



Enabling Grids for E-science

# EGEE

## The e-Science Production Grid (in Europe)

*Torsten Antoni*

*Institut für wissenschaftliches Rechnen*

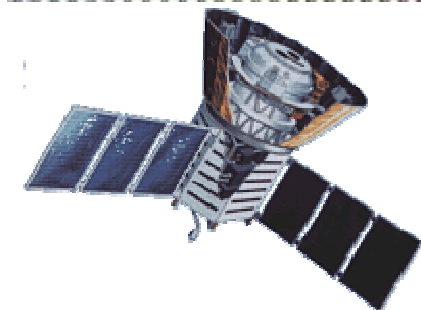
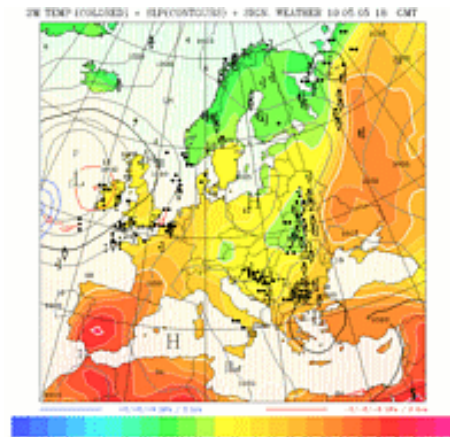
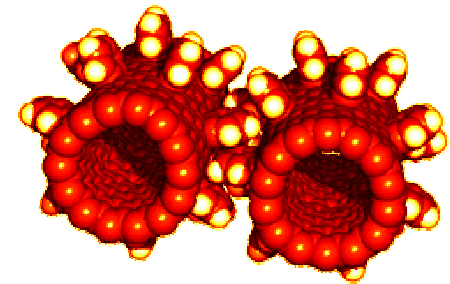
*Forschungszentrum Karlsruhe*

[www.eu-egee.org](http://www.eu-egee.org)



# The rationale for Grids

- Science is becoming increasingly **digital** and needs to deal with increasing amounts of data
- **Simulations** get ever more detailed
  - Nanotechnology – design of new materials from the molecular scale
  - Modelling and predicting complex systems (weather forecasting, river floods, earthquake)
  - Decoding the human genome
- **Experimental Science** uses ever more sophisticated **sensors** to make precise measurements
  - Need high statistics
  - Huge amounts of data
  - Serves user communities **around the world**



- **Integrating computing power and data storage capacities at major computer centres**
- **Providing seamless access to computing resources distributed around the globe**



- More effective and seamless collaboration of dispersed communities, both scientific and commercial
- Ability to run large-scale applications comprising thousands of computers, for wide range of applications

- Distributed applications already exist, but they tend to be *specialized systems* intended for a single purpose or user group
  
- Grids go further and take into account:
  - Different kinds of *resources*
    - Not always the same hardware, data and applications
  - Different kinds of *interactions*
    - User groups or applications want to interact with Grids in different ways
  - *Dynamic* nature
    - Resources and users added/removed/changed frequently

- **Virtual Organizations**
  - People from different organizations but with common goals get together to solve their problems in a cooperative way – similar to a HEP experiment
- **Virtualized shared computing resources**
  - Members of VOs have access to computing resources outside their home institutions. Resource providers typically have a contract/MoU with the VO, not with the VO members
- **Virtualized shared data resources**
  - Similar to computing resources
- **Other resources may be shared and virtualized as well:**
  - Instruments, sensors, even people

**Virtualization of resources is needed to abstract from their heterogeneity**

# EGEE

- Great investment in developing Grid technology

- Sample of National Grid projects:

- Austrian Grid Initiative
- DutchGrid
- France: Grid'5000; ACI Grid
- Germany: D-Grid; Unicore
- Greece: HellasGrid
- Grid Ireland
- Italy: INFNGrid; GRID.IT
- NorduGrid
- UK e-Science: National Grid Service; OMII; GridPP



- EGEE provides framework for national, regional and thematic Grids





- **Objectives**

- consistent, robust and secure service grid **infrastructure** for many applications
- improving and maintaining the **middleware**
- attracting **new resources and users** from industry as well as science

- **Structure**

- 71 leading institutions in 27 countries, federated in regional Grids
- leveraging national and regional grid activities worldwide
- funded by the EU with ~32 M Euros for first 2 years starting 1st April 2004



- **Objectives**

- Large-scale, production-quality **infrastructure** for e-Science
  - leveraging national and regional grid activities worldwide
  - consistent, robust and secure
- improving and maintaining the **middleware**
- attracting **new resources and users** from industry as well as science

- **EGEE**

- 1st April 2004 – 31 March 2006
- 71 leading institutions in 27 countries, federated in regional Grids

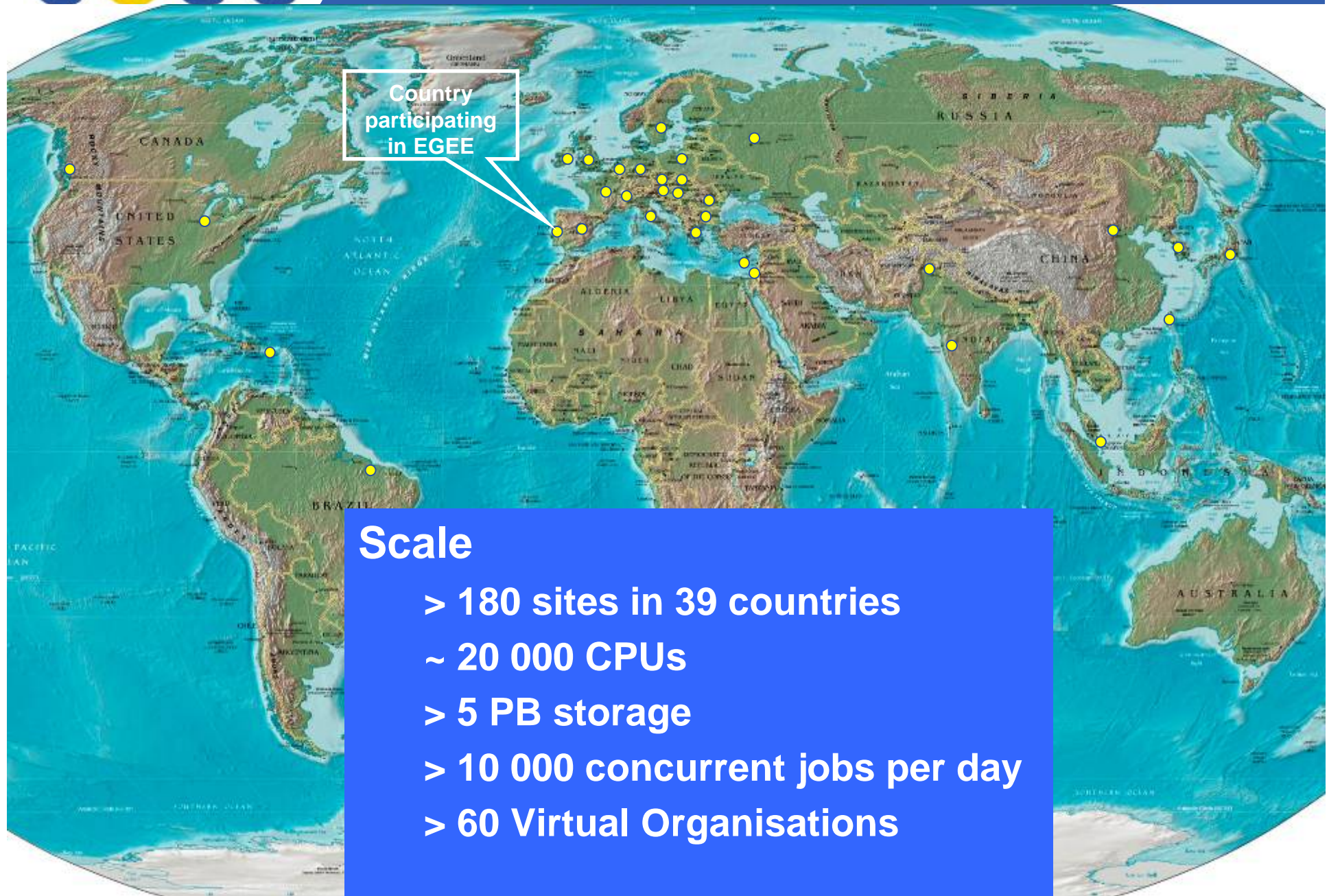
- **EGEE-II**

- Start 1 April 2006 (for 2 years)
- Expanded consortium
  - > 90 partners in 32 countries (also non-European partners)
  - Related projects, incl.
    - *BalticGrid*
    - *SEE-GRID*
    - *EUMedGrid*
    - *EUChinaGrid*
    - *EELA*



# Infrastructure





## Scale

- > 180 sites in 39 countries
- ~ 20 000 CPUs
- > 5 PB storage
- > 10 000 concurrent jobs per day
- > 60 Virtual Organisations

- **Production service**
  - Based on the LCG-2 service
  - With new resource centres and new applications encouraged to participate
  - Stable, well-supported infrastructure, running only well-tested and reliable middleware
  
- **Pre-production service**
  - Run in parallel with the production service (restricted nr of sites)
  - First deployment of new versions of the middleware
  - Applications test-bed
  
- **GILDA testbed**
  - <https://gilda.ct.infn.it/testbed.html>
  - Complete suite of Grid elements and applications
    - Testbed, CA, VO, monitoring
  - Everyone can register and use GILDA for training and testing

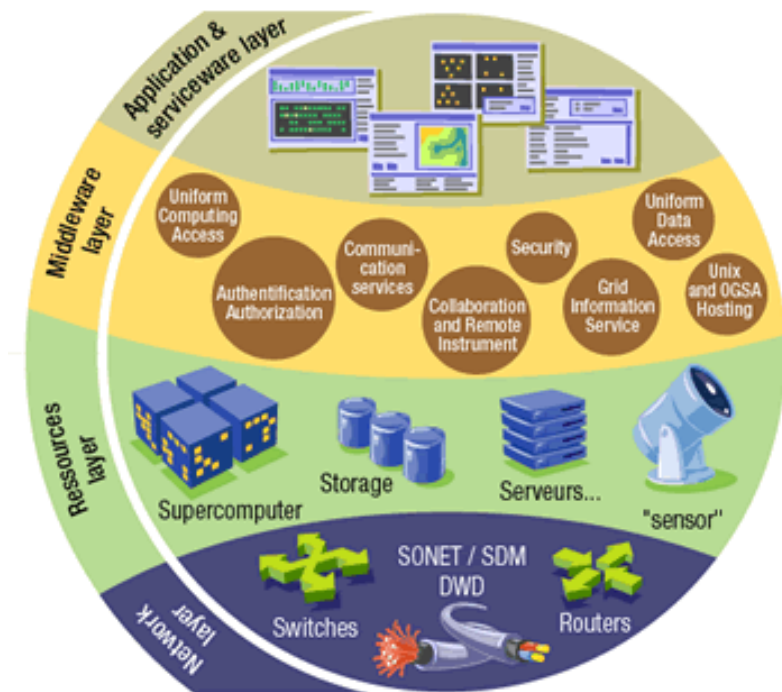


# Middleware



- The Grid relies on advanced software, called **middleware**, which interfaces between resources and the applications

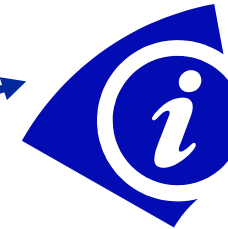
- The **GRID** middleware:
  - Finds convenient places for the application to be run
  - Optimises use of resources
  - Organises efficient access to data
  - Deals with authentication to the different sites that are used
  - Runs the job & monitors progress
  - Recovers from problems
  - Transfers the result back to the user



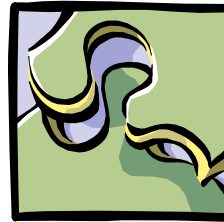
User Interface



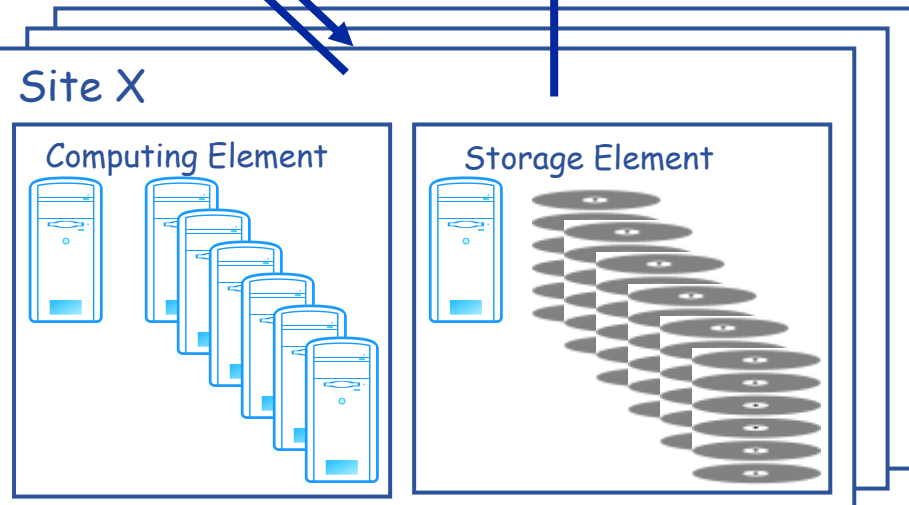
Information System



Resource Broker



File and Replica Catalogs



update credential



Authorization Service

submit  
retrieve

query

retrieve  
submit

query

publish state



- gLite

- Exploit **experience and existing components** from VDT (Condor, Globus), EDG/LCG, AliEn, and others



- Develop a **lightweight stack of generic middleware** useful to EGEE applications (HEP and Biomedics are pilot applications).

- Should eventually deploy dynamically (e.g. as a globus job)
- Pluggable components – cater for different implementations

- Focus is on **re-engineering and hardening**

- **Computing Element**
  - Gatekeeper (*Globus*)
  - Condor-C (*Condor*)
  - CE Monitor (*EGEE*)
  - Local batch system (*PBS, LSF, Condor*)
- **Storage Element**
  - gLite-I/O (*AliEn*)
  - Reliable File Transfer (*EGEE*)
  - GridFTP (*Globus*)
  - SRM: Castor (*CERN*), dCache (*FNAL, DESY*), other SRMs
- **Workload Management**
  - WMS (*EDG*)
  - Logging and bookkeeping (*EDG*)
  - Condor-C (*Condor*)
- **Information and Monitoring**
  - R-GMA (*EDG*)
- **Catalog**
  - File/Replica & Metadata Catalogs (*EGEE*)
- **Security**
  - GSI (*Globus*)
  - VOMS (*DataTAG/EDG*)
  - Authentication for C and Java based (web) services (*EDG*)

Now doing rigorous scalability and performance tests on pre-production service

- **Centered around VOs**
  - It's ultimately the VO who gets resources allocated and needs to decide how to best use them (share them among the VO users)
  
- **Distinguish between *infrastructure* and VO services**
  
- **Infrastructure services**
  - Operated and trusted by the resource administrator
  - Implement *site policies*
    - Including what share of the resources are allocated to a VO
  - Provide the required security, auditing, and accounting
  - Grid and standard services
    - E.g. batch system, gatekeeper, gridFTP, ...

- **VO services**

- Implement **intra-VO policies**
  - Scheduling, priorities, etc.
- Managed and operated by a VO
  - Typically by sites on behalf of VOs
  - A service instance may serve multiple VOs
- Currently mostly higher level services
  - Resource brokers, catalogs, ...
- There is the need of deploying VO services closer to the resource
  - Better information about the resource and better control about the resource
  - Downside: more and more services to be deployed at the sites

- **In principle, Grid security requirements are not different from standard security requirements**
  - Users want their data and application secured (including data transfer)
  - Sites want access to their resources secured and audited
- **What makes it challenging are the different administrative domains interconnected on the Grid and the need to establish mutual trust**

- **Grid security is based on X.509 PKI infrastructure**
  - **Certificate Authorities** (CA) issue (long lived) **certificates** identifying individuals (much like a passport)
  - Trust between CAs and sites is established (offline)
  - User identification is done by using (short lived) **proxies** of their certificates
- **Proxies can**
  - Be **delegated** to a service such that it can act on the user's behalf
  - Include **additional attributes** (like VO information via the VO Membership Service VOMS)
  - Be stored in an **external proxy store** (myProxy)
  - Be **renewed** (in case they are about to expire)

- **Heterogeneity**

- Data is stored on different storage systems using different access technologies

- Need common interface to storage resources

- Storage Resource Manager (SRM)

- **Distribution**

- Data is stored in different locations – in most cases there is no shared file system or common namespace
- Data needs to be moved between different locations

- Need to keep track where data is stored

- File and Replica Catalogs

- Need scheduled, reliable file transfer

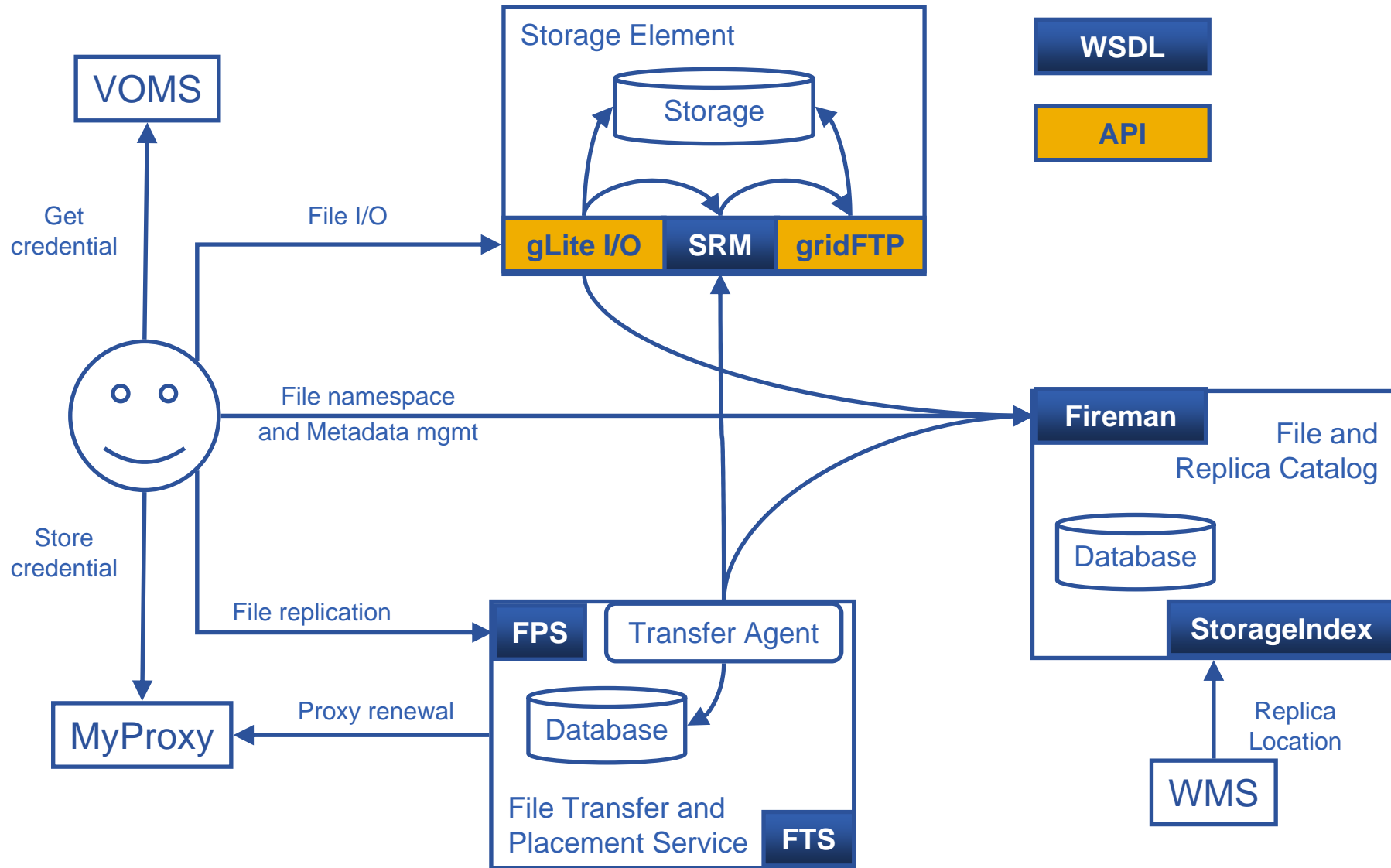
- File transfer and placement services

- **Different Administrative Domains**

- Data is stored at places you would normally have no access to
- Security and auditing implications

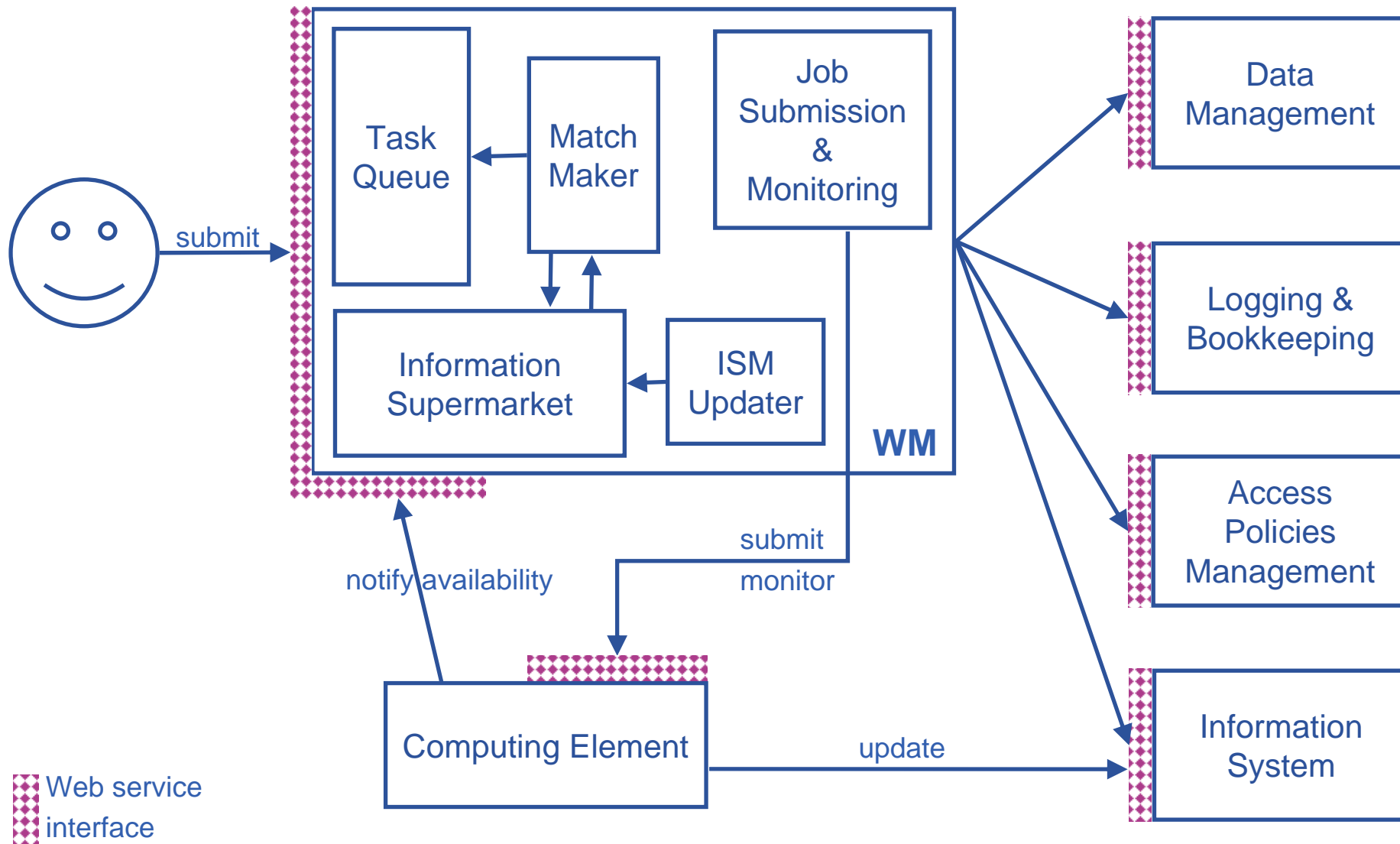
- Need a common security model

- ACLs enforcement based on Grid identities – DNs



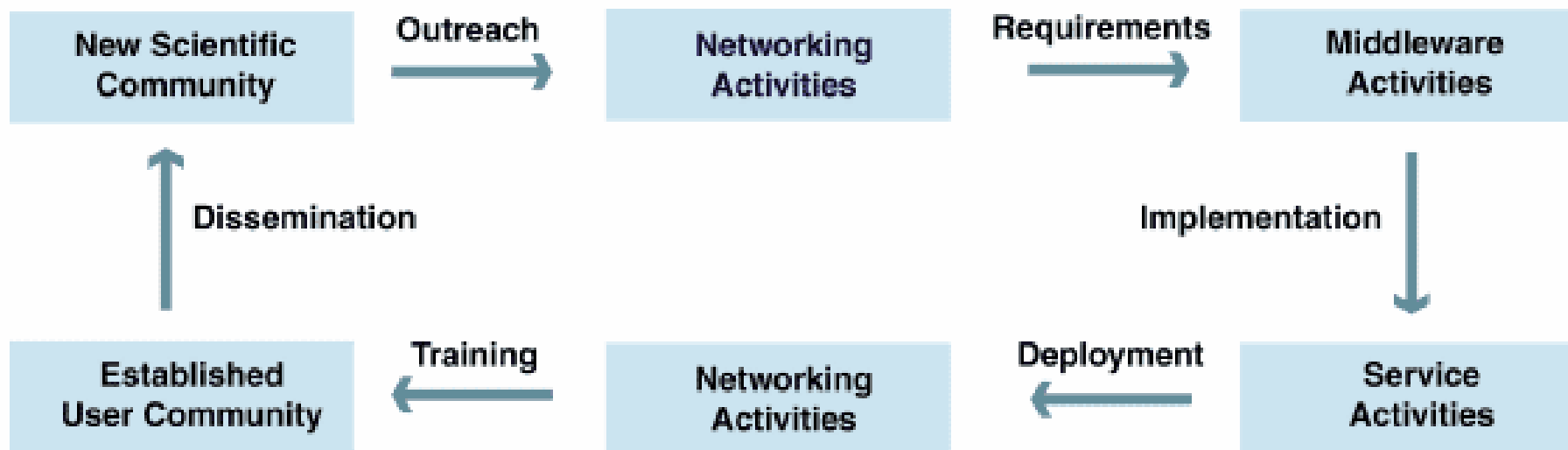


- **Computational tasks of thousands of users need to be scheduled on the available Grid resources**
- **Grid (Meta)Scheduling consists of:**
  - Resource **Discovery/Brokering**
    - Find suitable resources
  - **Matchmaking**
    - Assign a job to a resource that satisfies job requirements
  - **Job execution**
    - **Reliably** execute the jobs and retrieve output
    - Deal with error management
- **Job execution requires to find the “right” Computing Element (computing resource)**
  - with maybe boundary conditions (architecture, software installed, data accessible, etc.)



# Applications

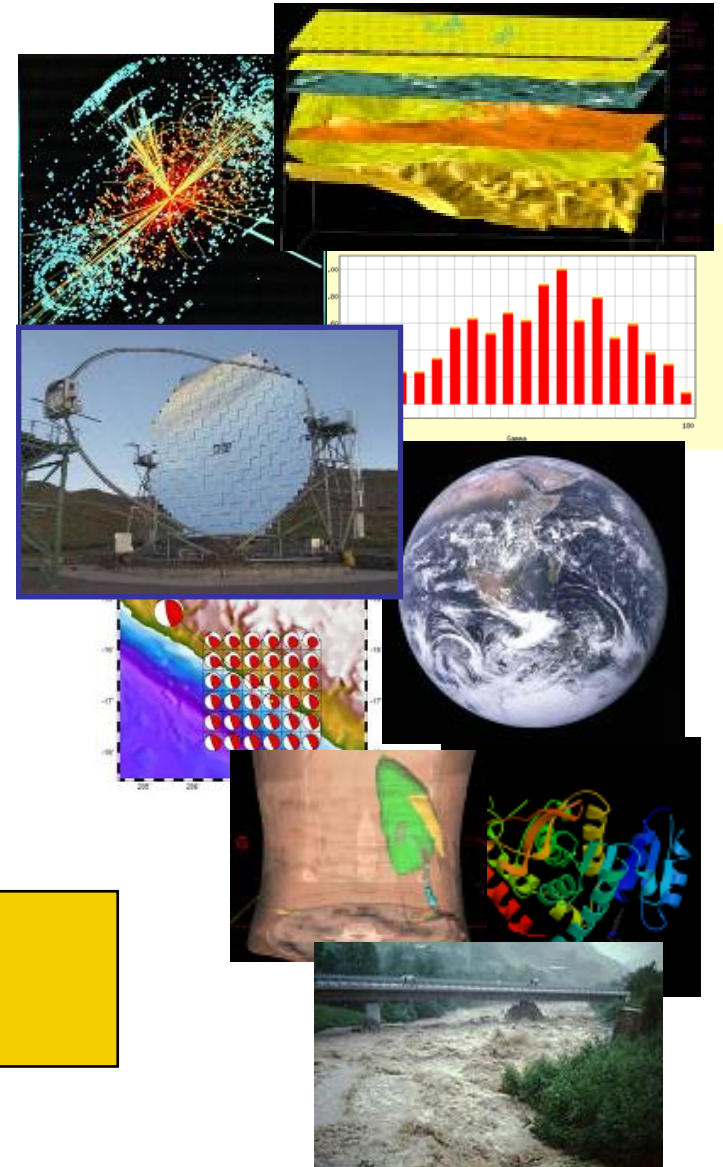
- **New user communities** (via dissemination and training events)
  - Possibility to explore benefits of EGEE via GILDA (training and dissemination testbed)
- **Negotiation process**
  - EGAAP (EGEE Generic Applications Advisory Panel) approves new applications
  - MoU to understand application requirements in detail
  - OAG (Operations/Applications Group) negotiates resource allocation
  - Application becomes part of already existing VO or new VO is formed



- **Tools to easily access Grid resources through high level Grid middleware (gLite)**
  - VO management (VOMS etc.)
  - Workload management
  - Data management
  - Information and monitoring
  
- **Application can**
  - interface directly to gLite
  - or
  - use higher level services such as portals, application specific workflow systems etc.

- **>20 applications from 7 domains**
  - High Energy Physics
  - Biomedicine
  - Earth Sciences
  - Computational Chemistry
  - Astronomy
  - Geo-Physics
  - Financial Simulation
- **Further applications in evaluation**

**Applications now moving from testing to routine and daily usage**



# User information & support

- **User education**
- **Simple access to a broad range of information**
- **Round the clock support for the users of grid data, compute, networking and VO specific services**
- **Application integration and support**



- More than 170 **training** events and summer schools across many countries
  - >2000 people trained  
induction; application developer; advanced; retreats
  - Material archive online with ~250 presentations



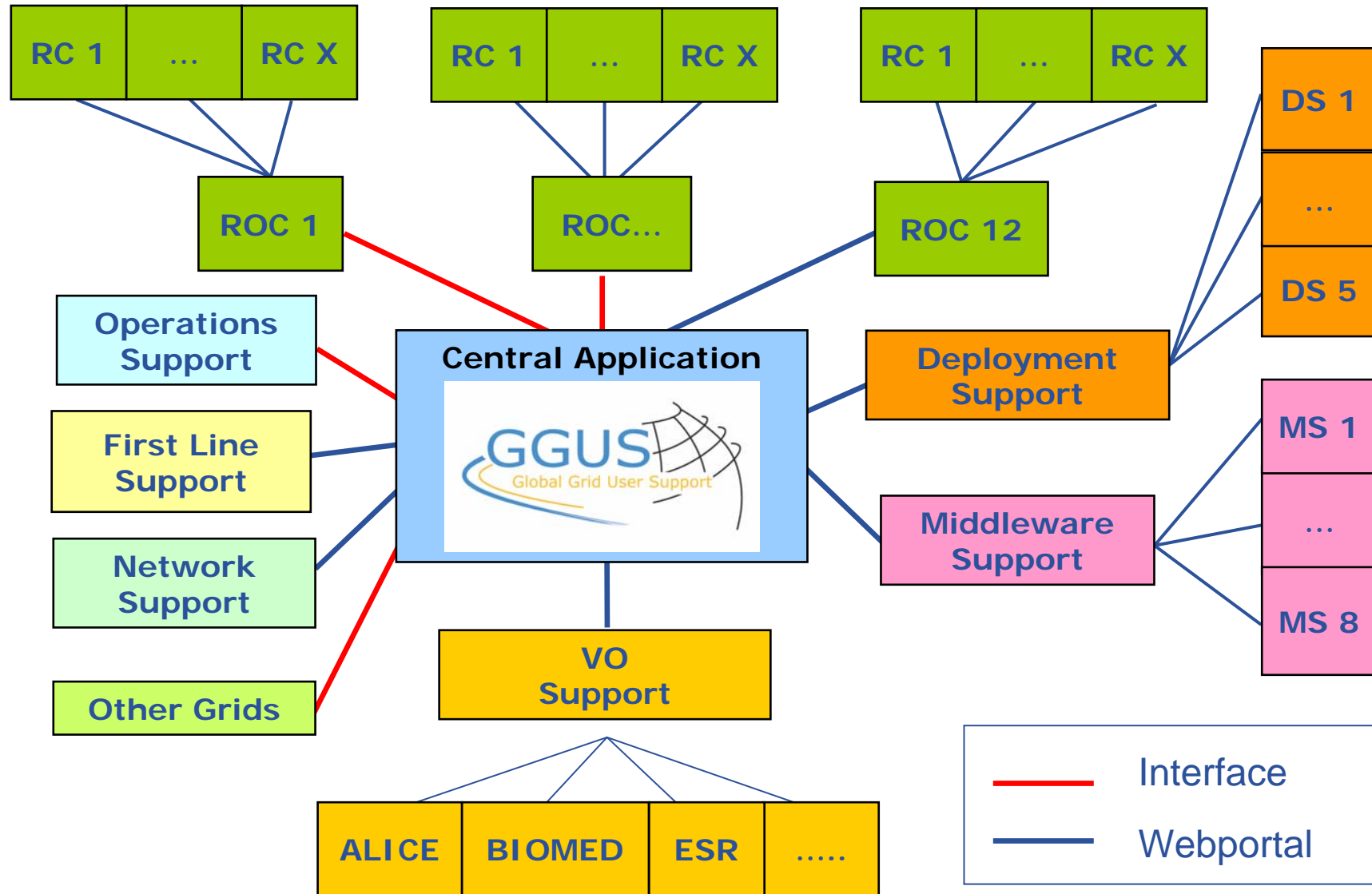
- Public and technical websites
  - Dissemination material
- constantly evolving to expand information and keep it up to date



- 4 **conferences** organized (~ 460 @ Pisa)

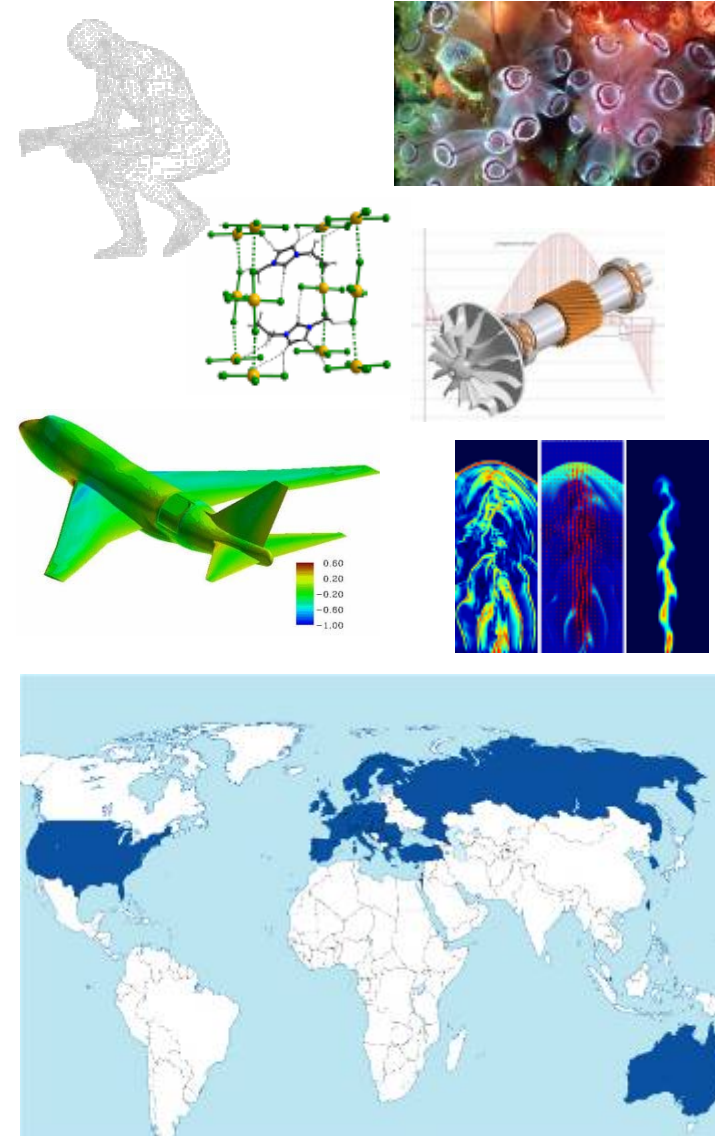


- Next conference: September 2006 in Geneva ~600 participants



# EGEE-II

- **EGEE-II proposal submitted to the EU**
  - On 8 September 2005
  - Start 1 April 2006
  
- **Natural continuation of EGEE**
  - Emphasis on providing an infrastructure for e-Science
    - increased support for applications
    - increased multidisciplinary Grid infrastructure
    - more involvement from Industry
  - Expanded consortium
    - > 90 partners in 32 countries (Non-European partners in USA, Korea and Taiwan)
    - related projects
  
- **world-wide Grid infrastructure**
- **increased international collaboration**



- **Aim of EGEE:**

*“to establish a seamless European Grid infrastructure for the support of the European Research Area (ERA)”*

- **Achievements of EGEE:**

- Exceeding almost all final goals
- Scope expanded beyond Europe

- **Transition EGEE → EGEE-II**

- EGEE conceived as first two years of four-year plan
- Services continuously available

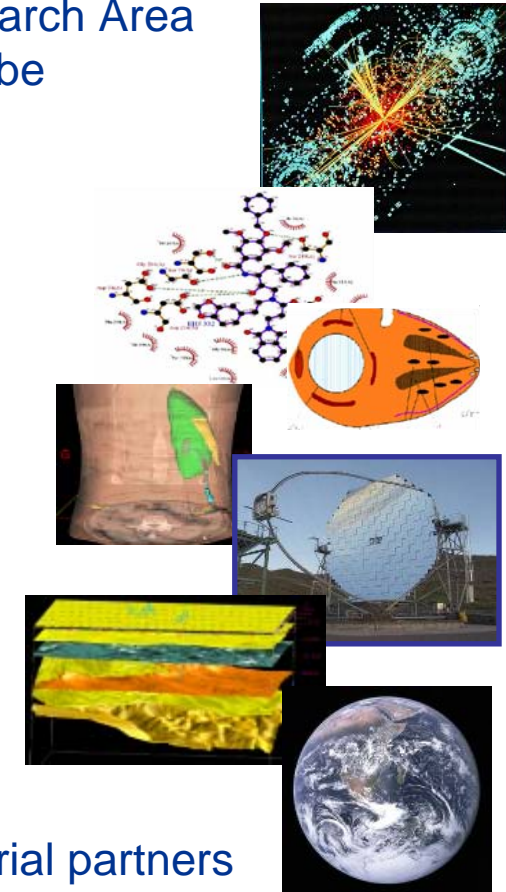


- **EGEE-II start:**

- Full capacity from day one
- Large-scale, production-quality infrastructure
- Supporting a wide range of applications
- Staff with extensive knowledge of Grid technology



- **Infrastructure**
  - Manage and operate production Grid for European Research Area
  - Interoperate with e-Infrastructure projects around the globe
  - Contribute to Grid standardisation efforts
  
- **Support applications from diverse communities**
  - High Energy Physics
  - Biomedicine
  - Earth Sciences
  - Astrophysics
  - Computational Chemistry
  - **Fusion**
  - Geophysics (incl. industrial application EGEODE)
  - Finance, Multimedia
  - ...
  
- **Industry**
  - Reinforce links with the full spectrum of interested industrial partners
  
- + Disseminate knowledge about the Grid through training
- + Prepare for sustainable European Grid Infrastructure

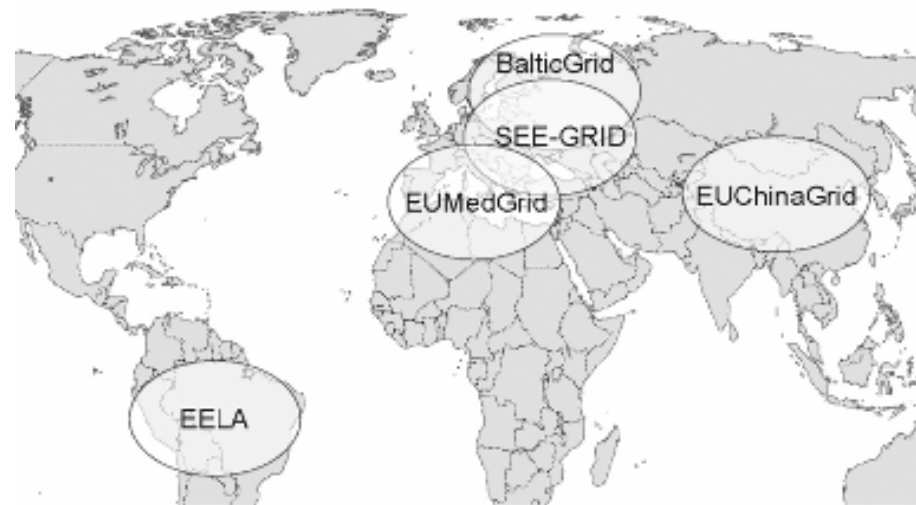


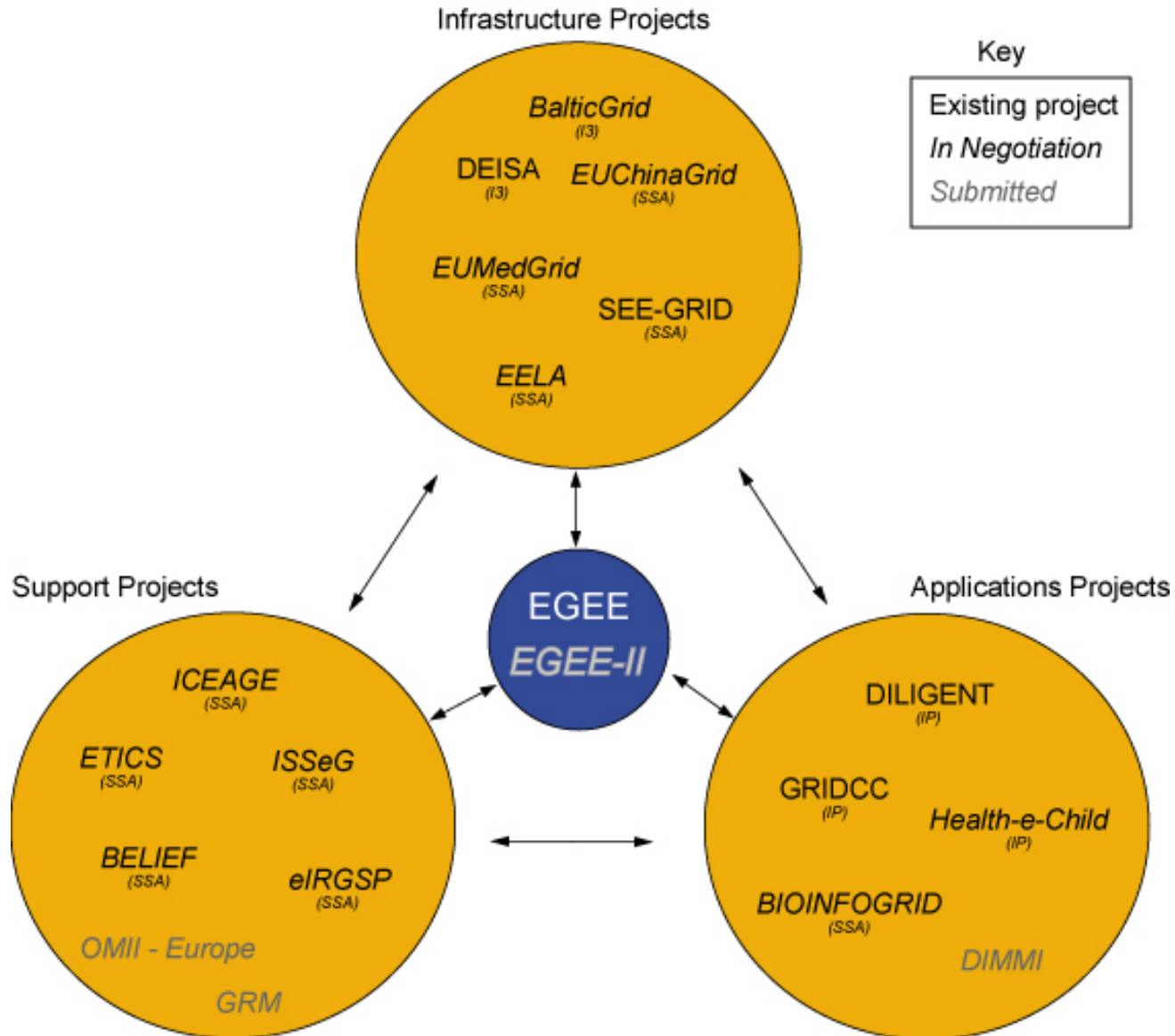
- More than 90 partners
- 32 countries
- 12 federations
- ➔ Major and national Grid projects in Europe, USA, Asia



**+ 27 countries through related projects:**

- BalticGrid
- SEE-GRID
- EUMedGrid
- EUChinaGrid
- EELA

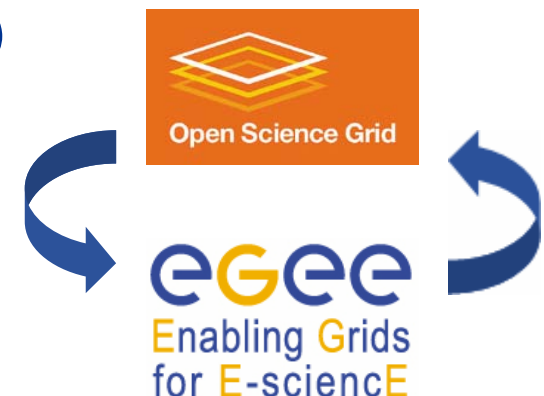






- **We currently see different flavors of Grids deployed worldwide**
  - Because of application needs, legacy constraints, funding, etc.
  - Diversity is essential to find best solutions for standardization
- **Grid computing standards are only being defined**
  - WS-\*, GGF, and others
  - A production infrastructure cannot be an early adopter of quickly changing standards
- **Many applications need to operate on more than one Grid infrastructure**
  - Pragmatic approach to interoperability is key
  - Provides valuable input to standardization process
- **EGEE is highly interested in interoperability**
  - Efforts ongoing with OSG, ARC, NAREGI, and others

- **Successful demonstration of cross job submission with Open Science Grid sites**
  - Works in both directions
  - Based on BDII, GIP (→ VDT)
  - Small changes to allow correct app environment to be set up
  - Sustainable – not just a one-off demonstration
- **Inter-operation**
  - Can we share operational oversight?
    - Gain more coverage (2 shifts/day)
  - Share monitoring tools and experience (SFT)
  - Common application environment tests
  - Strong interest from both sides
  - Follow up in operations workshops



- **EGEE-II started on April 1<sup>st</sup>**
  - Smooth transition to continuation project
  - Further support for more application domains
  - Increased number of partners from US and AP
  
- **Unified EGEE middleware distribution gLite 3.0 ready in Spring 2006**
  
- **Reinforce interoperability work**
  - Continue close collaborations with OSG
    - **Interoperation** aspect
    - Very interested in seeing common usage of both infrastructures going beyond HEP applications
    - Explore potential synergies in interoperability with supercomputing Grids (TeraGrid and DEISA)
    - Common usage and contributions to VDT very important
  - Multi-Grids interoperability
  
- **Work towards a long-term sustainable Grid infrastructure in Europe**

- **We have a window of opportunity to move grids from research to production, as networks did a few years ago**
- **Success will lead to the adoption of grid technology as the main computing infrastructure for science**
- **The work of EGEE and related grid projects will be critical in establishing multi-disciplinary production grids with a global scope**
- **Closer industrial involvement is actively sought**
- **If we succeed then the potential return to international scientific communities will be enormous and open the way for commercial and industrial applications**



- **EGEE Website**

<http://www.eu-egee.org>

- **How to join**

<http://public.eu-egee.org/join/>

- **EGEE Project Office**

[projectoffice@eu-egee.org](mailto:projectoffice@eu-egee.org)

