An overview of the EGEE infrastructure and middleware

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Enabling Grids for E-science in Europe

Acknowledgement

- This talk is based on the work of many people:
  - the EDG developers
  - the EDG training team
  - the NeSC training team

Enabling Grids for E-science in Europe

Goals

- To introduce the major components of the EGEE grid
  - Infrastructure and fabric
  - Middleware
  - Organisation

Overview

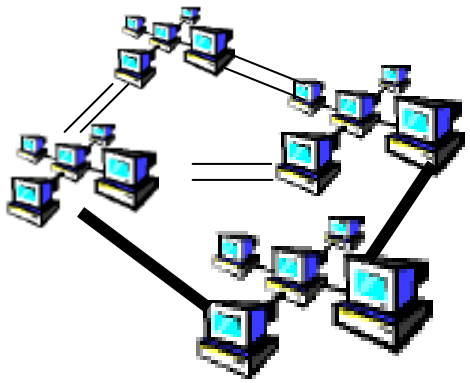
- Enabling Grid Computing:
  fabric + infrastructure + middleware
  - Authentication and Authorization
  - Information services
  - Other Grid services
  - The major components of the infrastructure
  - The software stack
- EGEE grid organisation

What are the characteristics of a Grid system?

Numerous Resources

Ownership by Mutually Distrustful Organizations & Individuals

Connected by Heterogeneous, Multi-Level Networks



Different Security Requirements & Policies Required

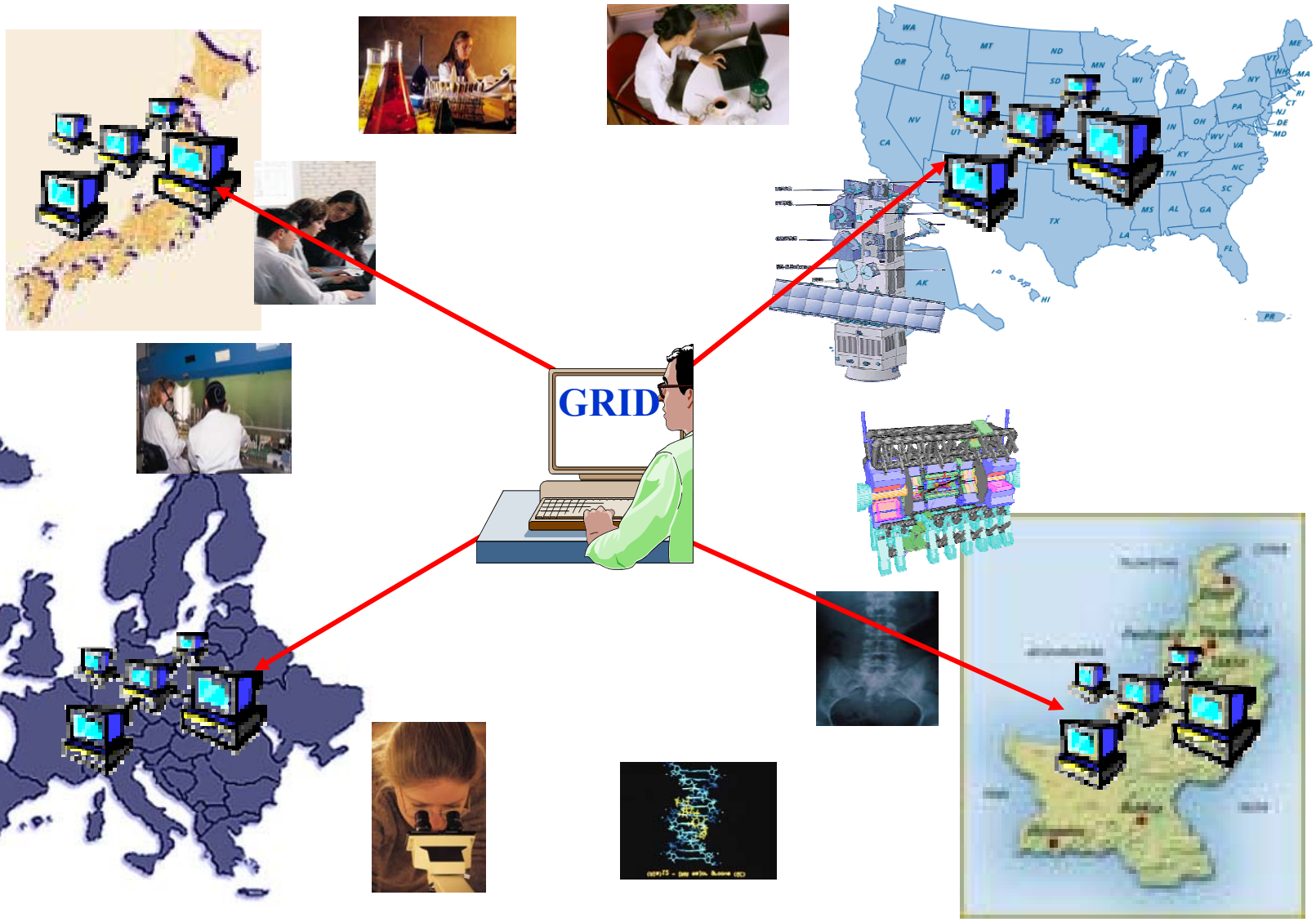
Different Resource Management Policies

Potentially Faulty Resources

Geographically Separated

Resources are Heterogeneous

What are the characteristics of a Grid system?



How do I login on the Grid ?

- Distribution of resources: secure access is a basic requirement
  - secure communication
  - security across organisational boundaries
  - single “sign-on" for users of the Grid
- Two basic concepts:
  - Authentication: *Who am I?*
    - “Equivalent” to a pass port, ID card etc.

  - Authorisation: *What can I do?*
    - Certain permissions, duties etc.

Security in the Grid

- In industry, several security standards exist:
  - Public Key Infrastructure (PKI)
    - PKI keys
    - SPKI keys (focus on authorisation rather than certificates)
    - RSA
  - Secure Socket Layer (SSL)
    - SSH keys
  - Kerberos
- Need for a common security standard for Grid services
  - Above standards do not meet all Grid requirements (e.g. delegation, single sign-on etc.)
- Grid community mainly uses X.509 PKI for the Internet
  - Well established and widely used (also for www, e-mail, etc.)

PKI – Basic overview

- Public Key Infrastructure (also called asymmetric cryptography)
- One primary advantage: it is generally easier than distributing secret keys securely, as required in symmetric keys

Entity A (Alice)

public key e
private key d

applies the decryption transformation

$$m = D_d(c).$$

Entity B (Bob)

public key
private key

wishing to send a **message m** to A:
ciphertext $c = E_e(m)$

encryption transformation E_e
decryption transformation D_d

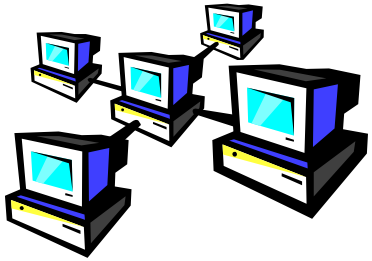
Involved entities

Certificate Authority

User

Public key
Private key
certificate

Resource
(site offering services)



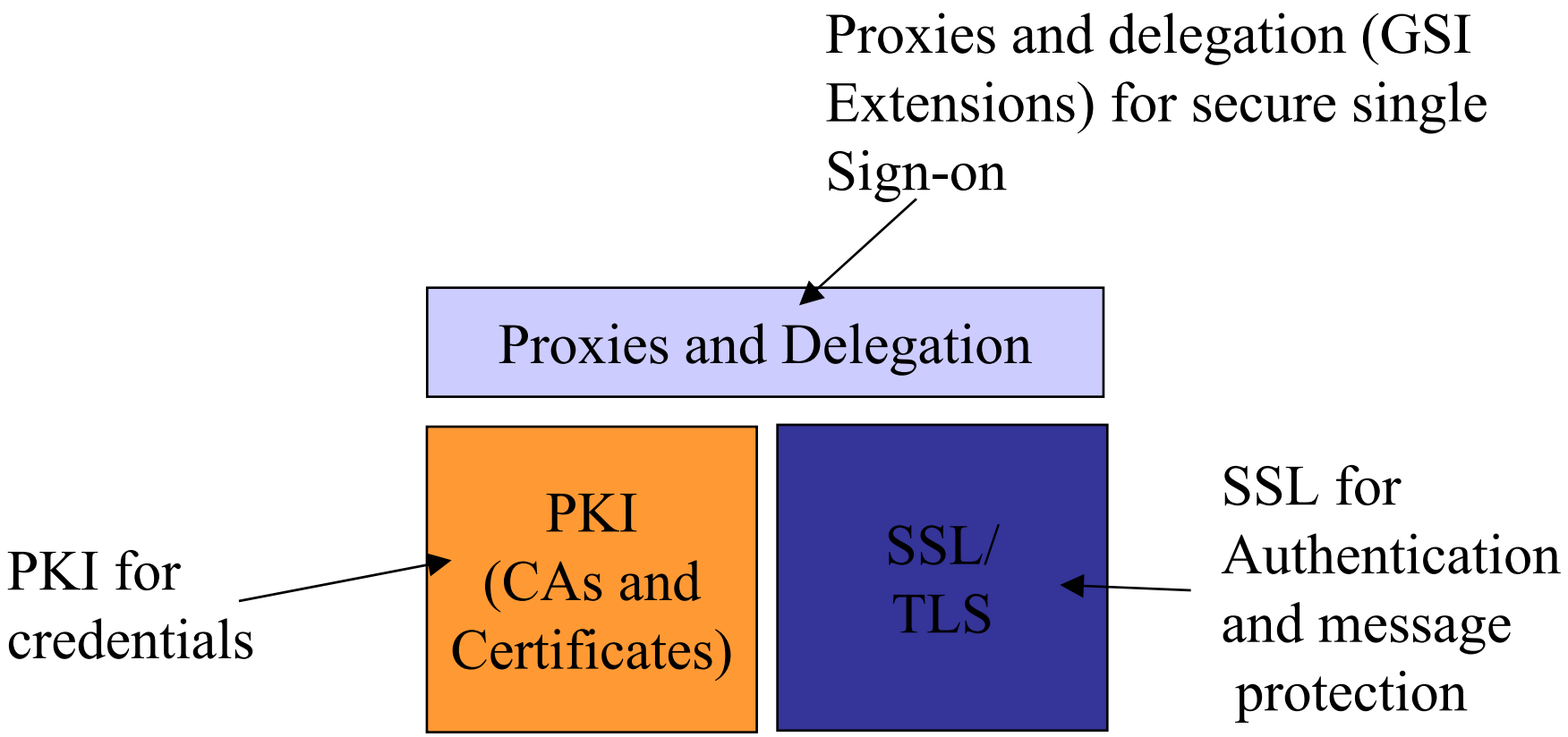
X.509 alias ISO/IEC/ITU 9594-9

- X.509 is ITU Standard:
  - ITU-T Recommendation X.509 (1997 E). Information technology - Open Systems Interconnection - The Directory: **Authentication Framework**
  - Defines a **certificate format** (originally based on X.500 Directory Access Protocol)
    - Latest standard: X.509 version 3 certificate format
- X.509 certificate includes:
  - User identification (someone's subject name)
  - Public key
  - A "signature" from a Certificate Authority (CA) that:
    - Proves that the certificate came from the CA.
    - Vouches for the subject name
    - Vouches for the binding of the public key to the subject

Grid Security Infrastructure (GSI)

- Globus Toolkit™ proposed and implements the Grid Security Infrastructure (GSI)
  - Protocols and APIs to address Grid security needs
- GSI protocols extend standard public key protocols
  - Standards: X.509 & SSL/TLS
  - Extensions: X.509 Proxy Certificates (single sign-on) & Delegation
- GSI extends standard GSS-API (Generic Security Service)
  - The GSS-API is the IETF standard for adding authentication, delegation, message integrity, and message confidentiality to applications.
- Proxy Certificate:
  - Short term, restricted certificate that is derived form a long-term X.509 certificate
  - Signed by the normal end entity cert, or by another proxy
  - Allows a process to act on behalf of a user
  - Not encrypted and thus needs to be securely managed by file system

GSI General Overview

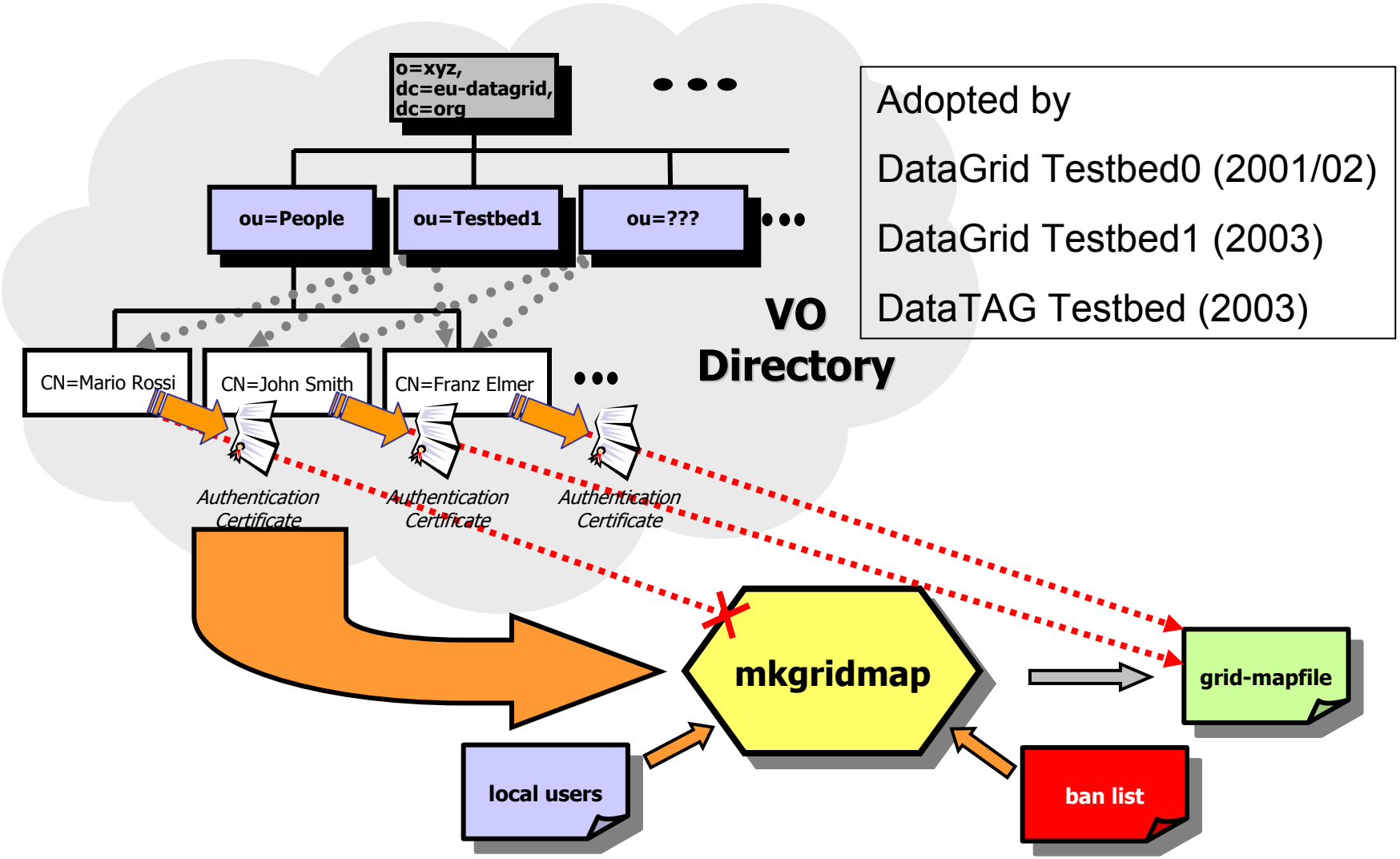


Based on Slide from Globus Tutorial

Authorisation Requirements

- Detailed user rights need to be centrally managed and assigned
  - User can have certain group membership and roles
- Involved parties:
  - Resource providers (RP, provides access to the resource)
    - keep full control on access rights
    - traceability user level (not VO level)
  - Virtual Organisation (VO) of the user (member of a certain group should have same access rights independent of resource)
- Agreement required between resource providers and VO
  - RPs evaluate authorisation granted by VO to a user and map into local credentials to access resources
- Need tool to manage membership for large VOs (10,000 users)

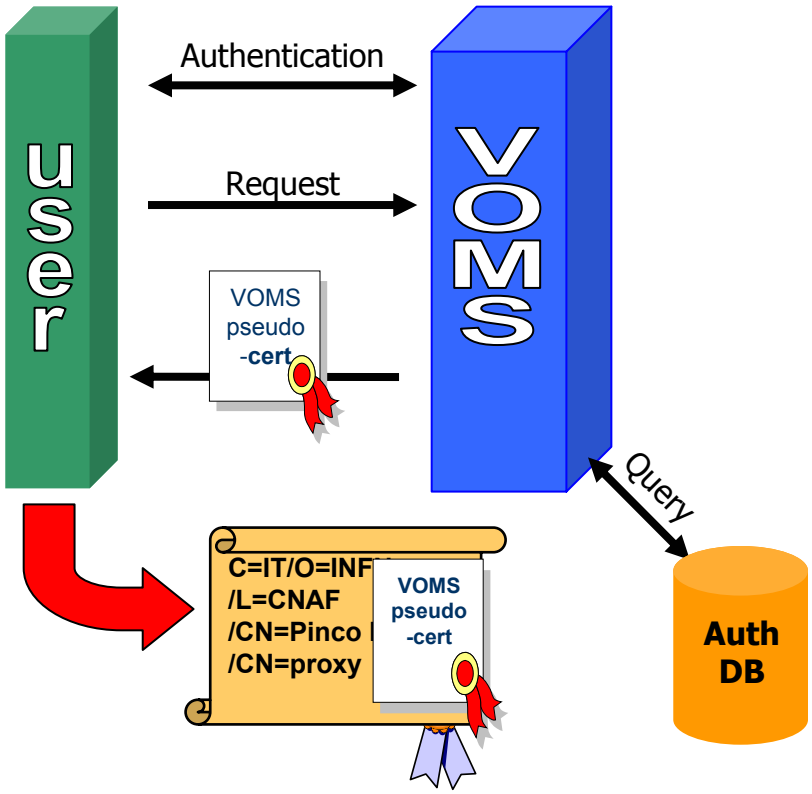
Example: VO-LDAP server for Authorisation



Improvements/Extensions

- Community Authorisation Service (CAS)
  - Provided by the Globus Alliance
  - Original concepts
- Virtual Organisation Membership Service (VOMS)
  - Provided by EU DataGrid and DataTAG projects
  - Some different concepts

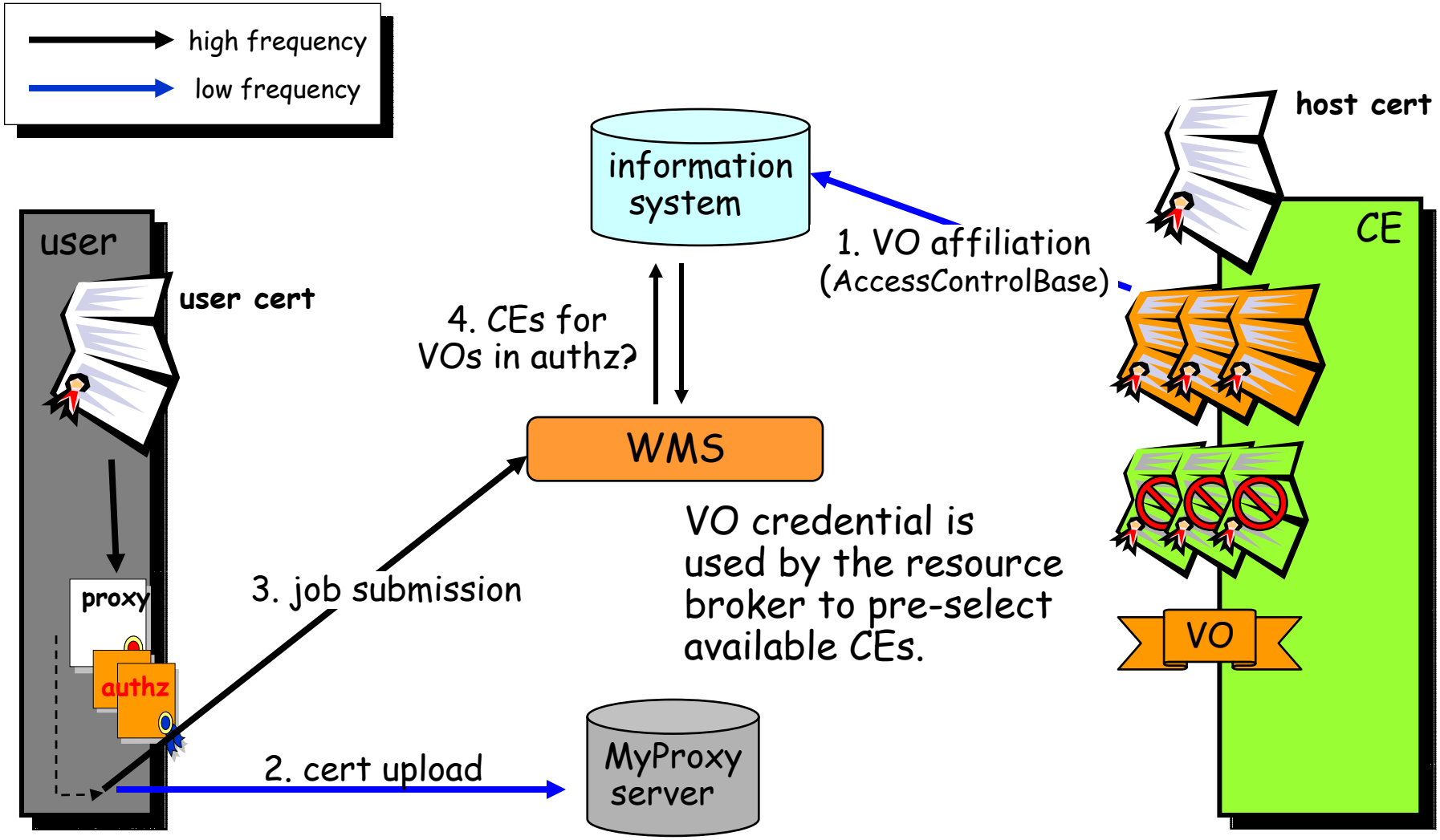
VOMS Operations



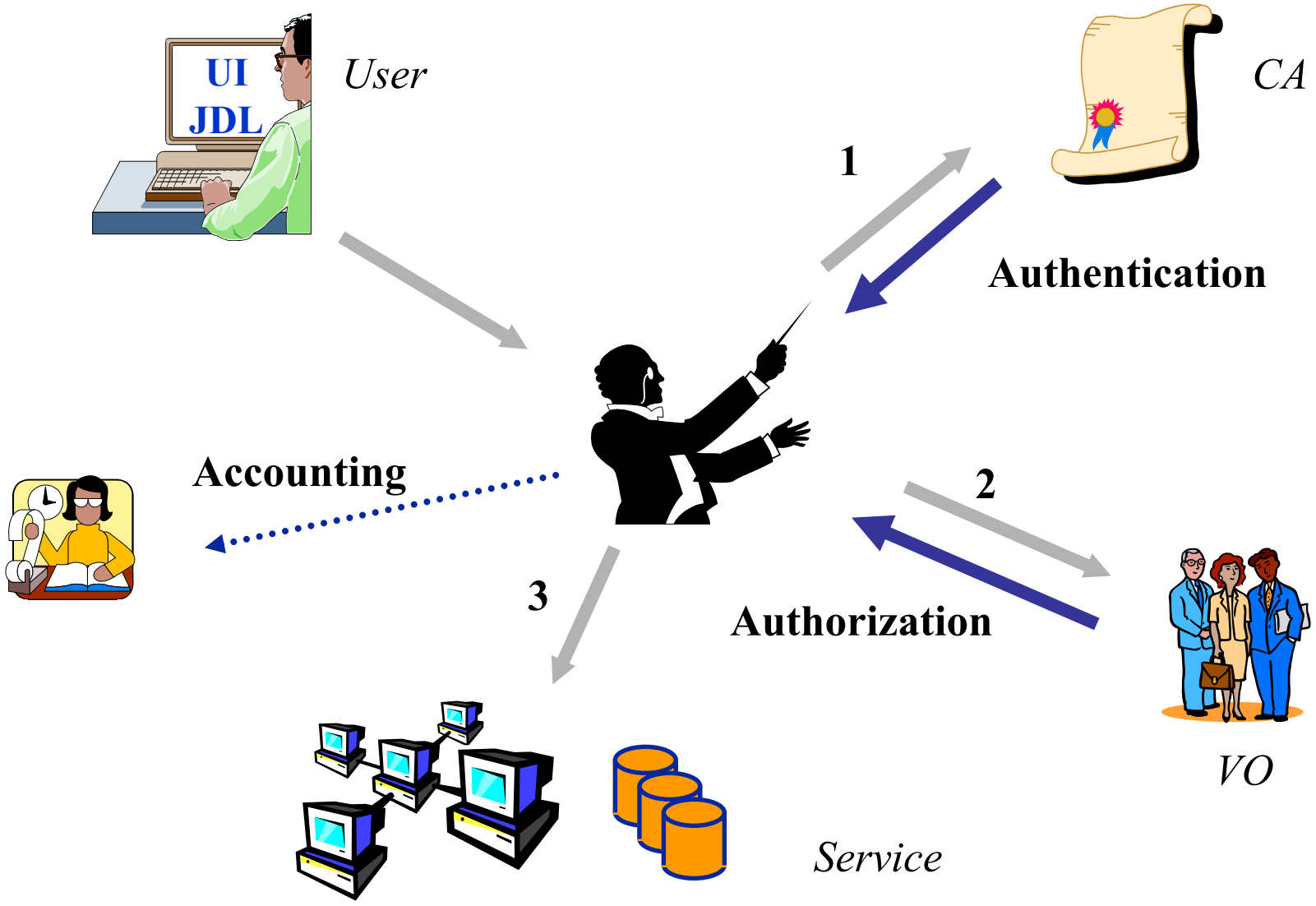
1. Mutual authentication Client-Server
   - Secure communication channel via standard Globus API
2. Client sends request to Server
3. Server checks correctness of request
4. Server sends back the required info (signed by itself) in a "Pseudo-Certificate"
5. Client checks the validity of the info received
6. Optionally: [Client repeats process for other VOMS's]
7. Client creates proxy certificates containing all the info received into a (non critical) extension
8. Client may add user-supplied auth. info (kerberos tickets, etc...)

Based on: http://www.slac.stanford.edu/econf/C0303241/proc/pres/317.PPT

Job Submission using VOMS

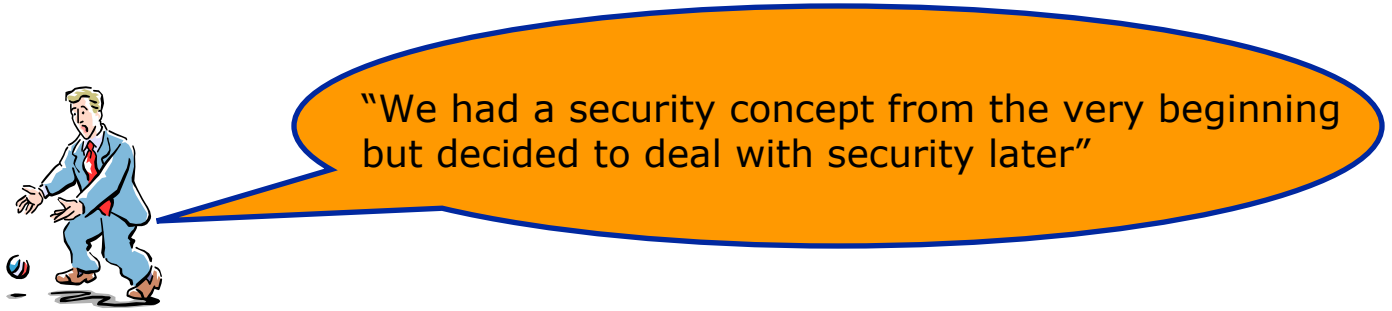


Authentication and Authorization



Security Summary

- Security is important for Grid middleware:
  - In particular in commercial use
- Security solutions need to be integrated from the very beginning



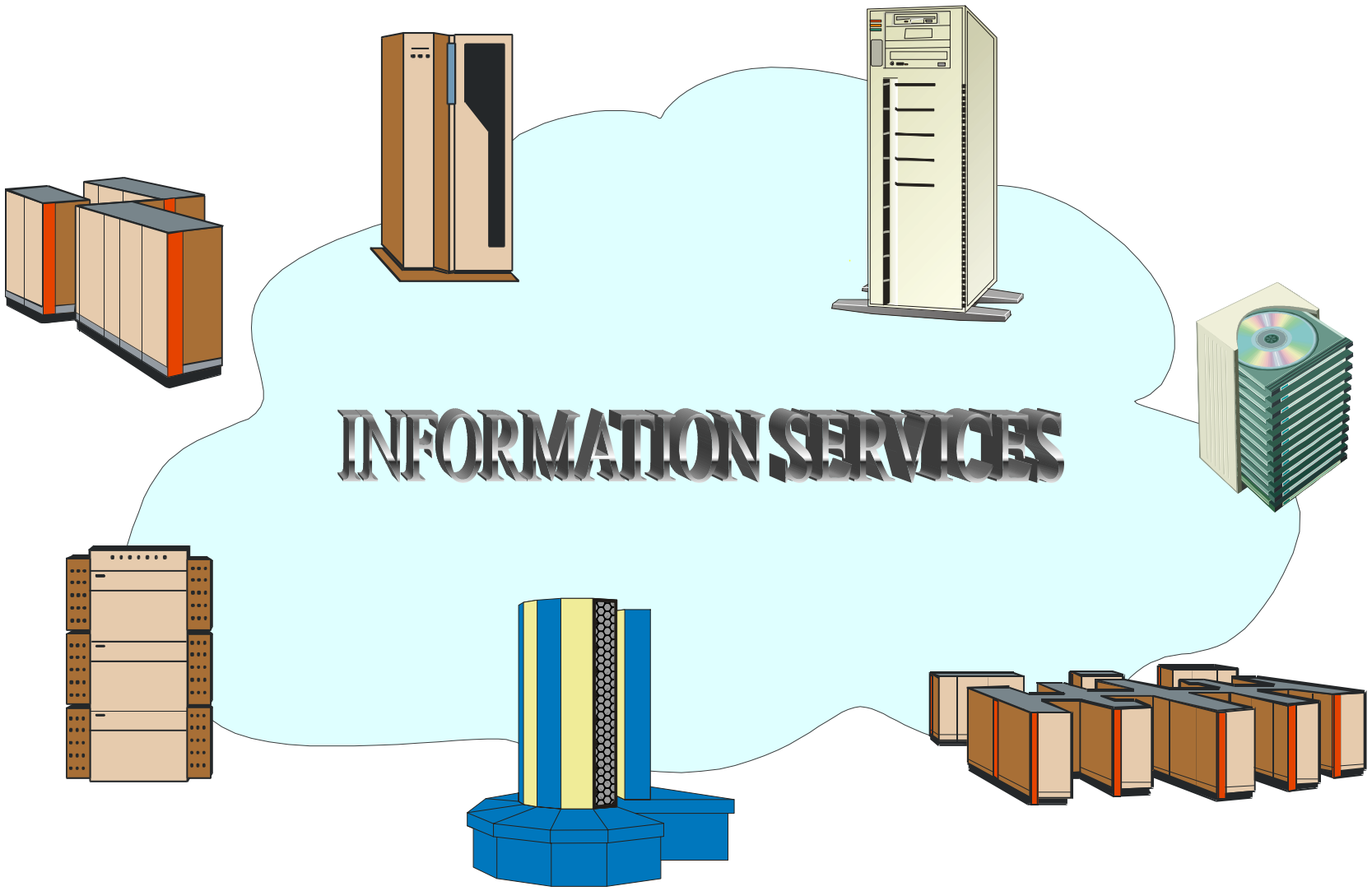
- Grid security relies on PKI
  - Requires: authentication & authorization
- Basic entities:
  - Users – CA (Certificate Authorities) – Resource Providers

Enabling Grids for E-science in Europe

The middleware

- EGEE middleware built upon the VDT toolkit provides generic Grid services:
  - Information
  - Job submission
  - Data management
  - Security
  - Logging
  - Monitoring
- EGEE supports computation and data storage by multiple virtual organisations

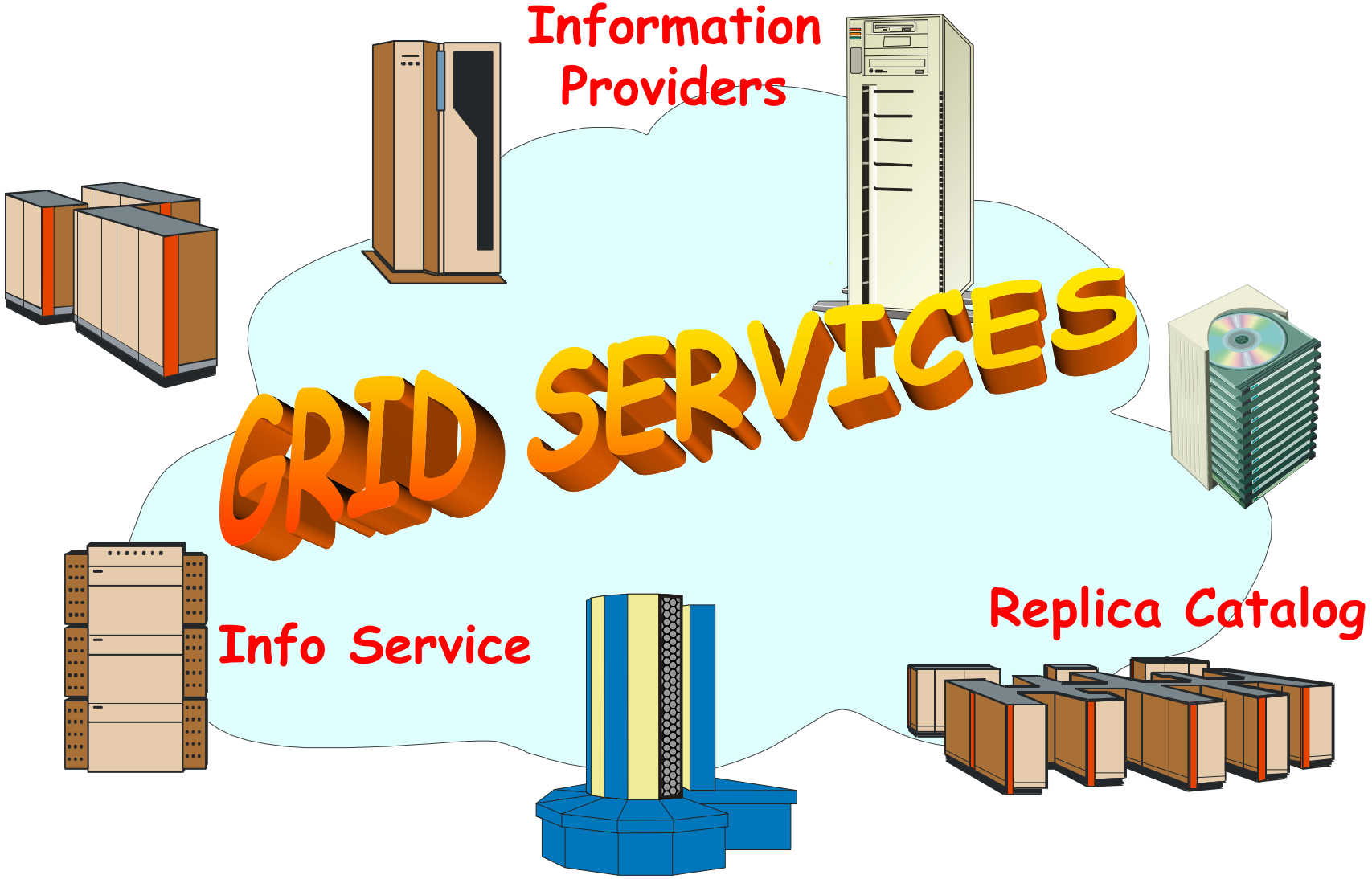
Situation on a Grid



Features of a grid information system

- Provides information on both:
  - The Grid itself
    - Mainly for the middleware packages
    - The user may query it to understand the status of the Grid
  - Grid applications
    - For users
- Flexible infrastructure
  - Able to cope with nodes in a distributed environment with an unreliable network
  - Dynamic addition and deletion of information producers
  - Security system able to address the access to information at a fine level of granularity
  - Allow new data types to be defined
  - Scaleable
  - Good performance
  - Standards based

Situation on a Grid Cont'd



Information Services

- Hardware:
  - EDG Information Service
  - Information Providers
- Data:
  - Replica Catalog
    - LDAP (release 1.4)
    - RLS (release 2.0)
- Software & Services:
  - EDG Grid Services:
    - Information Service
      - MDS
      - R-GMA
  - Application Services:
    - Currently only EDG applications directly supported

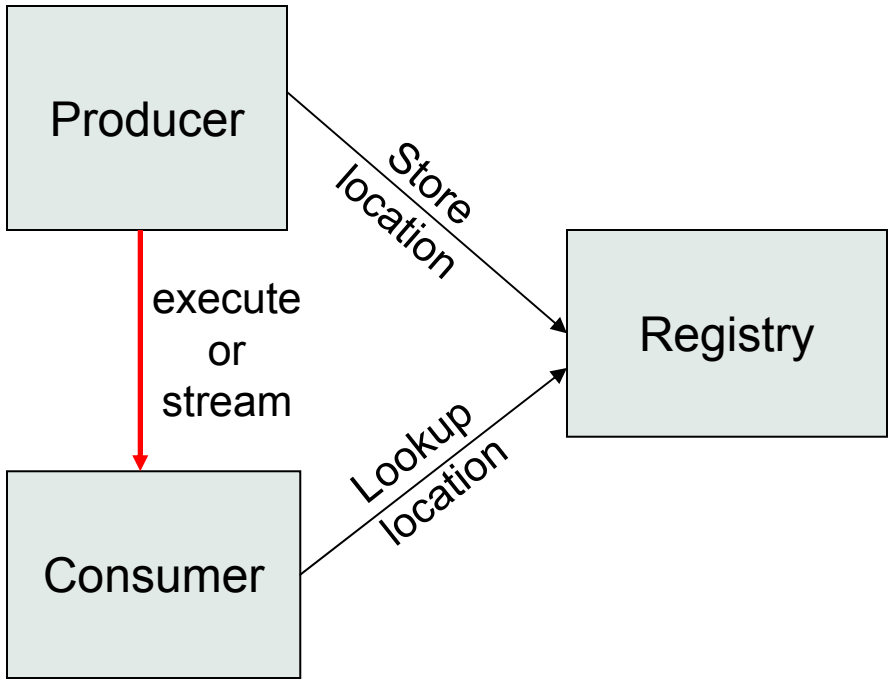
Machine Types:

- Information Service (IS)
  - Top level MDS
  - R-GMA registry
- Replica Catalog (RC, RLS)

EDG Information Providers

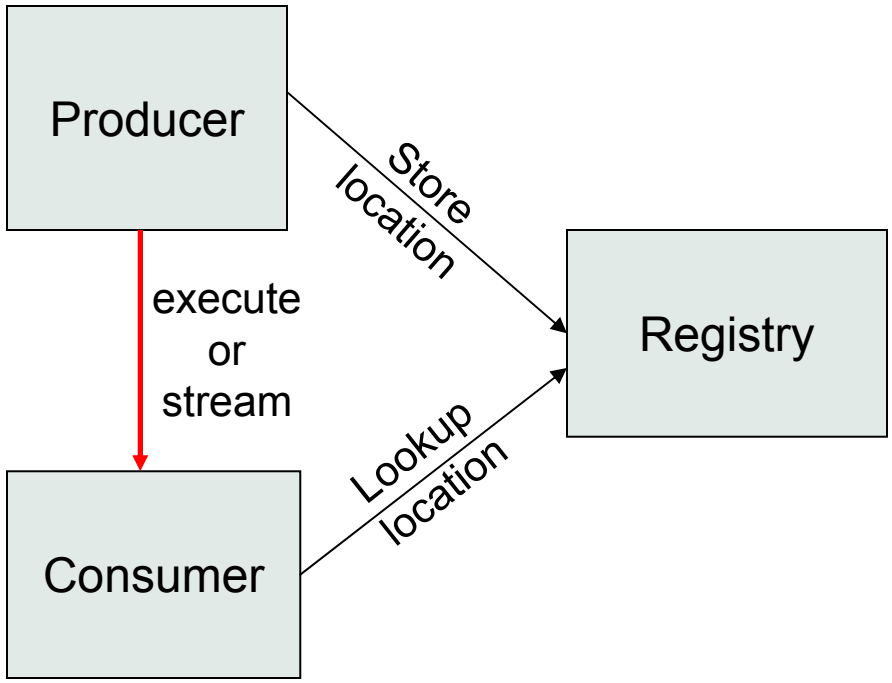
- EDG information providers
  - Software that provides information about resources and infrastructure
  - Provided by the developer of a service or the responsible for the resource
- The information providers produce data in LDIF format
  - This is a legacy from when Globus MDS was the primary information system (LDAP based)
- R-GMA publishes the data
  - Gin (gadget in) is used to invoke the information provider scripts and publish via StreamProducers
  - Gout (gadget out) republishes the data via a LatestProducer and then to an OpenLDAP database
    - This is to provide backwards compatibility during the transition from MDS to R-GMA

GMA



- From GGF
- Very simple model
- Does not define:
  - Data model
  - Data transfer mechanism
  - Registry implementation

R-GMA



- Use the GMA from GGF
- A relational implementation
  - Powerful data model and query language
    - All data modelled as tables
    - SQL can express most queries in one expression
- Applied to both information and monitoring
- Creates impression that you have one RDBMS per VO

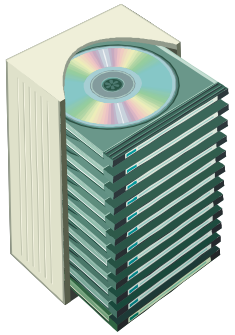
Main EDG Grid Services

- Authentication & Authorization
- Job submission service
  - Resource Broker
- Replica Management
  - EDG-Replica-Manager
  - Mass storage system support
- Logging & Bookkeeping
- Monitoring

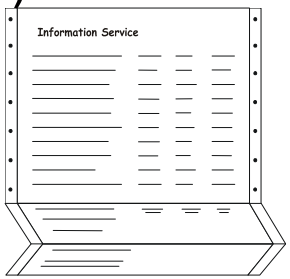
Main Logical Machine Types

- User Interface (UI)

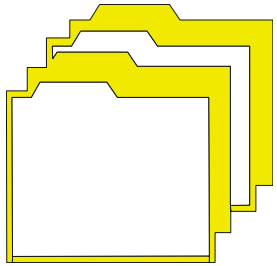
- Storage Element (SE)



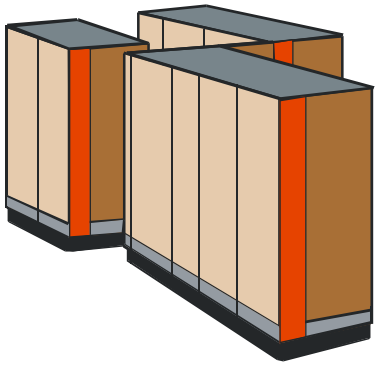
- Information Service (IS)



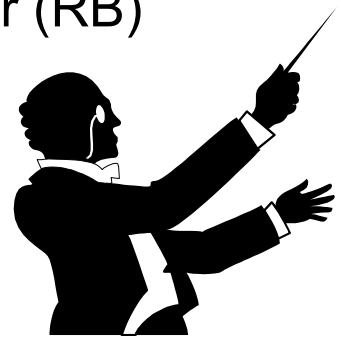
- Replica Catalog (RC,RLS)



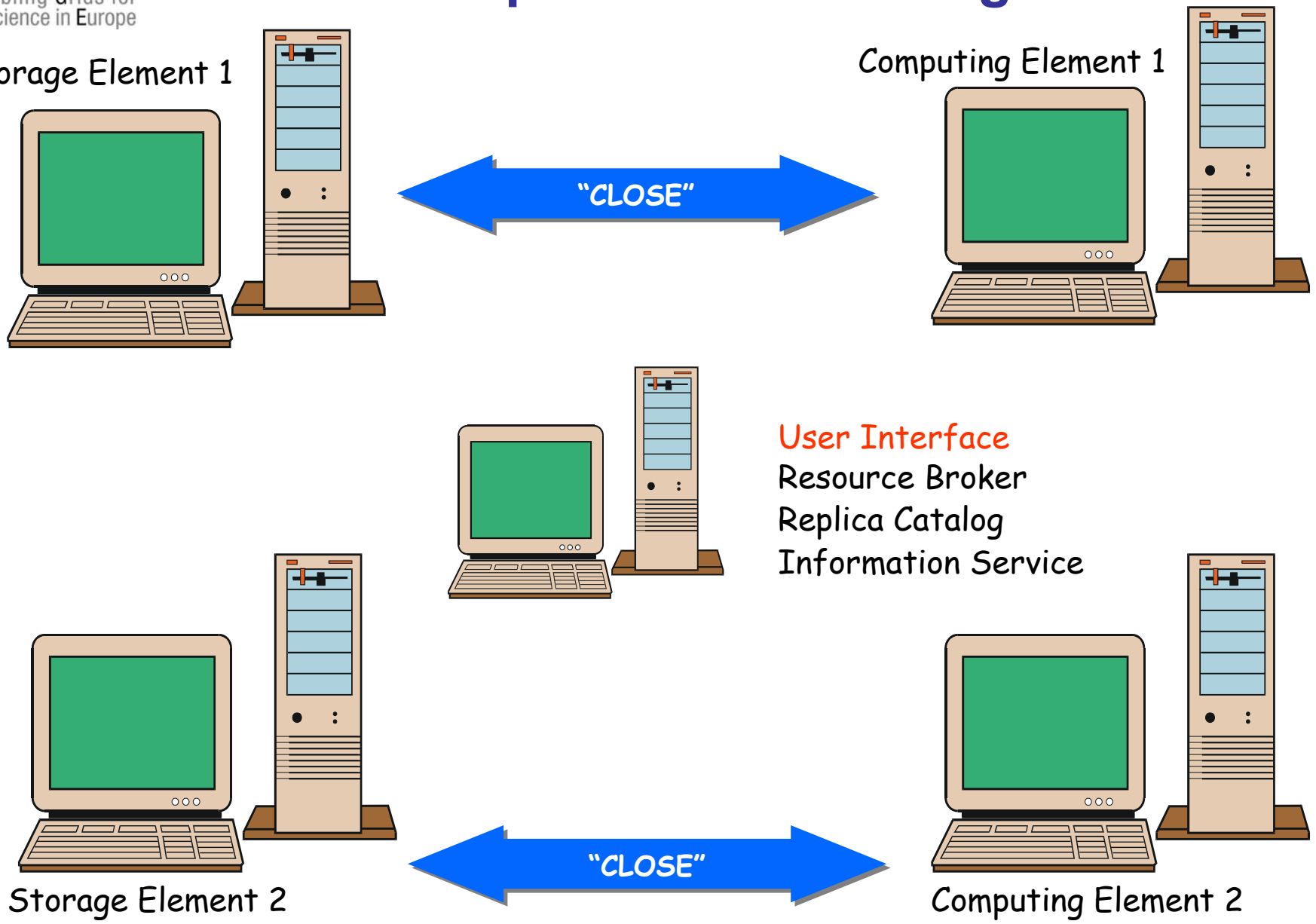
- Computing Element (CE)
  - Frontend Node
  - Worker Nodes (WN)



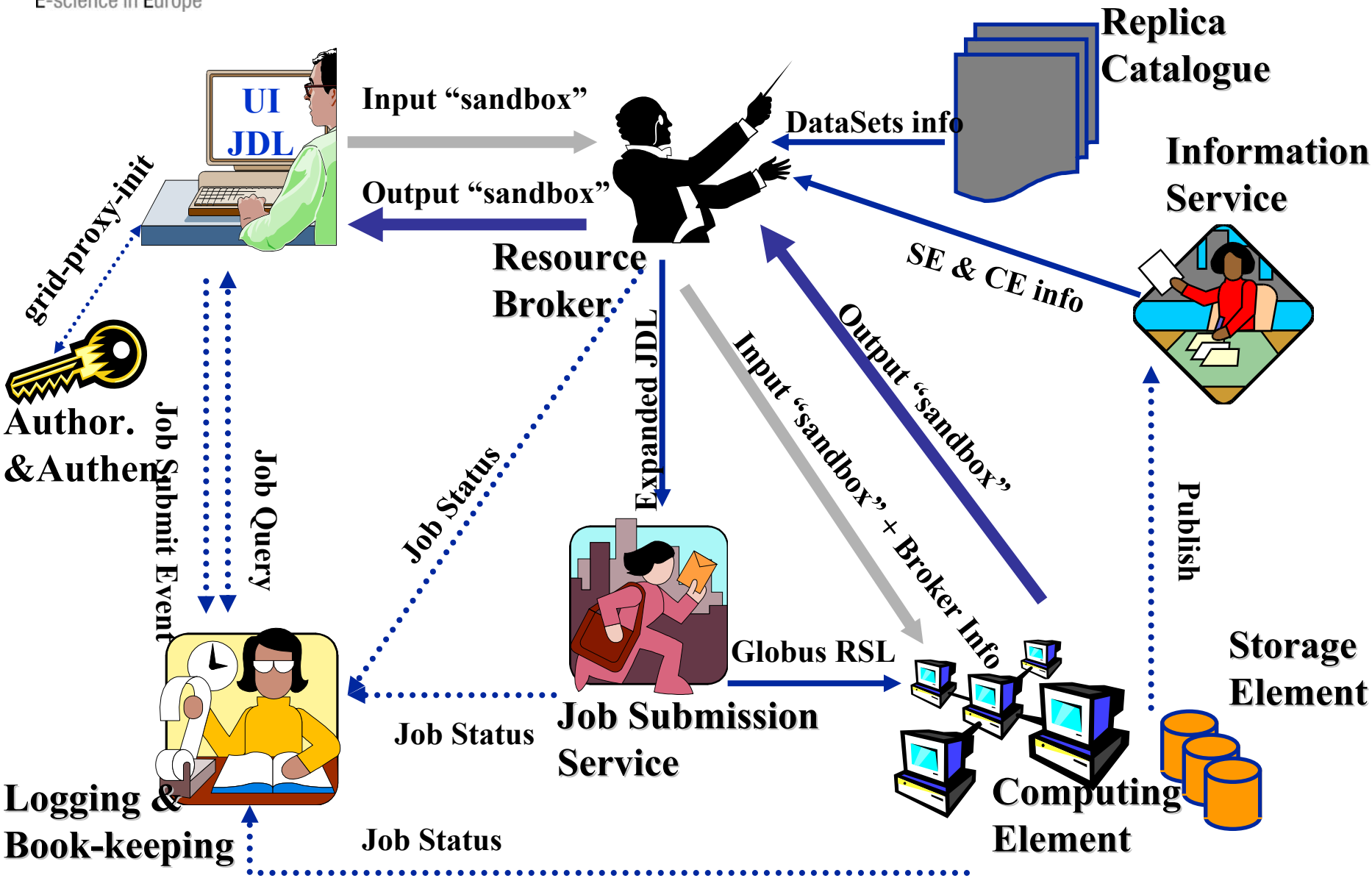
- Resource Broker (RB)



A Simple Testbed Configuration



The lifecycle of an EGEE job



Main Services per Machine Type

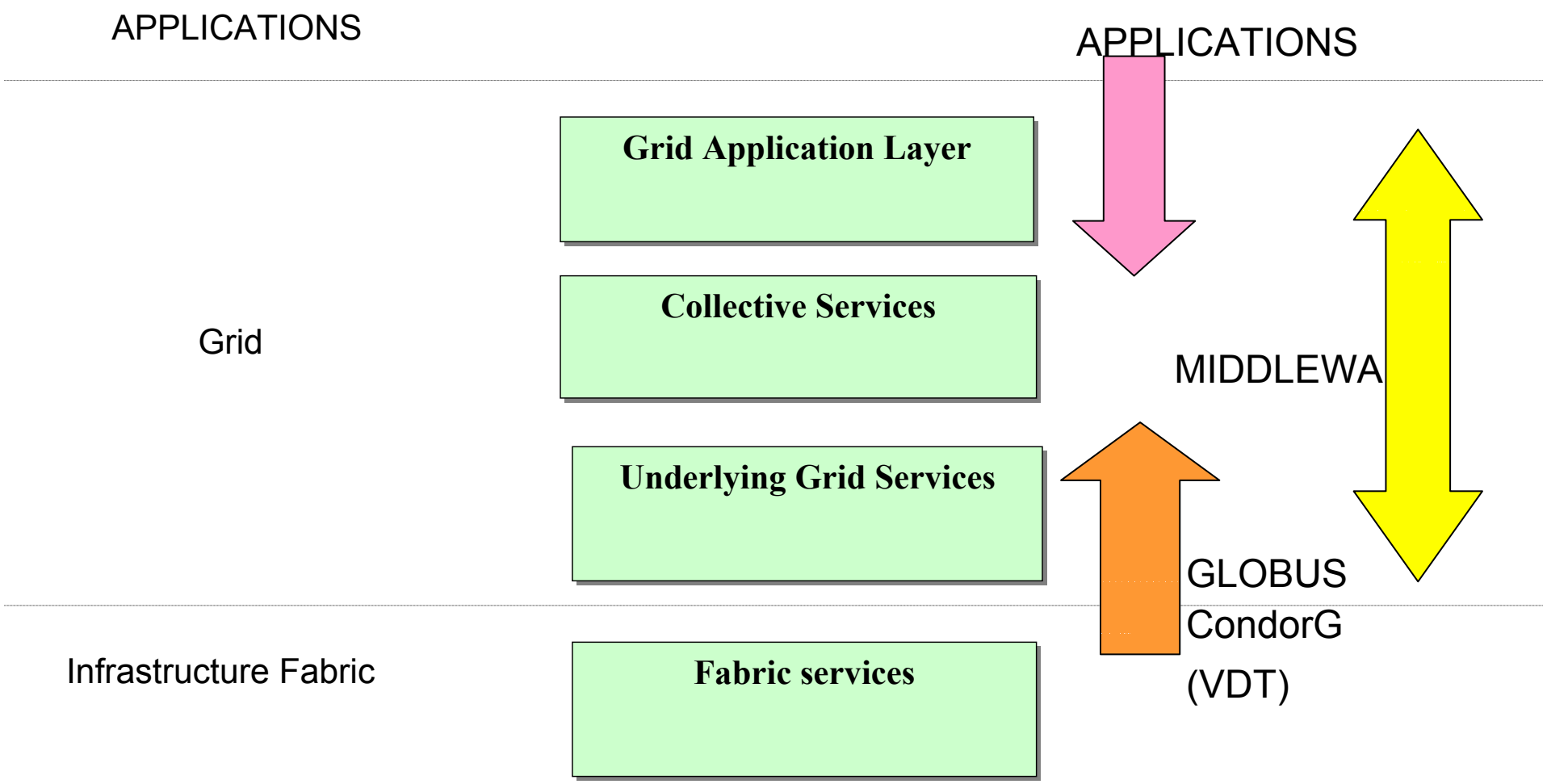
Daemon	UI	IS	CE (frontend)	WN	SE	RLS	RB
Globus Gatekeeper	-	-	✓	-	-	-	-
RLS-LRC	-	-	-	-	-	✓	-
RLS-RMC	-	-	-	-	-	✓	-
GridFTP	-	-	✓	-	✓	-	✓
R-GMA	-	✓	-	-	-	-	-
R-GMA GOUT	-	-	-	-	-	-	✓
R-GMA GIN	-	-	✓	-	✓	-	-
Broker (Network server, job control)	-	-	-	-	-	-	✓
CondorG Job submission	-	-	-	-	-	-	✓
Logging & Bookkeeping	-	-	-	-	-	-	✓
Local Logger	-	-	✓	-	-	-	✓
CRL Update	-	-	✓	-	✓	-	✓
Grid mapfile Update	-	-	✓	-	✓	-	✓
RFIO	-	-	-	-	✓	-	-
EDG-SE	-	-	-	-	✓	-	-

Where are we now?

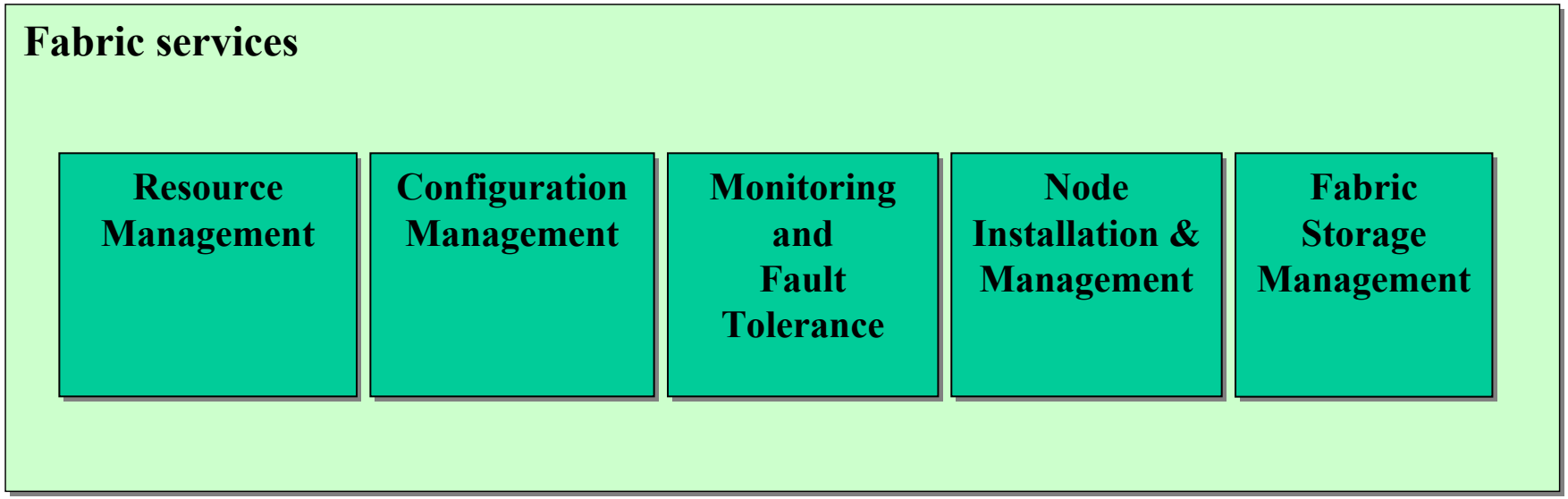
- Enabling Grid Computing:
  fabric+infrastructure+ middleware
  - Information services
  - Grid services
  - The major components
  - **The software stack**

- EGEE grid organisation

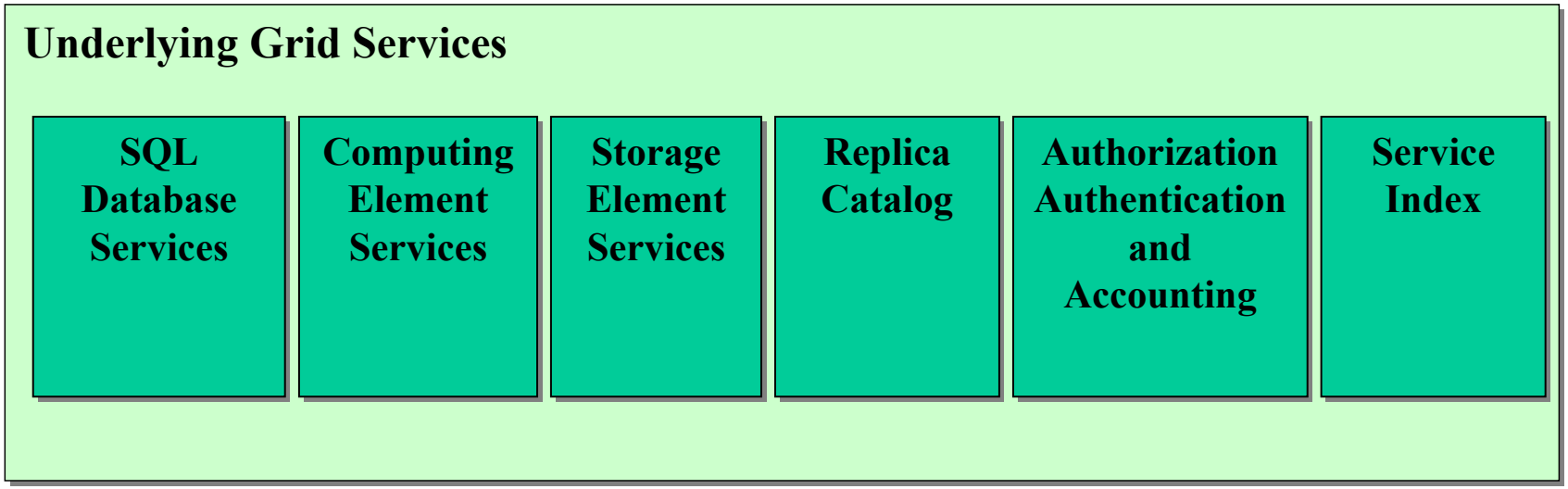
The grid software stack



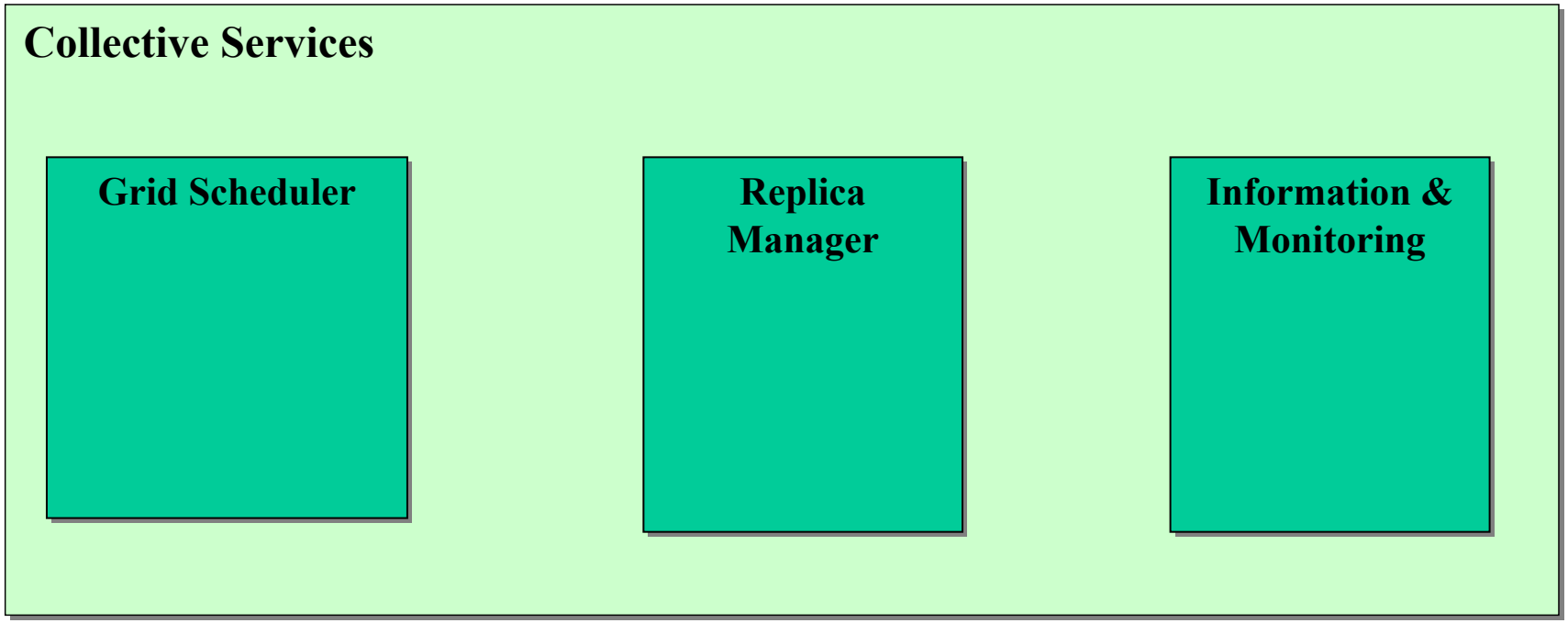
The grid software stack - Fabric



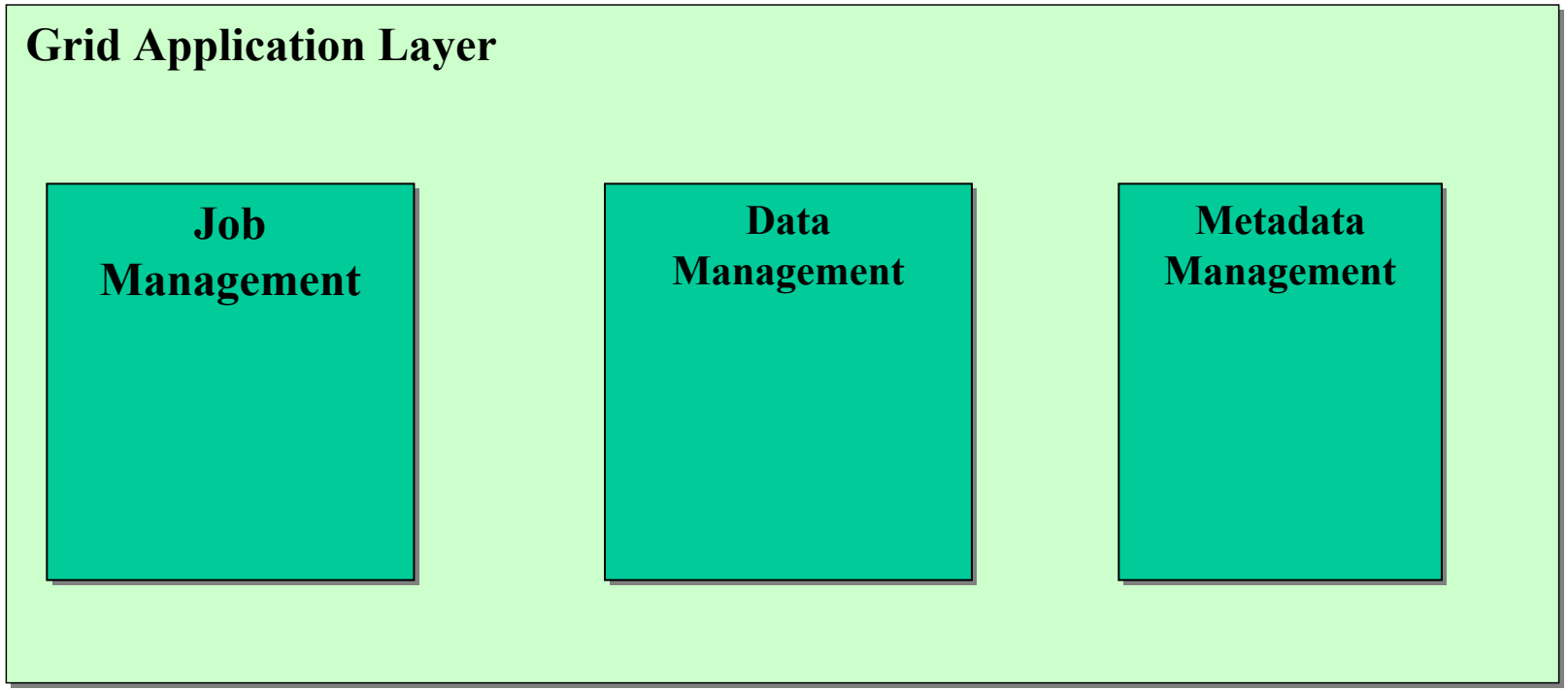
The grid software stack – Grid services



The grid software stack – Collective services



The grid software stack – Application layer



Enabling Grids for E-science in Europe

EGEE

- EGEE is distinctive because of the emphasis on :
  - Production quality of service
  - Multiple virtual organisations

Enabling Grids for E-science in Europe

Where are we now?

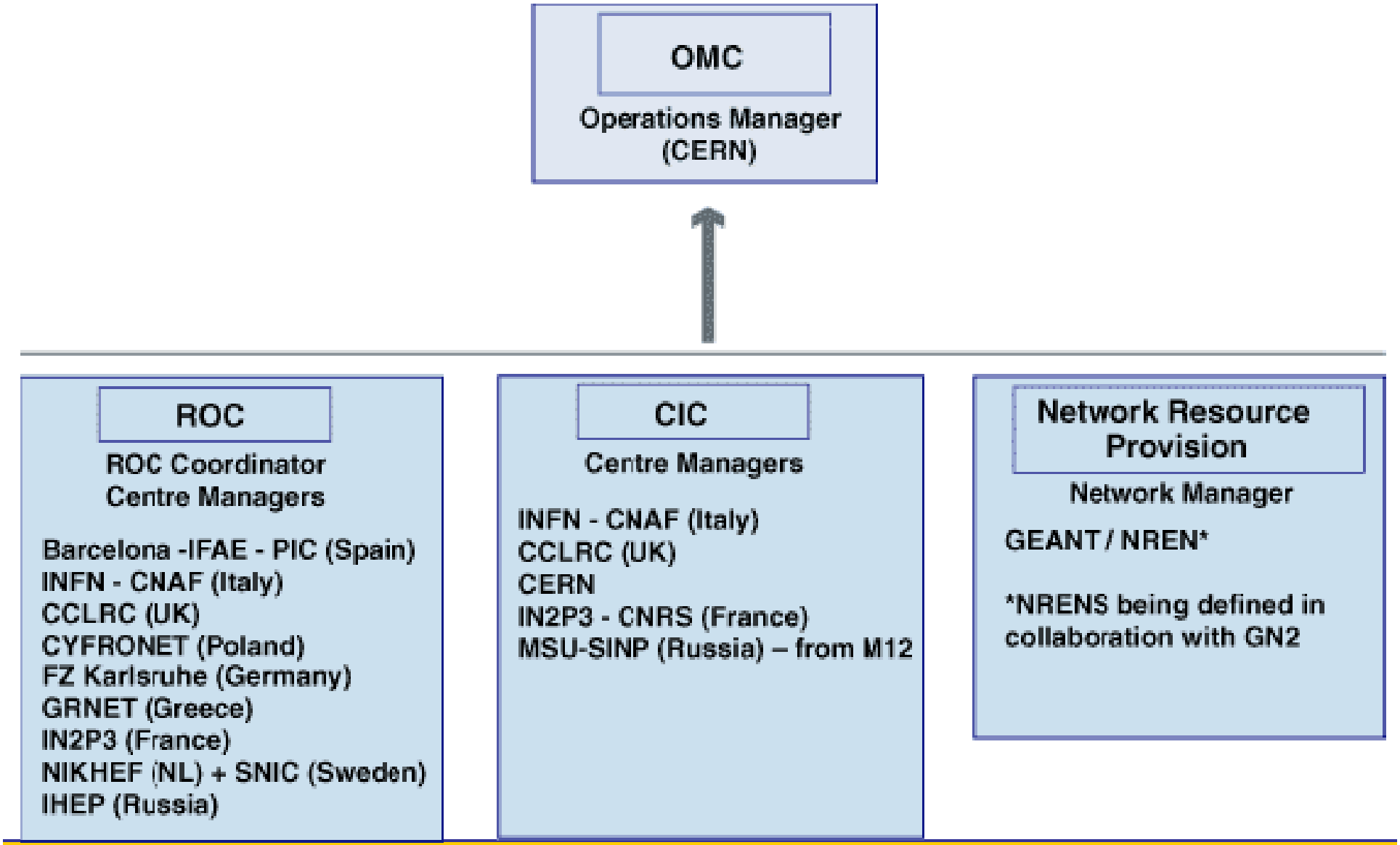
- Enabling Grid Computing:
  fabric+infrastructure+ middleware

- EGEE grid organisation
  - **Virtual Organisations**
  - Operations management and testbeds

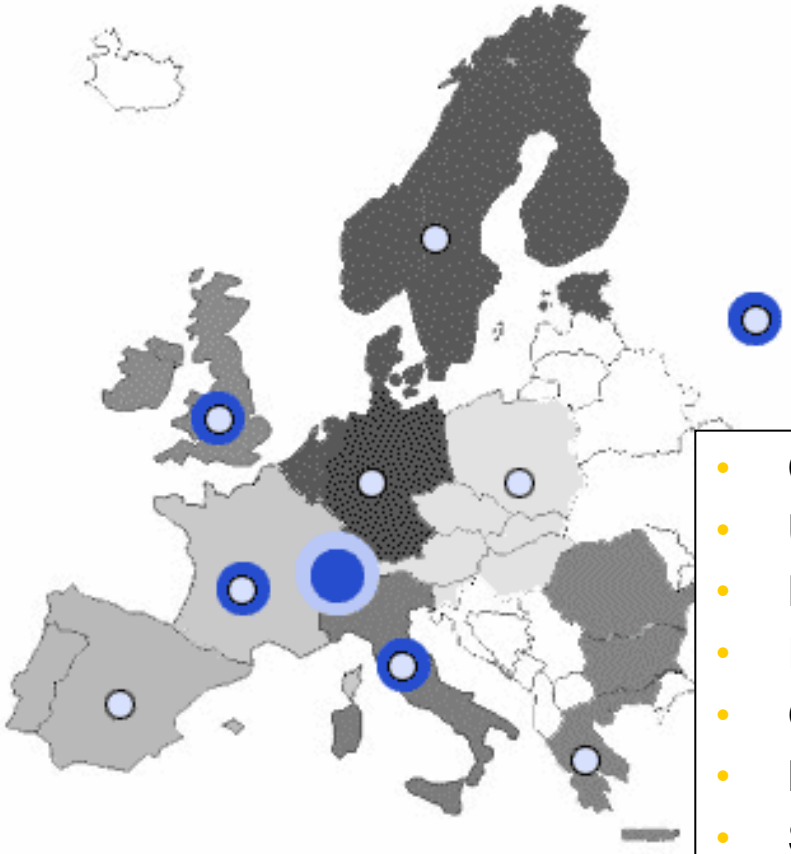
Virtual organisations

- An EGEE user must belong to a VO
- A VO
  - Controls access to specified CE, SE
  - Usually comprises geographically distributed people
  - Requires the ability to know who has done what, and who will not be allowed to do it again…. Security.
- Current VO's:
  - HEP communities, biology, astronomy,…
- VOMS: enhanced flexibility in VO management

Grid Operations Management Structure



Operations Infrastructure



Operations Management Centre

Core Infrastructure Centre

Regional Operations Centre

- CERN (OMC, CIC)
- UK+Ireland (CIC,ROC)
- France (CIC, ROC)
- Italy (CIC, ROC)
- Germany+Switzerland (ROC)
- Northern Europe (ROC)
- South West Europe (ROC)
- South East Europe (ROC)
- Central Europe (ROC)
- Russia (CIC – M12, ROC)

- 48 Partners involved in SA1
- ROC's in several regions are distributed across many sites

Pre-production service

- For next version middleware
- Initially – start with EGEE middleware as soon as there is a basic release
  - For year 1 pre-production will run EGEE m/w, production will run LCG-2
  - When EGEE middleware is ready – move to production and pre-production service will be next EGEE candidate release
    - Even incremental component changes – get away from big-bang changes
    - Expect to updated services on pre-production even one by one
- Initial resources – come from EDG application testbed sites, perhaps also some of the new smaller sites
- While waiting for first EGEE release – could deploy LCG-2 to get pre-production system up
- Support is 8 hours x 5 days

Training/demo service

- Permanent need for tutorials, demonstrations etc.
- Cannot disturb production system, or guarantee pre-production
- Ideally need dedicated (small) service
  - Kept in an operational state
  - Need sufficient resources to be available (another testbed!)
- Currently fulfilled by GILDA service (via GENIUS portal)

Conclusions

- The EGEE Grid requires resources, an infrastructure and middleware that allows for:
  - Authentication and Authorization
  - Information services
  - Job and Data Management
  - Monitoring and fault recovery
- We have seen the main components of the EGEE Grid Service and Organization
  - EGEE is VO based
  - The Grid Operations Management Structure monitors and controls the overall functionality
- The EGEE tutorials ensure training at all levels with hands-on on the GILDA dedicated testbed