#)

AsiaPacific	BNL	CERN	Canada	CentralEurope	China	FNAL	France	GermanySwitzerland	HP
India	Italy	Japan	NorthemEurope	Pakistan	Russia	SouthEasternEurope	SouthWesternEurope	UKI	
BGHRNE	BG01-IPP	BC02-IM	CY01-LCG2	GR-01-AUTH	GR-02-UoM				
HG-01-GRNET	ROGRID-ICI	TAU-LCG2	WEIZMANN-LCG2						

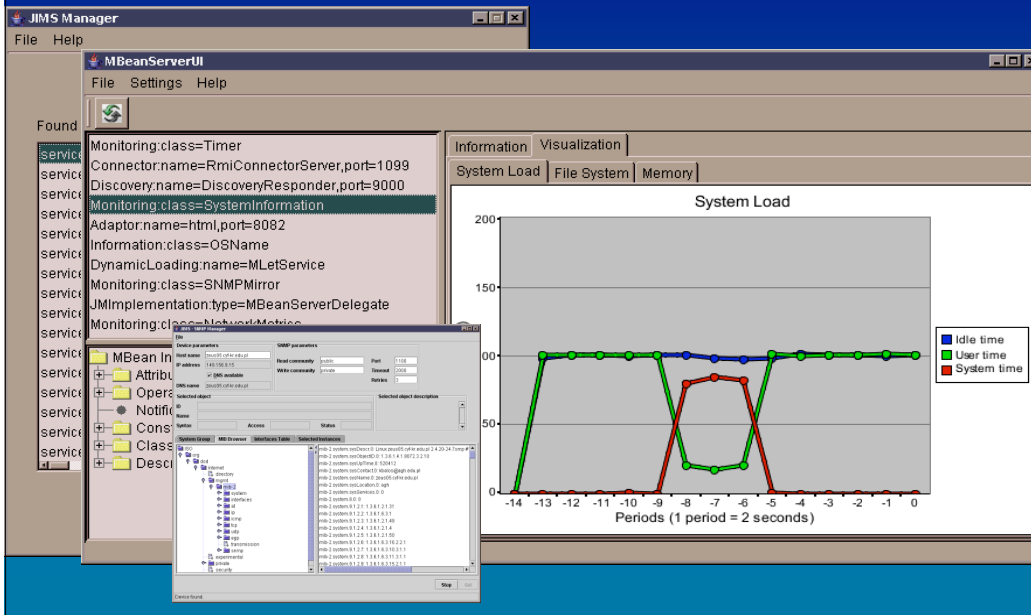
**Color Legend**

GSTAT	OK	INFO	NOTE	WARN	ERROR	CRIT	MAINT	OFF		
SFT	OK	Nov	Crit	Job	Sub	Job	List	Match	Sched	Down

No	Site Reports	GIS Host	bdli	rma	bnode	sanity	serv	version	totalCPU	freeCPU	runJob	waitJob	scAvail TB	seUsed TB	maxCPU	avgCPU	DI		
1	BGHRNE	ce1.infn.bas.bg	ok		ok			LCG-2.3.0	16	16	0	0	0.03	0	16	15	OK		
2	BG01-IPP	ce001.grid.bas.bg	ok	ok	ok	ok		LCG-2.3.1	7	6	1	0	0.10	0.02	21	6	SD		
3	BC02-IM	ce001.infn.bas.bg	ok		ok			LCG-2.3.1	4	4	0	0	0.05	0.01	5	4	SD		
4	CY01-LCG2	ce101.grid.ucy.ac.cy	ok		ok	ok	ok	LCG-2.3.0	14	10	5	0	0.01	0.00	24	13	OK		
5	GR-01-AUTH	node001.grid.auth.gr	ok	ok				LCG-2.3.0	8	8	0	0	0.21	0.00	8	7	OK		
6	GR-02-UoM	alexander.it.uom.gr	ok		ok			LCG-2.3.1	24	24	0	0	0.85	0.00	24	23	CT		
7	HG-01-GRNET	ce01.isabella.gnet.gr	ok	ok	ok	ok	ok	LCG-2.3.0	64	64	0	0	3.18	0.00	64	63	CT		
8	TAU-LCG2	lcfagg.es.tau.ac.il	ok		ok			LCG-2.3.0	16	16	0	0	0.08	0.05	24	17	IS		
9	WEIZMANN-LCG2	wipp.ce.weizmann.ac.il	error		error		na								0	0	SD		
10	ROGRID-ICI	tesbed001.grid.ici.ro	error		error		na								5	1	SD		
Total									10	5	153	148	6	0	4.53	0.10	189	149	

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Generated: Wed Mar 9, 2005

# JIMS



JIMS Manager

MBeanServerUI

Monitoring: class=Timer  
Connector.name=RmiConnectorServer,port=1099  
Discovery.name=DiscoveryResponder,port=9000  
Monitoring: class=SystemInformation  
Adaptor.name=html,port=9082  
Information: class=OSName  
DynamicLoading: name=MLetService  
Monitoring: class=SNMPMirror  
JMIImplementation: type=MBeanServerDelegate  
Monitoring: class=MjvnetMetrics

System Load

Information Visualization

System Load

200  
150  
100  
50  
0  
-50  
-100

14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Periods (1 period = 2 seconds)

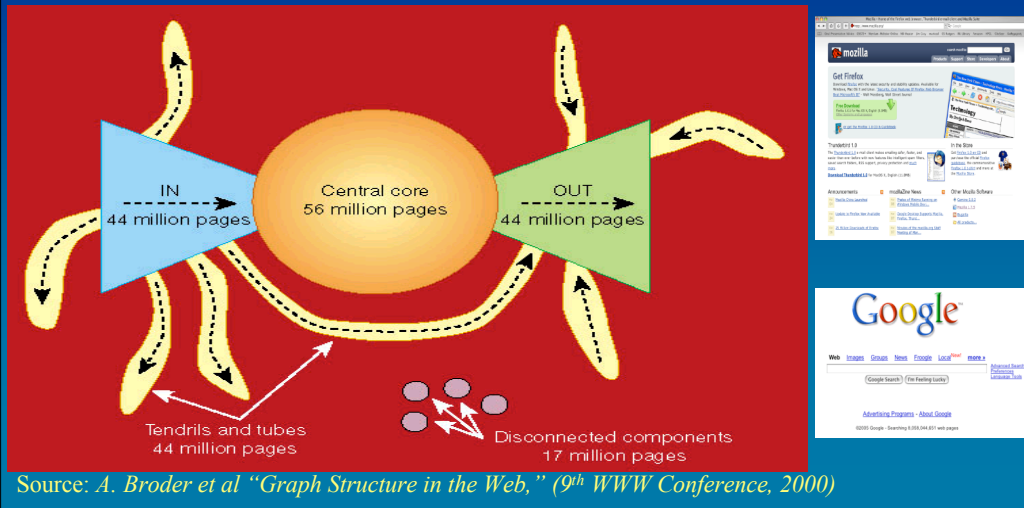
Idle time  
User time  
System time

Legend: Idle time (blue), User time (green), System time (red)



## Simple, yet powerful..

- Lessons learned from the Web or... why the Web has been so successful?



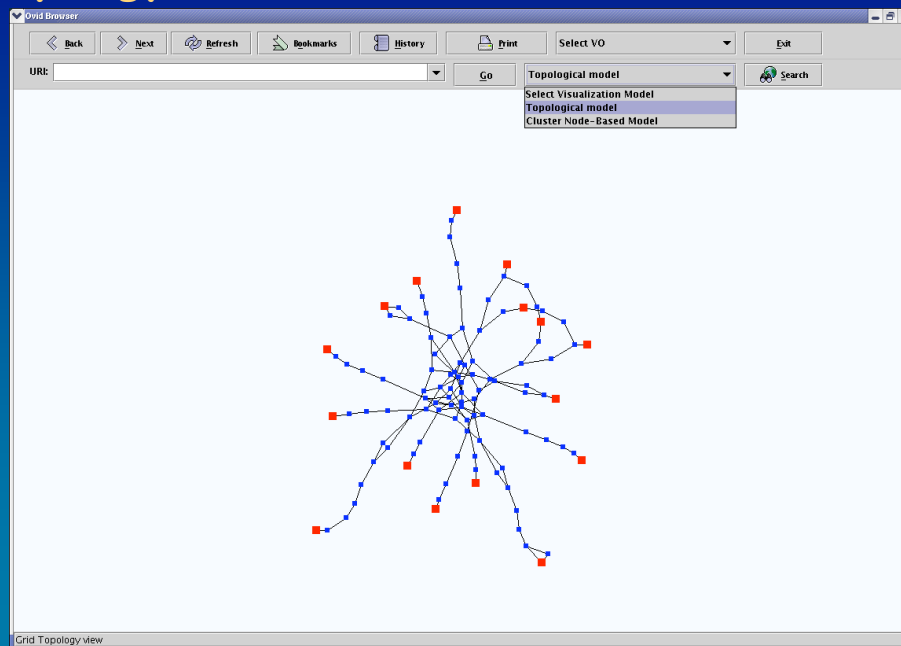
## Navigating and Searching the Grid

- Key differences from the Web
  - Which are the information containers?
  - Hyperlinks?..
  - Information Retrieval makes no good..
- Navigation: the Ovid browser
  - Supporting the seamless navigation of users in the Grid information space.
- Towards a search engine for the Grid:
  - What is the information space we would like to search in?

## Ovid: A (universal) browser for Grids

- Navigational primitives designed to cope with network disorientation and information overloading;
- A small set of core graphical views, i.e. visual abstractions of Grid information;
- Support for embedding and implementing hyperlinks connecting related entities represented within different information views;
- A plug-in mechanism, for the seamless integration with Ovid of third-party monitoring clients;
- A modular software design (model-view-controller architecture), for the easy integration of different visualization algorithms.

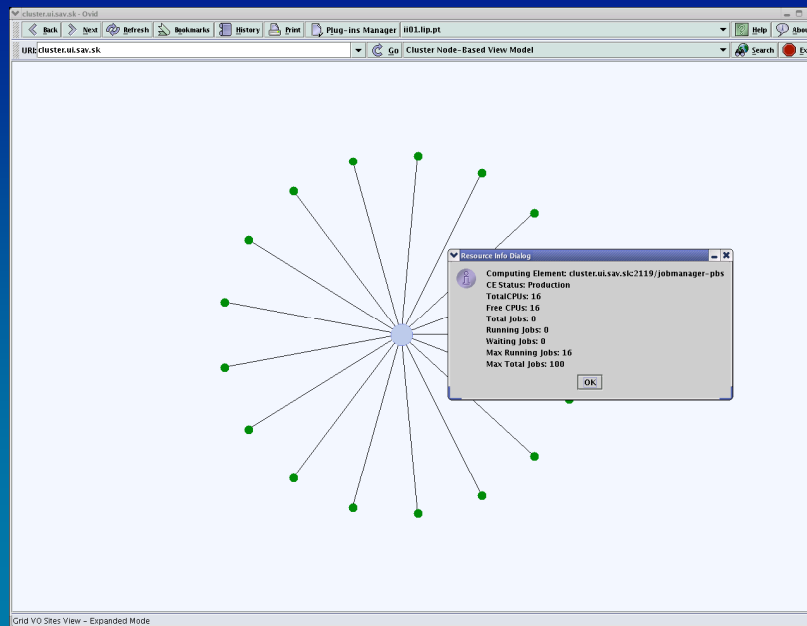
## Topology of the CrossGrid VO



## Ovid: EGEE VO



## Ovid: Querying a Grid node



## Ovid's Search interface

The screenshot shows the Ovid application window with a search results dialog box open. The dialog box is titled "Search results for: nl" and contains the following text:

```
Results found through search  
kr2.das2.nikhef.nl*MDS plug-in  
wn1.das2.nikhef.nl*MDS plug-in  
wn2.das2.nikhef.nl*MDS plug-in  
wn4.das2.nikhef.nl*MDS plug-in  
ds2d.das2.nikhef.nl*MDS plug-in
```

Below the text are two buttons: "View resource" and "Cancel". The background of the window displays a network diagram with several nodes and connections, including a central node with many surrounding nodes.

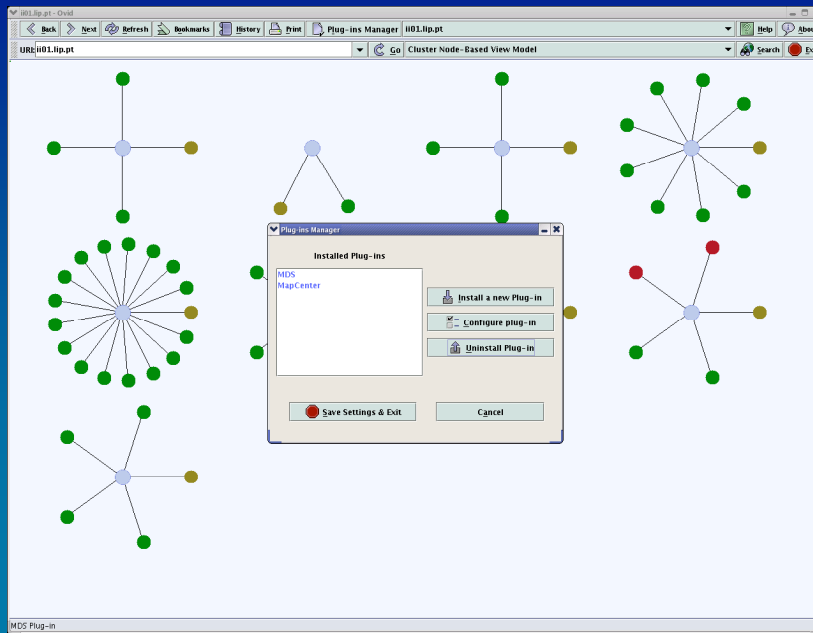
## Ovid: Bookmarks manager

The screenshot shows the Ovid application window with a Bookmarks Manager dialog box open. The dialog box is titled "Bookmarks Manager" and contains the following text:

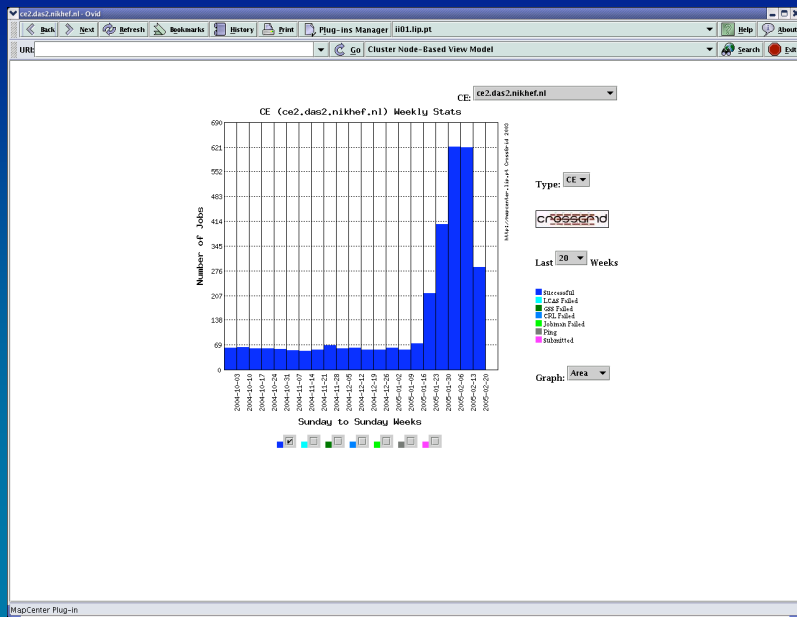
```
Today: Thu Feb 17 2005  
Current Resource: i101.lip.pt - MDS  
zeus25.cyf-kr.edu.pl*MDS plug-in  
cluster.us.sav.sk*MDS plug-in  
zeus24.cyf-kr.edu.pl*MDS plug-in  
i101.lip.pt*MDS plug-in
```

Below the text are five buttons: "Bookmark Current Resource", "Clear Bookmarks", "Exit", "Open Selected Bookmark", and "Remove Selected Bookmark". The background of the window displays a network diagram with several nodes and connections, including a central node with many surrounding nodes.

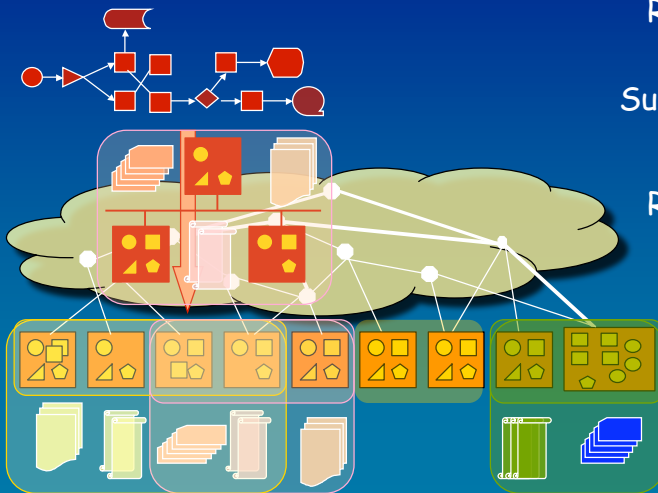
# Ovid: Plug-in mechanism



# MapCenter's plug-in



## What information we want to search for?



### Resource Specifications:

#### Virtual Organizations:

#### Applications:

#### Summary & Statistics

- Policies
- Capabilities
- Log People
- Configurations
- Association

#### Resource Status:

#### Data-sets:

- Resources
- Data
- Availability
- Metadata
- Monitoring data
- Replicas

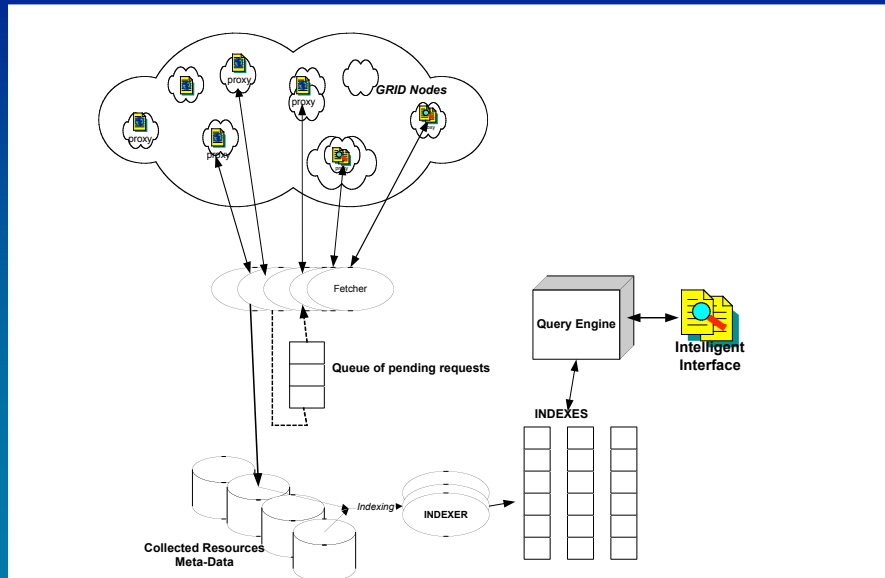
#### Services:

- Interface
- Metadata

## Towards a Grid Search Engine (GRISEN)

- Based on the notion of "grid entity," which represents various (permanent or transient) resources on the Grid: computational, storage, and network; services, software and datasets; workflows and VO's; "best practices"; policies for use, pricing, QoS etc.
- Grid entities:
  - Capture characteristics of Grid-architecture components.
  - Have a common naming scheme.
  - Can be described by metadata using a common hierarchical data model (RDF or XML).
  - Have their metadata published in "proxies."

## A Reference Architecture for GRISEN



## Conclusions and Future Work

- Our motivation stems from the need to provide *effective systems* and *tools* for the users of future *massive Grids* that will enable:
  - ⇒ The *performance exploration* of Grid resources and the *selection of appropriate resources* for dispatching Grid jobs.
  - ⇒ *End-user navigation* in the Grid information space.
  - ⇒ The *searching* for interesting/relevant information for various Grid-related resources.

## Conclusions and Future Work

- Automatic configuration and management of Grid benchmarks is important to:
  - Keep performance-metrics ontology "fresh."
  - Support the automatic auditing of resource providers by VOs: performance capacity, policy compliance, reliability of information services, etc.
  - Derive indirect, collective metrics expressing "quality features" of Grid infrastructures: level of heterogeneity, infrastructure health, reliability, robustness.
  - Automate the process of metrics-filtering.
  - Use benchmarking as a mechanism for driving automatic remote healing.

## Conclusions and Future Work

- Navigation and Searching in the Grid, is essentially a process of capturing, managing, and querying...
- ... a very large, fragmented, incomplete, heterogeneous, and often inconsistent, implicit metadata space.
- Looking at issues of:
  - Metadata representation (RDF) and navigation.
  - Metadata integration.
  - The scalability of metadata management (RDF/Jena).





Wed, 9 Mar 2005 20:29:29 +0200



# Questions ?

Wed, 9 Mar 2005 20:29:29 +0200

*South Eastern Europe Grid Infrastructure*