Enabling Grids for E-science in Europe

EGEE - An international computing Grid infrastructure

By Fabrizio Gagliardi
EGEE Project Director
CERN
Geneva
Switzerland

Outline

- Introduction to EGEE
- General status and plans
- The future of the EGEE Grid infrastructure

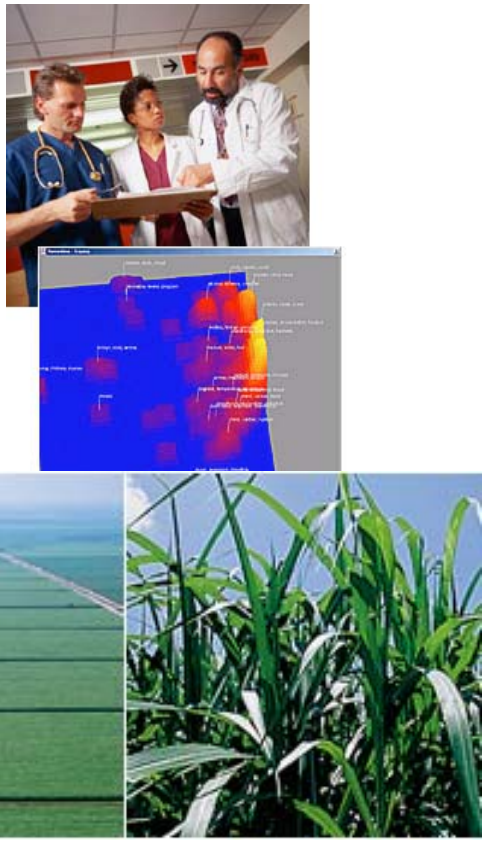
What is the Grid?

- The World Wide Web provides seamless access to information that is stored in many millions of different geographical locations
- In contrast, the Grid is a new computing infrastructure which provides seamless access to computing power and data distributed over the globe
- The name Grid is chosen by analogy with the electric power grid: plug-in to computing power without worrying where it comes from, like a toaster

What is driving grid development?

Data and compute intensive sciences are next generation applications that have extreme needs but are likely to become mainstream in the next 5 years

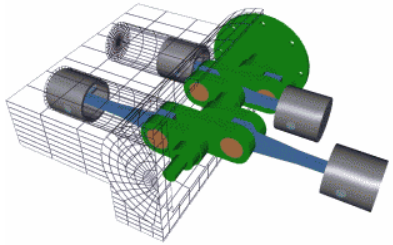
- Physics/Astronomy: data from different kinds of research instruments
- Medical/Healthcare: imaging, diagnosis and treatment
- Bioinformatics: study of the human genome and proteome to understand genetic diseases
- Nanotechnology: design of new materials from the molecular scale
- Engineering: design optimization, simulation, failure analysis and remote Instrument access and control
- Natural Resources and the Environment: weather forecasting, earth observation, modeling and prediction of complex systems: river floods and earthquake simulation



The Vision

- An international network of scientists will be able to model a new flood of the Danube in real time, using meteorological and geological data from several centers across Europe

- A team of engineering students will be able to run the latest 3D rendering programs from their laptops using the Grid.



- A geneticist at a conference, inspired by a talk she hears, will be able to launch a complex bio-molecular simulation from her mobile phone

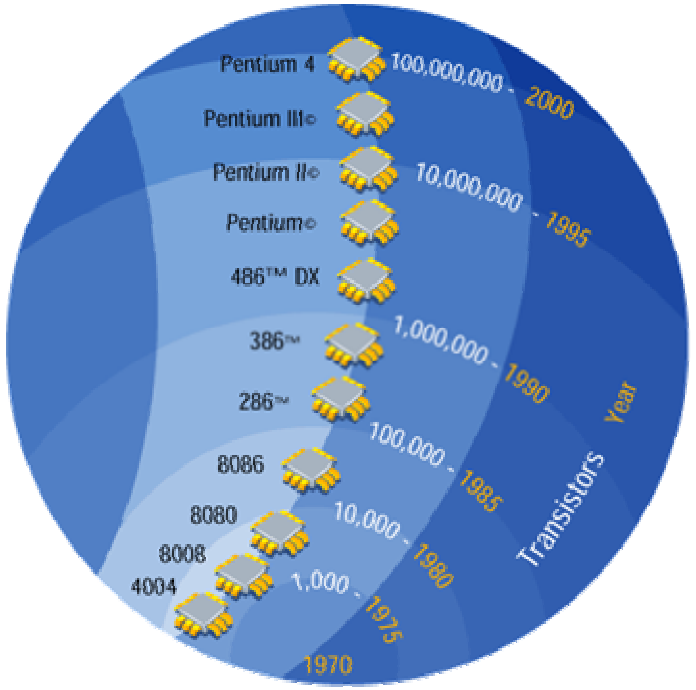
Access to a production quality GRID will change the way science and much else is done

How does the grid work?

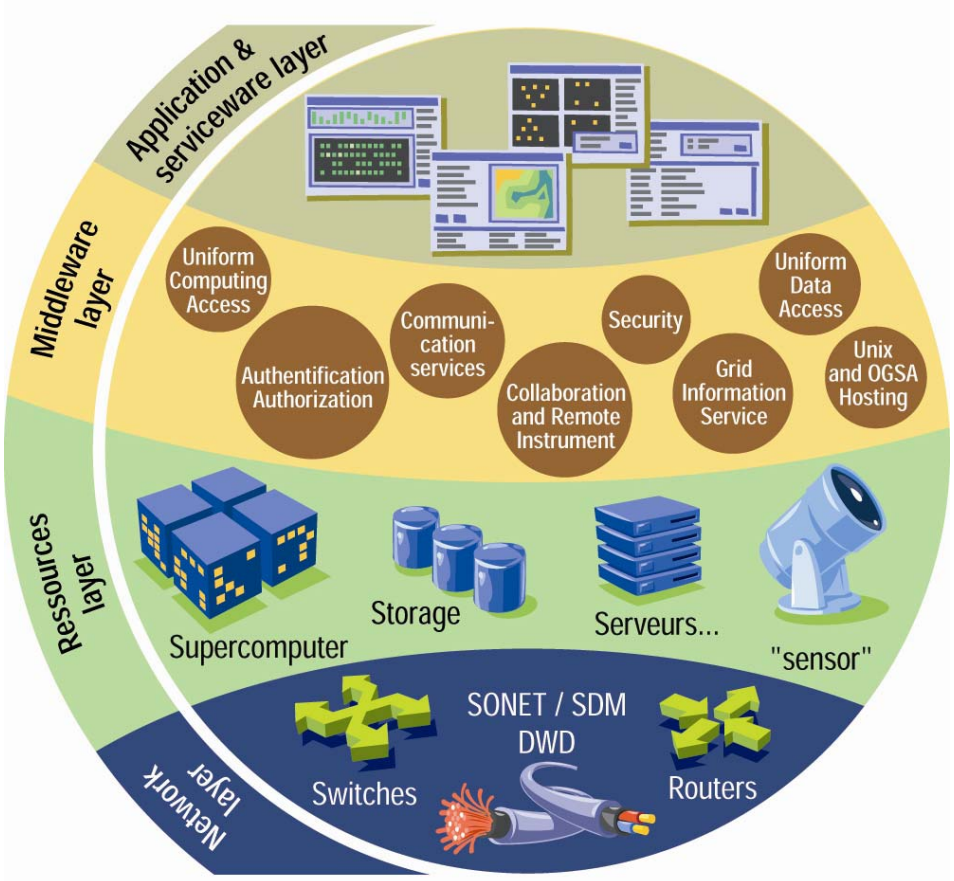
- The Grid relies on advanced software, called middleware, which ensures seamless communication between different computers and different parts of the world
- The Grid search engine not only finds the data the scientist needs, but also the data processing techniques and the computing power to carry them out
- It distributes the computing task to wherever in the world there is available capacity, and sends the result back to the scientist

The Grid: why now?

- Networking, commodity computing and distributed software tools are ripe for Grid technology
- Science more digital oriented and dominated by data
- Many public funded projects in the US and in the EU
- Also industrial and commercial Grids (see a good sample on the www.cern.ch/gridcafe portal and also www.gridstart.org)
- CERN networking land speed record: (6.25 Gb/sec over 11'000 Km) from California to CERN (10'000 times ADSL speed) < 10 sec to download a DVD



We are ready for a new computing paradigm !



What do we expect?

- The Grid will provide:
  - Access to a world-wide virtual computing laboratory with almost infinite resources
  - Possibility to organize distributed scientific communities in VOs
  - Transparent access to distributed data and easy workload management
  - Easy to use application interfaces

Introduction to EGEE - Content

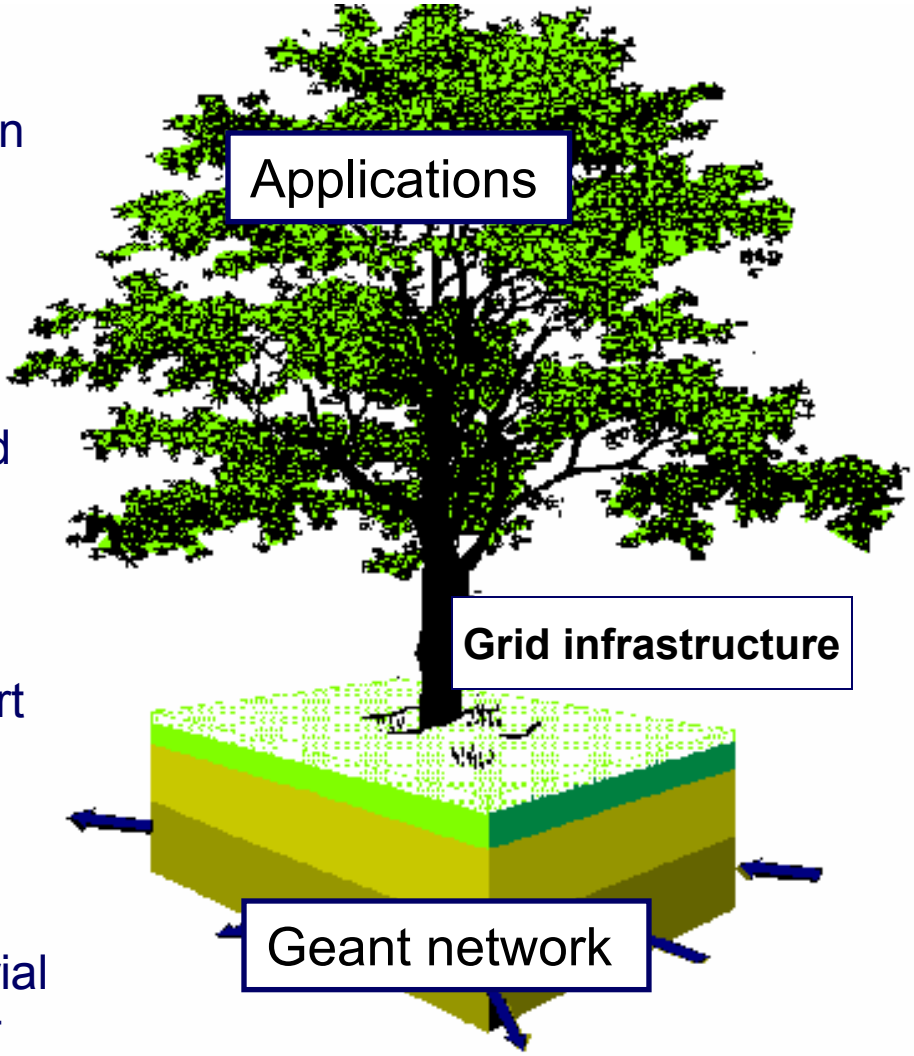
- EGEE - *what is it and why is it needed?*
- Grid operations – *providing a stable service*
- Grid middleware – *current and future*
- Networking activity – *pilot applications*
- Summary

The material of this talk has been contributed by several colleagues in the EGEE project

Despite its name EGEE is an International project involving in particular Israel, Russia and the US

EGEE Manifesto

- **Goal**
  - Create a wide European Grid production quality infrastructure on top of present and future EU RN infrastructure
- **Build On**
  - EU and EU member states major investments in Grid Technology
  - International connections (US and AP)
  - Several pioneering prototype results
  - Large Grid development teams in EU require major EU funding effort
- **Approach**
  - Leverage current and planned national and regional Grid programmes
  - Work closely with relevant industrial Grid developers, NRENs and US-AP projects



What is EGEE?

- 70 leading institutions in 27 countries, federated in regional Grids
- 32 M Euros EU funding (2004-5), O(100 M) total budget
- Aiming for a combined capacity of over 20’000 CPUs (the largest international Grid infrastructure ever assembled)
- ~ 300 dedicated staff

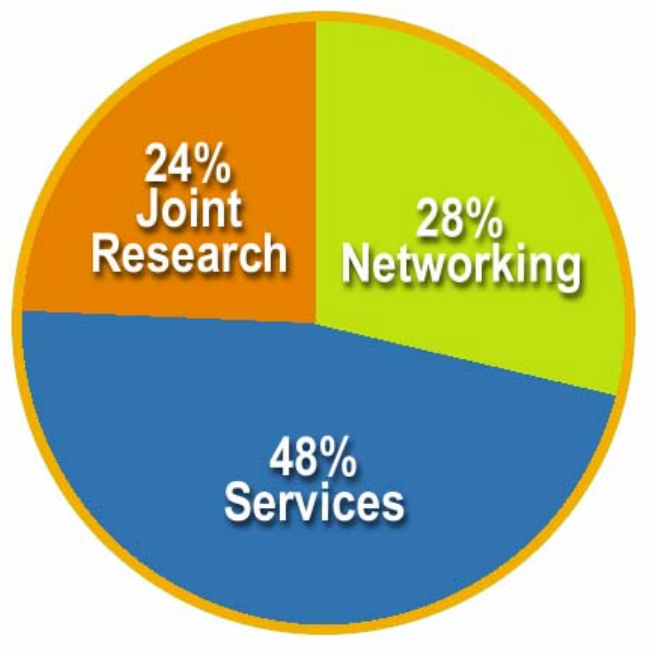
What will EGEE provide?

- Simplified access *(access to all the operational resources the user needs)*
- On demand computing *(fast access to resources by allocating them efficiently)*
- Pervasive access *(accessible from any geographic location)*
- Large scale resources *(of a scale that no single computer centre can provide*)
- Sharing of software and data *(in a transparent way)*
- Improved support *(use the expertise of all partners to offer in-depth support for all key applications)*

EGEE Activities

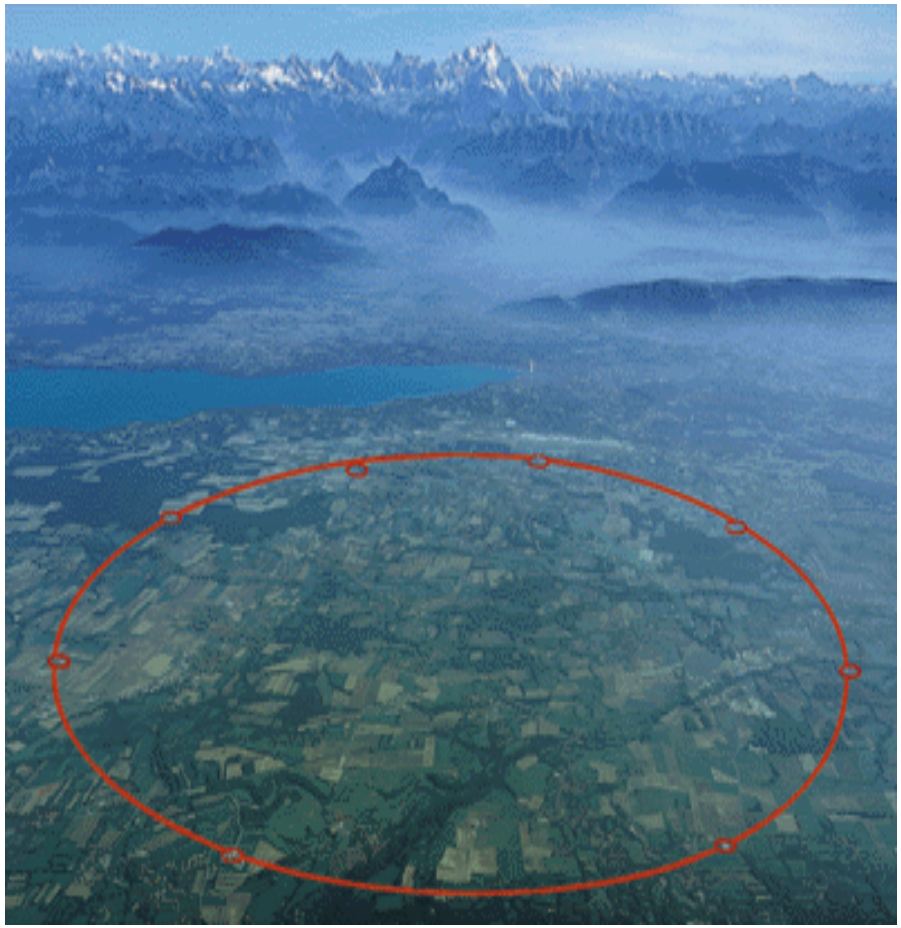
- Emphasis on operating a production grid and supporting the end-users

- **48 % service activities** (Grid Operations, Support and Management, Network Resource Provision)
- **24 % middleware re-engineering** (Quality Assurance, Security, Network Services Development)
- **28 % networking** (Management, Dissemination and Outreach, User Training and Education, Application Identification and Support, Policy and International Cooperation)



EGEE and LCG

- **EGEE builds on the work of LCG to establish a grid operations service**
- **LCG (LHC Computing Grid) - Building and operating the LHC Grid**
- A collaboration between:
  - The physicists and computing specialists from the LHC experiment
  - The projects in Europe and the US that have been developing Grid middleware
  - The regional and national computing centres that provide resources for LHC
  - The research networks



- **Mission:**
  - Prepare and deploy the computing environment that will be used by the experiments to analyse the LHC data
  - Started September 2001

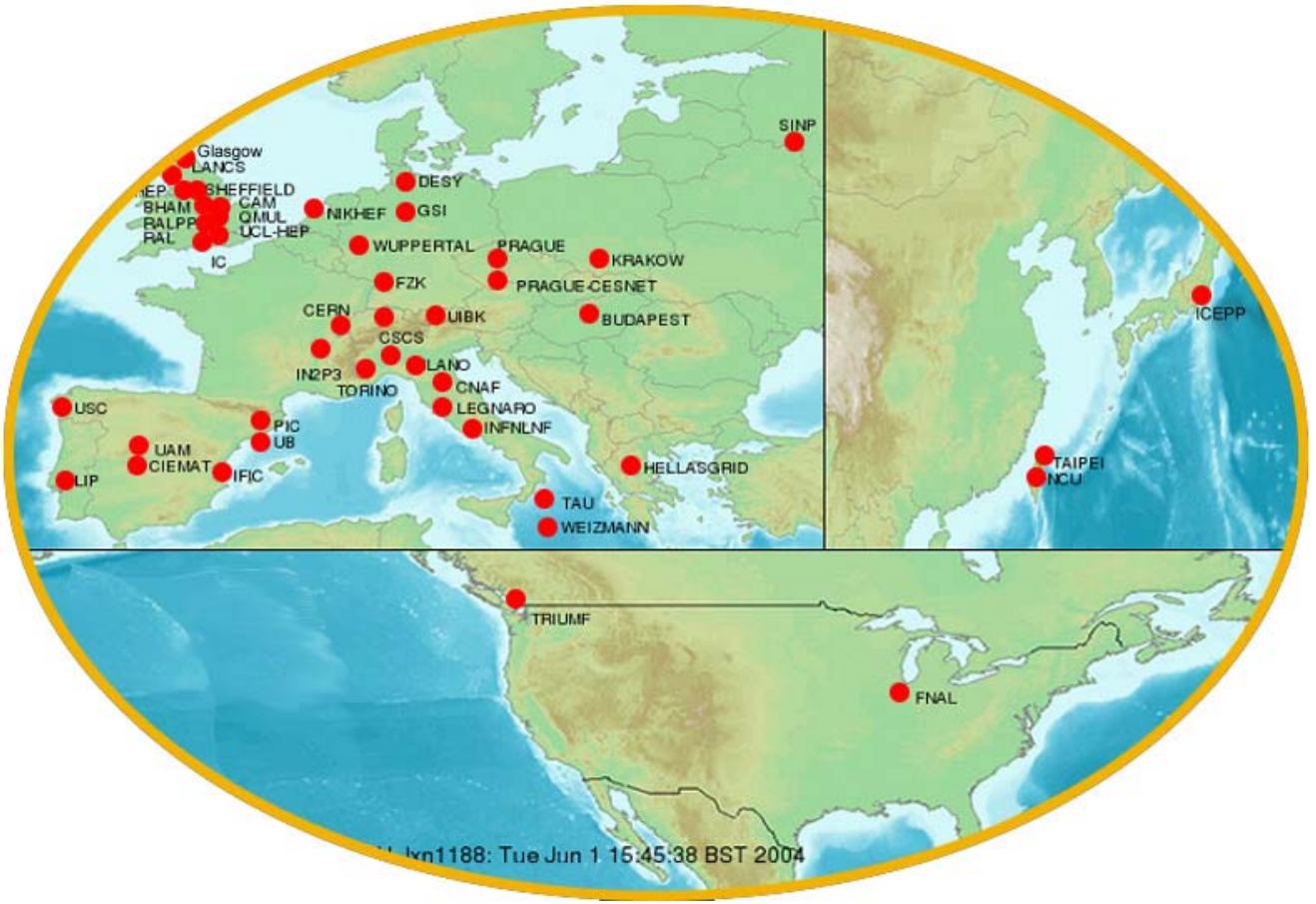
- **Strategy:**
  - Integrate thousands of computers at dozens of participating institutes worldwide into a global computing resource
  - Rely on software being developed in advanced grid technology projects, both in Europe and in the USA (EDG, VDT, others)

EGEE infrastructure

- Access to networking services provided by **GEANT** and the **NRENs**
- Production Service:
  - in place (based on HEP LCG-2)
  - for production applications
  - MUST run reliably, runs only proven stable, debugged middleware and services
  - Will continue adding new sites in EGEE federations
- Pre-production Service:
  - For middleware re-engineering
- Certification and Training/Demo testbeds

LCG-2/EGEE-0 (I)

- Based on HEP-LCG testbed: more than 60 sites worldwide (+ few non-HEP)



LCG-2/EGEE-0 (II)

Regional Centres Connected to the LCG Grid

07-May-04

country	*centre*	*country*	*centre*
Austria	**UIBK**	**Portugal**	**LIP, Lisbon**
Canada	**TRIUMF, Vancouver**	**Russia**	**SINP, Moscow**
	Univ. Montreal	**Spain**	**PIC, Barcelona**
	Univ. Alberta		**IFIC, Valencia**
Czech Republic	**CESNET, Prague**		**IFCA, Santander**
	University of Prague		**University of Barcelona**
France	IN2P3, Lyon**		**Uni. Santiago de Compostela**
Germany	**FZK, Karlsruhe**		**CIEMAT, Madrid**
	DESY		**UAM, Madrid**
	University of Aachen	**Switzerland**	**CERN**
	University of Wuppertal		CSCS, Manno**
Greece	**GRNET, Athens**	**Taiwan**	**Academia Sinica, Taipei**
Holland	**NIKHEF, Amsterdam**		**NCU, Taipei**
Hungary	**KFKI, Budapest**	**UK**	**RAL**
Israel	Tel Aviv University**		**Cavendish, Cambridge**
	Weizmann Institute		**Imperial, London**
Italy	**CNAF, Bologna**		**Lancaster University**
	INFN, Torino		**Manchester University**
	INFN, Milano		**Sheffield University**
	INFN, Roma		**QMUL, London**
	INFN, Legnaro	**USA**	**FNAL**
Japan	ICEPP, Tokyo**		BNL**
Poland	**Cyfronet, Krakow**		

** not yet in LCG-2

Centres in process of being connected

country	*centre*
China	**IHEP, Beijing**
India	**TIFR, Mumbai**
Pakistan	**NCP, Islamabad**

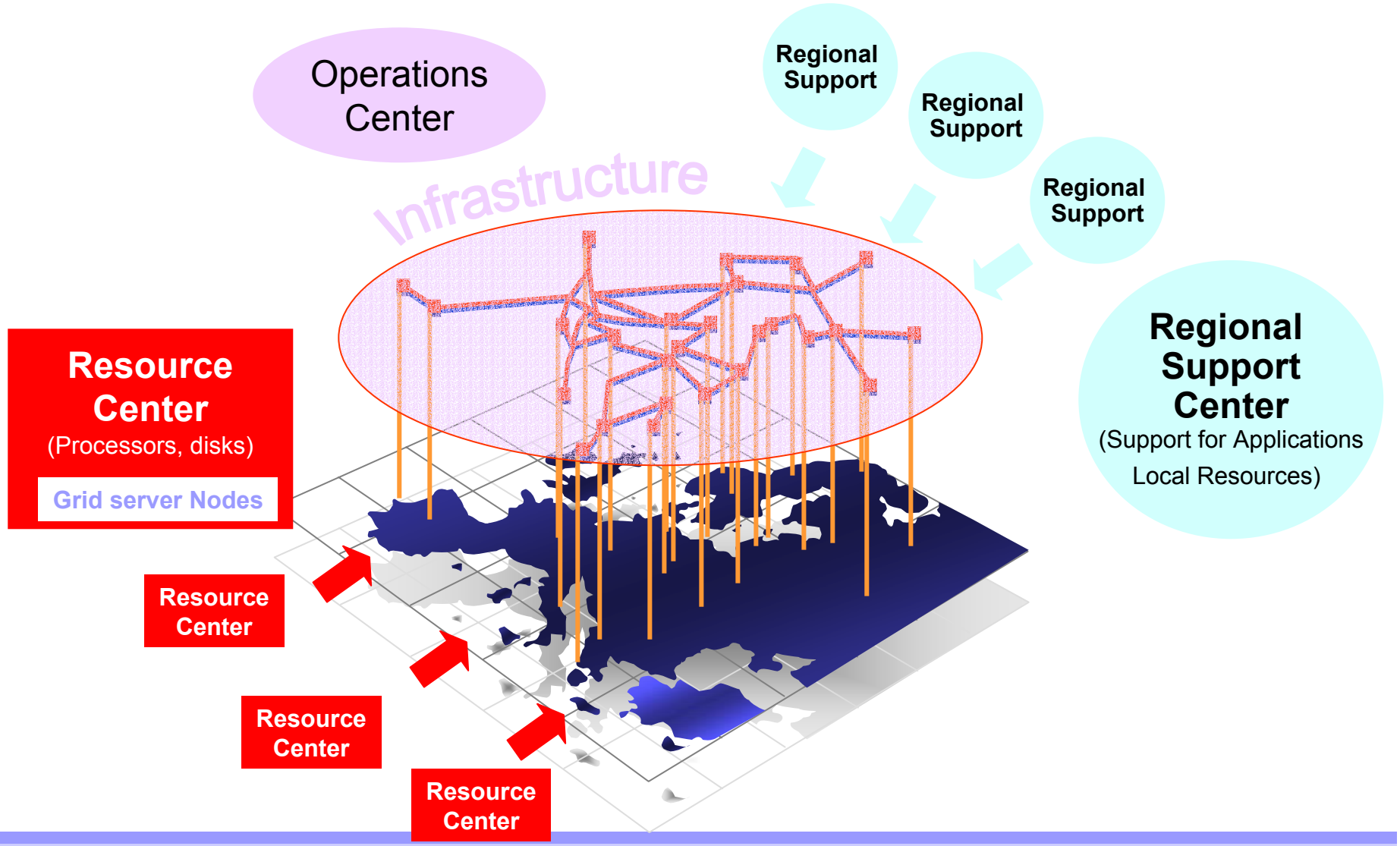
Hewlett Packard to provide "Tier 2-like" services for LCG, initially in Puerto Rico

EGEE Computing Resources

Resource Centers foreseen in TA

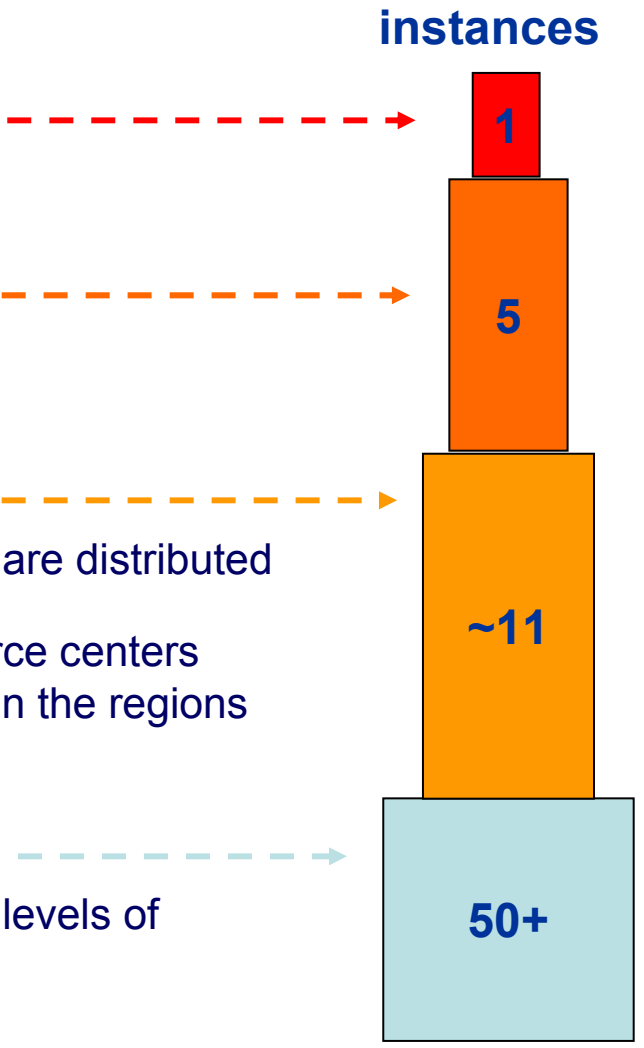
	April 2004: 10 sites		July 2005: 20 sites	
Region	CPU nodes	Disk (TB)	CPU Nodes	Disk (TB)
CERN	900	140	1800	310
UK + Ireland	100	25	2200	300
France	400	15	895	50
Italy	553	60.6	679	67.2
North	200	20	2000	50
South West	250	10	250	10
Germany + Switzerland	100	2	400	67
South East	146	7	322	14
Central Europe	385	15	730	32
Russia	50	7	152	36
Totals	**3084**	**302**	**8768**	**936**

EGEE Operations



Operations Structure

- Clear layered structure
  - Operations Management Centre (CERN)
    - Overall grid operations coordination
  - Core Infrastructure Centers (CIC)
    - CERN, France, Italy, UK, Russia (from M12)
    - Operate core grid services
  - Regional Operations Centers (ROC)
    - One in each federation, in some cases these are distributed centers
    - Provide front-line support to users and resource centers
    - Support new resource centers joining EGEE in the regions
    - Support deployment to the resource centers
  - Resource Centers
    - Many in each federation of varying sizes and levels of service
    - Not funded by EGEE directly



EGEE Operations (I): OMC and CIC

- Operation Management Centre
  - located at CERN, coordinates operations and management
  - coordinates with other grid projects
- Core Infrastructure Centres
  - behave as single organisations
  - operate core services (VO specific and general Grid services)
  - develop new management tools
  - provide support to the Regional Operations Centres

EGEE Operations (II): ROC

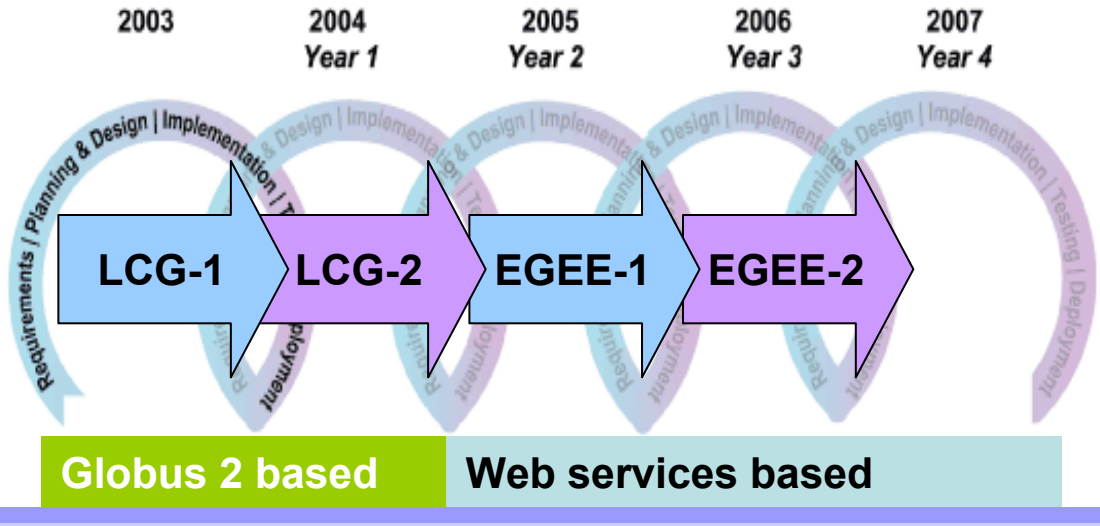
- Regional Operations Centre responsibilities and roles:
  - Testing (certification) of new middleware on a variety of platforms before deployment
  - Deployment of middleware releases + coordination + distribution inside the region
  - integration of ‘Local’ VO
  - Development of procedures and capabilities to operate the resources
  - First-line user support
  - Bring new resources into the infrastructure and support their operation
  - Coordination of integration of national grid infrastructures Provide resources for pre-production service

Deployment Issues

- **Need to expand on existing LCG service while maintaining stability**
  - Add more sites/resources (some have no previous experience with grids)
    - Experience has shown that this can be effort consuming
    - Problematic sites have been causing problems for the whole system
  - Introduce applications and VOs from non-HEP (Bio-medical)
    - Need to clarify processes and information flow
- **Portability**
  - Support for further platforms (currently just RedHat 7.3)
  - Middleware dependencies and packaging
- Middleware Support
  - Deterministic Support Model has been formalized
  - Essential to have (so far excellent) VDT support for Condor/Globus
- **"24x7" operational support**
  - Currently have GOC at RAL http://goc.grid-support.ac.uk/
  - Being replicated at Taipei (and maybe Canada?)
  - Prototype accounting system (based on R-GMA) ready for the release in April 2004 (testing, documentation and packaging done)

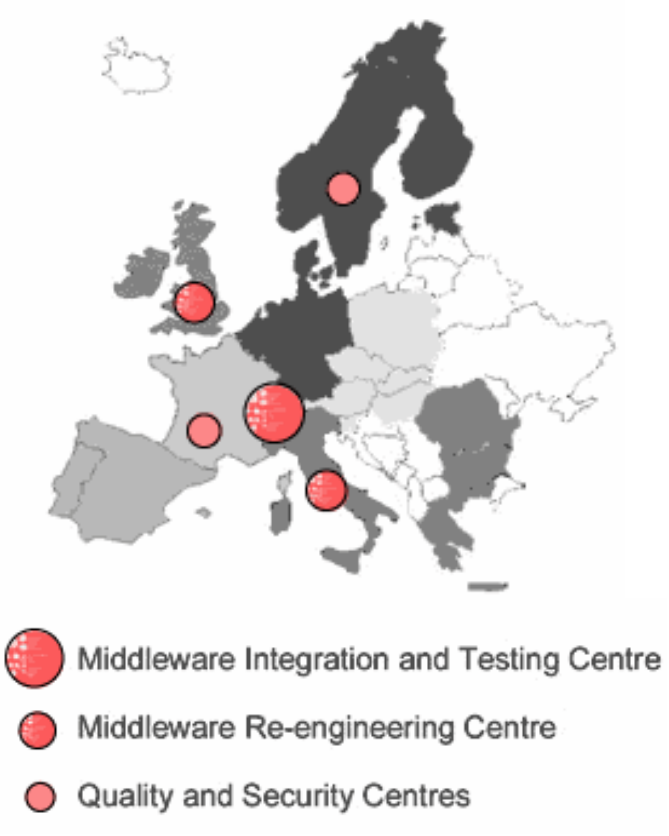
EGEE Implementation

- **From day 1 (1st April 2004)**
  - Production grid service based on the LCG infrastructure running LCG-2 grid middleware (SA)
  - LCG-2 will be maintained until the new generation has proven itself (fallback solution)
- **In parallel develop a "next generation" grid facility**
  - Produce a new set of grid services according to evolving standards (Web Services)
  - Run a development service providing early access for evaluation purposes
  - Will replace LCG-2 on production facility in 2005



EGEE Middleware Activity

- Middleware selected based on requirements of Applications and Operations
- Harden and re-engineer existing middleware functionality, leveraging the experience of partners
- Provide robust, supportable components
- Support components evolution towards a service oriented approach (Web Services)



EGEE Middleware: gLite

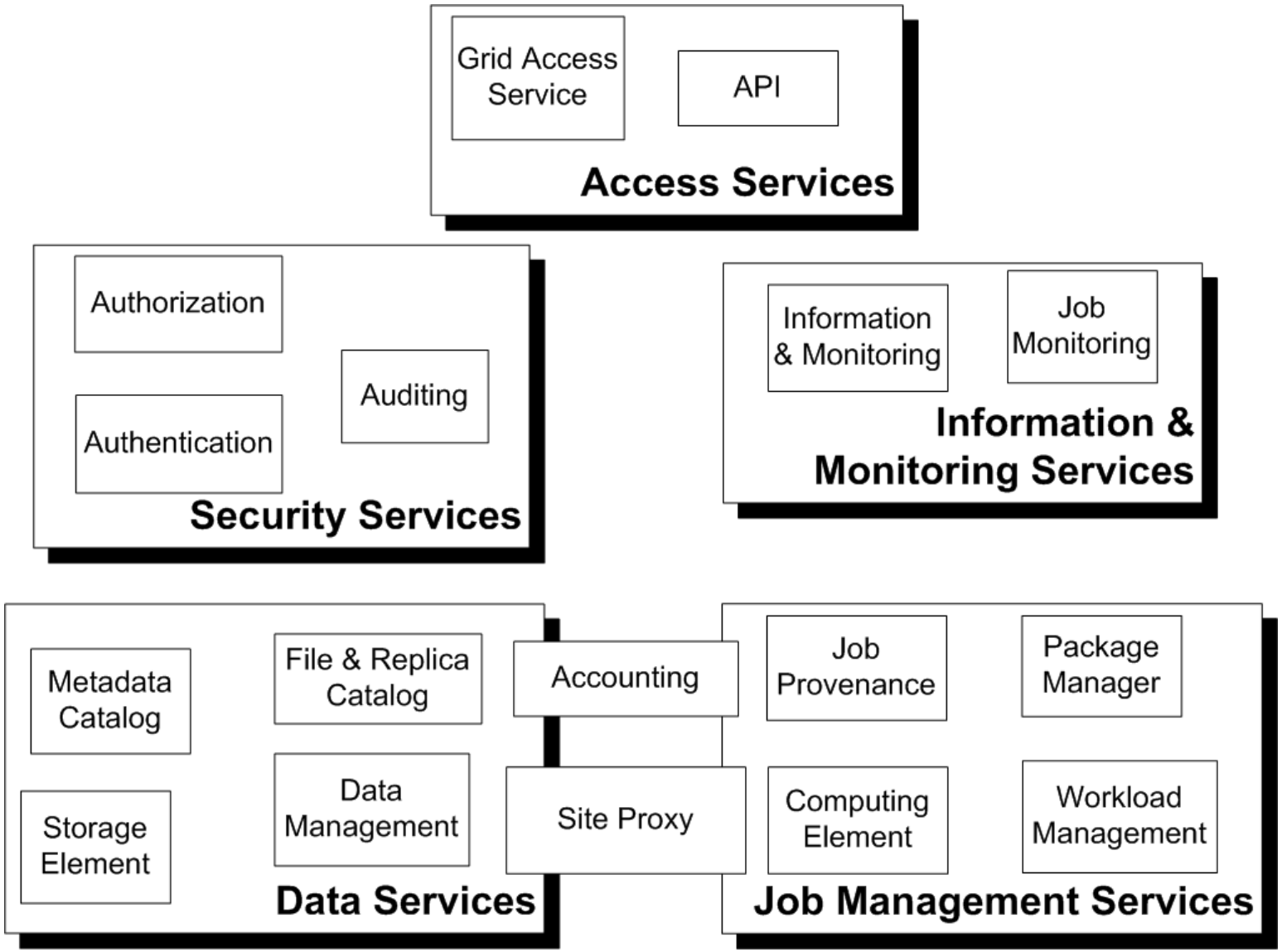
- **gLite**
  - Exploit experience and existing components from VDT (CondorG, Globus), EDG/LCG, AliEn, and others
  - Develop a lightweight stack of generic middleware useful to EGEE applications (HEP and Biomedics are pilot applications).
    - Should eventually deploy dynamically (e.g. as a globus job)
    - Pluggable components – cater for different implementations
  - Focus is on re-engineering and hardening
  - Early prototype and fast feedback turnaround envisaged

Middleware Characteristics

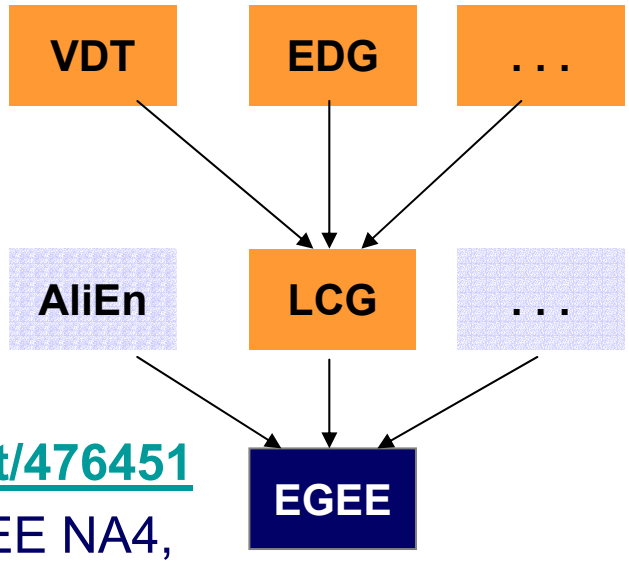
- Co-existence with deployed infrastructure
  - Co-existence (and convergence) with LCG-2 and Grid3 are essential for the EGEE Grid service, this will be achieved by
    - Main services will run as an application (e.g. on LCG-2; Grid3)
    - Reduce requirements on site specific infrastructure
      - *Basically globus and SRM*
- Interoperability
  - Allow for multiple service implementations
- Use a service oriented approach
  - Services are a useful abstraction, allow for interoperability and pluggability
  - Standards are emerging (WSRF)
  - No mature WSRF implementations exist to date, hence we start with plain Web Services – WSRF compliance is not an immediate goal, but the WSRF evolution will be followed and eventually adopted
    - Web Services are Widely used in industry, Grid projects, Internet computing (Google, Amazon)
  - WS-I compliance is important

Exploit established standards where possible
Contribute to standardization efforts (e.g. GGF)

High Level Service Decomposition



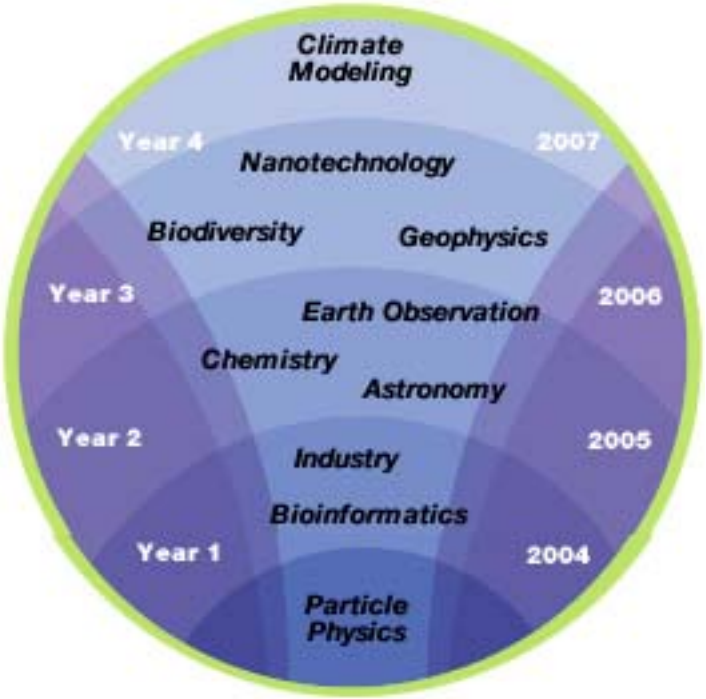
Implementation Approach



- Exploit experience and components from existing projects
  - AliEn, VDT, EDG, LCG, and others
- Design team works out architecture and design
  - Architecture: **https://edms.cern.ch/document/476451**
  - Feedback and guidance from EGEE PTF, EGEE NA4, LCG GAG, LCG Operations, LCG ARDA
- Components are initially deployed on a prototype infrastructure
  - Small scale (CERN & Univ. Wisconsin)
  - Get user feedback on service semantics and interfaces
- After internal integration and testing components are delivered to SA1 and deployed on the pre-production service

EGEE Applications

- EGEE Scope : ALL-Inclusive for academic applications (open to industrial and socio-economic world as well)
- The major success criterion of EGEE: how many satisfied users from how many different domains ?
- 5000 users (3000 after year 2) from at least 5 disciplines
- Two pilot applications selected to guide the implementation and certify the performance and functionality of the evolving infrastructure: Physics & Bioinformatics



Application domains and timelines are for illustration only

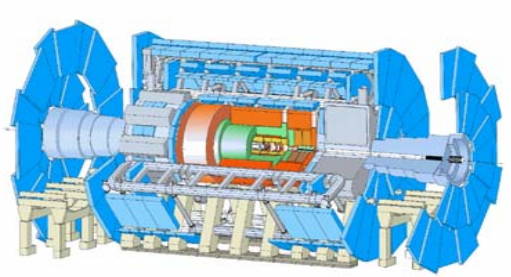
EGEE pilot application: HEP

- **HEP**
  - Running large distributed computing systems for many years
  - Focus for the future is on computing fo LHC (LCG)
  - The 4 LHC experiments and other current HEP experiments use grid technology e.g. Babar,CDF,D0..,
  - LHC experiments are currently executing large scale data challenges(DCs) involving thousands of processors world-wide and generating many Terabytes of data
  - Moving to so-called 'chaotic' use of gri with individual user analysis (thousands of users interactively operating within experiment VOs)

LHC experiments

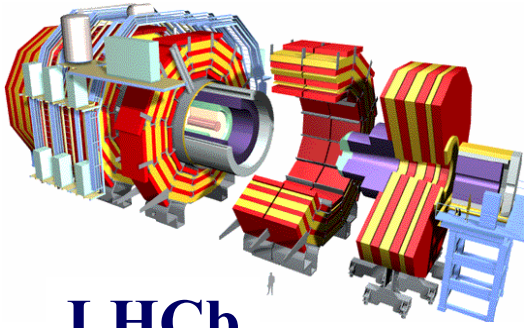
- **Storage**
  - Raw recording rate 0.1 – 1 GByte/s
  - Accumulating at 5-8 PetaByte/year
  - 10 PetaByte of disk

ATLAS



CMS

- **Processing**
  - 200,000 of today's fastest PCs



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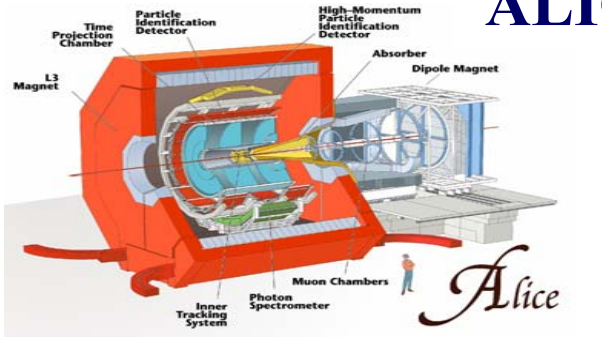
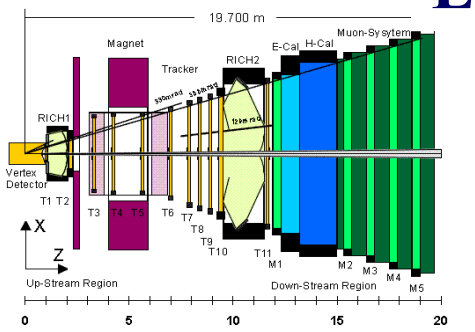


LHCb



LHC computing model (I)

Tier-0 – the accelerator centre

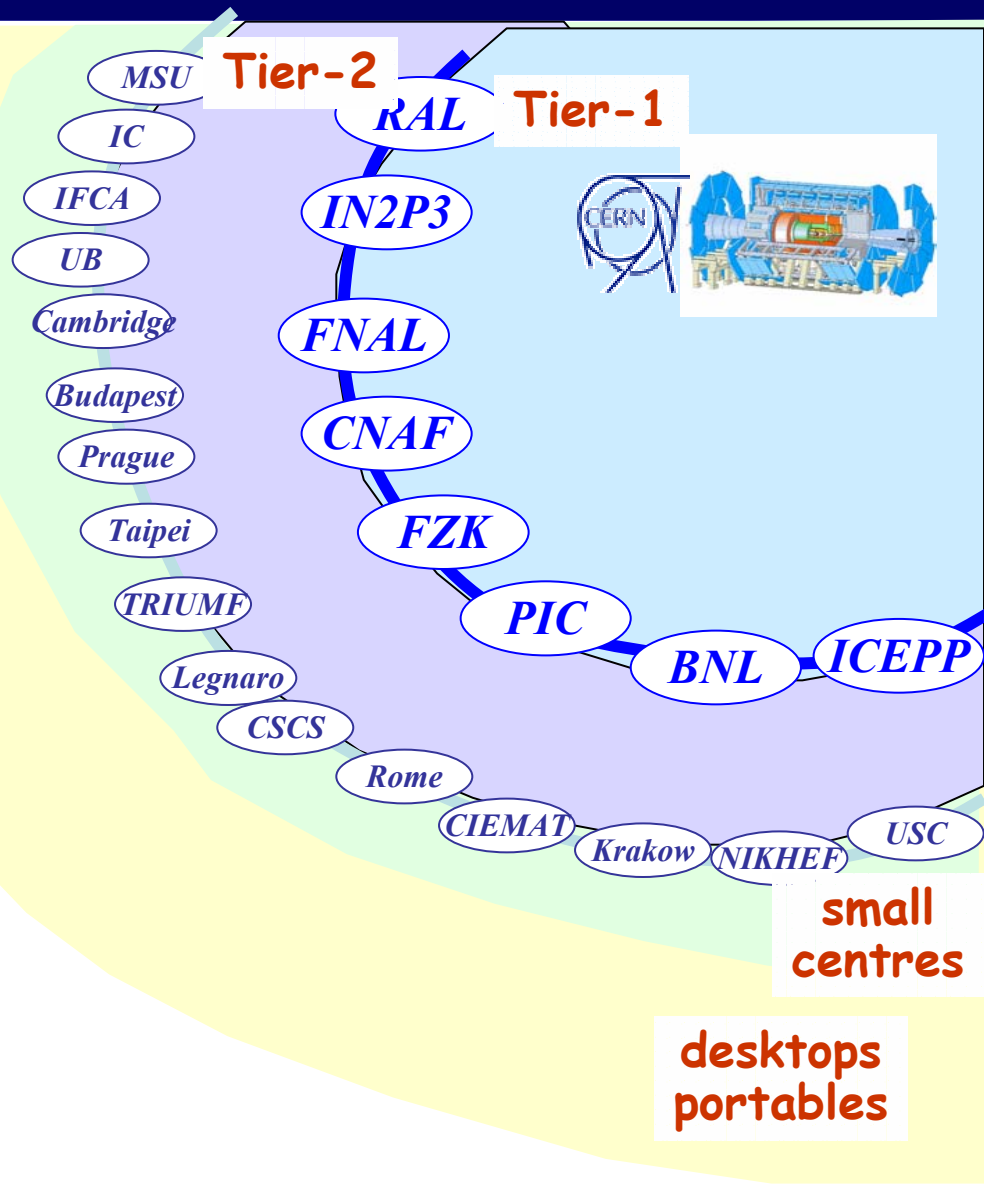
- Filter → *raw data*
- Reconstruction → *summary data* (ESD)
- Record *raw data* and *ESD*
- Distribute *raw* and *ESD* to Tier-1

Tier-1

- Permanent storage and **management** of *raw*, *ESD*, calibration data, meta-data, analysis data and databases
  → **grid-enabled data service**
- Data-heavy analysis
- Re-processing raw → ESD
- National, regional support

Tier-2

- Well-managed disk storage – grid-enabled
- Simulation
- End-user analysis – batch and interactive
- High performance parallel analysis (PROOF)



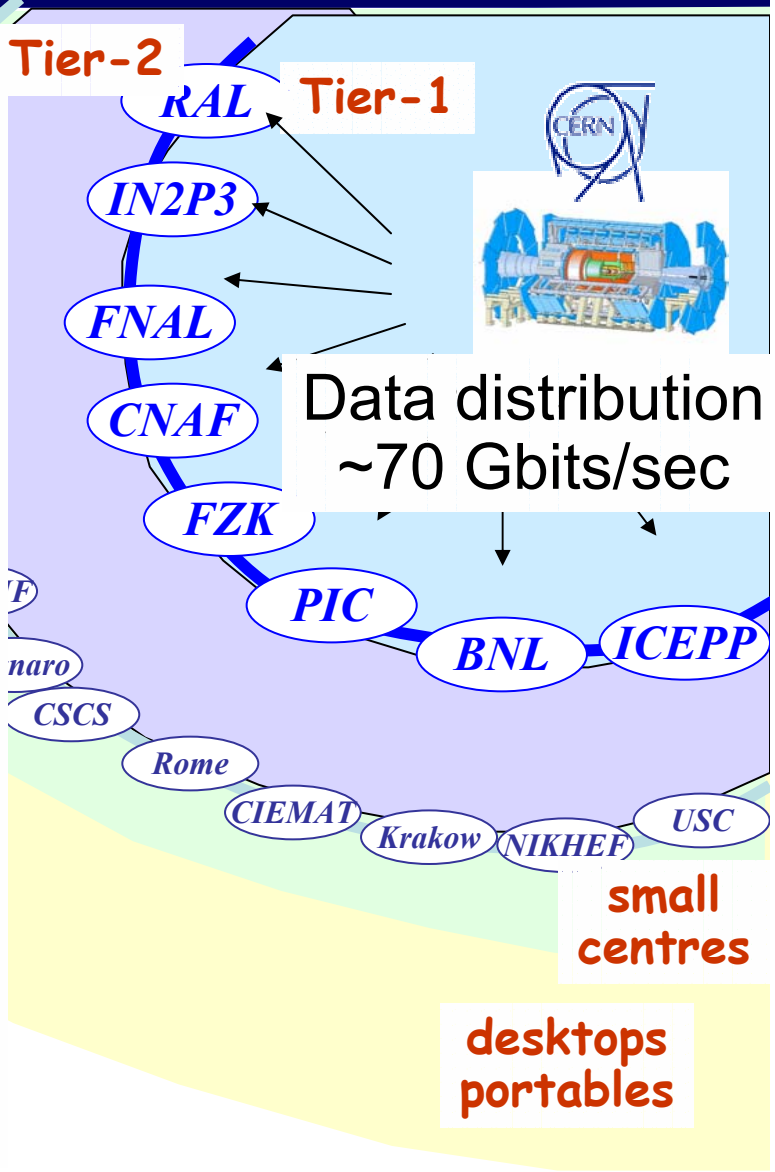
LHC computing model (II)

Current estimates of Computing Resources needed at Major LHC Centres

First full year of data - 2008

	*Processing M SI2000***	*Disk PetaBytes*	*Mass Storage PetaBytes*
CERN	20	5	20
Major data handling centres (Tier 1)	45	20	18
Other large centres (Tier 2)	40	12	5
Totals	**105**	**37**	**43**

*** Current fast processor ~1K SI2000*



CMS Data Challenge

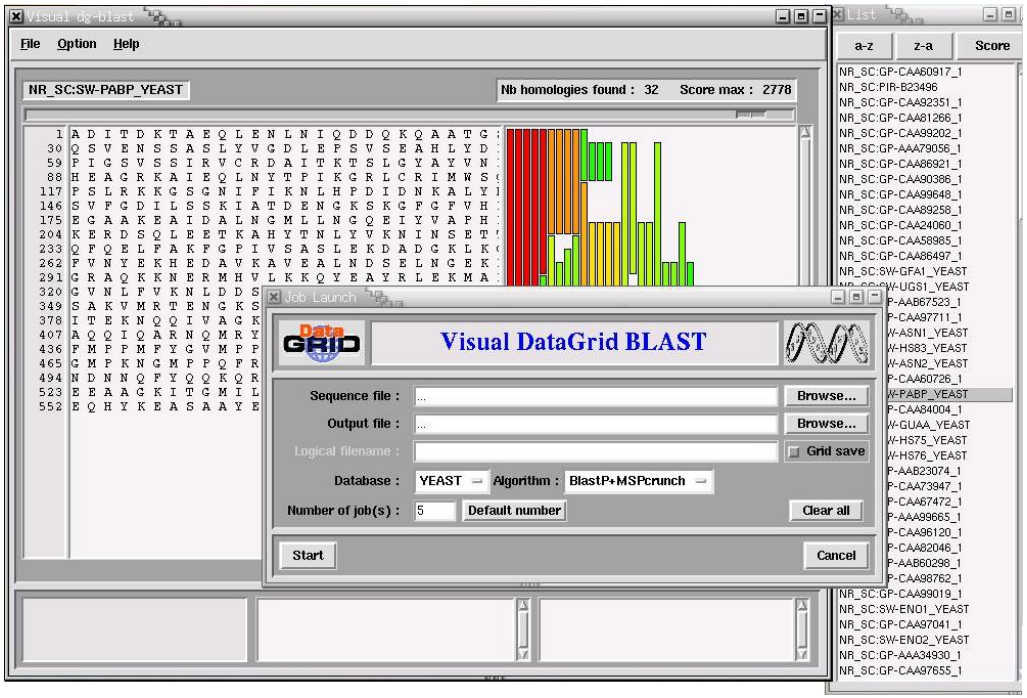
- Characteristics of CMS Data Challenge DC04 (just completed)……run with LCG-2 and CMS resources world-wide (US Grid3 was a major component)
- Pre-Challenge Production (Phase 1) – simulation generation and digitisation
  - After 8 months of continuous running:
    - 750,000 jobs
    - 3,500 KSI2000 months
    - 700,000 files
    - 80 TB of data
- Data Challenge (Phase 2)
  - Ran the full data reconstruction and distribution chain at 25 Hz
  - Achieved
    - 2,200 jobs/day (about 500 CPU's) running at Tier-0
    - Total 45,000 jobs Tier-0 and 1
    - 0.4 files/s registered to RLS (with POOL metadata)
    - Total 570,000 files registered to RLS
    - 4 MB/s produced and distributed to each Tier-1

EGEE pilot application: Biomedics

- Biomedics
  - Bioinformatics (gene/proteome databases distributions)
  - Medical applications (screening, epidemiology, image databases distribution, etc.)
  - Interactive application (human supervision or simulation)
  - Security/privacy constraints
    - Heterogeneous data formats - Frequent data updates - Complex data sets - Long term archiving
- BioMed applications deployed and expect to run first job on LCG-2 by September

BLAST – comparing DNA or protein sequences

- BLAST is the first step for analysing new sequences: to compare DNA or protein sequences to other ones stored in personal or public databases. Ideal as a grid application.
  - Requires resources to store databases and run algorithms
  - Can compare one or several sequence against a database in parallel
  - Large user community



Generic Application Support

- Getting new scientific and industrial communities interested and committed to use the grid infrastructure built by EGEE is key to the success of the project

- Questionnaire to get information and first requirements from new communities interested in using the EGEE Infrastructure (http://alipc1.ct.infn.it/grid/egee/na4/questionnaire/na4-genapp-questionnaire.doc)
- Feed-backs received so far (http://alipc1.ct.infn.it/grid/egee/na4/questionnaire):
  - Astrophysics (EVO and Planck satellite)
  - Earth Observation (ozone maps, seismology, climate)
  - Digital Libraries (DILIGENT Project)
  - Grid Search Engines (GRACE Project)
  - Industrial applications (SIMDAT Project)

- Interest also from Computational Chemistry (Italy and Czech Republic), Civil Engineering (Spain), and Geophysics (Switzerland and France) communities

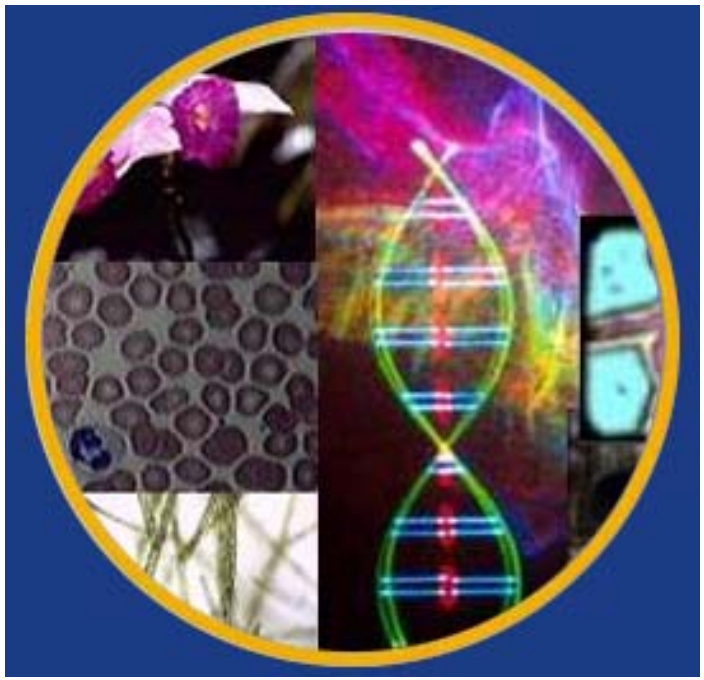
How to access EGEE (I)

0) Review information provided on the EGEE website (www.eu-egee.org)

1) Establish contact with the EGEE applications group lead by Vincent Breton (breton@clermont.in2p3.fr)

2) Provide information by completing a questionnaire describing your application

3) Applications selected based on scientific criteria, Grid added value, effort involved in deployment, resources consumed/contributed etc.



How to access EGEE (II)

4) Follow a training session

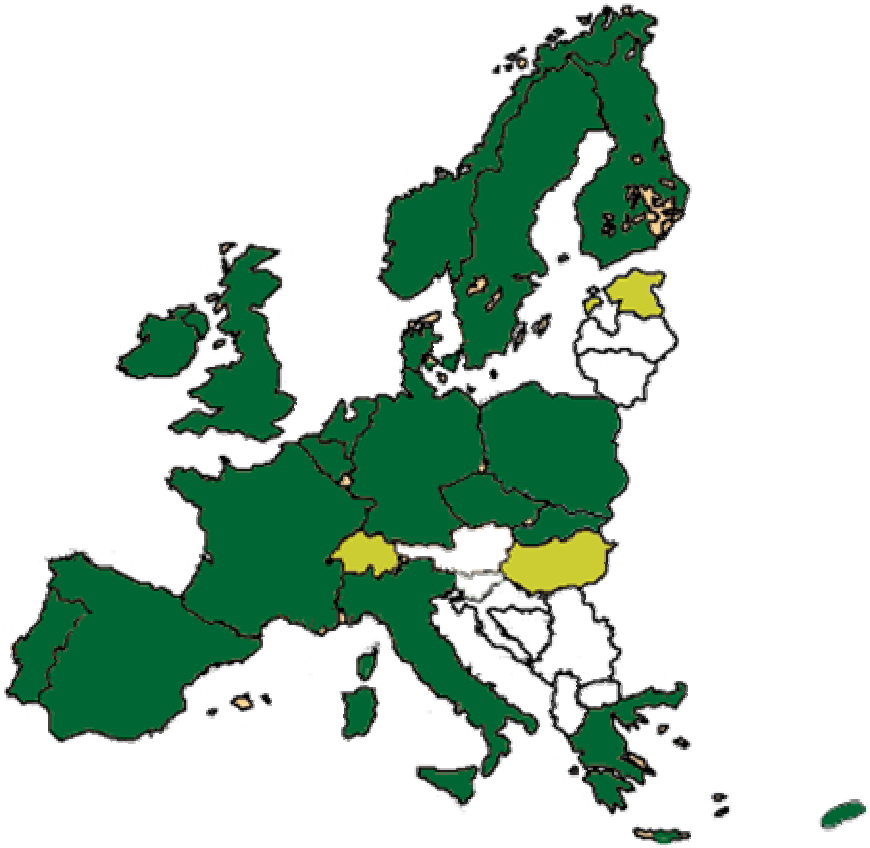
5) Migrate application to EGEE infrastructure with the support of EGEE BMI technical experts

6) Initial deployment for testing purposes

7) Production usage (contribute computing resources for heavy production demands)

How to access EGEE (III)

- Where to go for an accredited certificate?
- Everyone (almost) in Europe has a national CA



- Green: CA Accredited
- Yellow: being discussed

Other Accredited CAs:

- DoEGrids (US)
- GridCanada
- ASCCG (Taiwan)
- ArmeSFO (Armenia)
- CERN
- Russia (*HEP*)
- FNAL Service CA (US)
- Israel
- Pakistan

Joining EGEE – Overview of process

- Application nominates VO manager
- Find (CIC) to operate VO server
- VO is added to registration procedure
- Determine access policy:
  - Propose discussion (body) NA4 + ROC manager group
    - Which sites will accept to run app (funding, political constraints)
    - Need for a test VO?
- Modify site configs to allow the VO access
- Negotiate CICs to run VO-specific services:
  - VO server (see above)
  - RLS service if required
  - Resource Brokers (can be some general at CIC and others owned by apps), UIs – general at CIC/ROC – or on apps machines etc
  - Potentially (if needed) BDII to define apps view of resources
- Application software installation
  - Understand application environment, and how installed at sites
- Many of these issues can be negotiated by NA4/SA1 in a short discussion with the new apps community

User training and induction

- Training material and courses from introductory to advanced level
- Train a wide variety of users both internal to the EGEE consortium and from external groups from across Europe
- 7 courses/presentations already held and 5 more planned through July
- Experience with GENIUS portal and GILDA testbed (provided by INFN)
- Courses inline with the needs of the projects and applications

Dissemination

- 1st project conference
  - Over 300 delegates came to the 4 day event during April in Cork Ireland
  - Kick-off meeting bringing together representatives from the 70 partner organisations

- Websites, Brochures and press releases
  - For project and general public **www.eu-egee.org**
  - Information packs for the general public, press and industry

Moving your application to EGEE (I)

- **Data Intensive**
  - Access to diverse data sources (format, read/write, location etc.)
  - Quantity of data
- **Compute Intensive**
  - EGEE attracts mostly farms of commodity PCs
  - MPI available for distributed applications at many sites
  - Interface to DEISA for application migration is under discussion
- **Interfaces**
  - Standard interfaces provided (e.g. APIs, GENIUS portal)
  - Application specific interfaces can be linked to the infrastructure (DEVASPIM, HKIS, BioGrid)
  - Interactivity

Moving your application to EGEE (II)

- **Security**
  - Infrastructure can help control access to sites, data, network and information
- **EGEE sites are administered/owned by different organisations**
  - Sites have ultimate control over how their resources are used
  - Limiting the demands of your application will make it acceptable to more sites and hence make more resources available to you

Security & Intellectual Property

- The existing EGEE grid middleware is distributed under an Open Source License developed by EU DataGrid
  - No restriction on usage (scientific or commercial) beyond acknowledgement
  - Same approach for new middleware
- Application software maintains its own licensing scheme
  - Sites must obtain appropriate licenses before installation

EGEE and Industry

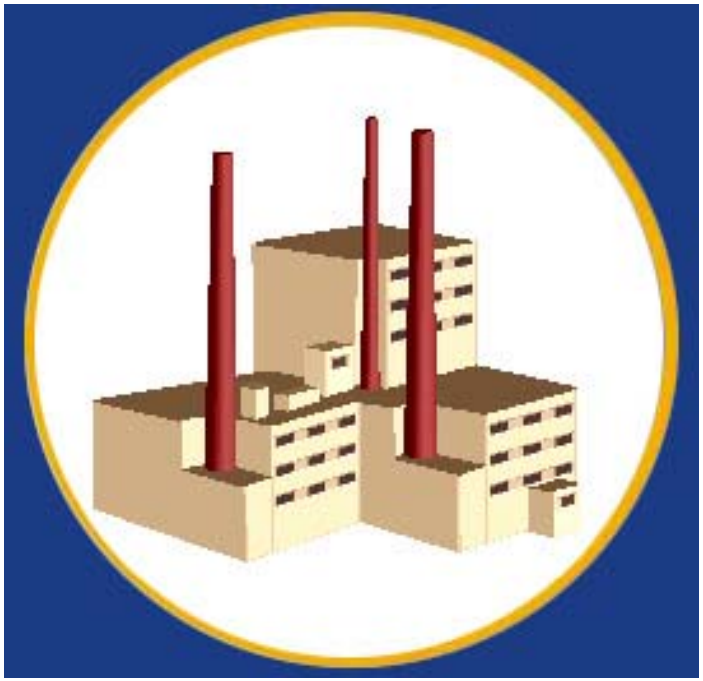
- **Industry as a partner** - Through collaboration with individual EGEE partners, industry has the opportunity to participate in specific activities, thereby increasing know-how on Grid technologies.
- **Industry as a user** - As part of the networking activities, specific industrial sectors will be targeted as potential users of the installed Grid infrastructure, for R&D applications.
- **Industry as a provider** - Building a production quality Grid will require industry involvement for long-term maintenance of established Grid services, such as call centres, support centres and computing resource provider centres

EGEE Industry Forum

- EGEE Industry Forum
  - raise awareness of the project in industry to encourage industrial participation in the project
  - foster direct contact of the project partners with industry
  - ensure that the project can benefit from practical experience of industrial applications

- For more info:

  www.eu-egee.org



Expected Developments in 2004

- **General:**
  - LCG-2 will be the service run in 2004 – aim to evolve incrementally
  - Goal is to run a stable service
- **Some functional improvements:**
  - Extend access to MSS – tape systems, and managed disk pools
  - Distributed vs replicated replica catalogs
    - To avoid reliance on single service instances
- **Operational improvements:**
  - Monitoring systems – move towards proactive problem finding, ability to take sites on/offline; experiment monitoring
  - Continual effort to improve reliability and robustness
  - Develop accounting and reporting
- **Address integration issues:**
  - With large clusters, with storage systems
  - Ensure that large clusters can be accessed via grid
  - Issue of integrating with other applications and non-LHC experiments

Overview of EGEE - Summary

- EGEE is expected to deliver a production Grid infrastructure for scientific applications
- The project started 2 months ago
  - We have a running grid service based on LCG-2
  - All EGEE activities are well advanced
  - Next generation middleware being designed – first prototype made available to applications
- Biomedical and physics are the pilot applications domains that will lead the exploitation of the EGEE Grid infrastructure
- The first project conference was held in Cork (Ireland) 18-22nd April
  - http://public.eu-egee.org/kickoff/index.html

Future of Grid - Content

- Background
- Grid Infrastructure
- A look into the Future
- Difference between RNs and Grid
- User perspectives
- International cooperation
- Summary

Background (I)

- Grid at a turning point
  - From research Grid to production Grid
  - Applications will soon depend on a high quality grid
- Grid is today what networks were yesterday
  - Research Networks use to be disparate testbed
  - Networks use to be non-standard and could not interoperate
  - Network standards were not defined and adopted
- Example of network standards
  - Winners: TCP/IP
  - Losers: ISO-OSI
- EU/EC played an important role in nurturing this evolution

Background (II)

- Natural selection played its role in network standards
- Only after an incubator period, did the industry turned research networks and testbeds to commercial and production like services
- Still today, research networks are working on the future of networking technology

Grid Infrastructure (I)

- Grid technology from Research to Production
- EGEE and Deisa are the first of this production generation
- Both will deploy services on top of Geant and GN2
- Meanwhile, initiatives such as the eIRG in Europe will develop appropriate international access policy and regulations
- Software development, multi-platform, is slow
- Evolution of the regulatory and policy framework is a human oriented activity and as such will require more time to develop

Grid Infrastructure (II)

- Deploying a production quality grid and a first wider set of grid applications is an important step in
  - validating and improving grid middleware from various aspects such as
    - Usability
    - Maintenance
    - Stability
    - Scalability
    - security

A look into the Future

- At the beginning of the EU FP7 (2007) it is conceivable that EGEE and Deisa will be running major international Grid infrastructures possibly together tightly integrated
- Need to continue our effort to complete the grid maturity in an EGEE-like EU funded consortium and make it embrace emerging standards
- Only then will it be ready to have the industry involved in its operations
- Grid users need a stable, committed and well maintained Grid infrastructure

Difference between RNs and Grid

- Networks are generally hardware intensive systems
- Grids are software intensive systems
- Software is much more volatile medium than hardware
- Still grid lack from stable internationally adopted standards

User perspectives

- A process of integration, in a seamless way, of new scientific communities (VO) will need to be developed and then supported
- Different categories of users, and corresponding support, should to be defined to meet their needs
- Some VOs will come with problems requiring computing power only, other data storage
- More organised user communities will come with problems, but also expertise, and computing resources

International cooperation

- Grid projects are by their intrinsic nature international
- Serve scientific communities established on a wide international basis
- Experienced excellent collaboration during the last several years
  - In particular between US and EU groups
  - Collaboration between the EU DataGrid, the Globus and VDT US teams is a good example
  - With the EU DataTAG and US iVDGL projects we introduced a more formal collaboration approach between the EU and the US

International cooperation

- In EGEE, we managed to go a step further where three US leading Grid development institutes
  - ANL/UoC, ISI, Wisconsin University
  - Now full partners in the project
- Israel, Russia and through the accompanying measure SEE-GRID the Balkan states are all partners in EGEE
- Several additional institutes from other countries are collaborating or planning to collaborate with EGEE through other EU accompany measures (Latino America, China, Mediterranean countries, Baltic republics, Far East)
- MoU signed with South Korea

Future of Grid - Summary

- We have a window of opportunity to turn Grid from research to production, as network did a few years ago
- If we succeed, could take part in the explosion of Grid and its adoption as a de-facto service and infrastructure
- The next 2 years of EGEE will be critical in establishing the first generation of production grid
- If we succeed then we are almost guaranteed continue funding for the next foreseeable future, if we fail
  - Then…