Introduction to GRID computing and overview of the European Data Grid Project

The European DataGrid Project

http://www.edg.org

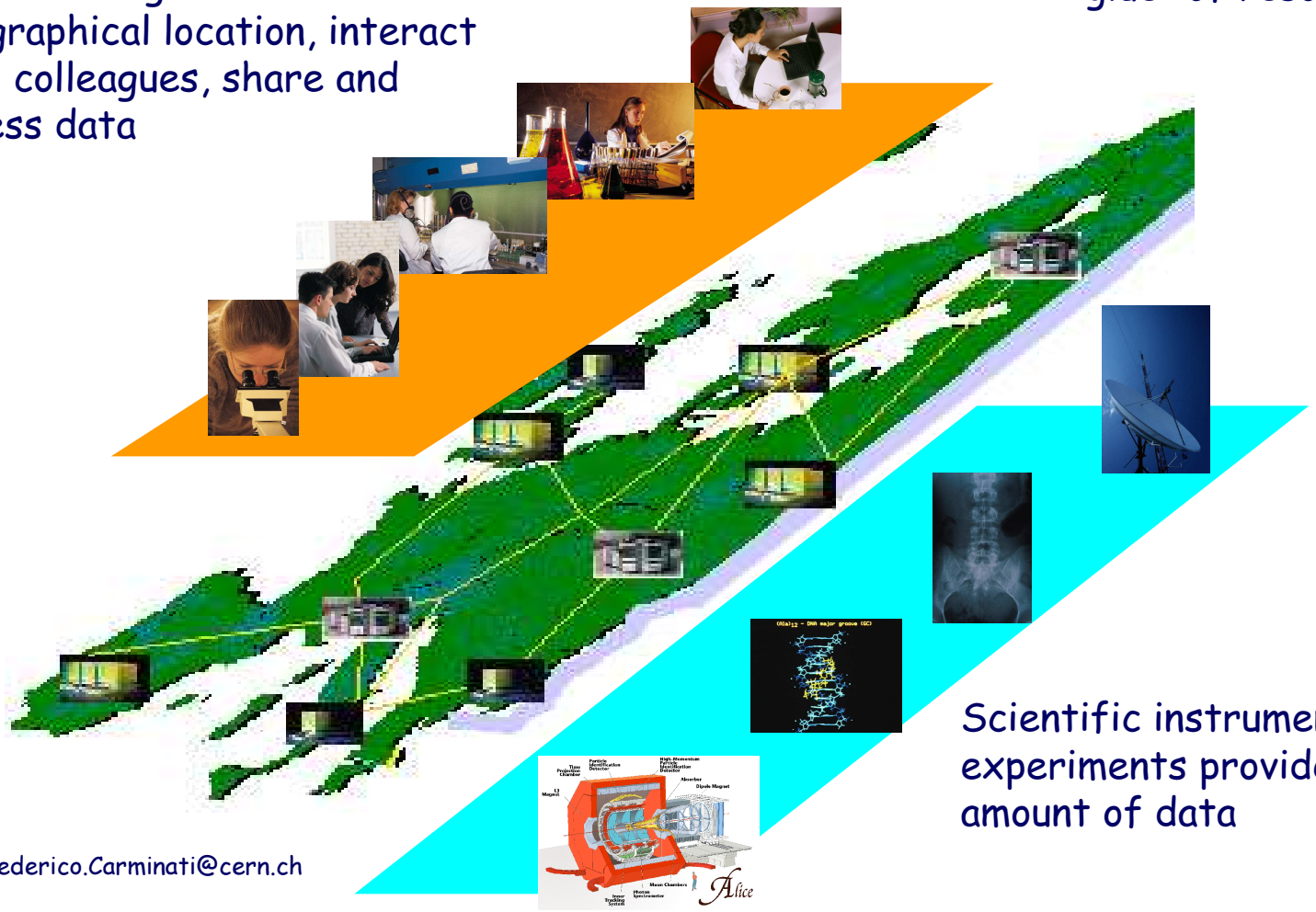
Overview

- What is GRID computing ?
- What is a GRID ?
- Why GRIDs ?
- GRID projects world wide
- The European Data Grid
  - Overview of EDG goals and organization
  - Overview of the EDG middleware components

The Grid Vision

The GRID: networked data processing centres and "middleware" software as the "glue" of resources.

Researchers perform their activities regardless geographical location, interact with colleagues, share and access data



Scientific instruments and experiments provide huge amount of data

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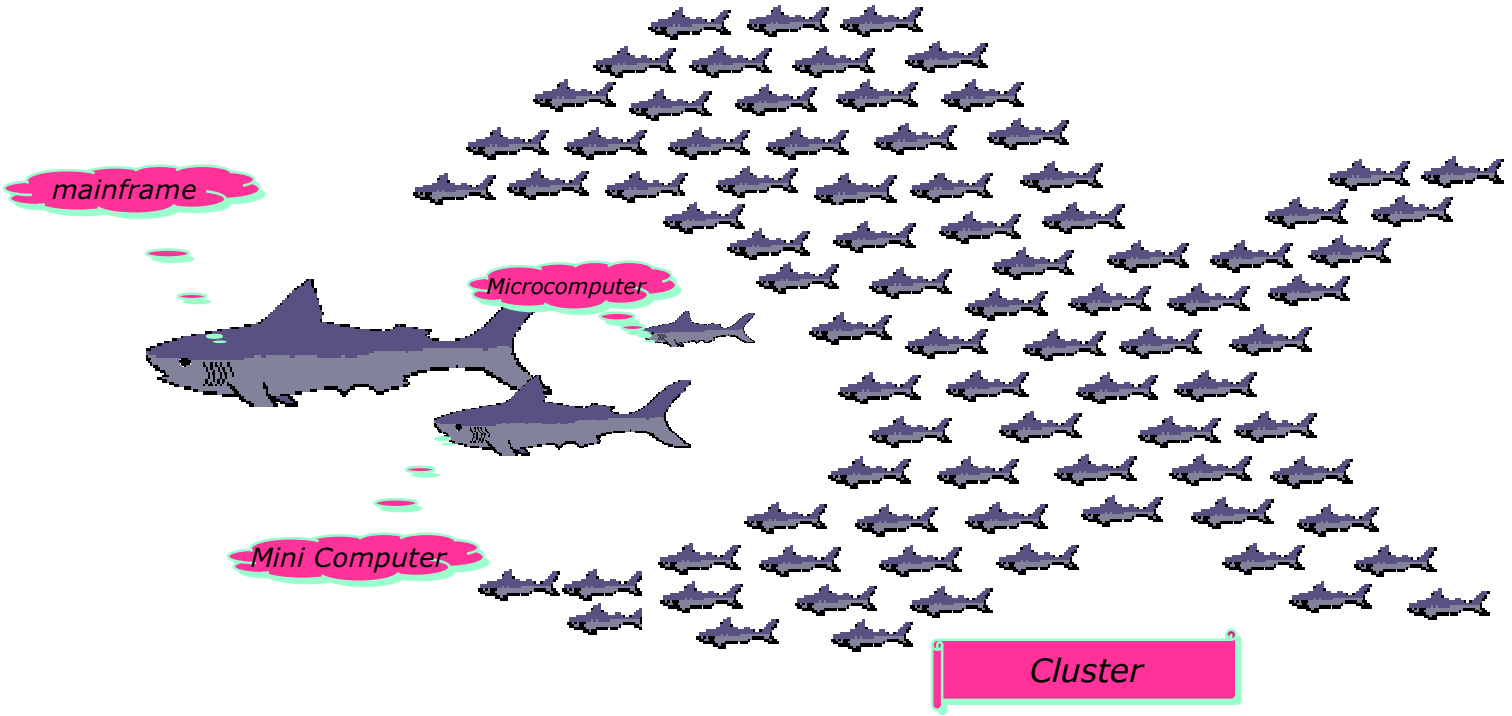
What is GRID computing :

- **coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations.** [I.Foster]
  - A VO is a collection of users sharing similar needs and requirements in their access to processing, data and distributed resources and pursuing similar goals.
- Key concept :
  - **ability to negotiate resource-sharing arrangements among a set of participating parties (providers and consumers) and then to use the resulting resource pool for some purpose** [I.Foster]

The GRID distributed computing idea 1/2

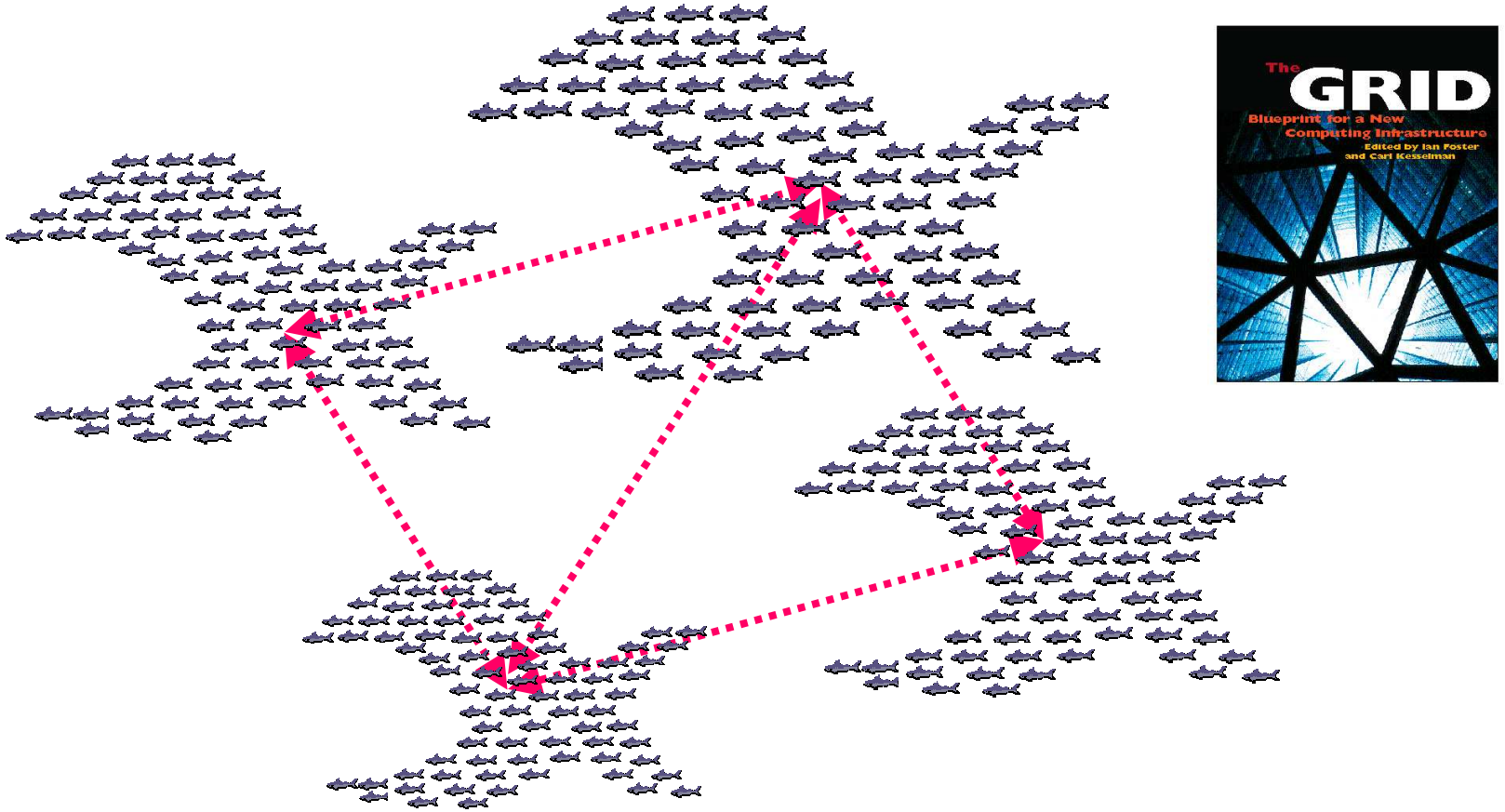
Once upon a time……



(by Christophe Jacquet, after N.O.W.)

The GRID distributed computing idea 2/2

…and today



(by Christophe Jacquet)

Differences between grids and distributed applications

- Distributed applications already exist, but they tend to be specialised 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 interaction
    - User groups or applications want to interact with grids in different ways
  - Dynamic nature
    - Resources and User Groups added/removed/changed frequently

Main characteristics of a grid architecture

- Service providers
  - Publish the availability of their services via information systems
  - Such services may *come-and-go or change* dynamically
  - E.g. a testbed site that offers *x* CPUs and *y* GB of storage
- Service brokers
  - Register and categorize published services and provide search capabilities
  - E.g. 1) EDG Resource Broker selects the best site for a "job"
    2) Catalogues of data held at each testbed site
- Service requesters
  - Single sign-on: log into the grid once
  - Use brokering services to find a needed service and employ it
  - E.g. CMS physicists submit a simulation job that needs 12 CPUs for 6 hours and 15 GB which gets scheduled, via the Resource Broker, on the CERN testbed site

GRID security

- Resource providers are essentially "opening themselves up" to itinerant users
- Secure access to resources is required
  - X.509 Public Key Infrastructure
- User's identity has to be certified by (mutually recognized) national Certification Authorities (CAs)
- Resources (node machines) have to be certified by CAs
- Temporary delegation from users to processes to be executed "in user's name" (proxy certificates)
- Common agreed policies for accessing resource and handling user's rights across different domains within Virtual Organizations

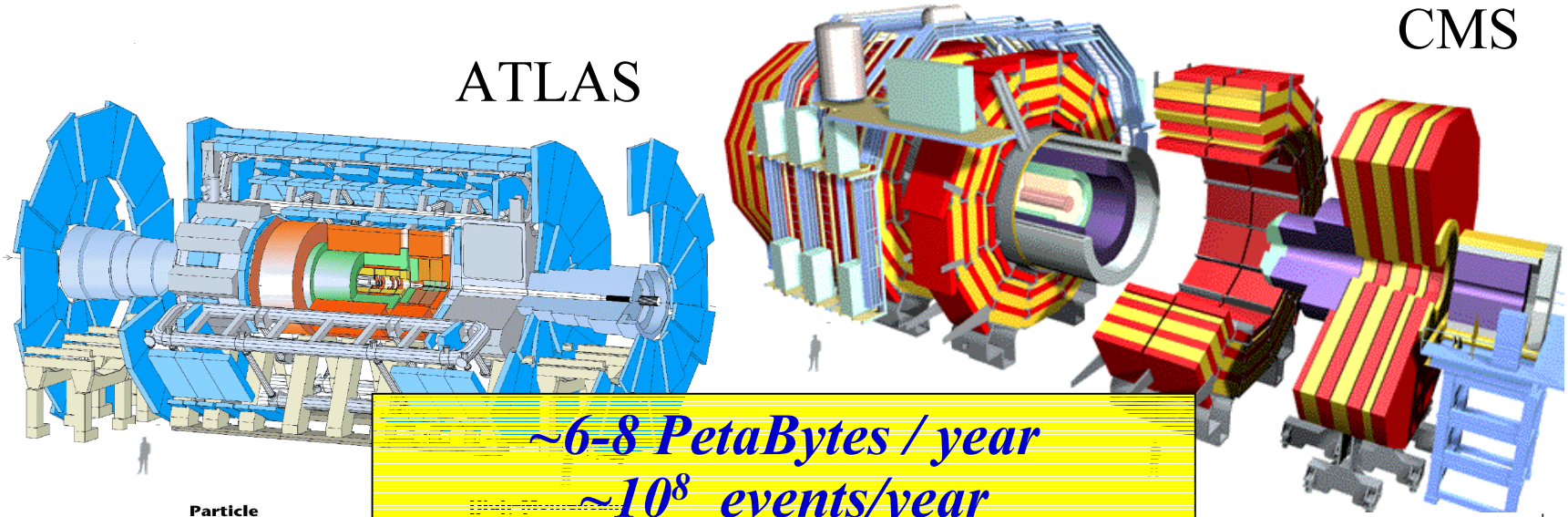
Why GRIDs

- **Scale** of the problems
  - frontier research in many different fields today requires world-wide collaborations (i.e. multi-domain access to distributed resources)
- GRIDs provide access to **large data processing power** and **huge data storage possibilities**
  - As the grid grows its usefulness increases (more resources available)
- Large communities of possible GRID users :
  - High Energy Physics
  - Environmental studies: Earthquakes forecast, geologic and climate changes, ozone monitoring
  - Biology, Genetics, Earth Observation
  - Astrophysics,
  - New composite materials research
  - Astronautics, etc.

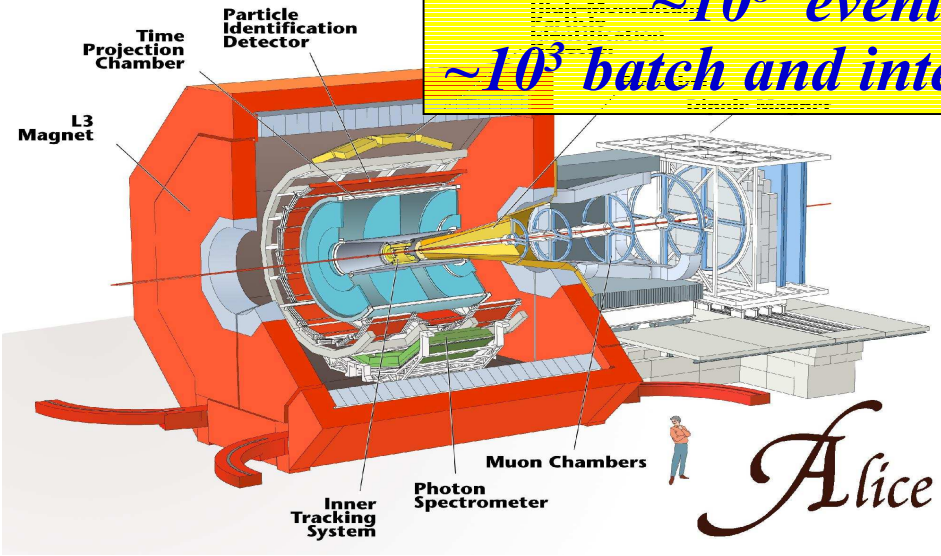
High Energy Physics *The LHC Detectors*

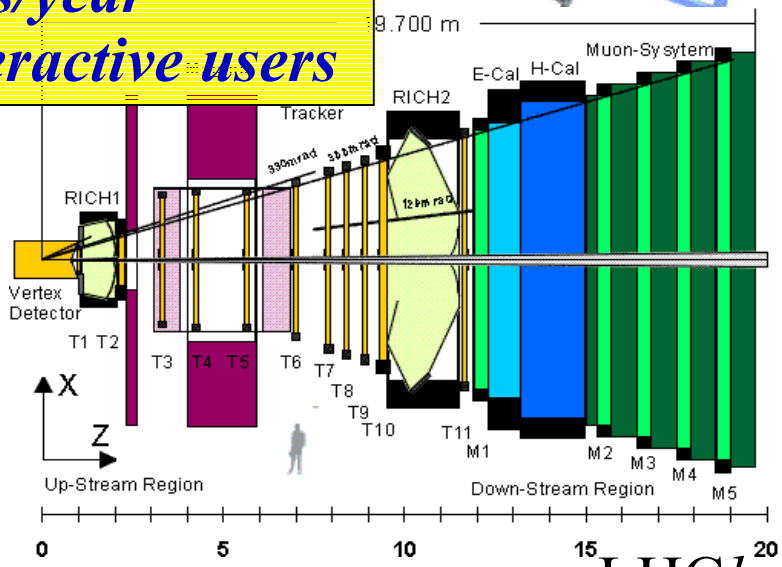
ATLAS

CMS



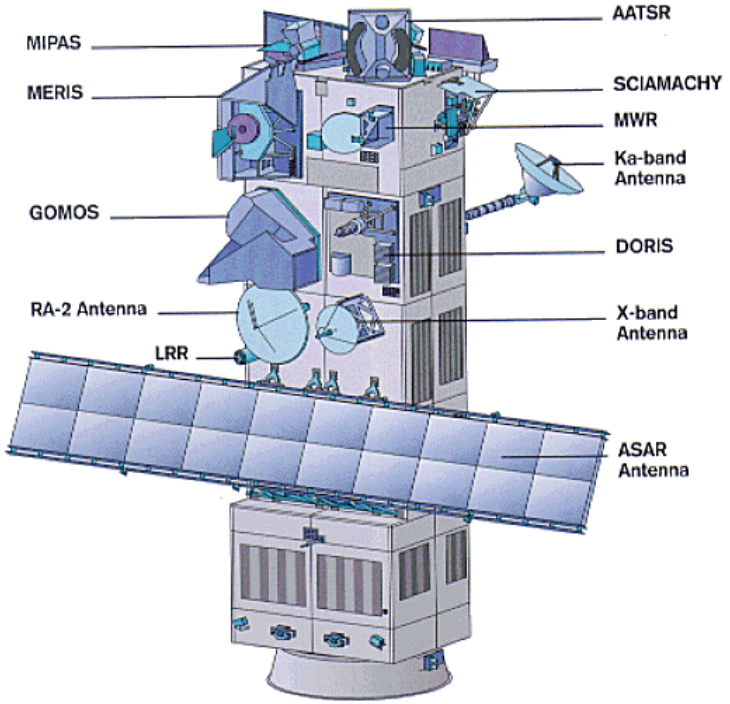
~6-8 PetaBytes / year
~10^8 events/year
~10^3 batch and interactive users





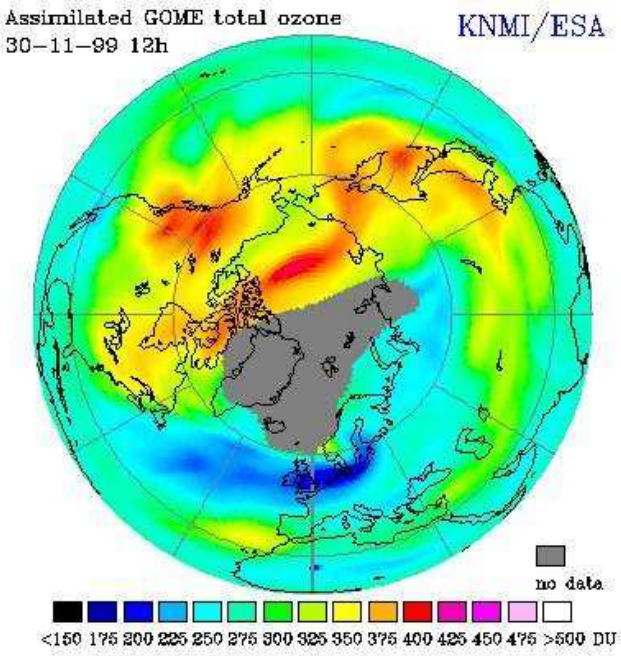
Federico.carminati , EU review presentation

Earth Observation



ESA missions:

- about 100 Gbytes of data per day (ERS 1/2)
- 500 Gbytes, for the next ENVISAT mission (2002).



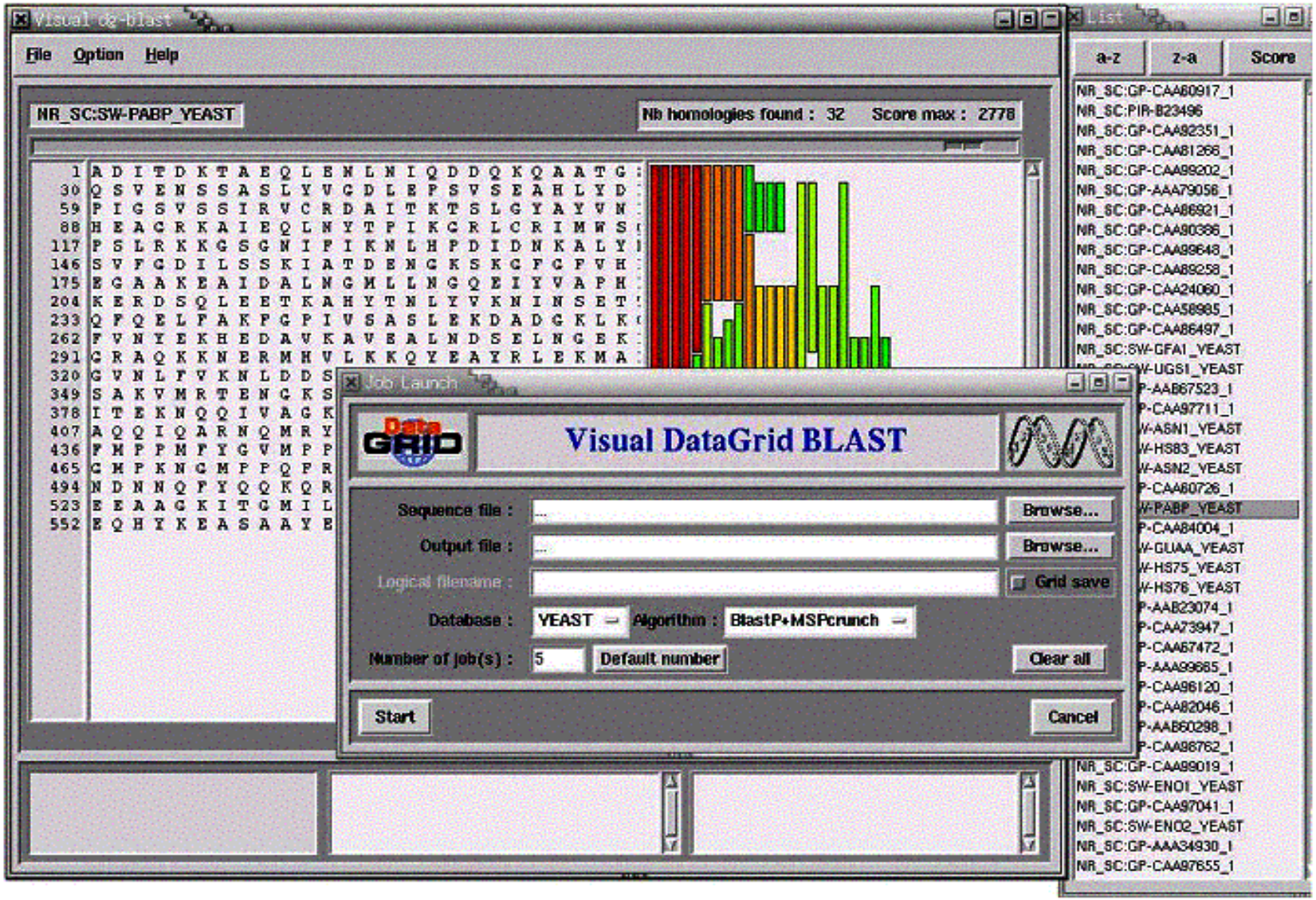
DataGrid contribute to EO:

- enhance the ability to access high level products
- allow reprocessing of large historical archives
- improve Earth science complex applications (data fusion, data mining, modelling …)

Source: L. Fusco, June 2001

Federico.Carminati , EU review presentation, 1 March 2002

Biology - BioInformatics



GRID projects world wide

- EU
  - EDG (EU-IST) – R&D EU GRID project [www.edg.org]
  - CrossGRID – QoS – interactive apps. [www.crossgrid.org]
  - DataTAG - inter-operability (EU-USA) [www.datatag.org]
  - LCG – The LHC Computing GRID – Deployment [cern.ch/lcg]
  - The new 16,2 B Euro EU VI Framework Prog. GEANT based GRID projects
- USA
  - GriPhyN [www.griphyn.org]
  - iVDGL-VDTv1 [www.idvgl.org]
  - PPDG (NSF, DoE) [www.ppdg.org]
- Asia
  - ApGrid [www.apgrid.org]
  - Pragma (USA-Asia)

And many more. . .

The European Data Grid

- To build on the emerging Grid technology to develop a sustainable computing model for effective share of computing resources and data
- Start : Jan 1, 2001 End : Dec 31, 2003
- Specific project objectives:
  - Middleware for fabric & Grid management (mostly funded by the EU)
  - Large scale testbed (mostly funded by the partners)
  - Production quality demonstrations (partially funded by the EU)
- To collaborate with and complement other European and US projects
- Contribute to Open Standards and international bodies:
  - Co-founder of Global GRID Forum and host of GGF1 and GGF3
  - Industry and Research Forum for dissemination of project results

The EDG Main Partners

- CERN – International (Switzerland/France)
- CNRS - France
- ESA/ESRIN – International (Italy)
- INFN - Italy
- NIKHEF – The Netherlands
- PPARC - UK

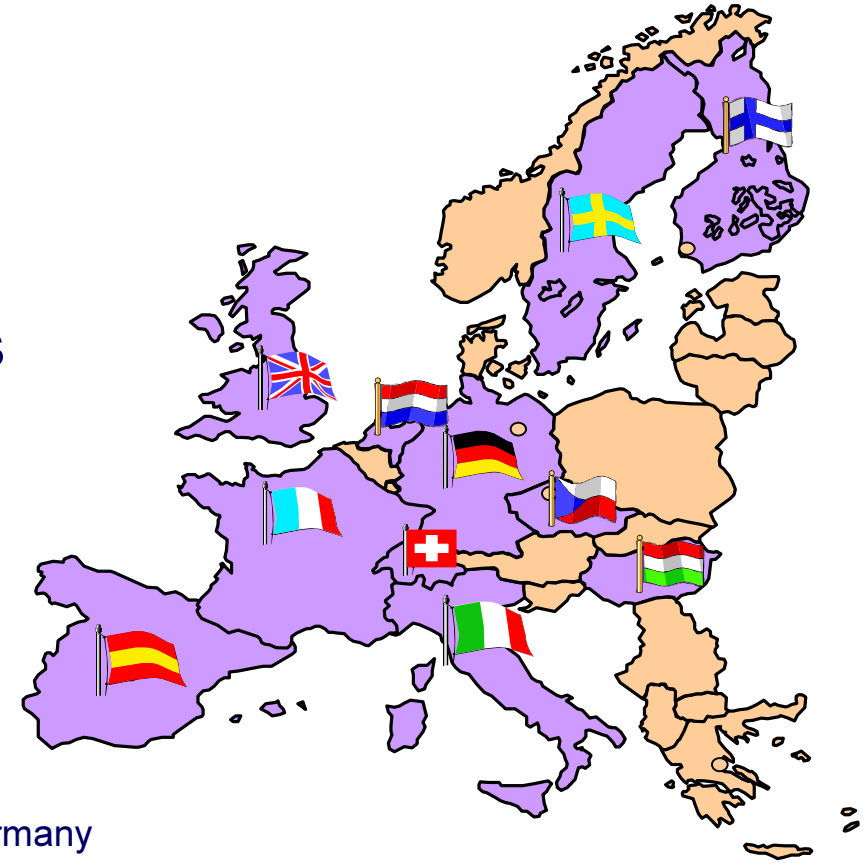
EDG Assistant Partners

Industrial Partners

- Datamat (Italy)
- IBM-UK (UK)
- CS-SI (France)

Research and Academic Institutes

- CESNET (Czech Republic)
- Commissariat à l'énergie atomique (CEA) – France
- Computer and Automation Research Institute, Hungarian Academy of Sciences (MTA SZTAKI)
- Consiglio Nazionale delle Ricerche (Italy)
- Helsinki Institute of Physics – Finland
- Institut de Fisica d'Altes Energies (IFAE) - Spain
- Istituto Trentino di Cultura (IRST) – Italy
- Konrad-Zuse-Zentrum für Informationstechnik Berlin - Germany
- Royal Netherlands Meteorological Institute (KNMI)
- Ruprecht-Karls-Universität Heidelberg - Germany
- Stichting Academisch Rekencentrum Amsterdam (SARA) – Netherlands
- Swedish Research Council - Sweden



EDG overview: Middleware release schedule

- Release schedule
  - **testbed 1:** 2001
  - **testbed 2:** 2002
  - **testbed 3:** 2003
  - Incremental releases between these major dates
- Each release includes
  - feedback on use of previous release by application groups
  - planned improvements/extension by middle-ware groups
- Application groups (HEP, EO, Bio-Info) are using existing software and testbed to explore how they can best exploit grids

EDG overview : current project status

- EDG currently provides a set of middleware services
  - Job & Data Management
  - GRID & Network monitoring
  - Security, Authentication & Authorization tools
  - Fabric Management
- Runs on Linux Red Hat 6.2 + updates platform
  - Site install & config tools and set of common services available
- 5 principle EDG 1.2.0 sites currently belonging to the EDG-Testbed
  - **CERN**(CH), RAL(UK), NIKHEF(NL), CNAF(I), CC-Lyon(F),
    - being deployed on other EDG testbed sites (~10)
- Intense middleware development continuously going on, concerning:
  - New features for job partitioning and check-pointing, billing and accounting
  - New tools for Data Management and Information Systems.
  - Integration of network monitoring information inside the brokering polices

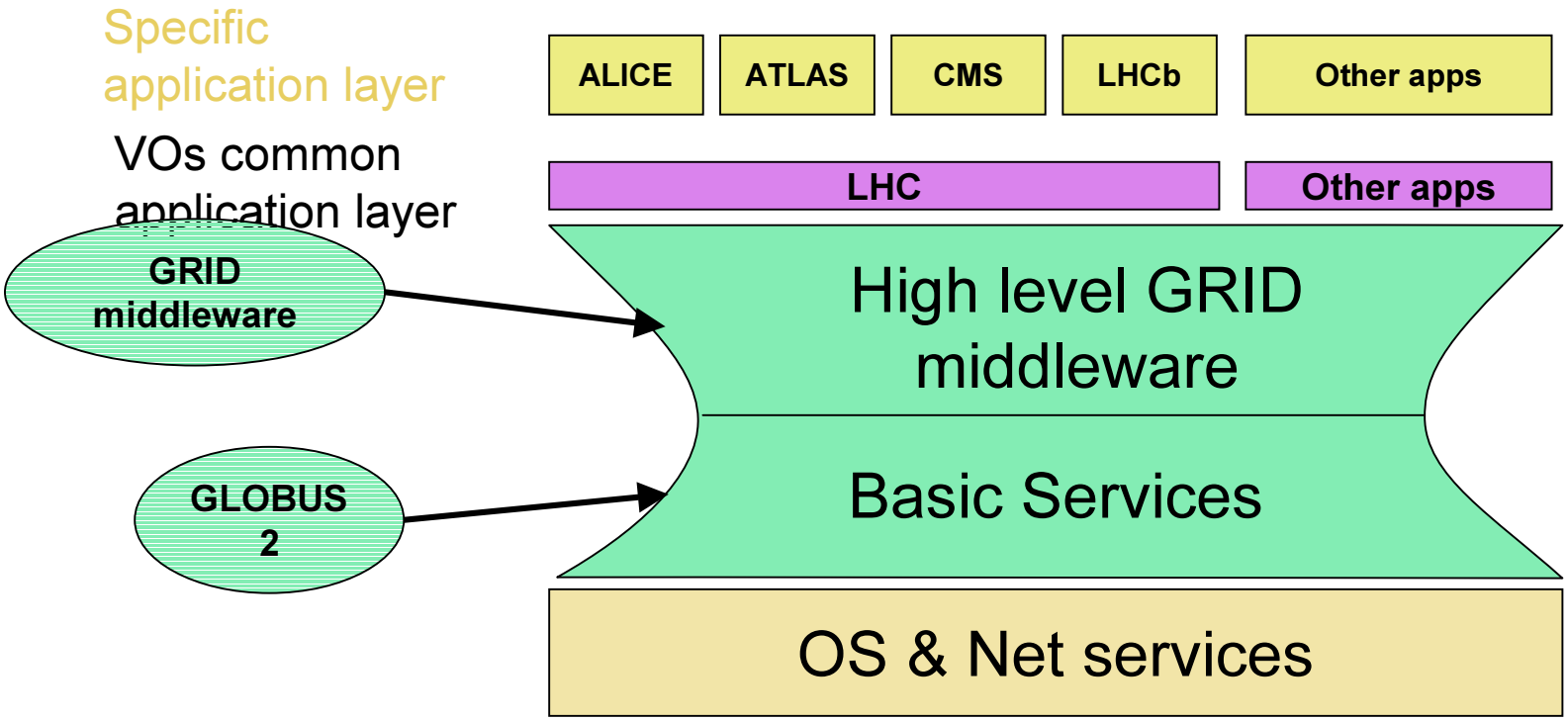
EDG structure : work packages

- The EDG collaboration is structured in 12 Work Packages:
  - WP1: Work Load Management System
  - WP2: Data Management
  - WP3: Grid Monitoring / Grid Information Systems
  - WP4: Fabric Management
  - WP5: Storage Element
  - WP6: *Testbed and demonstrators*
  - WP7: Network Monitoring
  - WP8: High Energy Physics Applications
  - WP9: Earth Observation
  - WP10: Biology
  - WP11: Dissemination
  - WP12: Management

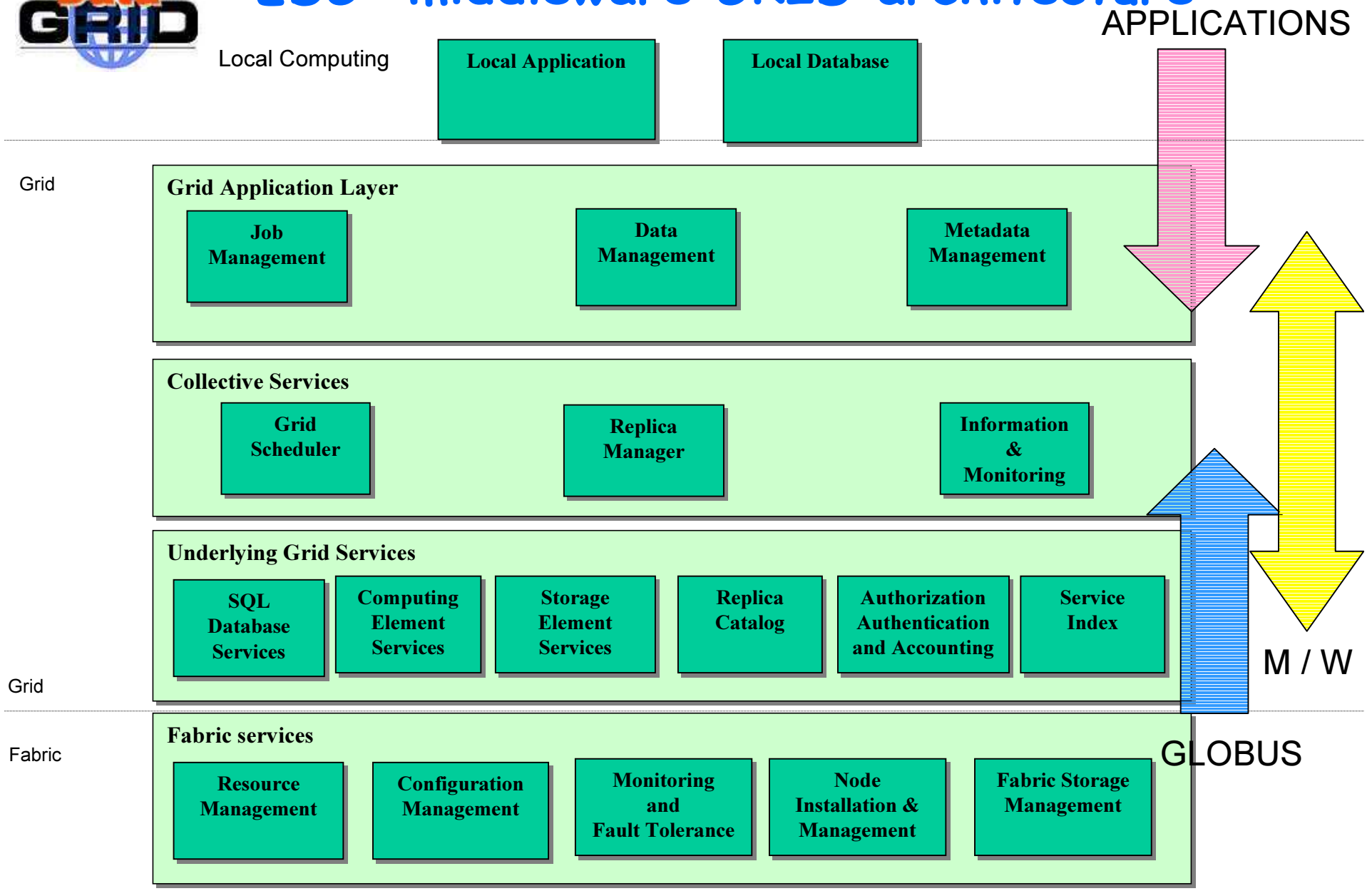
} **Applications**

EDG Globus-based middleware architecture

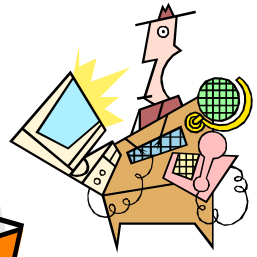
- Current EDG architectural functional blocks:
  - Basic Services (authentication, authorization, Replica Catalog , secure file transfer, Info Providers) rely on Globus 2
  - Higher level EDG middleware (developed within EDG)
  - Applications (HEP,BIO,EO)



EDG middleware GRID architecture



EDG interfaces

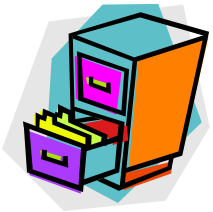


System Managers

Application Developers

Scientists

Certificate Authorities



File Systems

User Accounts

Local Application

Local Database

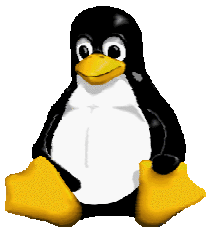
Grid Application Layer
- Job Management
- Data Management
- Metadata Management
- Object to File Mapping

Collective Services
- Information & Monitoring
- Replica Manager
- Grid Scheduler

Underlying Grid Services
- SQL Database Services
- Computing Element Services
- Storage Element Services
- Replica Catalog
- Authorization Authentication and Accounting
- Service Index

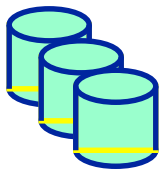
Fabric services
- Resource Management
- Configuration Management
- Monitoring and Fault Tolerance
- Node Installation & Management
- Fabric Storage Management

the globus project
www.globus.org

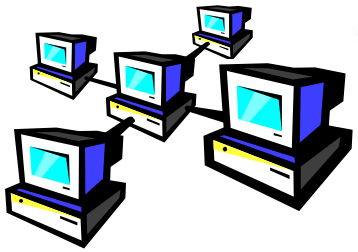


Operating Systems

Mass Storage Systems
HPSS, Castor



Storage Elements



Computing Elements

Batch Systems
PBS, LSF, etc.

EDG : reference web sites

- EDG web site
  - http://www.edg.org
- Source for all required software :
  - http://datagrid.in2p3.fr
- EDG testbed web site
  - http://marianne.in2p3.fr
- EDG users guide
  - http://marianne.in2p3.fr/datagrid/documentation/EDG-Users-Guide.html
- EDG tutorials web site
  - http://cern.ch/edg-tutorials
- EDG production testbed current real time updated set up
  - http://testbed007.cern.ch/tbstatus-bin/infoindexcern.pl