The Information System

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Outline

- **Information System**
  - lcg-infosites
  - R-GMA
- **Accounting System**
- **Monitoring System**

lcg-infosites
(the present)

Uses of the IS in EGEE/LCG

If you are a user

Retrieve information of Grid resources and status

Get the information of your jobs status

If you are a middleware developer

Workload Management System:
Matching job requirements and Grid resources

Monitoring Services:
Retrieving information of Grid Resources status and availability

If you are site manager or service

You “generate” the information for example relative to your site or to a given service

Elements behind the IS

```
************************************************************************
These are the data for alice: (in terms of CPUs)
************************************************************************
#CPU  Free   Total Jobs    Running   Waiting    Computing Element

------------------------------------------------------------------------

52     51       0            0          0    ce.prd.hp.com:2119/jobmanager-lcgpbs-long

16     14       3            2          1    lcg06.sinp.msu.ru:2119/jobmanager-lcgpbs-long

[.....]

The total values are:
----------------------
10347  5565     2717       924       1793
```

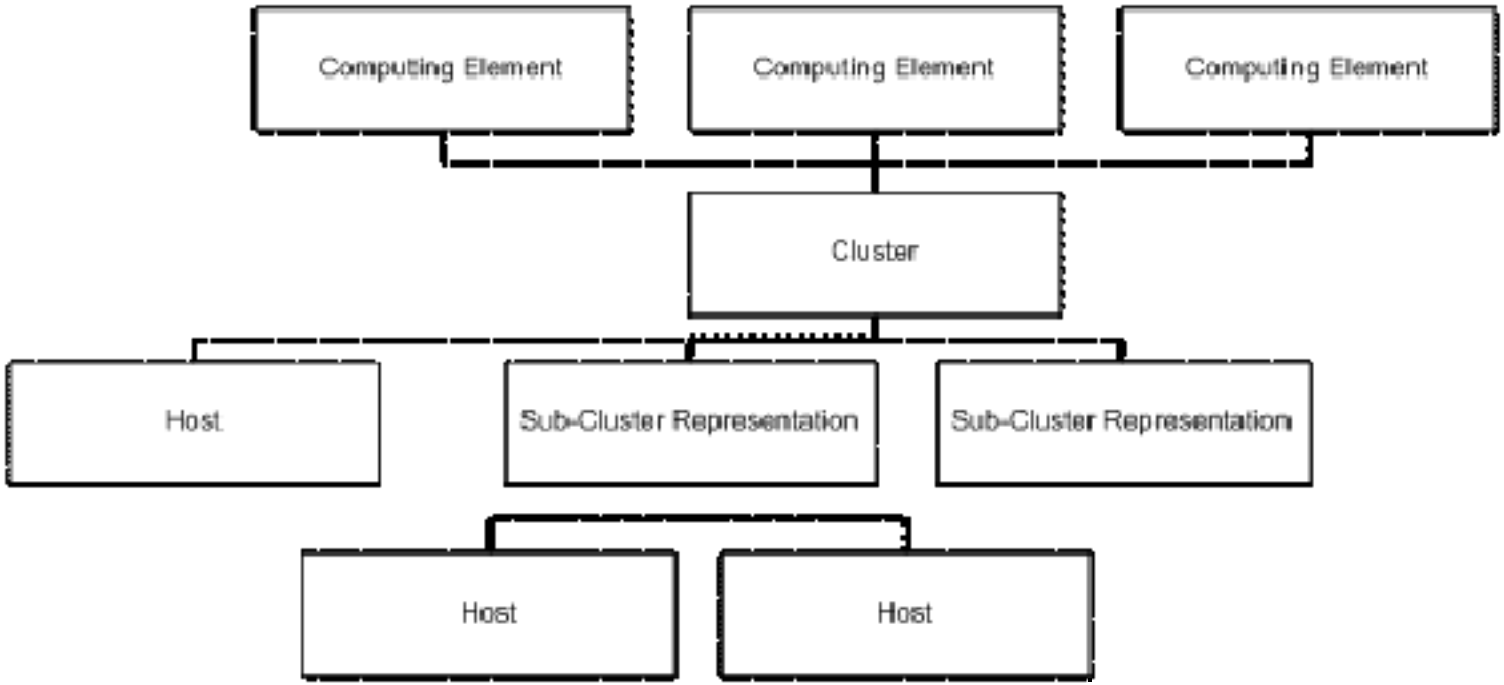
She will use some EGEE/LCG tools and after few moments…

- Something has managed this information: (General IS architecture)
- Something has provided it: (Providers, Servers)
- It is following a certain "schema": (GLUE Schema)
- And she has accessed it following a protocol: (Access Protocol: LDAP)

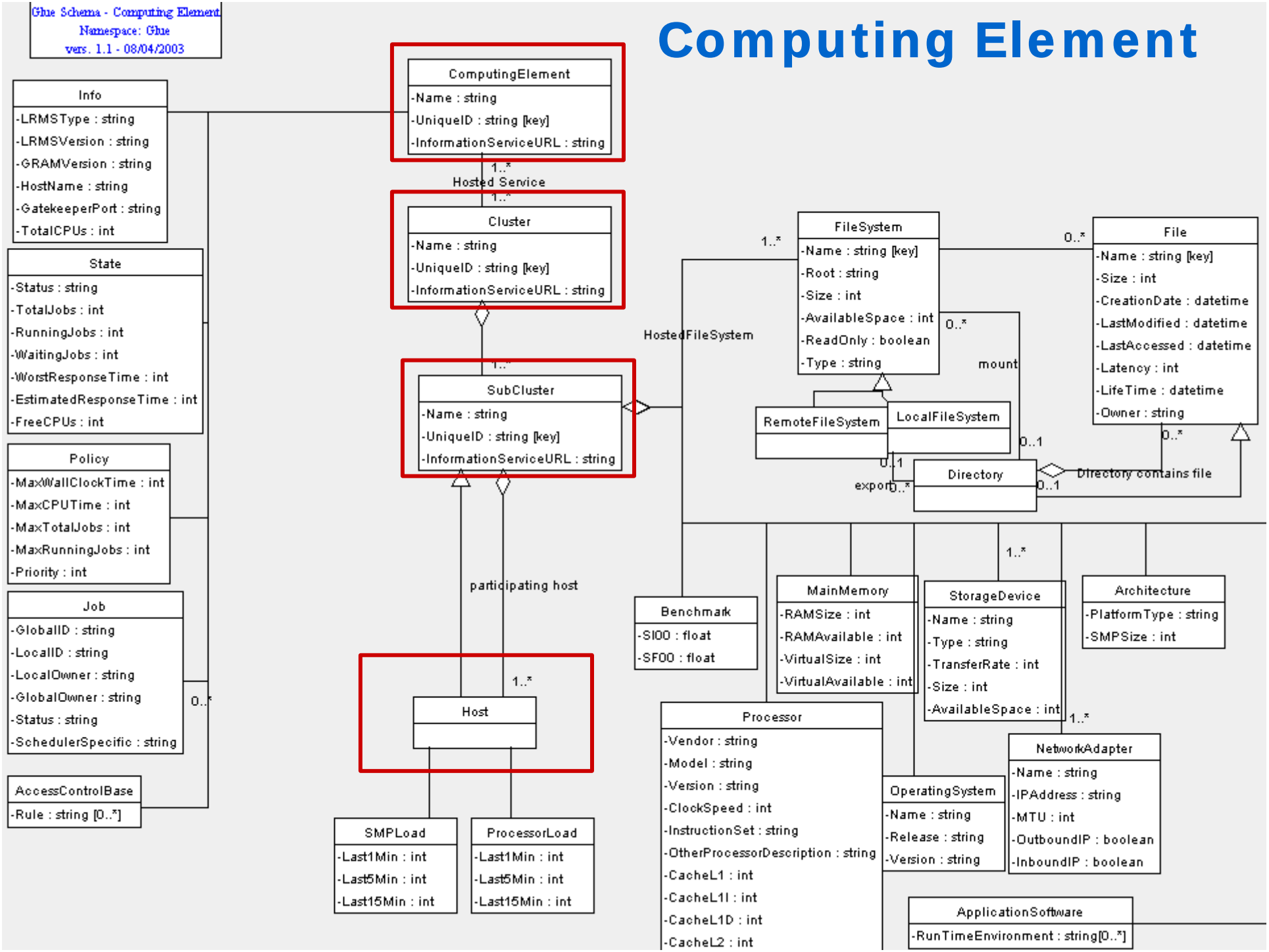
The GLUE Schema

- **Developed within High Energy Physics (HEP) community**
  - DataGrid / EGEE
  - DataTAG
  - Globus
- **Currently defines CEs and SEs**
- **Entire R-GMA Schema (not only GLUE):**
  - For service discovery and monitoring
  - http://hepunx.rl.ac.uk/egee/jra1-uk/glite-r1/schema/index.html

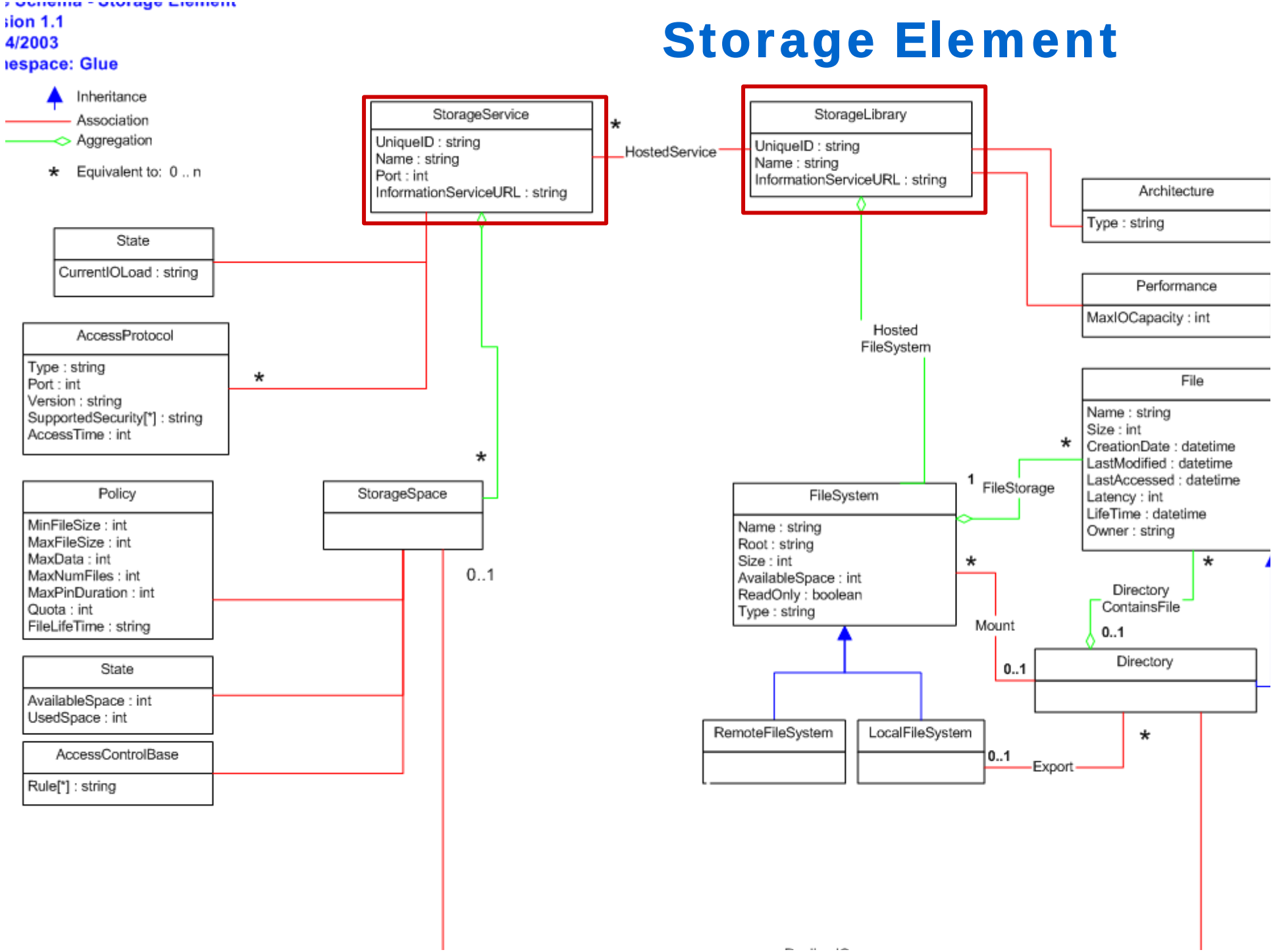
Computing Element Hierarchy



Computing Element



Storage Element



The Information System Elements

MDS: Monitoring and Discovery Service

- Adopted from Globus
- It is the general architecture of EGEE/LCG to manage Grid information

General steps:

1st. At each site providers report static and dynamic service status to servers

2nd. A central system queries these servers and stores the retrieved information in a database

3rd. This information will be accessed through a given access protocol

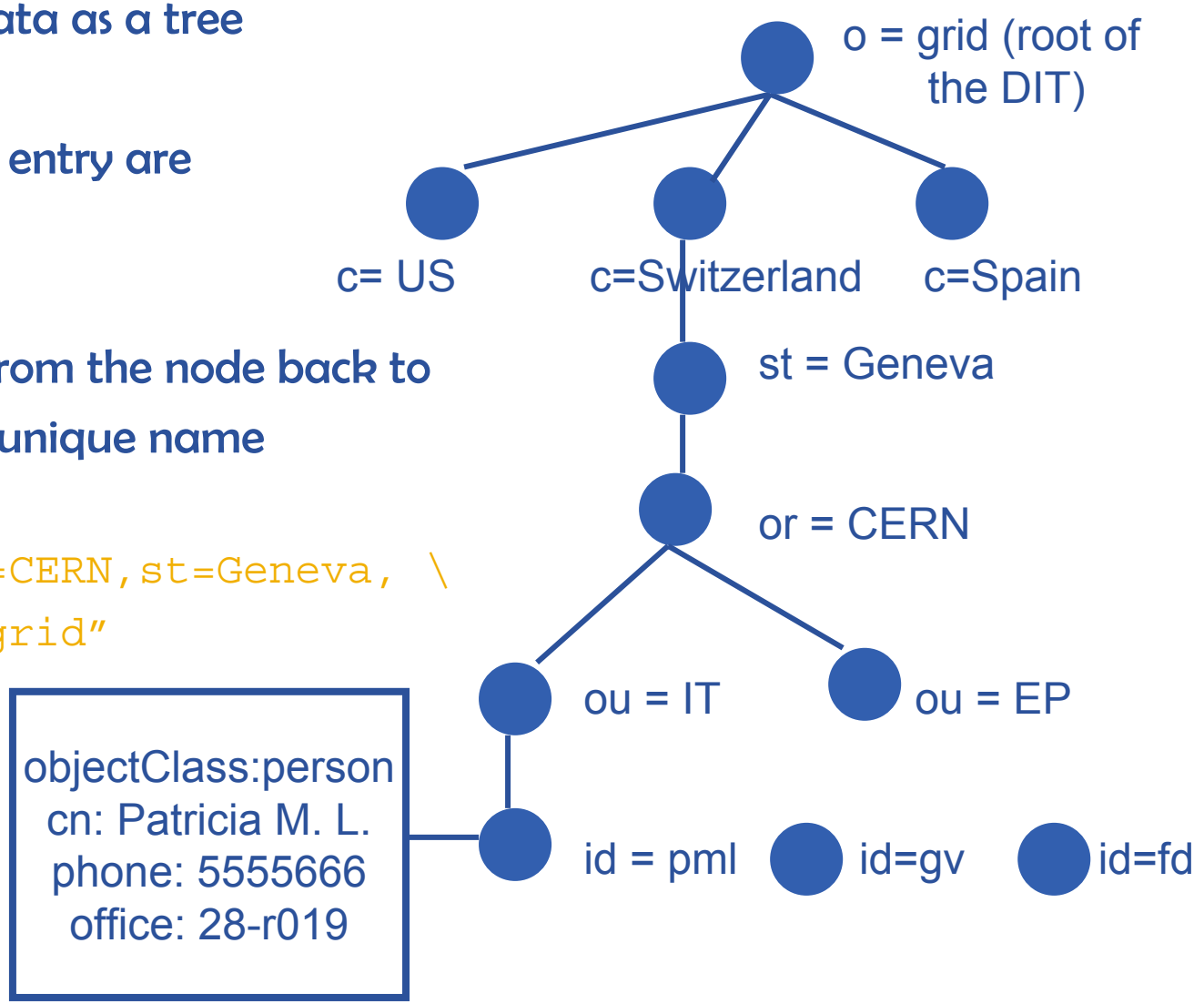
4th. The central system provides the information in a given schema

BDII (a MDS evolution) is the current EGEE/LCG Information System and it is based on LDAP

The LDAP Protocol

- LDAP structures data as a tree
- The values of each entry are uniquely named
- Following a path from the node back to the root of the DIT, a unique name is built (the DN):

```
"id=pml,ou=IT,or=CERN,st=Geneva, \
c=Switzerland,o=grid"
```



Implementation of IS in LCG-2

♠ lcg-infosites

- Already deployed in LCG-2 in the last release
- It is intended to be the most complete information retriever for the user:
  - ✓ Once he arrives at the Grid (on UIs)
  - ✓ To be used by the user applications (on WNs)
- Several versions of this script have been included in the software packages of ATLAS and the monitoring services of Alice (MonAlisa)
- You do not need a proxy

This will be tested during the hands-on session

lcg-infosites

```
> lcg-infosites --vo <your_vo> feature --is <your_bdii>
```

- It's mandatory to include the vo and the feature
- The –is option means the BDII you want to query. If not supplied, the BDII defined into the LCG_GFAL_INFOSYS will be interrogated

Features and descriptions:

closeSE	Names of the CEs where the user's VO is allowed to run together with their corresponding closest SEs
ce	Number of CPUs, running and waiting jobs and names of the CEs
se	SEs names together with the available and used space
lrc (rmc)	Name of the lrc (rmc) for the user's VO
all	It groups all the features just described
help	Description of the script

lcg-infosites

```
> lcg-infosites --vo alice se --is lxb2006.cern.ch
```

```
************************************************
These are the data for alice: (in terms of SE)
************************************************
Avail Space (Kb)      Used Space (Kb)            SEs
-----------------------------------------------------------------
33948480              2024792                    se.prd.hp.com
506234244             62466684                   teras.sara.nl
1576747008            3439903232                 gridkap02.fzk.de
1000000000000         500000000000               castorgrid.cern.ch
304813432             133280412                  gw38.hep.ph.ic.ac.uk
651617160             205343480                  mu2.matrix.sara.nl
1000000000000         1000000000                 lcgads01.gridpp.rl.ac.uk
415789676             242584960                  cclcgseli01.in2p3.fr
264925500             271929024                  se-a.ccc.ucl.ac.uk
668247380             5573396                    seitep.itep.ru
766258312             681359036                  t2-se-02.lnl.infn.it
660325800             1162928716                 tbn17.nikhef.nl
1000000000000         1000000000000              castorftp.cnaf.infn.it
14031532              58352476                   lcgse01.gridpp.rl.ac.uk
1113085032            1034242456                 zeus03.cyf-kr.edu.pl
                     [... ... ... ... ...]
```

R-GMA

(the future)

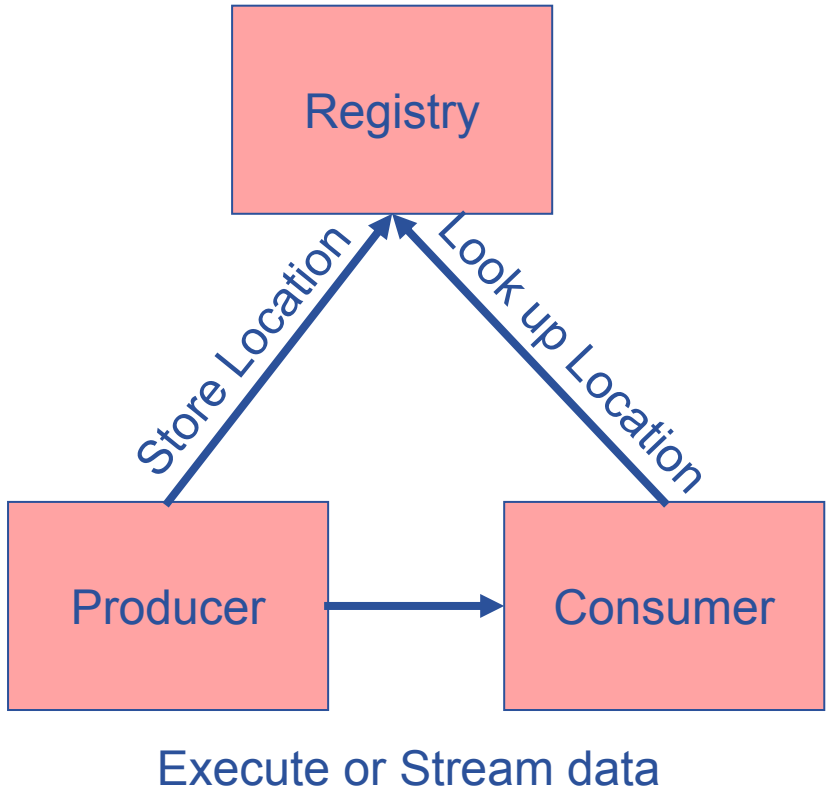
Introduction to R-GMA

- **Relational Grid Monitoring Architecture (R-GMA)**
  - Developed as part of the EuropeanDataGrid Project (EDG)
  - Now as part of the EGEE project.
  - Based the Grid Monitoring Architecture (GMA) from the Global Grid Forum (GGF).

- **Uses a relational data model.**
  - Data is viewed as a table.
  - Data structure defined by the columns.
  - Each entry is a row (tuple).
  - Queried using Structured Query Language (SQL).

GMA Architecture and Relational Model

- The Producer stores its location (URL) in the Registry.
- The Consumer looks up producer URLs in the Registry.
- The Consumer contacts the Producer to get all the data.
- Or the Consumer can listen to the Producer for new data.

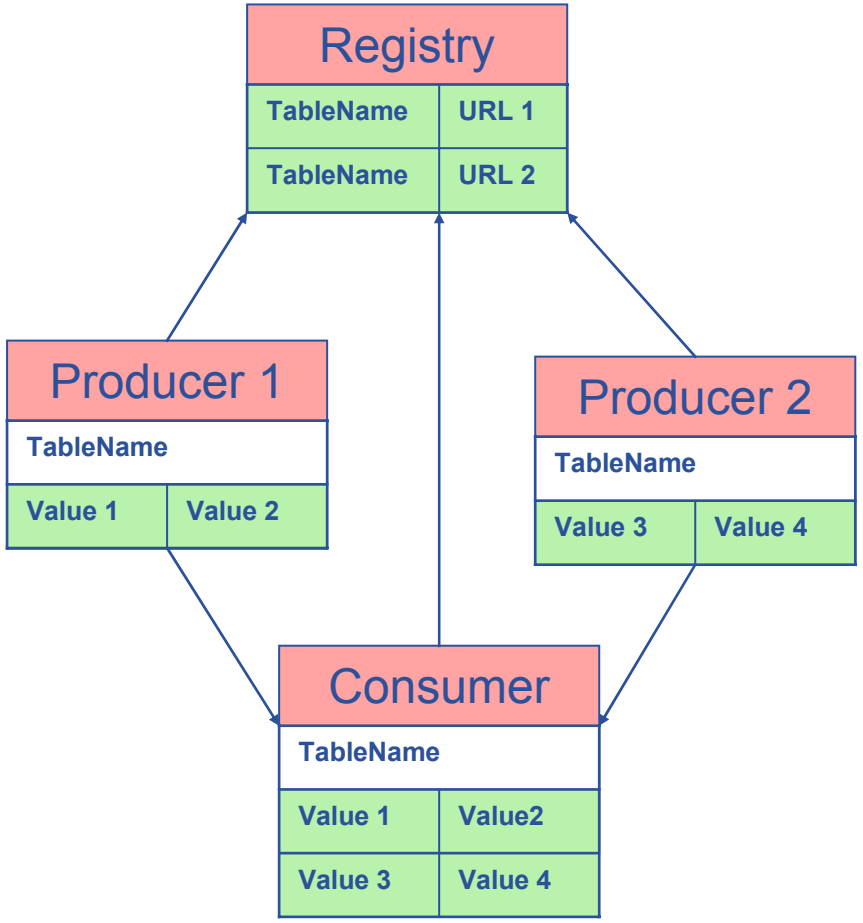


name	ID	birth	Group
Tom	4	1977-08-20	HR

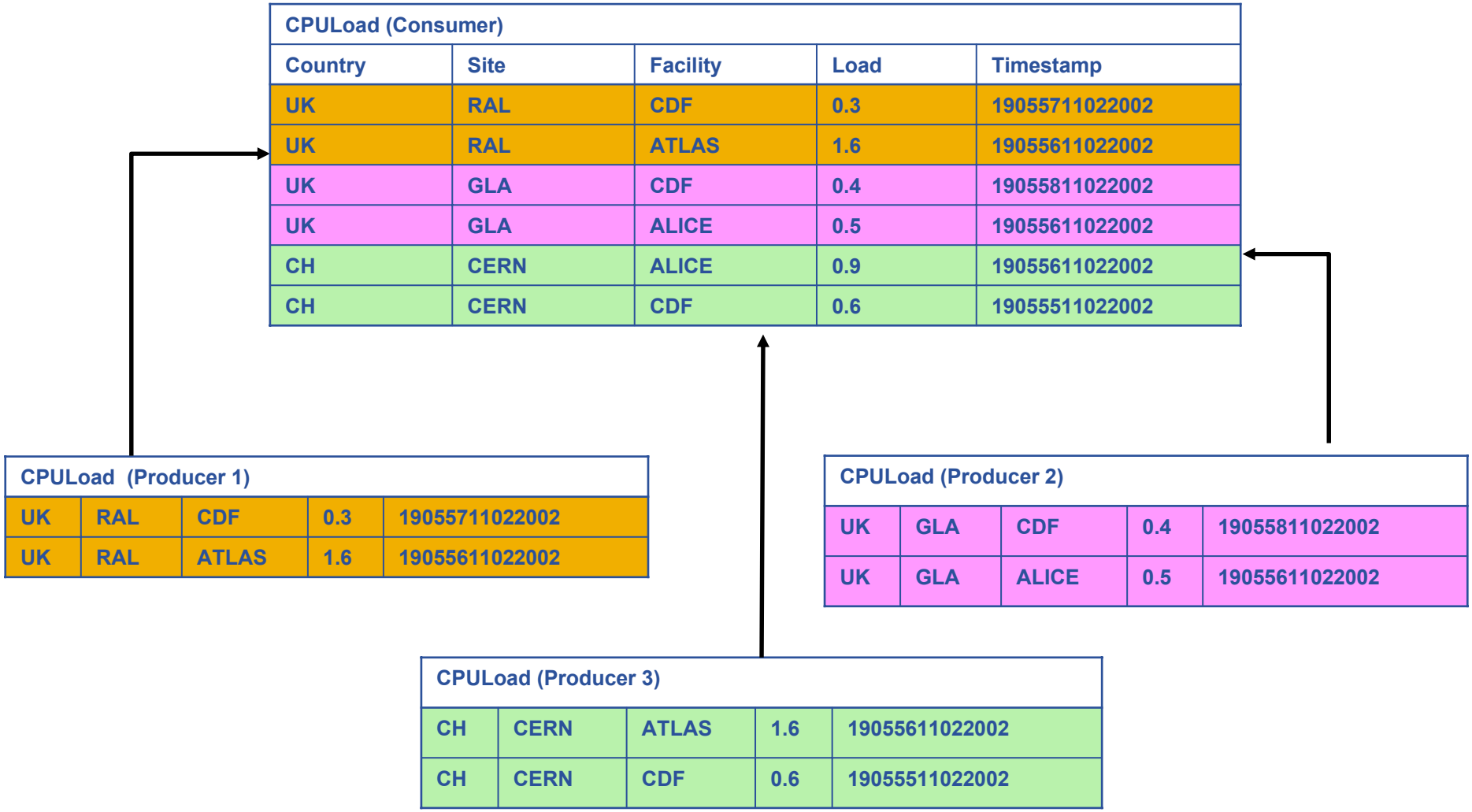
SELECT * FROM people WHERE group='HR'

Multiple Producers

- The Consumer will get all the URLs that could satisfy the query.
- The Consumer will connect to all the Producers.
- Producers that can satisfy the query will send the tuples to the Consumer.
- The Consumer will merge these tuples to form one result set.



Select * from CPULoad



CPULoad (Consumer)

Country	Site	Facility	Load	Timestamp
UK	RAL	CDF	0.3	19055711022002
UK	RAL	ATLAS	1.6	19055611022002
UK	GLA	CDF	0.4	19055811022002
UK	GLA	ALICE	0.5	19055611022002
CH	CERN	ALICE	0.9	19055611022002
CH	CERN	CDF	0.6	19055511022002

CPULoad (Producer 1)

UK	RAL	CDF	0.3	19055711022002
UK	RAL	ATLAS	1.6	19055611022002

CPULoad (Producer 2)

UK	GLA	CDF	0.4	19055811022002
UK	GLA	ALICE	0.5	19055611022002

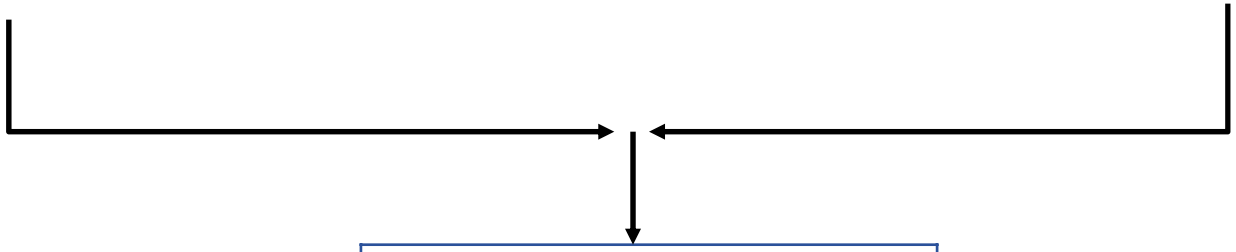
CPULoad (Producer 3)

CH	CERN	ATLAS	1.6	19055611022002
CH	CERN	CDF	0.6	19055511022002

Joins

Service				
URI	VO	type	emailContact	site
gppse01	alice	SE	sysad@rl.ac.uk	RAL
gppse01	atlas	SE	sysad@rl.ac.uk	RAL
gppse02	cms	SE	sysad@rl.ac.uk	RAL
lxshare0404	alice	SE	sysad@cern.ch	CERN
lxshare0404	atlas	SE	sysad@cern.ch	CERN

ServiceStatus				
URI	VO	type	up	status
gppse01	alice	SE	y	SE is running
gppse01	atlas	SE	y	SE is running
gppse02	cms	SE	n	SE ERROR 101
lxshare0404	alice	SE	y	SE is running
lxshare0404	atlas	SE	y	SE is running



Result Set (Consumer)	
URI	emailContact
gppse02	sysad@rl.ac.uk

SELECT Service.URI Service.emailContact FROM Service S, ServiceStatus SS
WHERE (S.URI= SS.URI and SS.up='n')

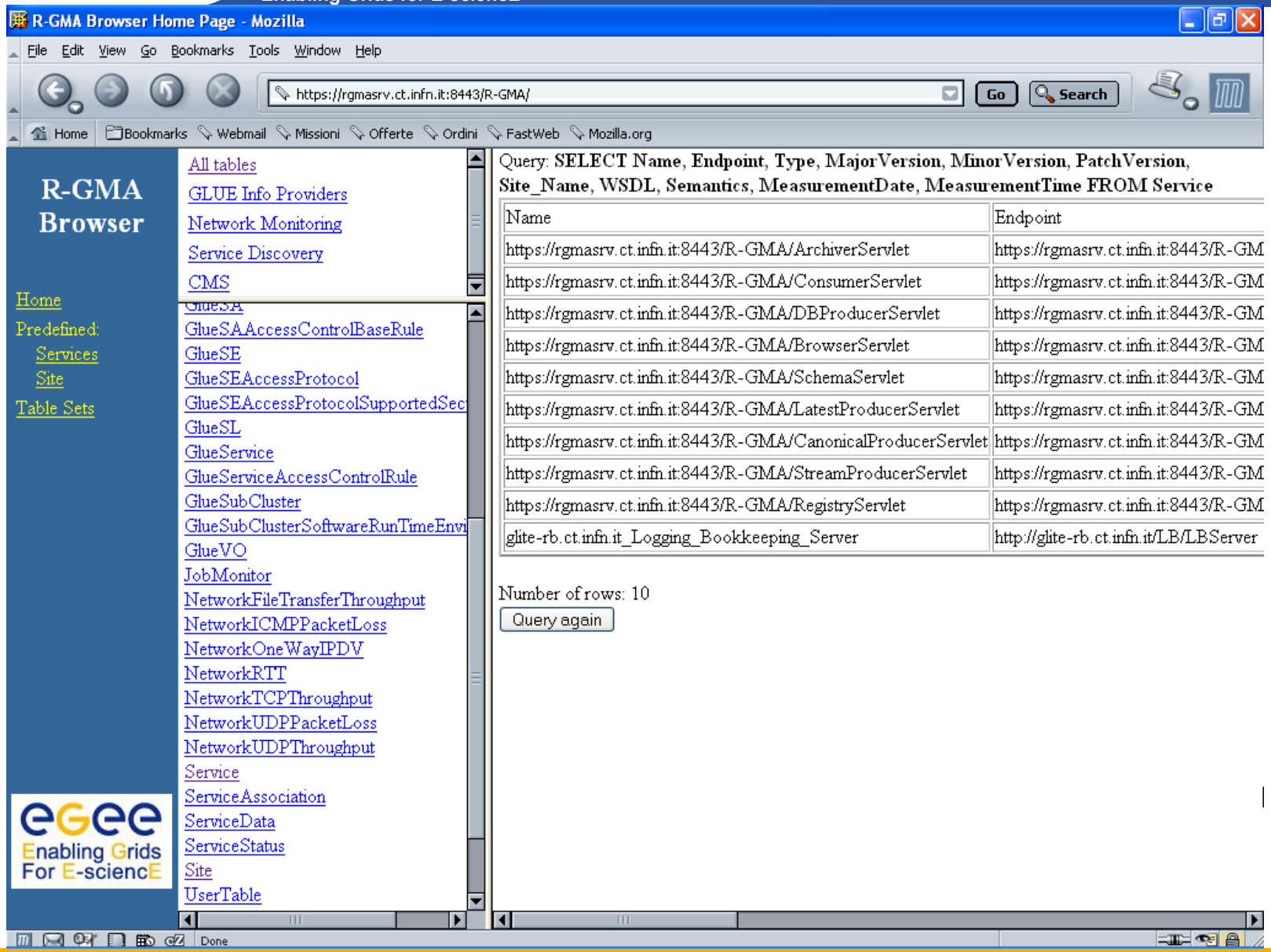
The R-GMA Browser

- **The easiest way to try out R-GMA.**
  - It is installed on the machine running the Registry and Schema:

    https://rgmasrv.ct.infn.it:8443/R-GMA
  - You can also install it along with the Producer and Consumer Servlets.

- **Using the Browser you can do the following.**
  - Browse the tables in the schema.
  - Look at the table definitions.
  - See all the available producers for a table.
  - Query a table.
  - Query only selected producers.

The R-GMA Browser (II)



R-GMA APIs

- **APIs exist in Java, C, C++, Python.**
  - For clients (servlets contacted behind the scenes)
- **They include methods for…**
  - Creating consumers
  - Creating primary and secondary producers
  - Setting type of queries, type of produces, retention periods, time outs…
  - Retrieving tuples, inserting data
  - …
- **You can create your own Producer or Consumer.**

More information

- **R-GMA overview page.**
  - http://www.r-gma.org/
- **R-GMA in EGEE**
  - http://hepunx.rl.ac.uk/egee/jra1-uk/
- **R-GMA Documenation**
  - http://hepunx.rl.ac.uk/egee/jra1-uk/LCG/doc/

Grid Accounting

A generic Grid accounting process involves many subsequent phases that can be divided in:

- **Metering:** collection of usage metrics on computational resources.
- **Accounting:** storage of such metrics for further analysis.
- **Usage Analysis:** Production of reports from the available records.
- **Pricing:** Assign and manage prices for computational resources.
- **Billing:** Assign a cost to user operations on the Grid and charge them.

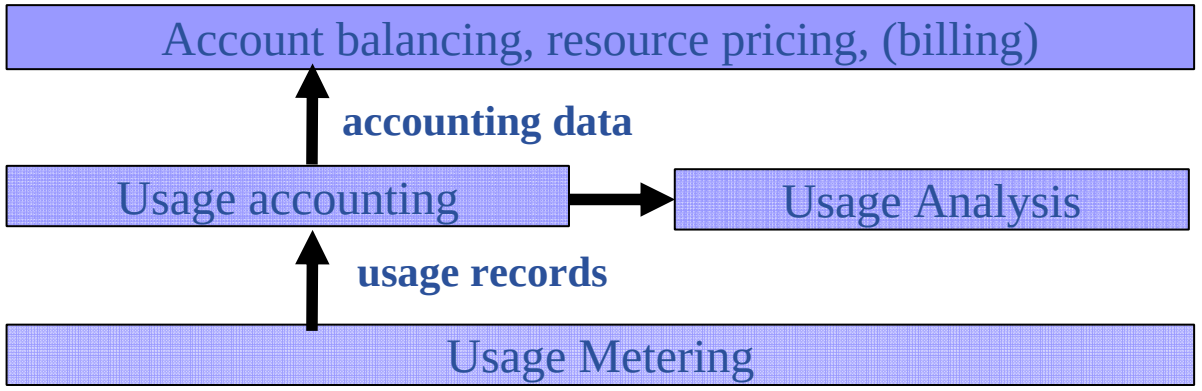
In this presentation we briefly describe these steps and give a quick overview of DGAS, the accounting middleware of the EGEE project.

DGAS

The *Data Grid Accounting System* was originally developed within the EU Datagrid Project and is now being maintained and re-engineered within the EU EGEE Project.

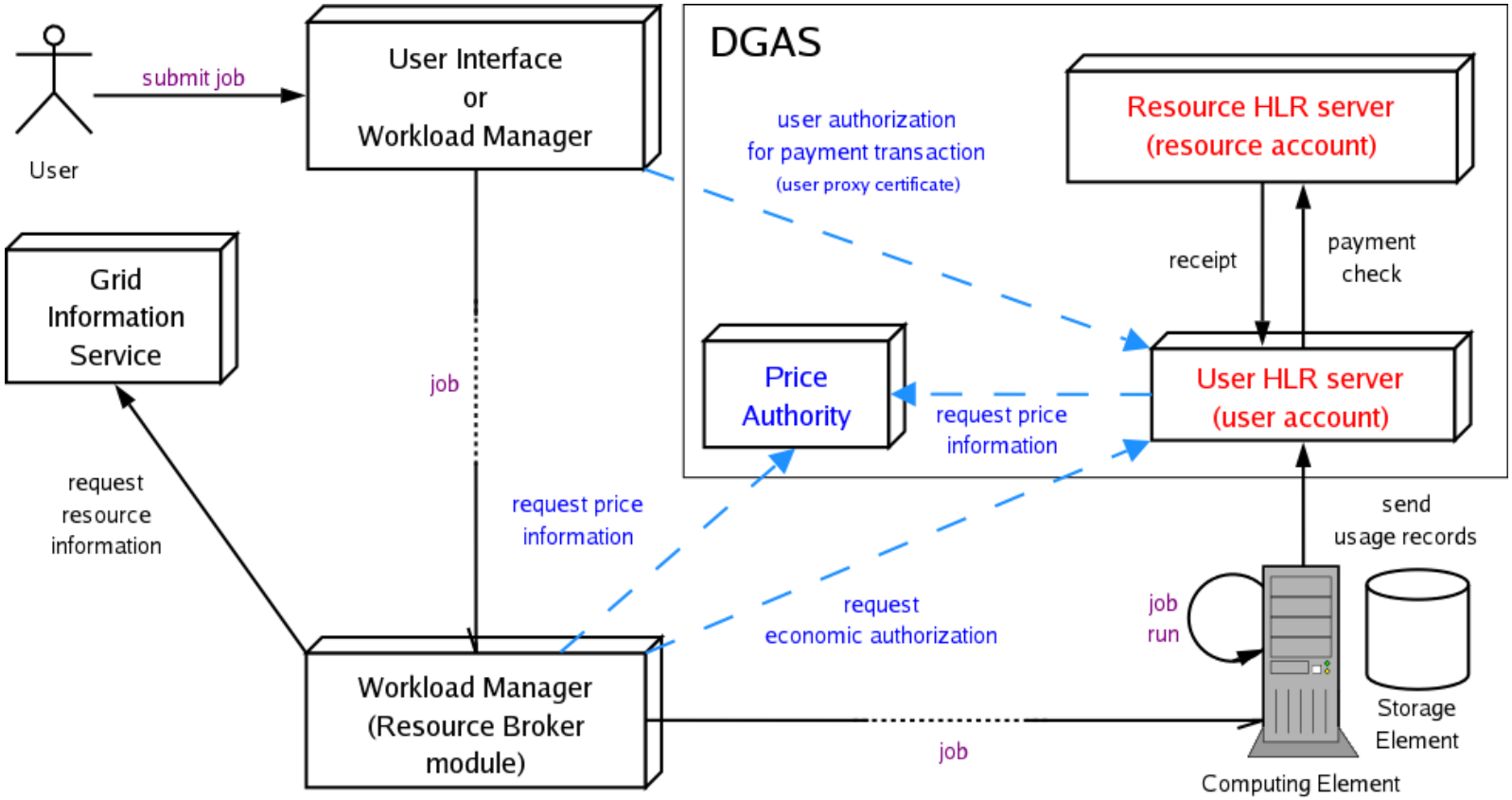
The Purpose of *DGAS* is to implement *Resource Usage Metering*, *Accounting* and *Account Balancing* (through *resource pricing*) in a fully distributed Grid environment. It is conceived to be distributed, secure and extensible**.**

The system is designed in order for Usage Metering, Accounting and Account Balancing (through resource pricing) to be indipendent layers.



DGAS accounting architecture

A simplified view of DGAS within the WMS context.



DGAS: Metering

Usage Metering **on Computing Elements is done by lightweight sensors installed on the Comuting Elements. These sensors parse PBS/LSF/Torque event logs to built** *Usage Records* **that can be passed to the accounting layer.**

For a reliable accounting of resource usage (essential for billing) it is important that the collected data is *unequivocally* associated to the unique grid ID of the user (certificate subject/DN), the resource (CE ID) as well as the job (global job ID).

A process, completely transparent to the Grid User collects the necessary information needed by the Accounting. These, and the corresponding metrics are sent via an *encrypted* channel to the Accounting System *signed with the user credentials*.

DGAS: Accounting

The usage of *Grid Resources* by *Grid Users* is registered in appropriate servers, called Home Location Registers (HLRs) **where both users and resources are registered.**

In order to achieve scalability, accounting records can be stored on an arbitrary number of independent HLRs**. At least one HLR per VO is foreseen, although a finer granularity is possible.**

Each HLR keeps the records of all grid jobs submitted or executed by each of its registered users or resources, thus being able to furnish usage information with many granularity levels:

Per user or resource,

per group of users or resources,

per VO.

Accounting requires usage metering, but not necessarily resource pricing and billing.

Balancing and Resource Pricing

Resource pricing **is done by dedicated** Price Authorities (PAs) **that may use different pricing algorithms: manual setting of fixed prices, dynamical determination of prices according to the state of a resource.**

In order to achieve scalability, prices can be established by an *arbitrary number of independent PAs****. At least one PA per VO is foreseen (VOs will want to retain control on the pricing of their resources).***

Price algorithms **are dynamically linked by the PA server and can be re-implemented according to the resource owners' needs.**

The job cost **is determined (by the HLR service) from *resource prices* and *usage records*.**

Account balancing **is done by exchanging virtual credits between the *User HLR* and the *Resource HLR*.**

What about billing/charging?

The *Account Balancing* provided by DGAS is intentionally generic. It may be used for different use cases, such as:

> *Monitoring* of overall resource consumption by users and resource contribution by owners.

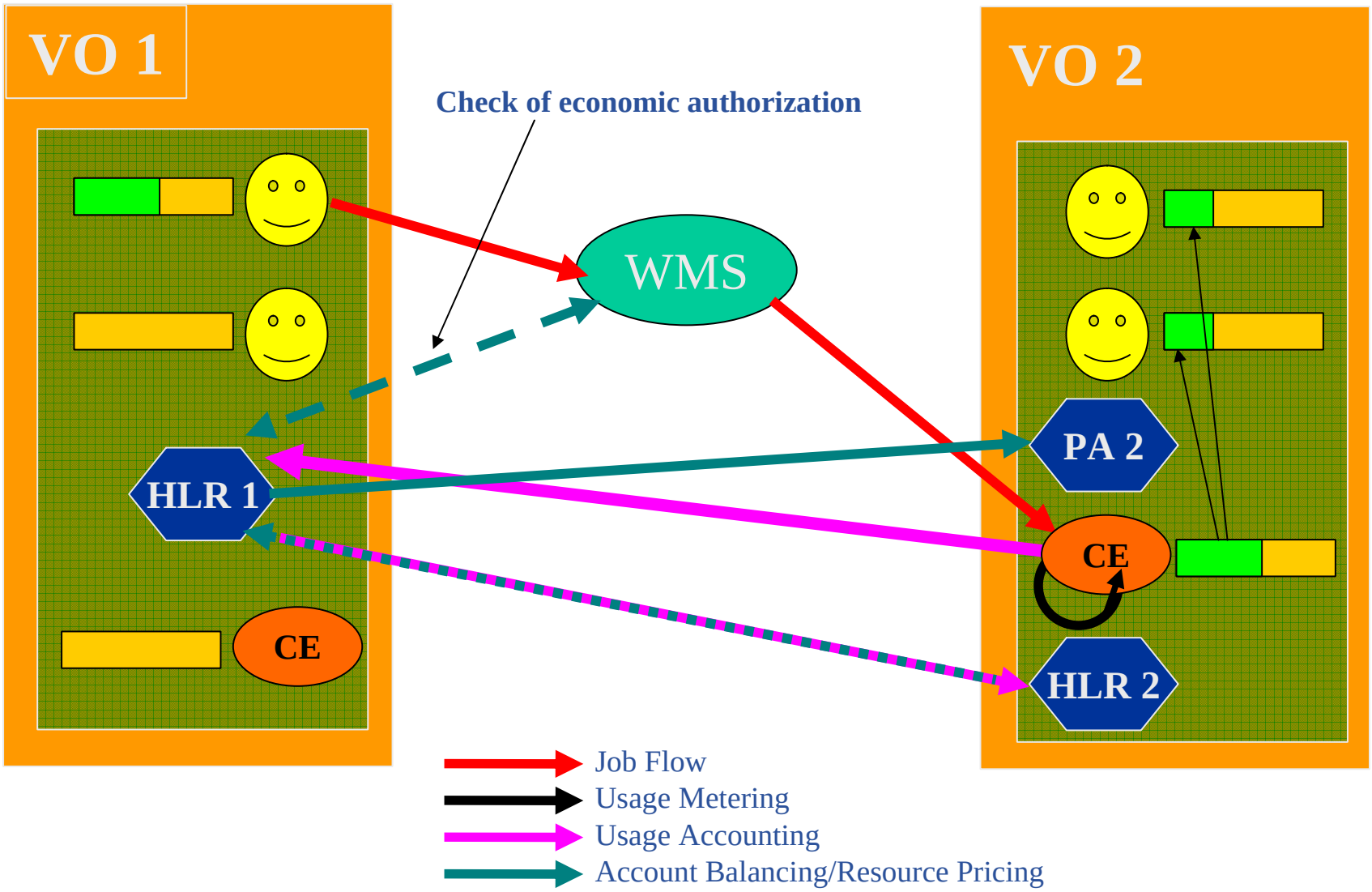
> *Redistribution of credits* earned by a VO's resources to the VOs users (for balanced resource sharing between VOs).

> *Billing/charging* of users **after** resource usage.

> *Credit/quota acquisition* by users **before resource usage.**

The purpose of DGAS is not to define (and hence limit) the economic interactions between users and resource owners, but to provide the necessary means to enable them.

Example of economic accounting



References

- ***Further information and documentation about DGAS can be found at:***

  http://www.to.infn.it/grid/accounting

What is Monitoring
Terms and Concepts

- **Grid Monitoring**
  - the activity of **measuring** significant **grid resources related parameters**
  - in order to
    - **analyze usage**, **behavior and performance of the grid**
    - **detect and notify**
      - ***fault situations***
      - ***contract violations (SLA)***
      - ***user-defined events***

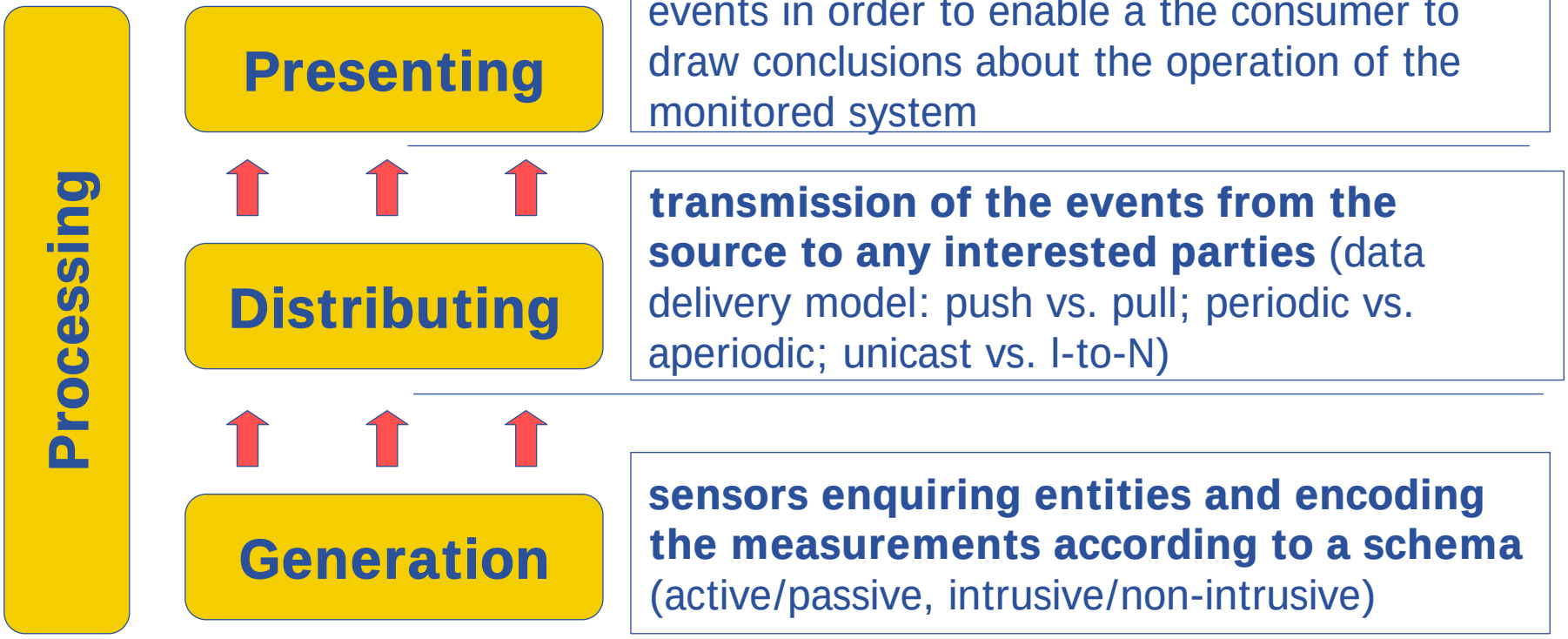
What is Monitoring
Terms and Concepts

- **Measurement**: the process by which numbers or symbols are assigned to feature of an entity in order to describe them according to clearly defined rules

- **Event**: collection of timestamped data associated with the attribute of an entity [2]

- **Event schema** (or simply schema): defines the typed structure and semantics of all events so that, given an event type, one can find the structure and interpret the semantics of the corresponding event [2]

The four main phases of monitoring



Use cases for Grid monitoring

- Virtual Organization:
  1. visualize at various aggregation levels the actual set of resources accessible to its members;
  2. Assess how Grid mapping functionalities from virtual to physical resources and users meet the members' demands
  3. analyze data retrospectively to understand how to improve the effectiveness of VO applications running in a Grid, as the target machine for different executions of the same application can vary over time

Use cases for Grid monitoring

- Site Administrator:
  - Visualize the managed Grid services in order to see how they are being used/performing (possibly divided by VO)
- User:
  - Is my job “working” (e.g., consuming CPU?)
- Grid Operation Center:
  - Status of Grid services (e.g., WMS, Service Discovery, CE, SE)
  - Free/busy resources per site/per VO at a given time
  - Timely notification about fault situations

GridICE: architectural insight

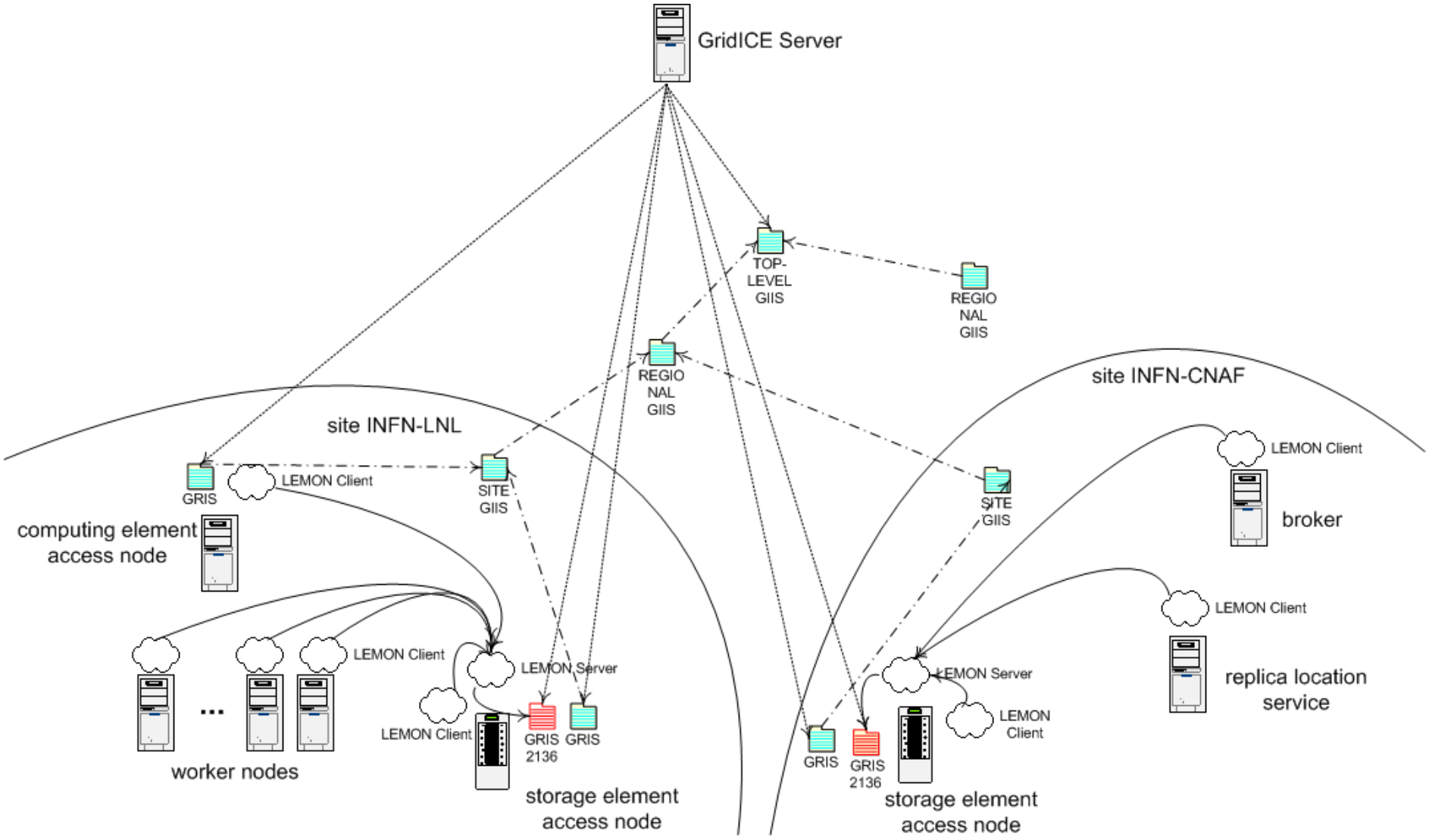
Monitoring: generating events

- *generation* of events:
  - Sensors: typically perl scripts or C programs
  - Schema:
    - GLUE Schema v.1.1 + GridICE extension
      - *System related (e.g., CPU load, CPU Type, Memory size)*
      - *Grid service related (e.g., CE ID, queued jobs)*
      - *Network related (e.g., Packet loss)* **[5]**
      - *Job usage (e.g., CPU Time, Wall Time)*
  - All sensors are executed in a periodic fashion

Monitoring: distributing

- *distribution* of events:
  - Hierarchical model
    - **Intra-site**: by means of the local monitoring service
      - *default choice, LEMON (http://www.cern.ch/lemon)*
    - **Inter-site**: by offering data through the Grid Information Service
    - **Final Consumer:** depending on the client application
  - Mixed data delivery model
    - **Intra-site**: depending on the local monitoring service (push for lemon)
    - **Inter-site**: depending on the GIS (current choice, MDS 2.x, pull)
    - **Final consumer**: pull (browser/application), push (publish/subscribe notification service)

Example deployment in LCG2



GridICE >> Site View >> General

Site	Domain	Computing Resources									Storage Resources		
		GK#	Q#	RunJob	WaitJob	SlotLoad	Power	WN#	CPU#	CPULoad	Available	Total	%
INFN-PISA2	pi.infn.it	1	7	4	0	100%	13K	2	4	100%	3.5 TB	3.5 TB	0%
INFN-ROMA1	roma1.infn.it	1	2	2	7	5%	235K	21	42	2%	31.1 GB	33.9 GB	8%
INFN-Roma1-CMS	roma1.infn.it	1	2	0	0	0%	48K	5	11	0%	63.2 GB	65.9 GB	4%
INFN-ROMA1-VIRGO	roma1.infn.it	1	2	6	0	86%	45K	7	14	29%	28.4 GB	31.2 GB	9%
INFN-ROMA2	roma2.infn.it	1	6	1	0	10%	86K	5	18	5%	1.1 TB	1.1 TB	3%
INFN-ROMA3	roma3.infn.it	1	3	0	0	0%	38K	4	8	0%	956.7 GB	956.7 GB	0%
INFN-TORINO	to.infn.it	1	8	56	29	100%	297K	28	56	93%	420.6 GB	1.9 TB	79%
NA-ICAR-CNR	dma.unina.it	1	6	3	16	100%	8K	3	3	100%	-	-	-
SNS	sns.it	1	7	1	0	8%	24K	3	6	0%	64.6 GB	67.7 GB	5%
SPACI-LECCE	egee.unile.it	1	6	0	7	0%	6K	1	1	0%	-	-	-
TOKYO-LCG2	icepp.jp	1	2	0	0	0%	-	-	-	-	896.8 GB	1.8 TB	51%
LCG_KNU	knu.ac.kr	1	5	5	484	100%	-	-	-	-	59 GB	61.6 GB	4%
NIKHEF-ELPROD	nikhef.nl	1	6	205	53	94%	-	-	-	-	895.2 GB	1.7 TB	48%
saralcg2	matrix.sara.nl	1	16	42	11	92%	-	-	-	-	90.6 GB	104.4 GB	13%
NCP-LCG2	ncp.edu.pk	1	6	0	0	0%	-	-	-	-	42.3 GB	44.1 GB	4%
PAKGRID-LCG2	pakgrid.org.pk	1	6	0	0	0%	-	-	-	-	59.5 GB	60.3 GB	1%
CYFRONET-LCG2	cyf-kr.edu.pl	1	9	55	179	92%	-	-	-	-	865 GB	2 TB	58%
egee.man.poznan.pl	egee.man.poznan.pl	1	5	0	0	0%	-	-	-	-	255.4 GB	255.6 GB	0%
WARSAW-LCG2	fuw.edu.pl	1	3	0	0	7%	-	-	-	-	348.1 GB	348.1 GB	0%
LIP-LCG2	lip.pt	1	4	12	10	38%	113K	7	23	14%	346 GB	696.9 GB	50%
ROGRID-ICI	grid.ici.ro	1	6	7	7	78%	76K	5	16	53%	138.2 GB	141.6 GB	2%
ITEP	itep.ru	1	7	2	0	5%	-	-	-	-	63.3 GB	68.6 GB	8%
JINR-LCG2	jinr.ru	1	5	2	0	10%	-	-	-	-	1.7 TB	1.7 TB	1%
RRC-KI	grid.kiae.ru	1	5	1	0	5%	-	-	-	-	762.5 GB	766.3 GB	0%
ru-Moscow-GCRAS-LCG2	wdcb.ru	1	3	0	0	0%	-	-	-	-	-	-	-
RU-Moscow-KIAM-LCG2	keldysh.ru	1	4	1	0	13%	-	-	-	-	97.4 GB	102.5 GB	5%
ru-Moscow-SINP-LCG2	sinp.msu.ru	1	9	33	1	69%	-	-	-	-	87.3 GB	104.9 GB	17%
ru-Novgorod-NOVSU-LCG2	novsu.ac.ru	1	5	0	0	0%	-	-	-	-	23.2 GB	23.4 GB	0%
ru-PNPI-LCG2	pnpi.nw.ru	1	1	58	28	100%	-	-	-	-	-	-	-
ru-PSN-LCG2	psn.ru	1	2	22	29	100%	-	-	-	-	167.8 GB	172.3 GB	3%
HPC2N	hpc2n.umu.se	1	1	50	75	52%	-	-	-	-	929.1 GB	934.9 GB	1%
NSC	nsc.liu.se	1	6	4	1	17%	-	-	-	-	59.4 GB	66.9 GB	11%
GOG-Singapore	ngpp.ngp.org.sg	1	3	0	0	3%	-	-	-	-	-	-	-

GridICE >> Site View >> Host Summary

Site	All			Broker			BDII			CE			SE			GC			Others		
	Total			Total			Total			Total			Total			Total			Total		
CERN-CIC	3	-	-	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	-	-	-
CNAF-T1	29	1	-	11	-	-	6	1	-	4	-	-	1	-	-	2	-	-	5	-	-
ESA-ESRIN	9	6	-	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	6	6	-
HPCC-UNILE	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
ifae	83	4	11	1	-	-	-	-	-	1	-	-	5	4	-	-	-	-	76	-	11
INAF-TRIESTE	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
INFN-BARI	27	1	-	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	24	1	-
infn-bologna	5	-	-	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	2	-	-
INFN-BOLOGNA-CMS	15	2	1	-	-	-	-	-	-	2	1	-	1	-	-	-	-	-	12	1	1
INFN-CAGLIARI	10	-	2	-	-	-	-	-	-	2	-	1	1	-	-	1	-	-	6	-	1
INFN-CATANIA	4	-	-	1	-	-	-	-	-	1	-	-	1	-	-	1	-	-	-	-	-
INFN-FERRARA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INFN-FIRENZE	19	-	-	-	-	-	-	-	-	1	-	-	1	-	-	1	-	-	16	-	-
INFN-FRASCATI	9	-	4	-	-	-	-	-	-	2	-	1	2	-	2	2	-	1	3	-	-
INFN-LECCE	3	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	1	-	-
INFN-LNL-2	17	1	-	-	-	-	-	-	-	1	1	-	1	-	-	1	-	-	14	-	-
INFN-LNL-LCG	94	-	12	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	92	-	12
INFN-MILANO	33	-	7	-	-	-	-	-	-	1	-	-	2	-	1	2	-	1	28	-	5
INFN-NAPOLI-ATLAS	21	-	1	-	-	-	-	-	-	2	-	-	1	-	1	1	-	-	17	-	-
INFN-PADOVA	64	-	6	7	-	-	1	-	-	1	-	-	4	-	-	1	-	-	50	-	6
INFN-PERUGIA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INFN-PISA	17	-	1	-	-	-	-	-	-	1	-	-	3	-	-	-	-	-	13	-	1
INFN-PISA2	5	-	1	-	-	-	-	-	-	1	-	-	1	-	1	1	-	-	2	-	-
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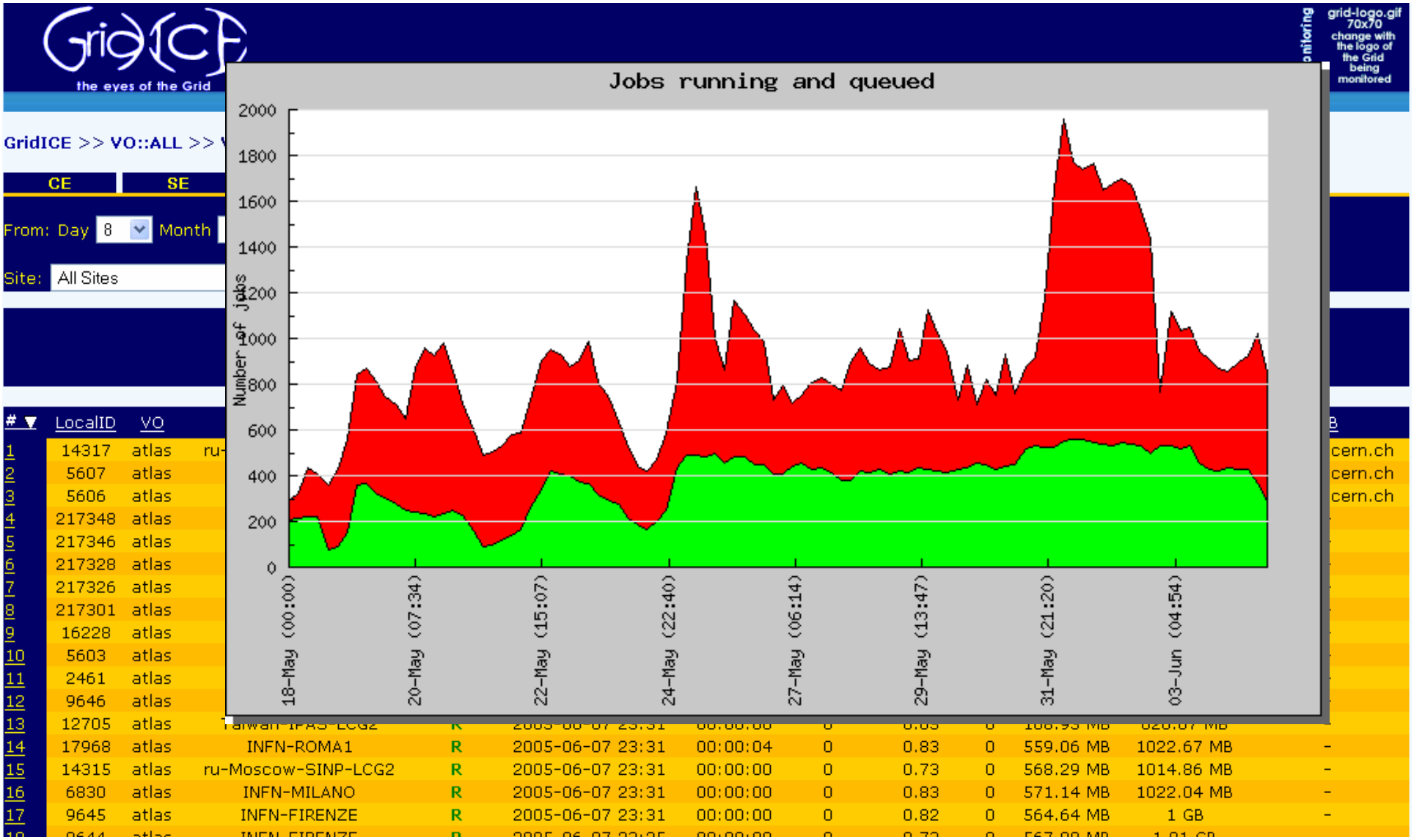
INFN-Roma1-CMS	7	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	5	-	-
INFN-ROMA1-VIRGO	9	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	7	-	-
INFN-ROMA2	9	-	2	-	-	-	-	-	-	1	-	-	1	-	-	1	-	1	6	-	1
INFN-ROMA3	6	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	4	-	-
INFN-TORINO	30	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	28	-	-
INFN-TRIESTE	3	-	3	-	-	-	-	-	-	1	-	1	1	-	1	-	-	-	1	-	1
[mi.infn.it]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NA-ICAR-CNR	5	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	3	-	-

Disappeared

Running/waiting jobs for a VO



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1	14317	atlas	ru-								cern.ch
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6	217328	atlas									
7	217326	atlas									
8	217301	atlas									
9	16228	atlas									
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11	2461	atlas									
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16	6830	atlas	INFN-MILANO	R	2005-06-07 23:31	00:00:00	0	0.83	0	571.14 MB	1022.04 MB
17	9645	atlas	INFN-FIRENZE	R	2005-06-07 23:31	00:00:00	0	0.82	0	564.64 MB	1 GB

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