Grid Computing on NorduGrid

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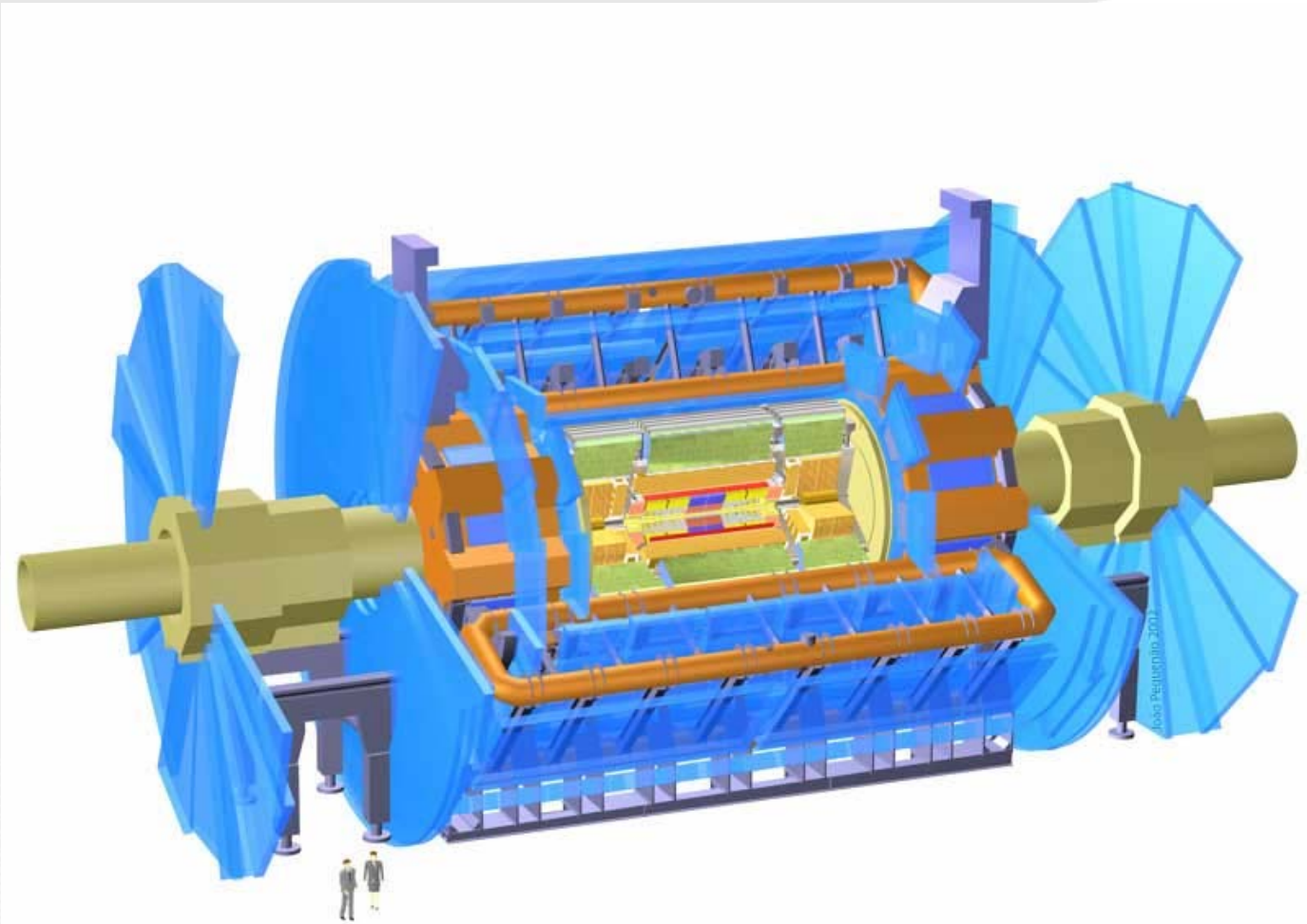
The Atlas experiment

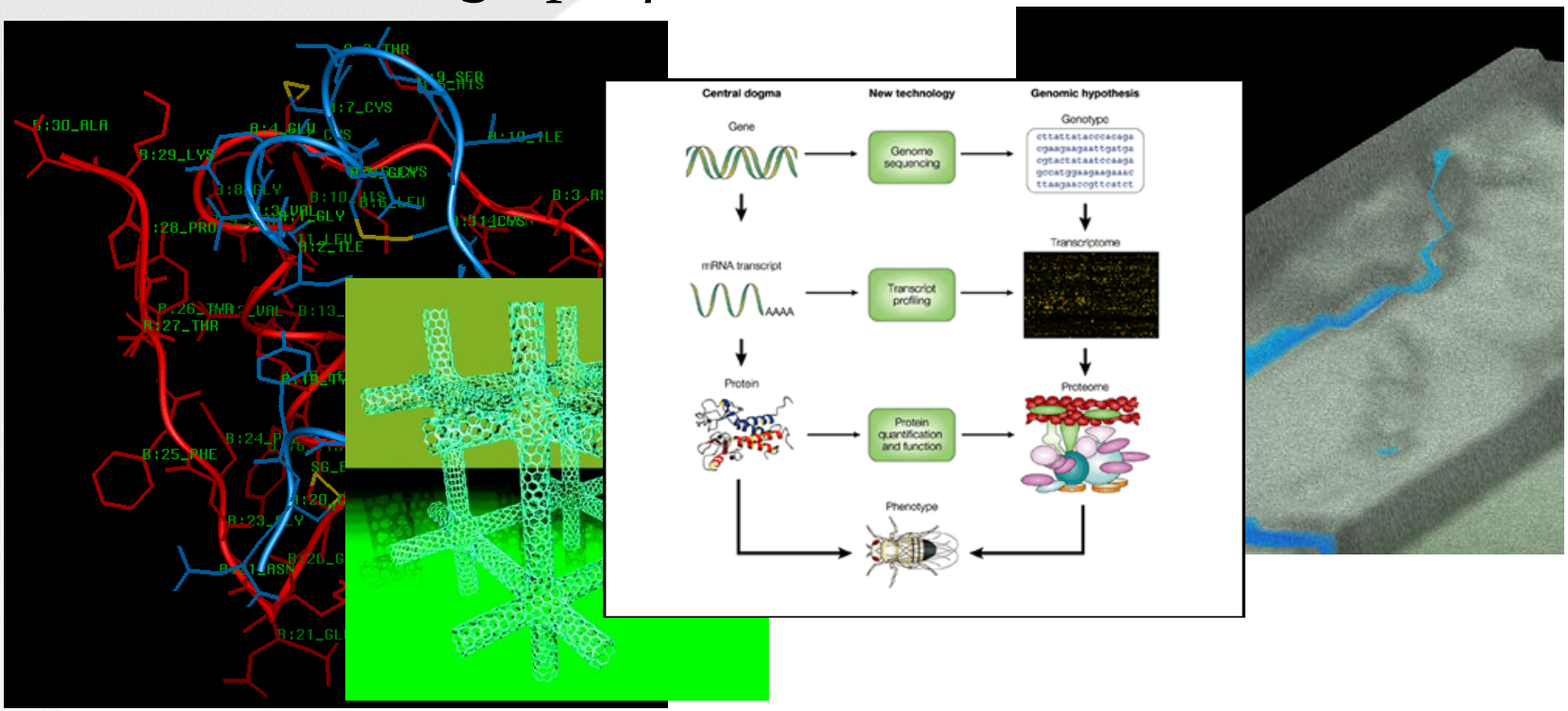


Agenda

- Grid Computing defined
- NorduGrid ARC – overall structure and use
- Demo
- Distributed model checking on NorduGrid
- Future

E-science

”Science (increasingly) done through distributed global collaborations enabled by the Internet, using very large data collections, tera-scale computing resources and high performance visualisation.”



The grand vision

A huge virtual distributed computer.

Definition

"A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities."

The Grid – a blueprint for a new computing infrastructure, 1998

DMC to the *people* need a Grid because

- Ordinary users of MC don't have the needed HW
- The software is too difficult to install and maintain

Challenges

- Make hardware owned by *different* organizations available to *non-members* of that organization.
- In such a way that normal operation of the equipment can continue.
- In such a way that the organization still can control who gets access.
- In such a way that we can control who gets access to specific pieces of data.
- In such a way that operations can be performed anonymously.
- And still charge for the use of hard- and software.

Challenges

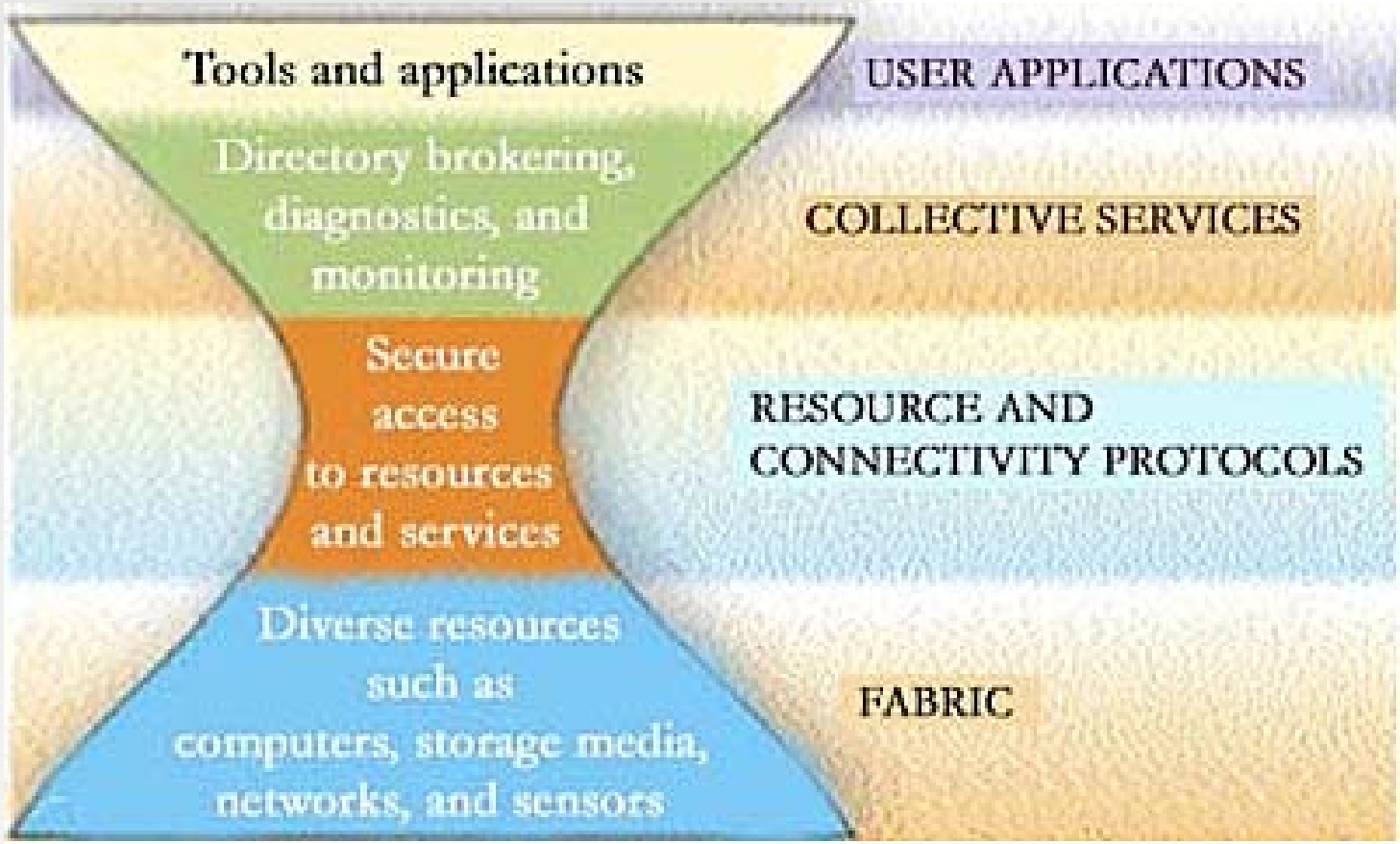
- Resource allocation and scheduling
- Authentication and authorization
- Protection
- Control
- Accounting

Globus

- An open source software toolkit used for building grids.
- Includes software services and libraries for resource monitoring, discovery, and management, plus security and file management.

Web: www.globus.org

The globus model



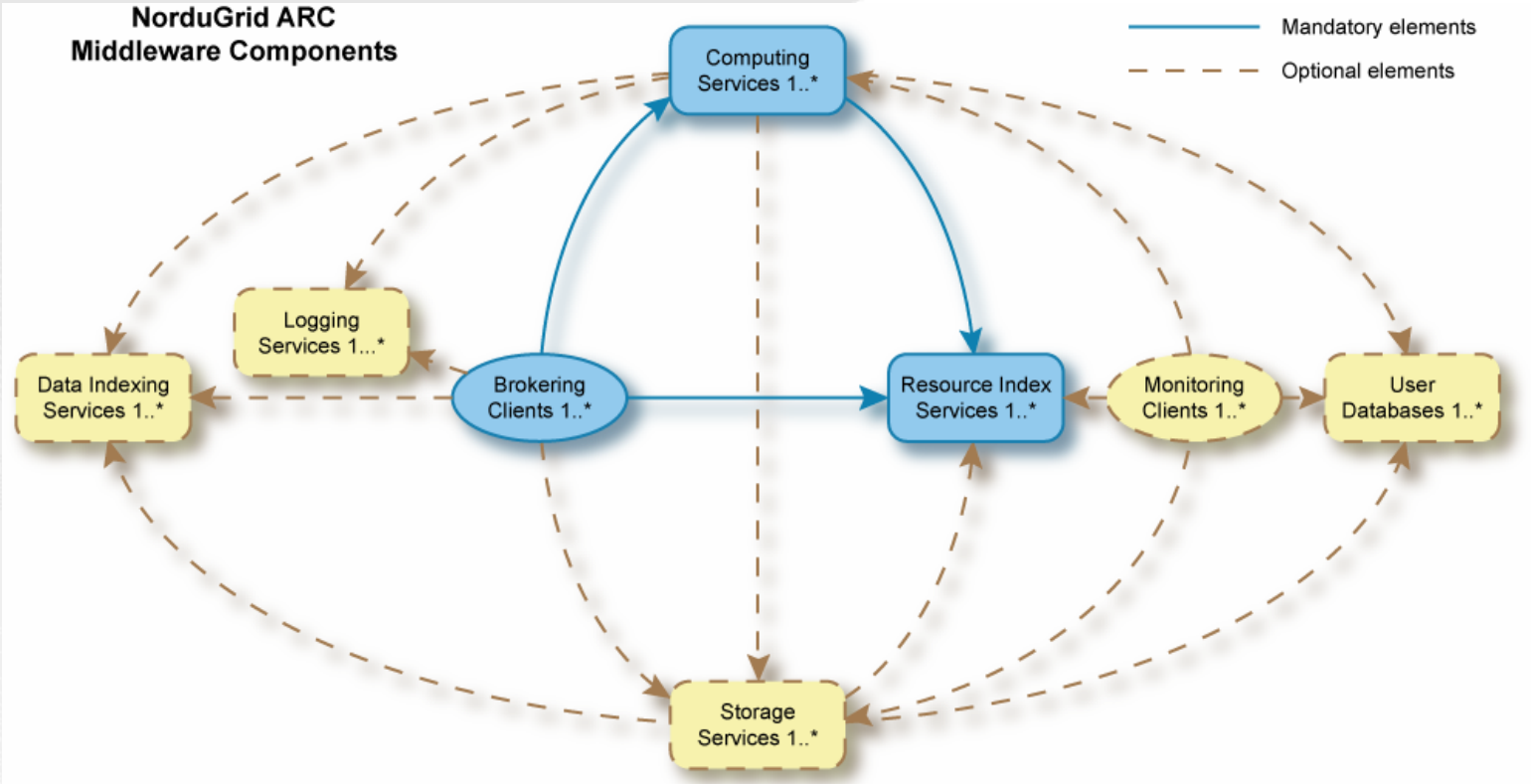
NorduGrid

- NorduGrid is a collaboration between a number of universities mostly located in the Nordic countries.
- NorduGrid Advanced Resource Connector is:
  - A Globus-based Grid middleware solution
- NorduGrid is a production Grid
  - Approximately 5000 CPUs
  - Approximately 75 TB of storage

Web: www.nordugrid.org

The Nordic Grid

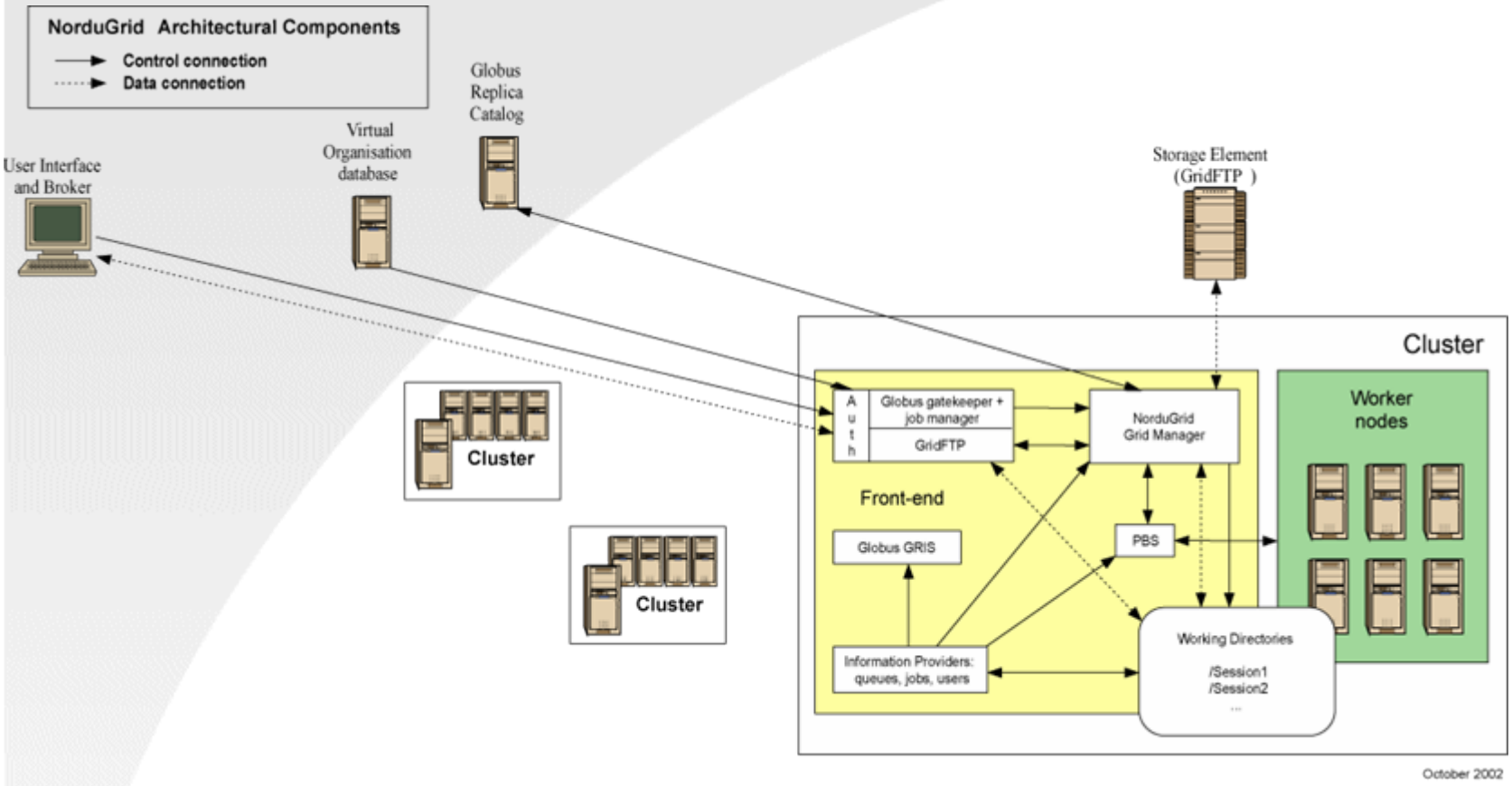
Demo


NorduGrid ARC
Middleware Components
Mandatory elements
Optional elements
Computing Services 1..*
Logging Services 1...*
Data Indexing Services 1..*
Brokering Clients 1..*
Resource Index Services 1..*
Monitoring Clients 1..*
User Databases 1..*
Storage Services 1..*

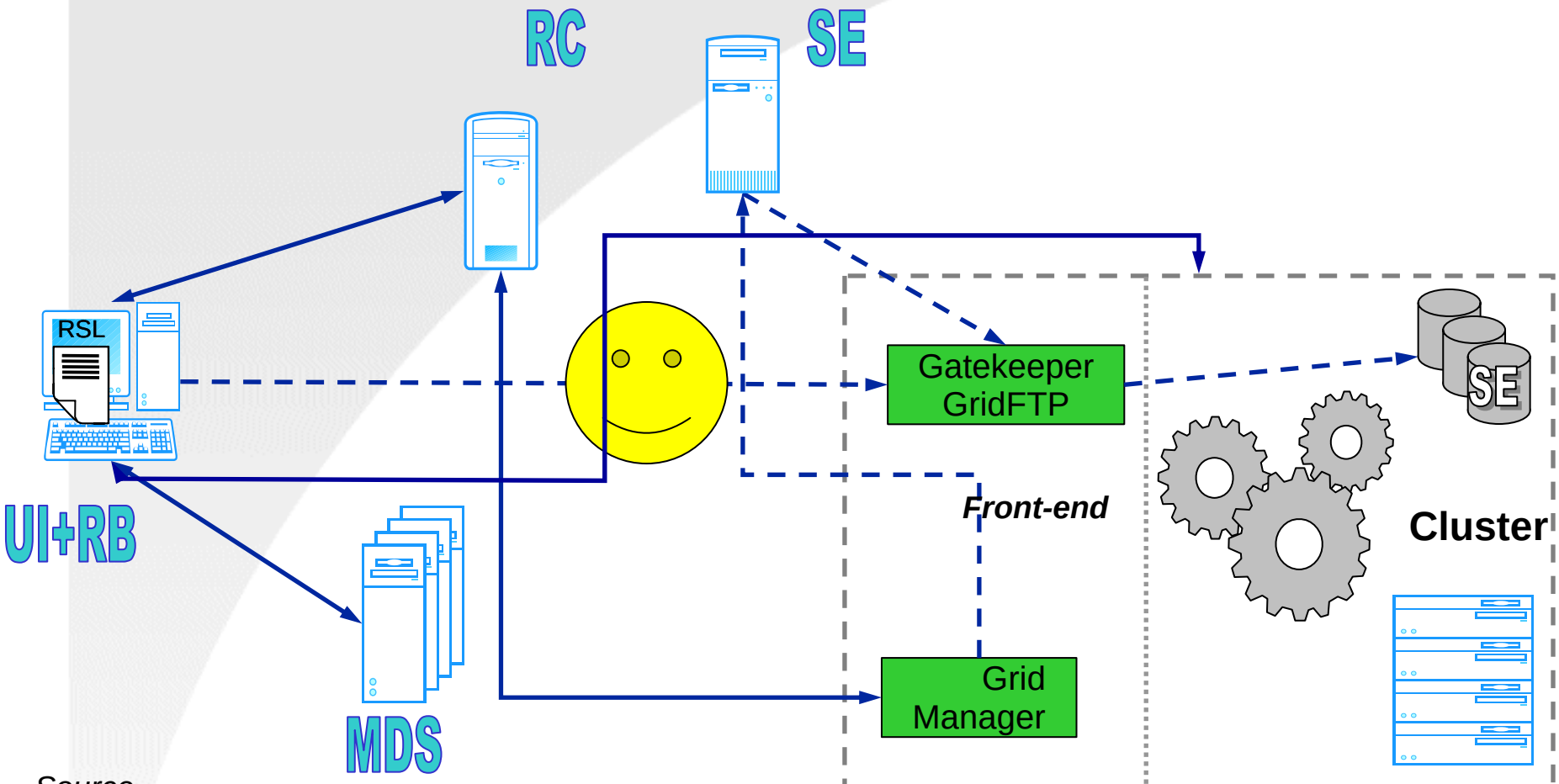
ARC Assumptions

- It should only be necessary to install Grid software on a single *front-end* machine.
- No/few modifications to the existing hardware/software configuration should be necessary.
- Bottlenecks known to exist in other Grid solutions should be avoided.

ARC Components

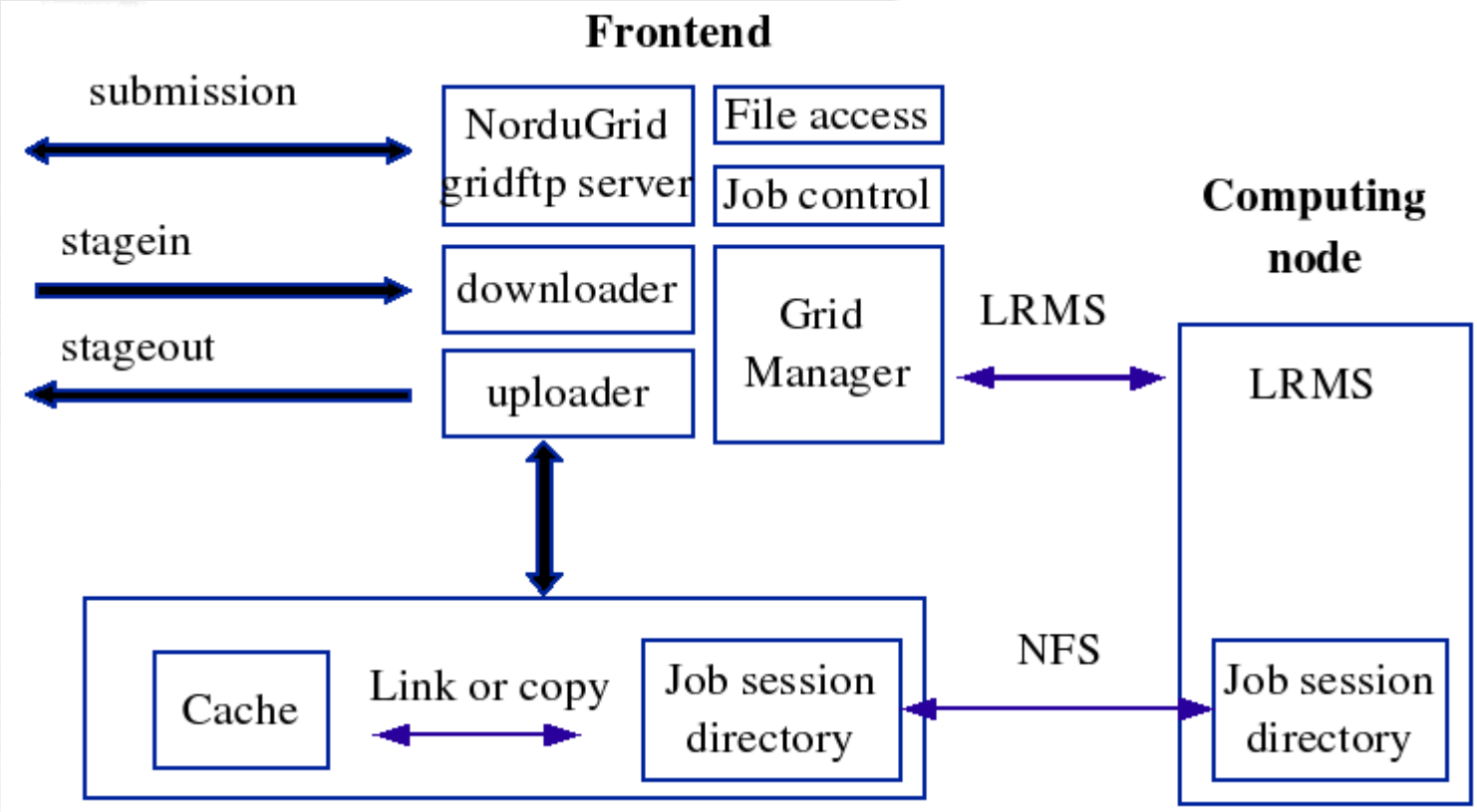


Workflow



Source
NorduGrid.org

Front-end


Frontend
submission
stagein
stageout
NorduGrid gridftp server
File access
Job control
downloader
uploader
Grid Manager
LRMS
Computing node
LRMS
Cache
Link or copy
Job session directory
NFS
Job session directory

The user-interface

ngsub	to submit a task
ngstat	to obtain the status of jobs and clusters
ngcat	to display the stdout or stderr of a running job
ngget	to retrieve the result from a finished job
ngkill	to cancel a job request
ngclean	to delete a job from a remote cluster
ngrenew	to renew user's proxy
ngsync	to synchronize the local job info with the MDS
ngcopy	to transfer files to, from and between clusters
ngremove	to remove files

Broker

- The user must be authorized to use the cluster and the queue
- The cluster's and queue's characteristics must match the requirements specified in the xRSL string (max CPU time, required free disk space, installed software etc)
- If the job requires a file that is registered in a Replica Catalog, the brokering gives priority to clusters where a copy of the file is already present
- From all queues that fulfills the criteria one is chosen randomly, with a weight proportional to the number of free CPUs available for the user in each queue
- If there are no available CPUs in any of the queues, the job is submitted to the queue with the lowest number of queued job per processor

DMC on NorduGrid

- Distributed Uppaal is available on NorduGrid, through a special *runtime environment.*
- No integrations with the Uppaal UI, but users specify queries in their Grid *xRSL* specification

A real DMC Grid should have
- Grid access integrated into the single processor UI
- The Grid should support interactive jobs
- Support advance reservations and co-scheduling