GRID interest and activities in ESA

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EIROFORUM Working Group on GRID

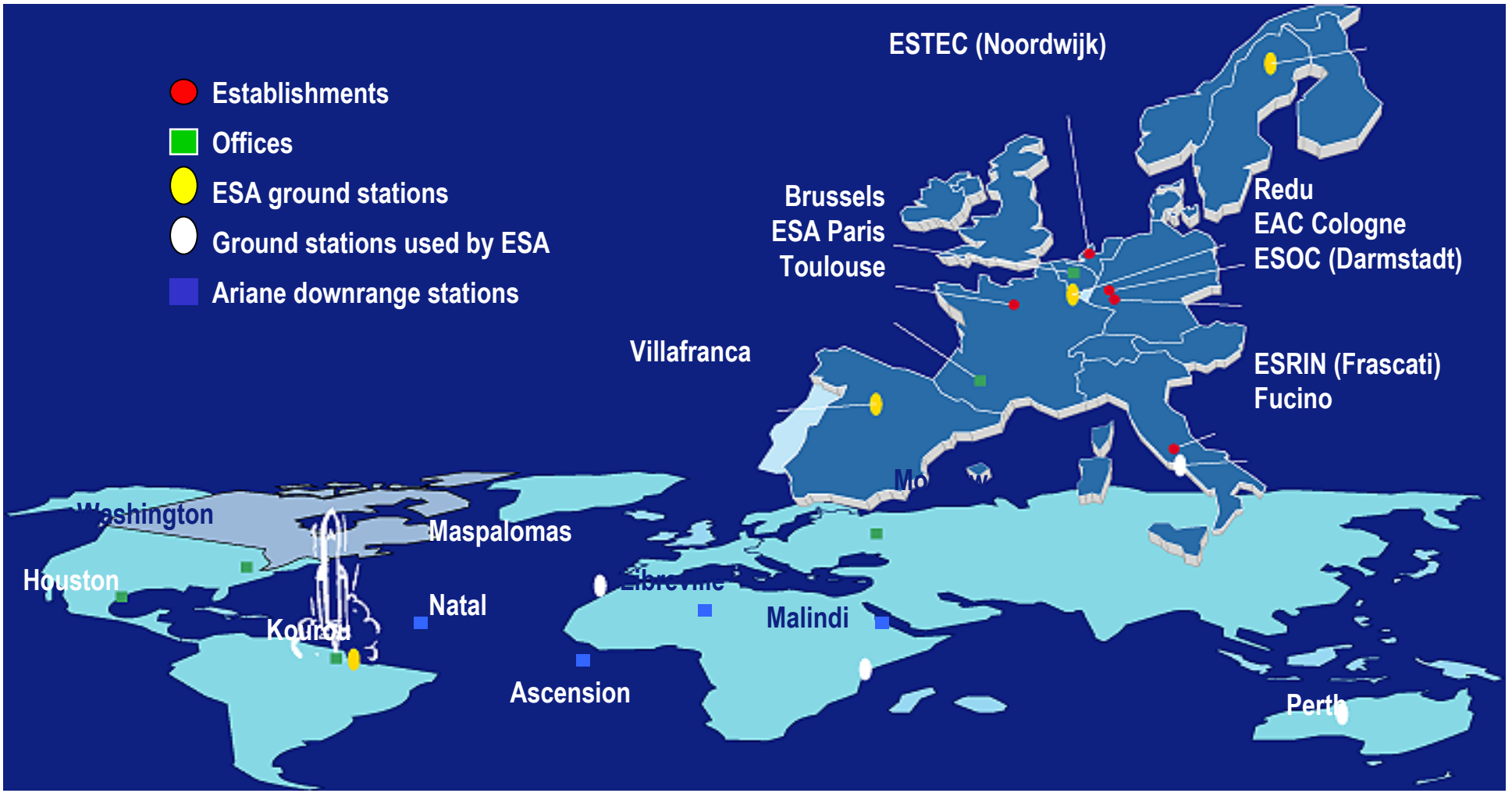
ESA activities

All member states participate in activities related to **space science** and in a common set of programmes (mandatory programmes).

In addition, members chose the level of participation in optional programmes :

- Earth observation
- Telecommunications
- Navigation
- Launcher development
- Internation Space Station

ESA location worldwide

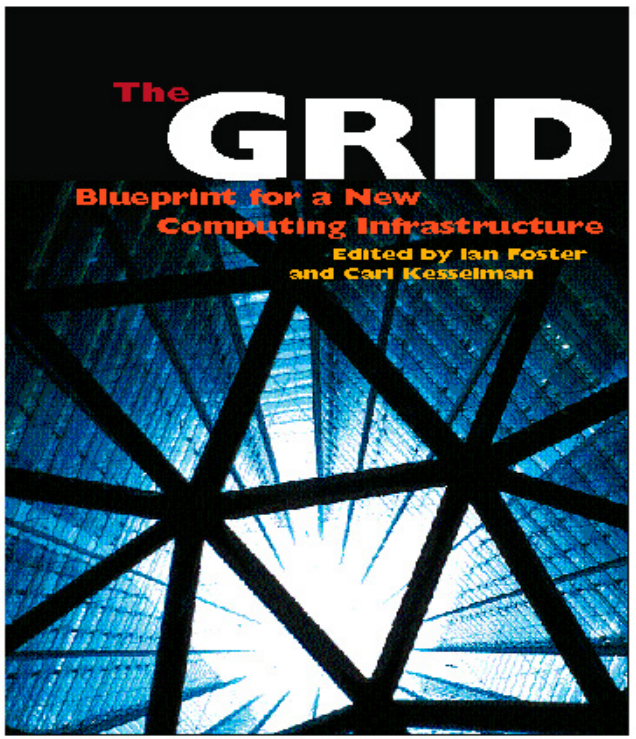


Summary

1. GRID and space applications
2. ESA participation in European GRID projects
3. ESA internal GRID activities
4. ESA GRID future perspectives and ideas for EIROFORUM GRID WG

Space Applications and Networking Computing

- **Distributed Computing**
  - Mission analysis, ESA-NASA ISS simulations, structural/thermal coupling...
- **High-Throughput Computing**
  - Space Science GEANT 4, CAD modeling
- **On-Demand Computing**
  - Generation of EO user products...
- **Data-Intensive Computing**
  - Archive data re-processing, climate modeling...
- **Collaborative Computing**
  - Scientists, Concurrent Design Facility, Instrument cal/val ...



Ian Foster and Carl Kesselman, editors, "The Grid: Blueprint for a New Computing Infrastructure," Morgan Kaufmann, 1999

The Grid from a Services View: ICT vs usage

Applications

Space Science | Cosmology | Environment

S/C modelling | Space weather | …

Application Toolkits

Distributed Computing Toolkit | Data-Intensive Applications Toolkit | Collaborative Applications Toolkit | Remote Visualization Applications Toolkit | Problem Solving Applications Toolkit | Remote Instrumentation Applications Toolkit

Grid Services (Middleware)

Resource-independent and application-independent services

authentication, authorization, resource location, resource allocation, events, accounting, remote data access, information, policy, fault detection

Grid Fabric (Resources)

Resource-specific implementations of basic services

E.g., Transport protocols, name servers, differentiated services, CPU schedulers, public key infrastructure, site accounting, directory service, OS bypass

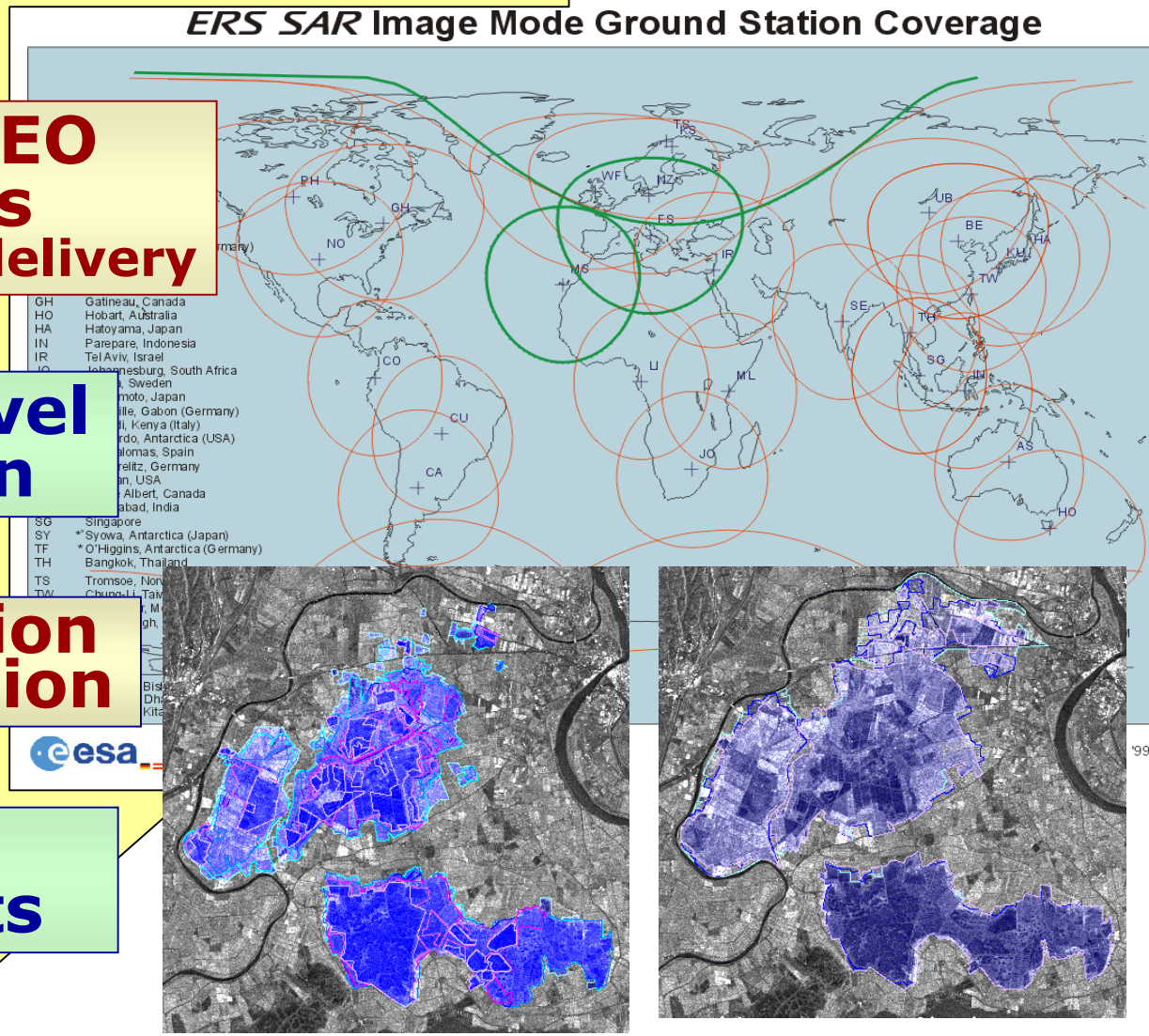
Earth Observation Community
GRID interactive scenario

Common access to EO missions catalogues
Acquisition plan, order, delivery

On demand high level products generation

Parametric data fusion and models integration

Collaborative publishing of results

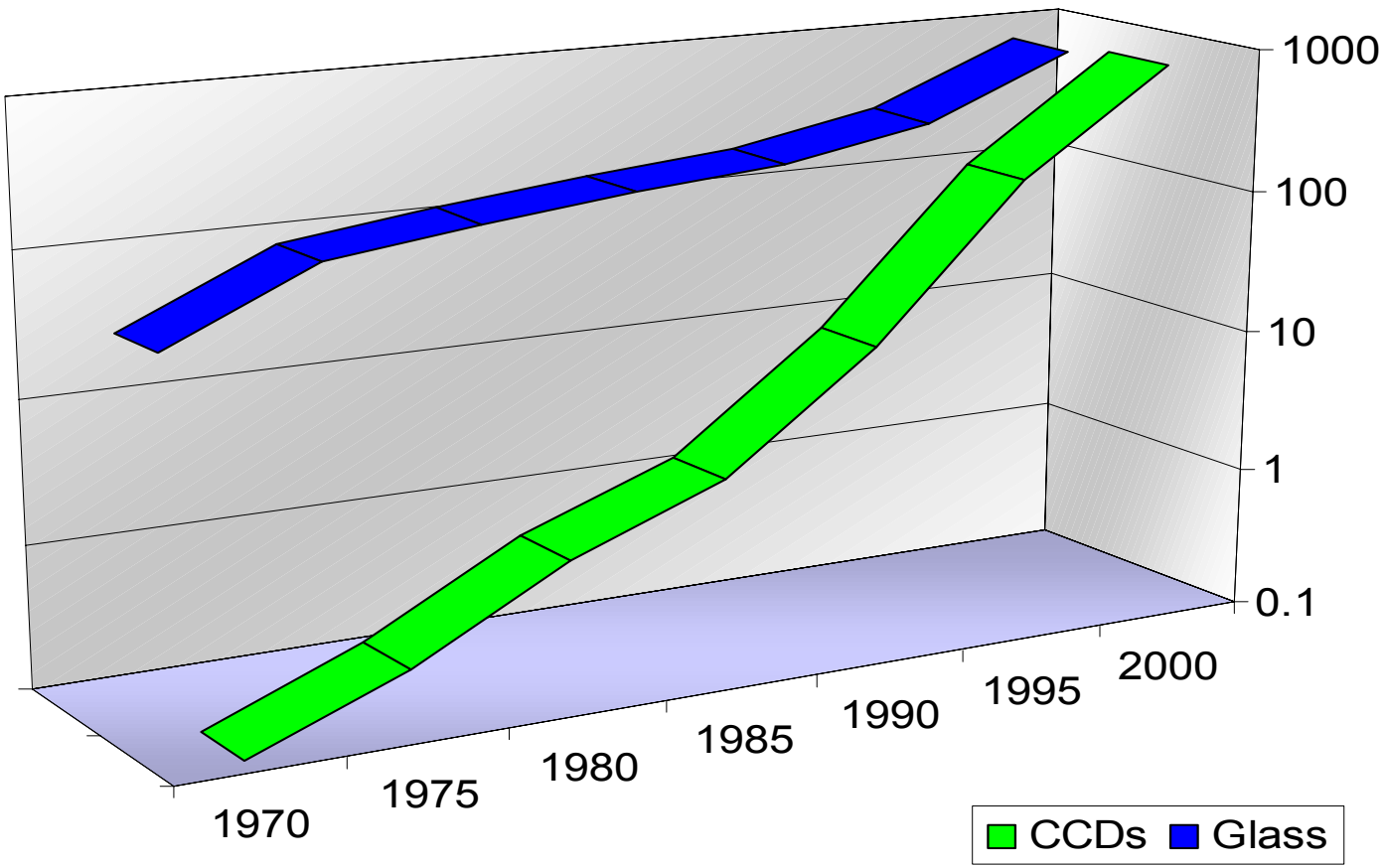


GRID is a priority technology to be used across space applications

- **Large operational experience in distributed operational environment**
- **Large volume of data to be handled**
- **Computing intensive applications**
- **Large world wide user community**
- **International cooperation**
- **Web based data services, interoperability and common standards across space agencies**
- **Real time (networks)**

Astronomy Data Flood : Glass vs. Silicon

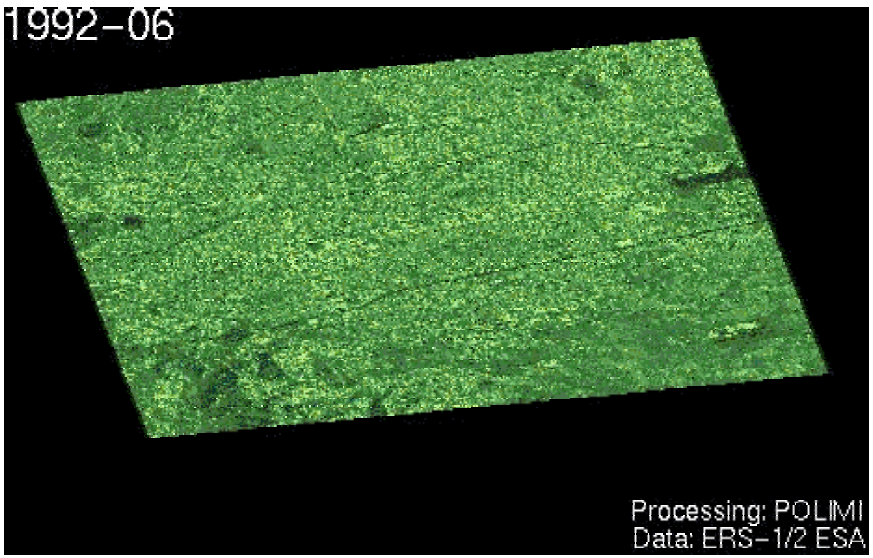
Total area of 3m+ telescopes in the world in m^2, total number of CCD pixels in Megapix, as a function of time. Growth over 25 years is a factor of 30 in glass, 3000 in pixels.



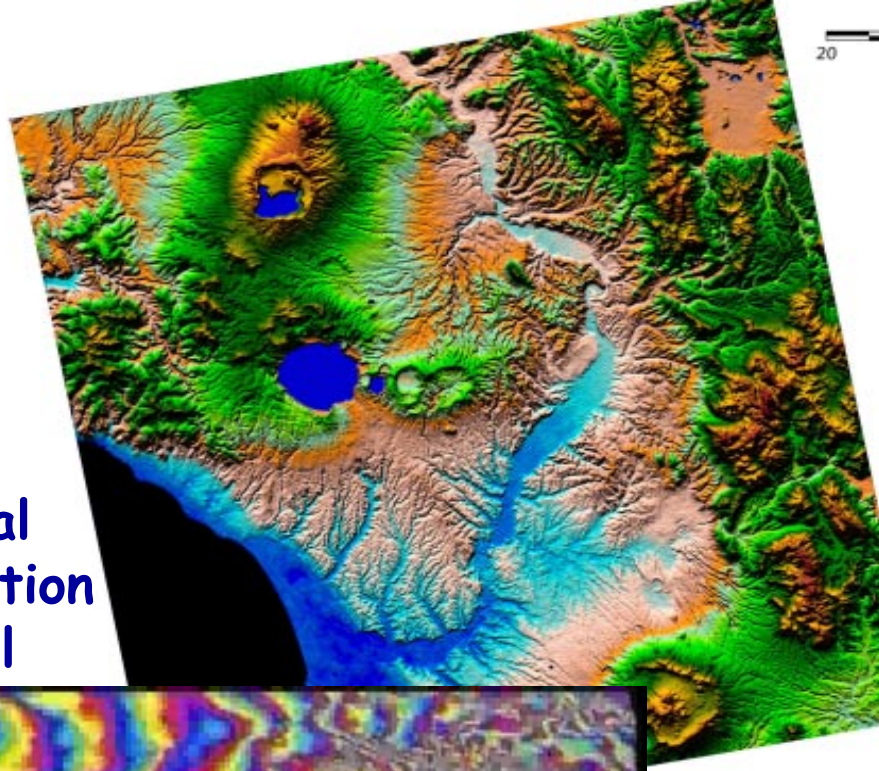
High demanding computing

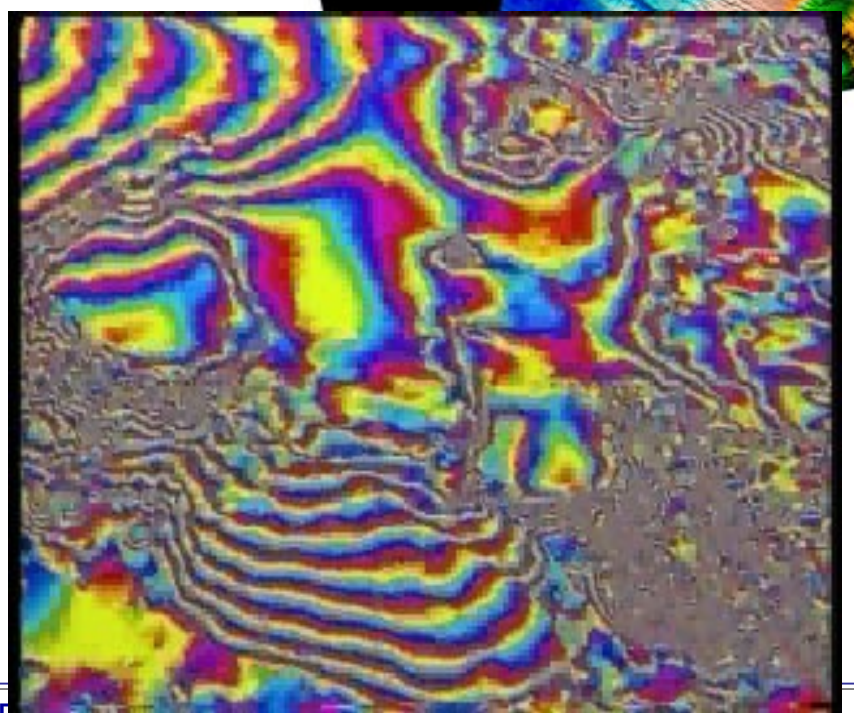
Pomona (Cal): subsidence velocity fields

40 ERS1/2 images (92-99), Ambiguity: 28 mm



Digital Elevation Model





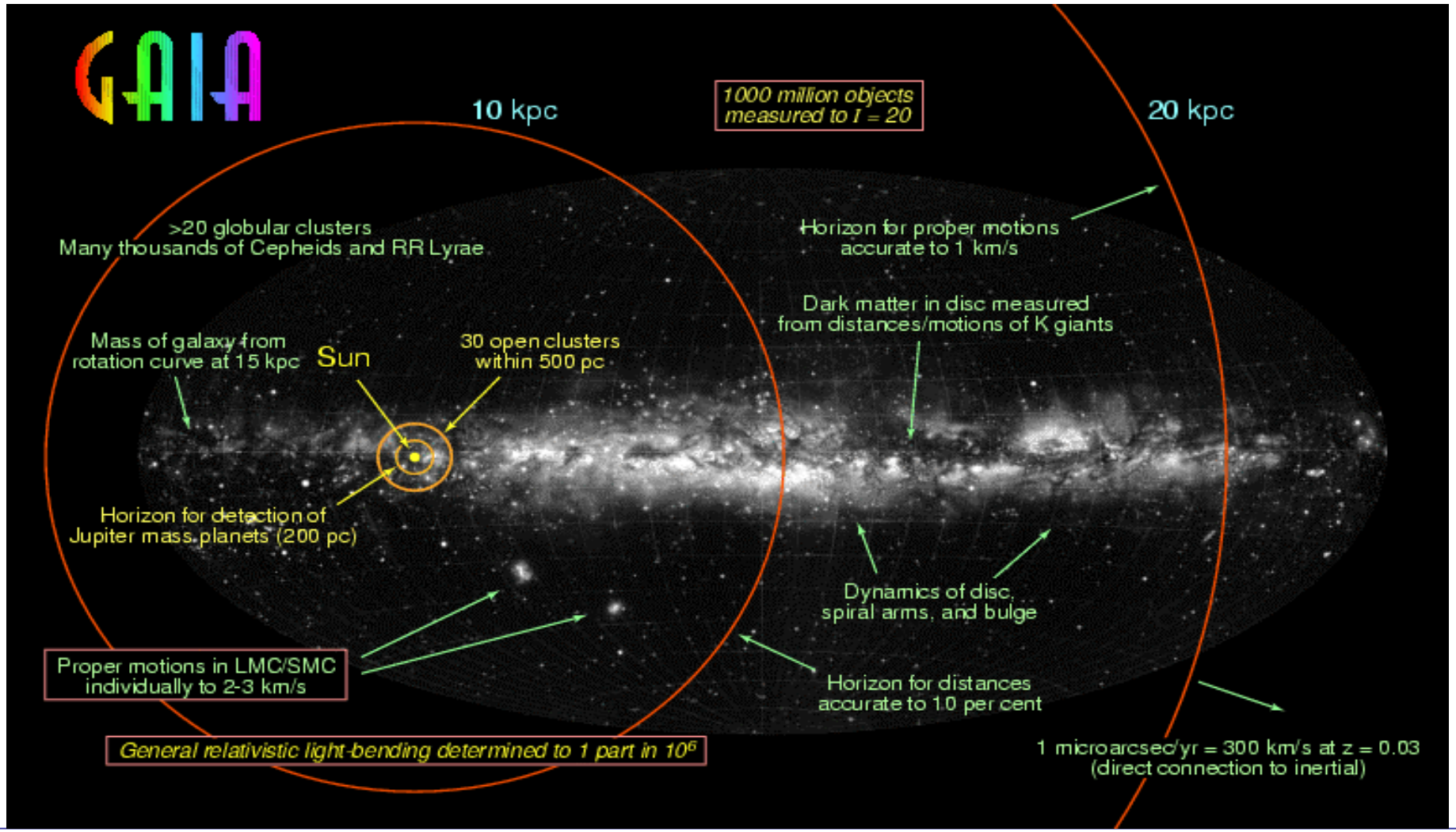
GRID requirements:

- large data files (10+ GB)
- stages with intensive processing
- science driven value adding


ENVISAT gets ready for operations !
• 10 instruments on board
• 200 Mbps data rate to ground
• 400 Tbytes data archived/year
• ~100 "standard" products
• 10+ dedicated facilities in Europe

1 billion stars

GAIA = 150 Terabytes



GRID technologies for Space Applications

- **Resource-independent and application-independent services (middleware)**
  - **authentication, authorization, resource location, resource allocation, remote data access,**
  - **accounting, security, quality of services, fault detection, real time services, …**
- **Specialized protocols, procedures, data standards, operational environments, interfaces to Space legacy systems…**
- **Specific communities environments/portals, metadata and data access, data policies…**
- **Dedicated application development environment, data handling tools fusion, mining, visualisation…**

Additional needed "ESA internal" GRID efforts

- **Access to Trans European High Speed Research Networks (VPN aspects)**
- **Open network access to existing operational Archives and Data Distributions systems**
- **Common/generic (not project specific) GRID infrastructure**
- **More involvement of user communities and service industry**

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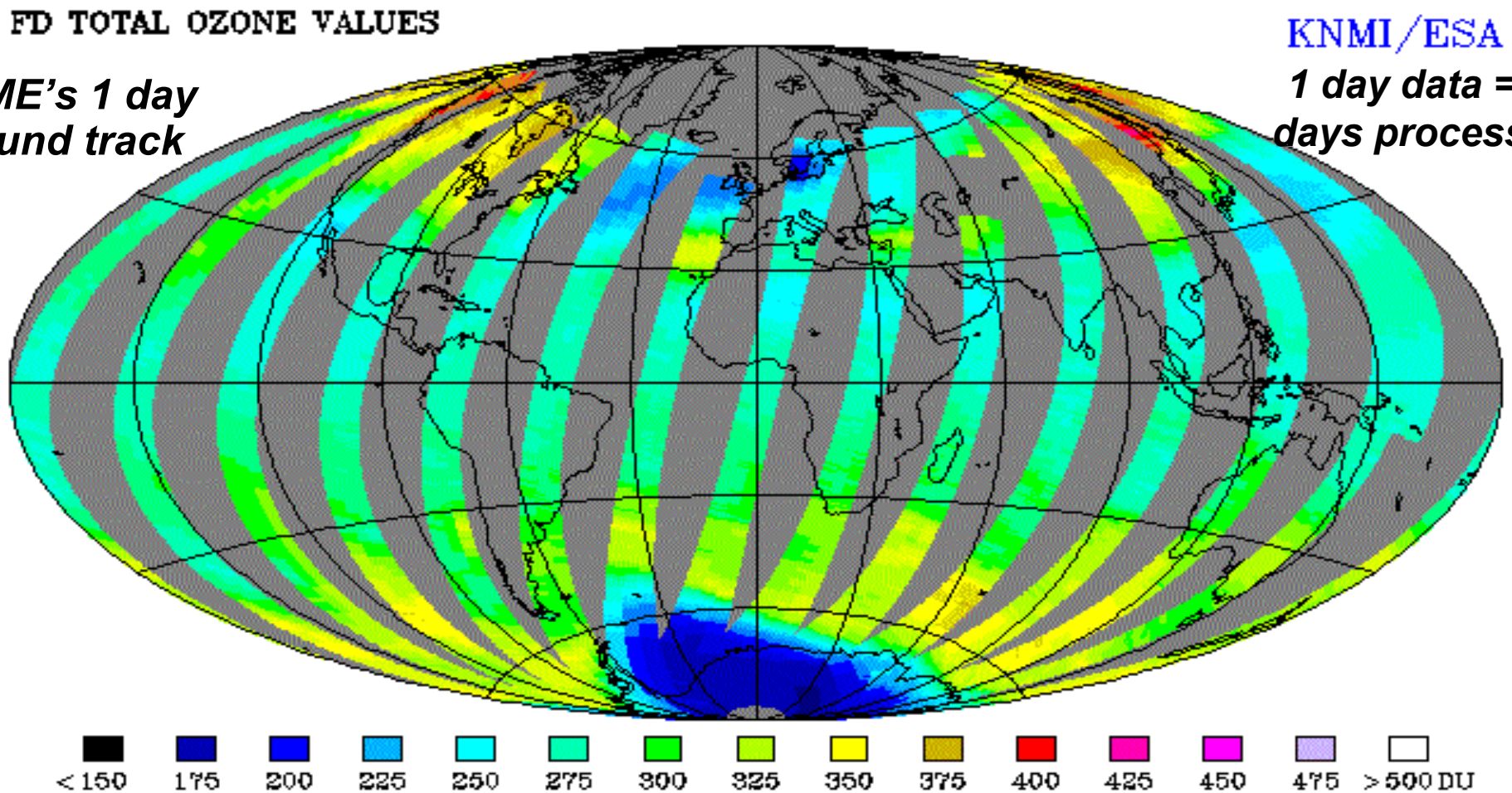
ESA participation in EU funded GRID projects (not exaustive)

- **DataGRID –** Earth Observation application
- **EGSO –** Solar radiance
- **AVO –** Astrophysical Virtual Observatory
- **DataTAG –** access to Trans Atlantic Connectivity
- …

DataGrid Earth Observation (WP9) Objectives

- **Specification of EO requirements**
- **Bringing Grid-aware application concepts into the Earth Science environment**
- **Adaptation of existing systems and selected EO applications to use the DataGrid infrastructure**
- **Testbed validation through prototyping activity**
- **Activities handled in coordination and synchronisation with other related and relevant work packages**

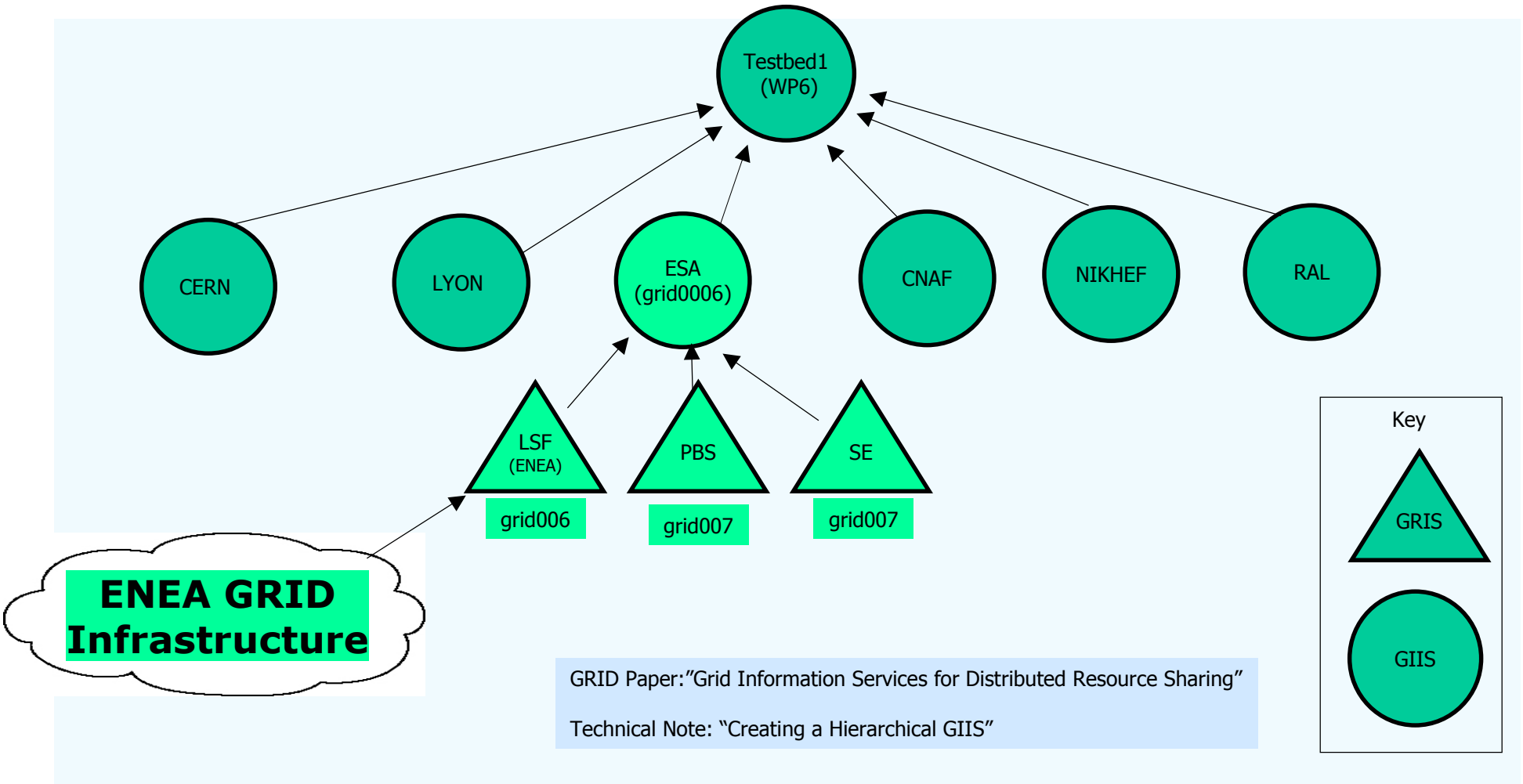
DataGrid EO application



GOME's 1 day ground track

1 day data = 40 days processing

DataGrid Hierarchical Testbed-1 Infrastructure



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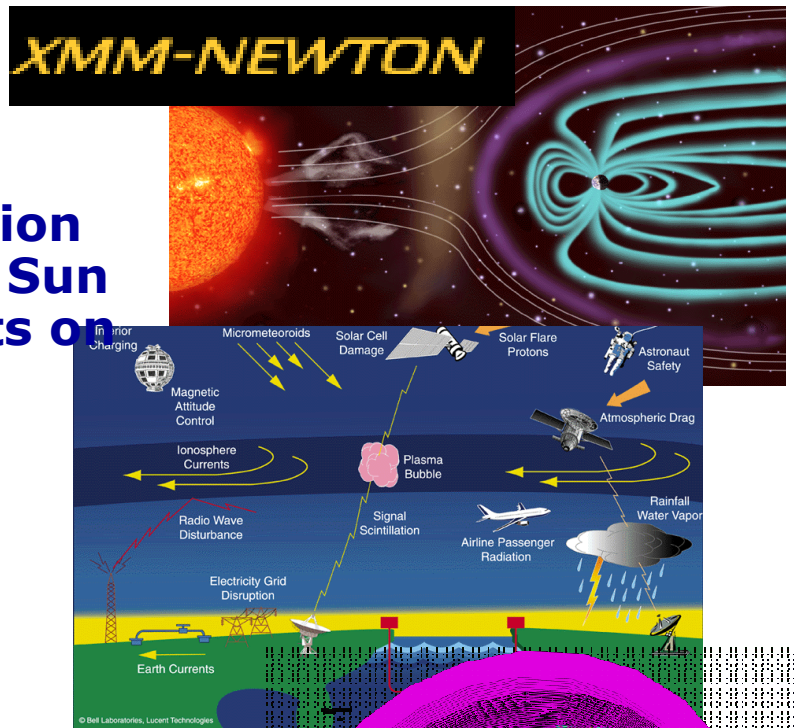
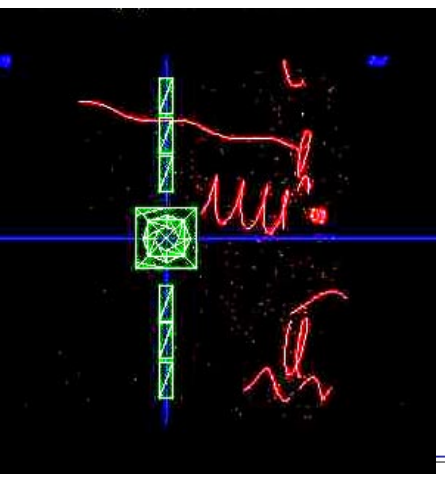
SpaceGRID : first ESA GRID study!

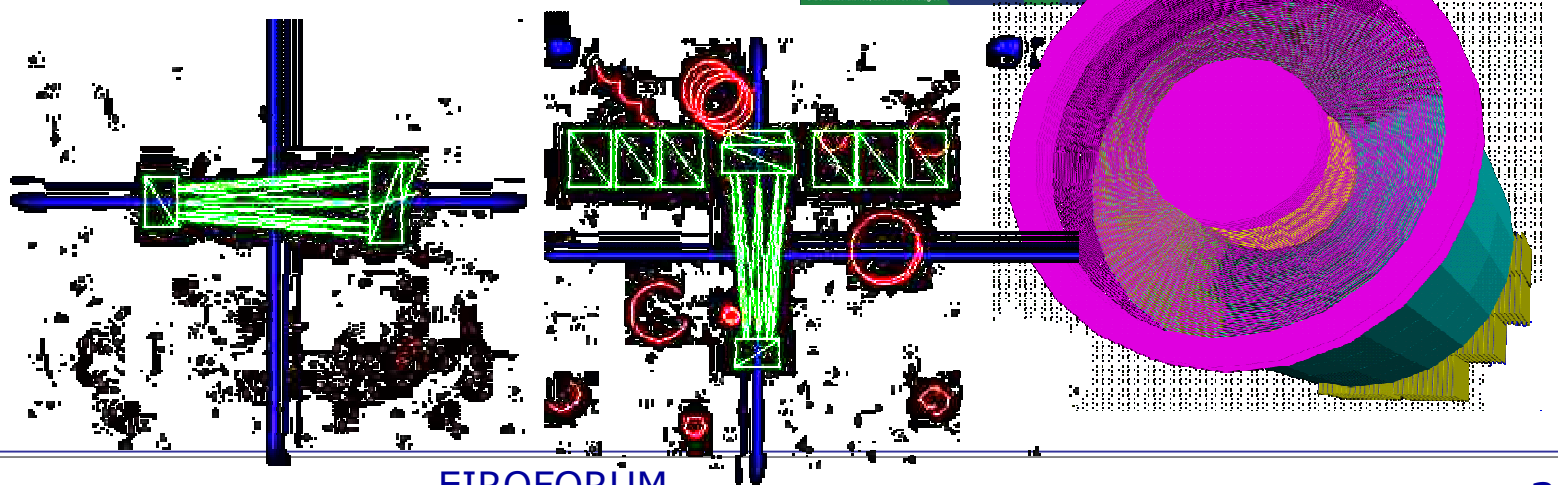
- **Assess how GRID technology can serve requirements across a variety of space disciplines**
- **Foster collaboration and enable shared efforts across space applications**
- **Sketch the design of an ESA-wide (and common) GRID infrastructure**
- **Proof of concept through prototyping**
- **Involve both industry and research centres**

Space science applications

- **Space Weather Simulation:**
  - **Simulation of a Coronal Mass Ejection and interplanetary shock from the Sun to the Earth and subsequent effects on the Earth's magnetosphere**
- **Geant4 Application:**
  - **simulation of high energy particle interactions inside a spacecraft system, components or detector**
- **Spacecraft/Plasma Simulation**

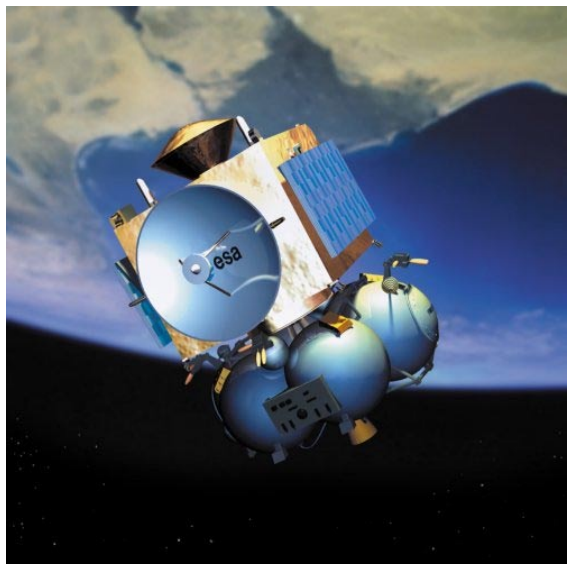






Spacecraft Engineering Analysis

- Large scale parametric stochastic analyses and design optimisation
- Multi-discipline Phase B/C/D analyses
- Concurrent / collaborative / multi-site e-engineering”
- Fine mesh analysis / results post-processing
- NURBS faces/elements analyses

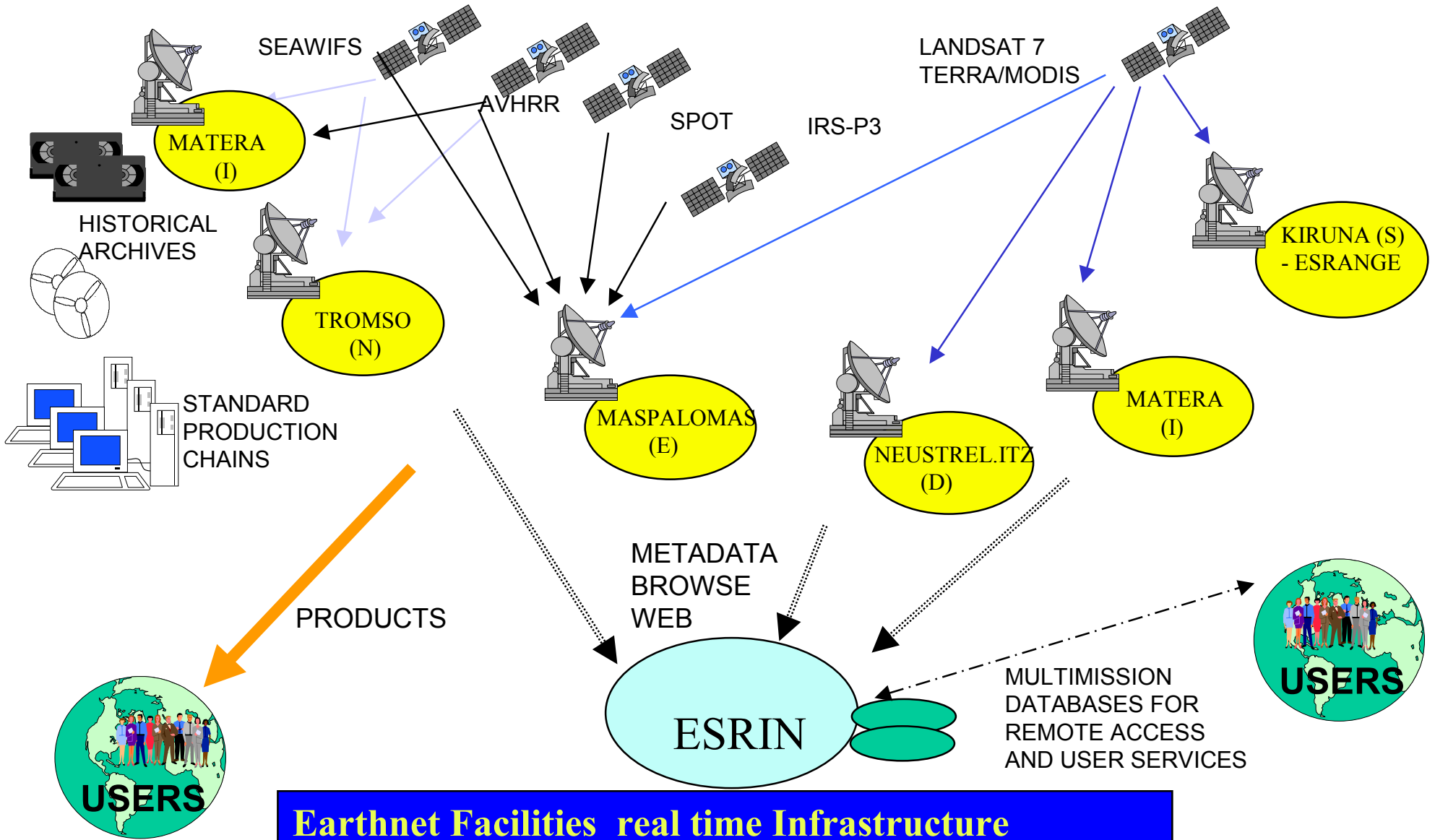


Earth Observation Analysis

- Future G/S requirements
- Collaborative environments

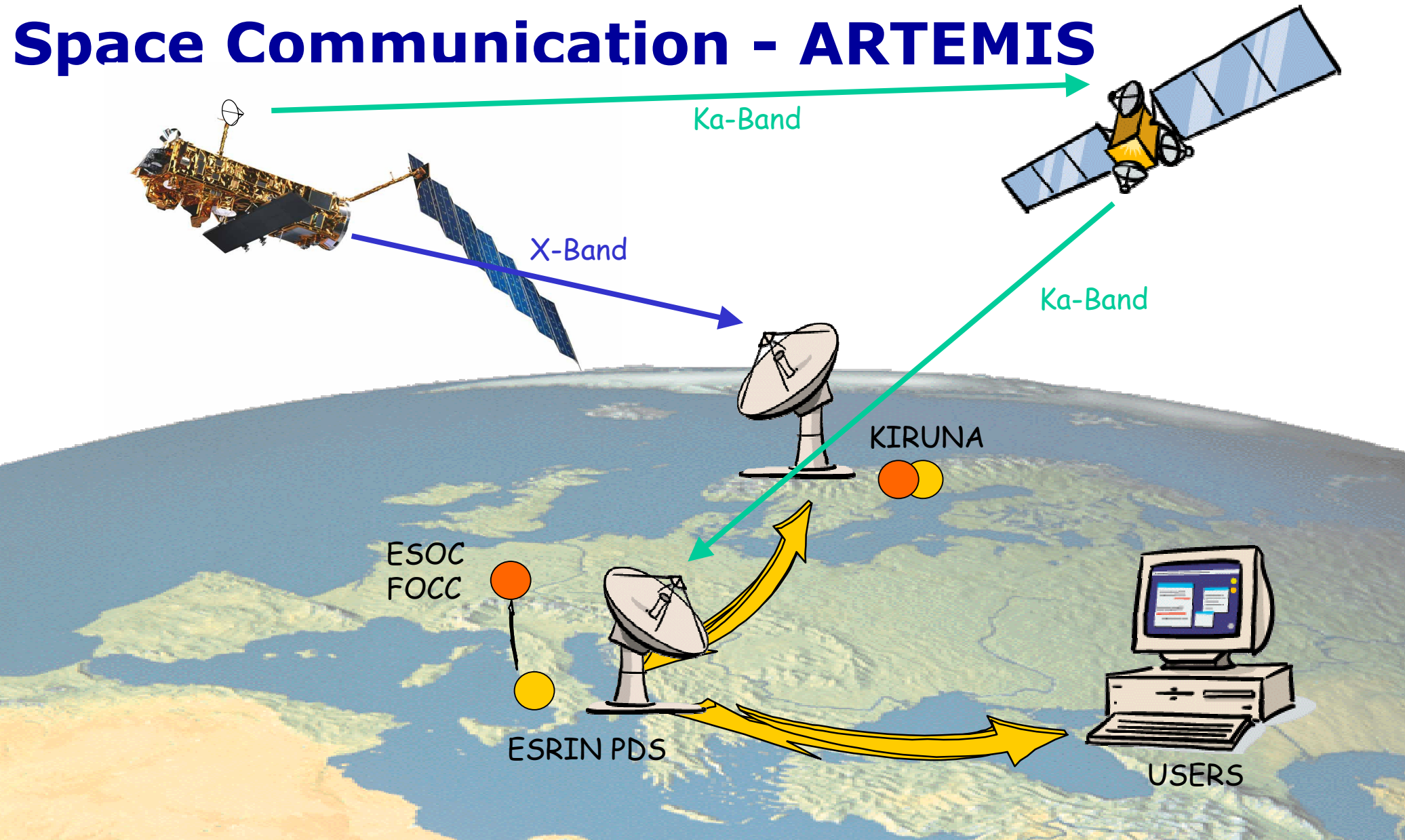
ESA internal GRID activities http://esagrid.esa.int

- SpaceGRID
- ESA Internal Grid Initiative
  - few key departments are now participating (after first year)
- Access to high speed research network
  - Corporate network (EQUANT), space links, … but …
- Distributed ESA internal GRID infrastructure
  - Gigabit connectivity to ENEA GRID infrastructure, but …
- External cooperation
  - Committee on EO Satellites, Bilateral NASA-ESA, …

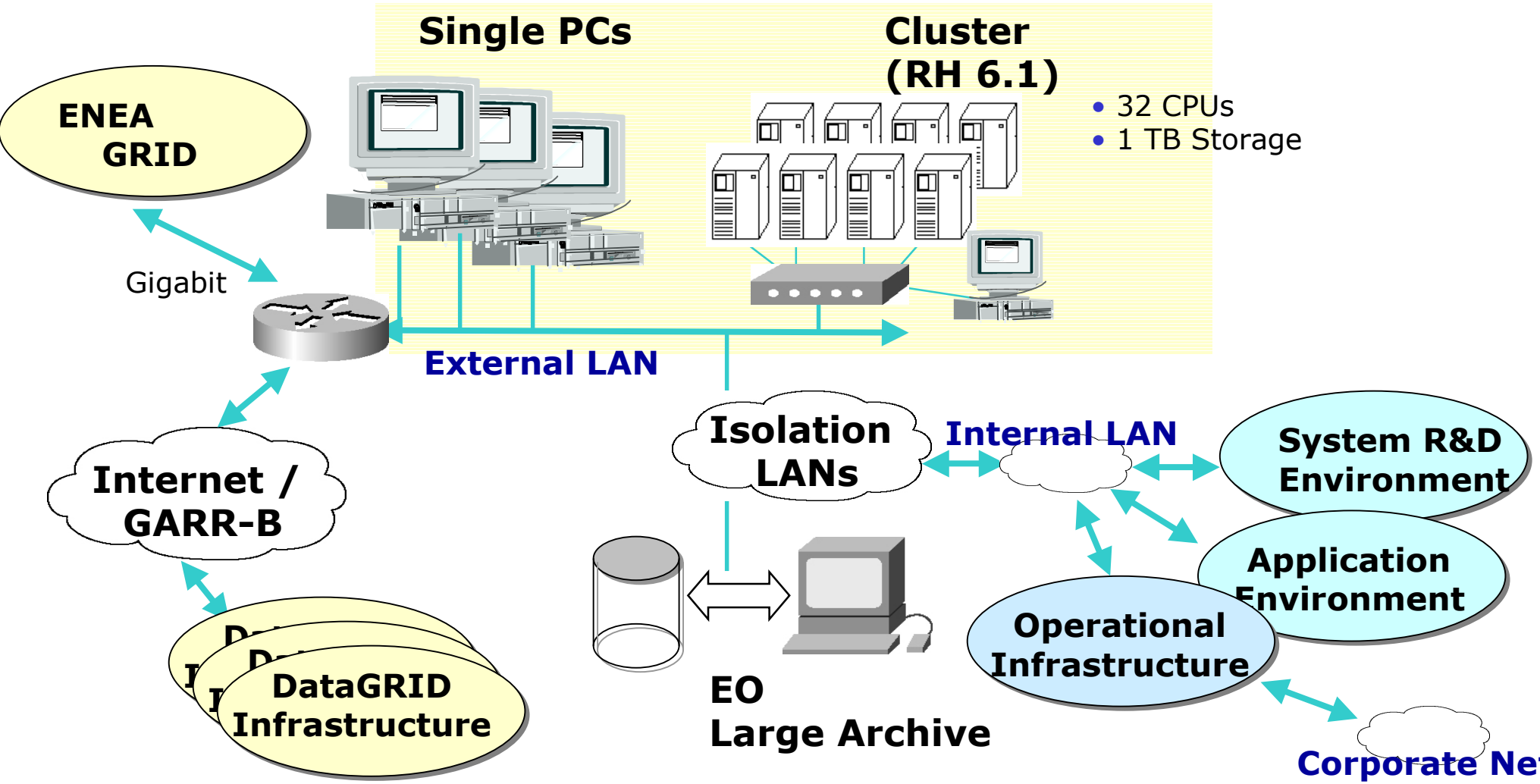


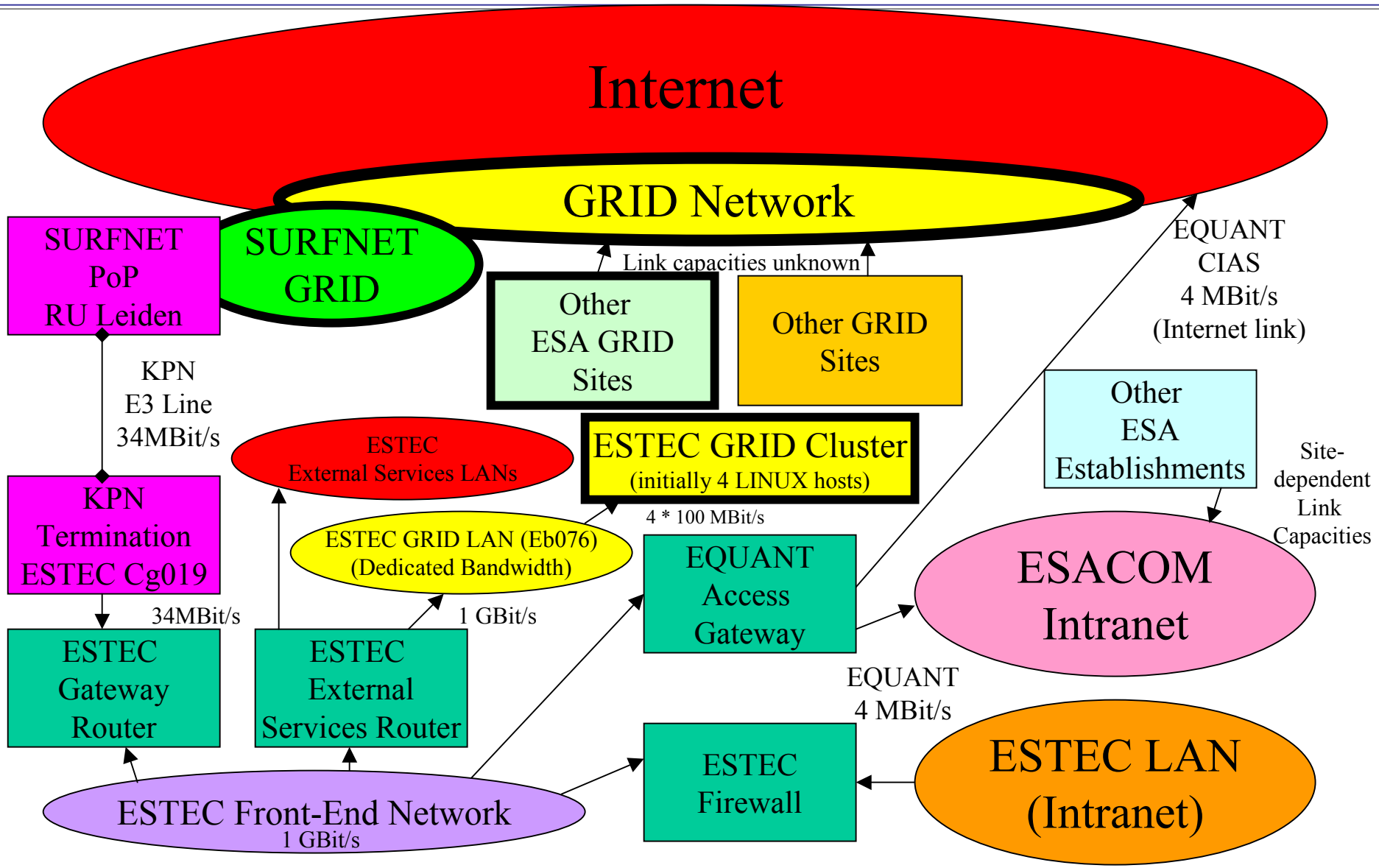
Earthnet Facilities real time Infrastructure

Space Communication - ARTEMIS

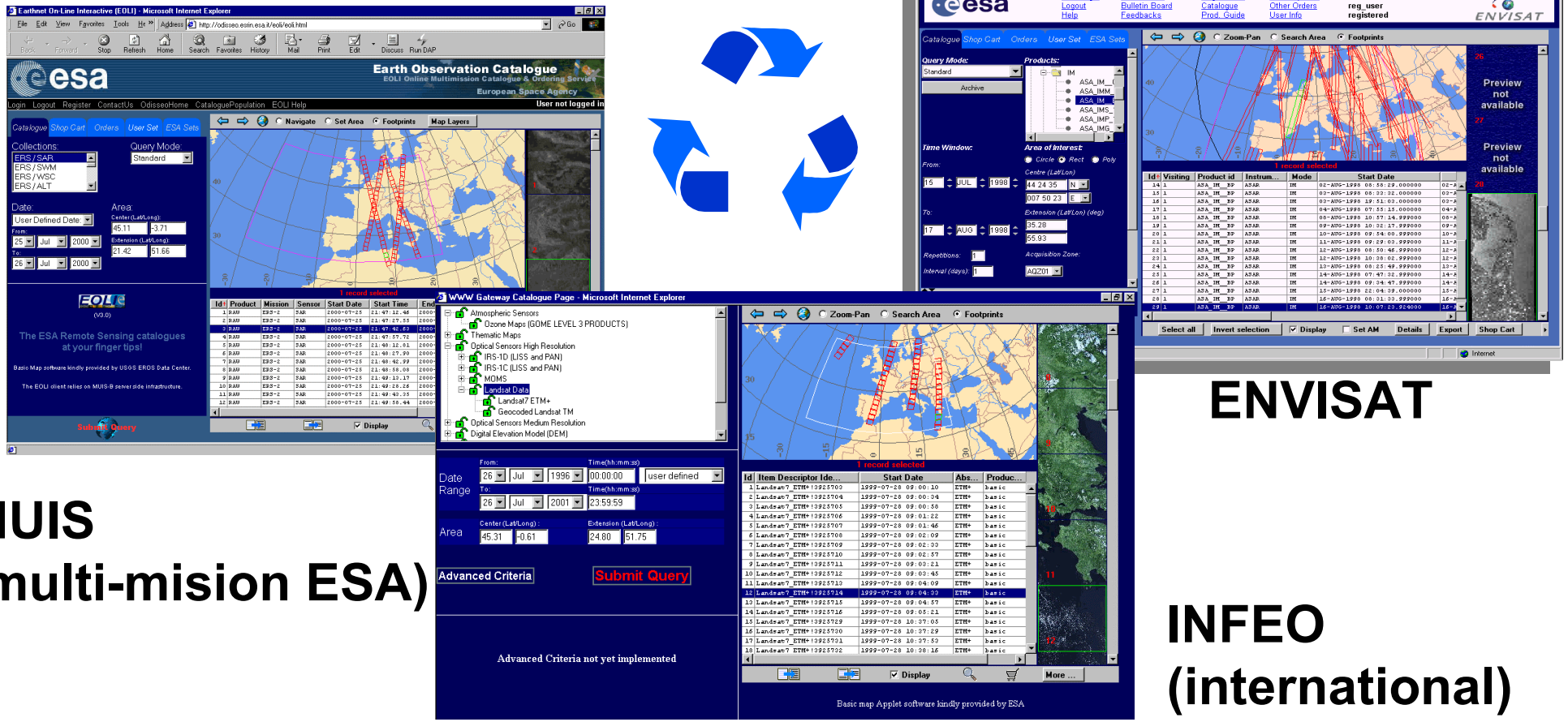


The ESRIN DataGRID infrastructure




Internet
GRID Network
SURFNET PoP RU Leiden
SURFNET GRID
Link capacities unknown
Other ESA GRID Sites
Other GRID Sites
EQUANT CIAS 4 MBit/s (Internet link)
KPN E3 Line 34MBit/s
ESTEC External Services LANs
ESTEC GRID Cluster (initially 4 LINUX hosts)
Other ESA Establishments
Site-dependent Link Capacities
KPN Termination ESTEC Cg019
4 * 100 MBit/s
ESTEC GRID LAN (Eb076) (Dedicated Bandwidth)
EQUANT Access Gateway
ESACOM Intranet
34MBit/s
1 GBit/s
ESTEC Gateway Router
ESTEC External Services Router
EQUANT 4 MBit/s
ESTEC Front-End Network 1 GBit/s
ESTEC Firewall
ESTEC LAN (Intranet)

EO interoperability experience

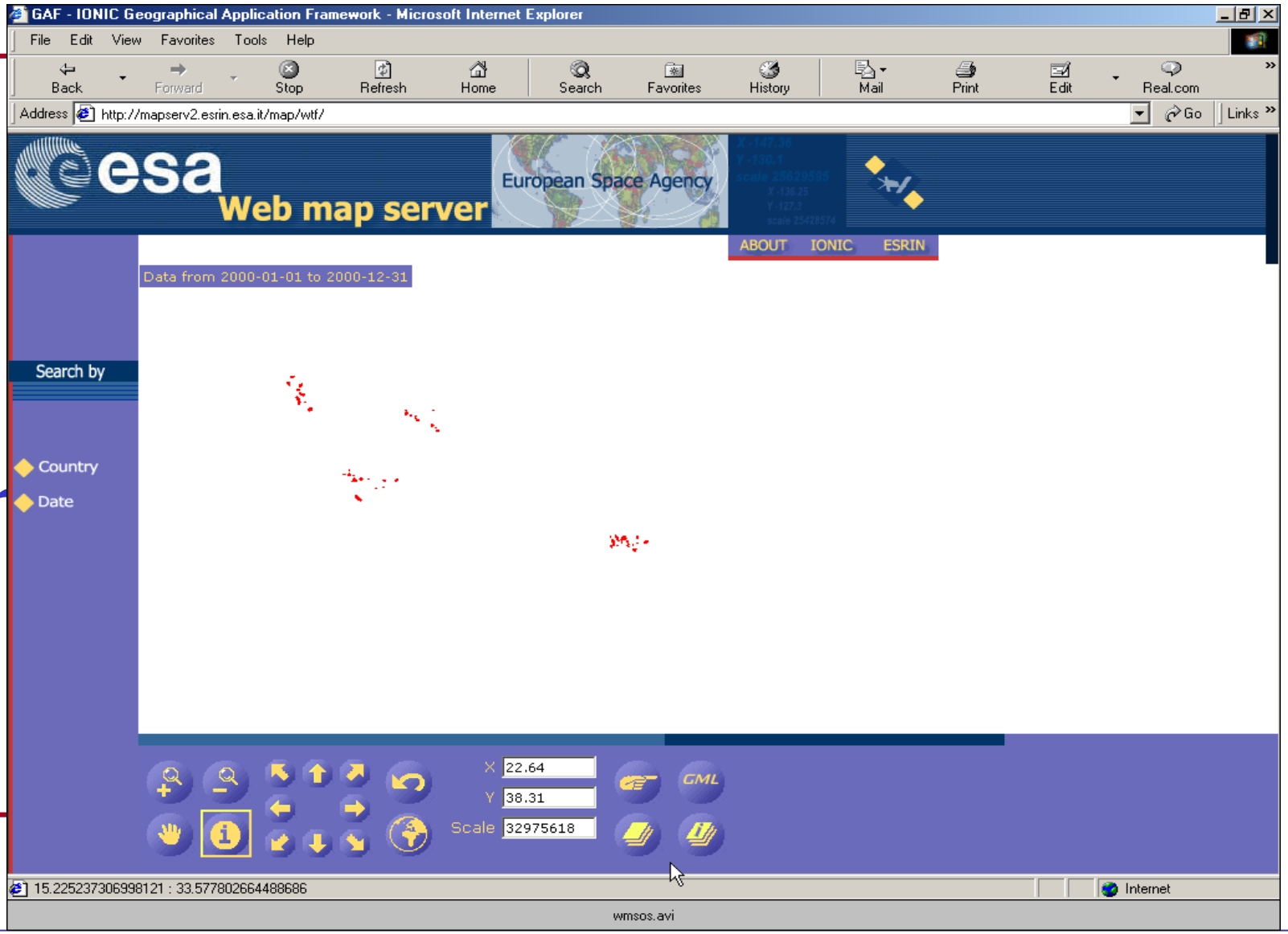


MUIS (multi-mision ESA)

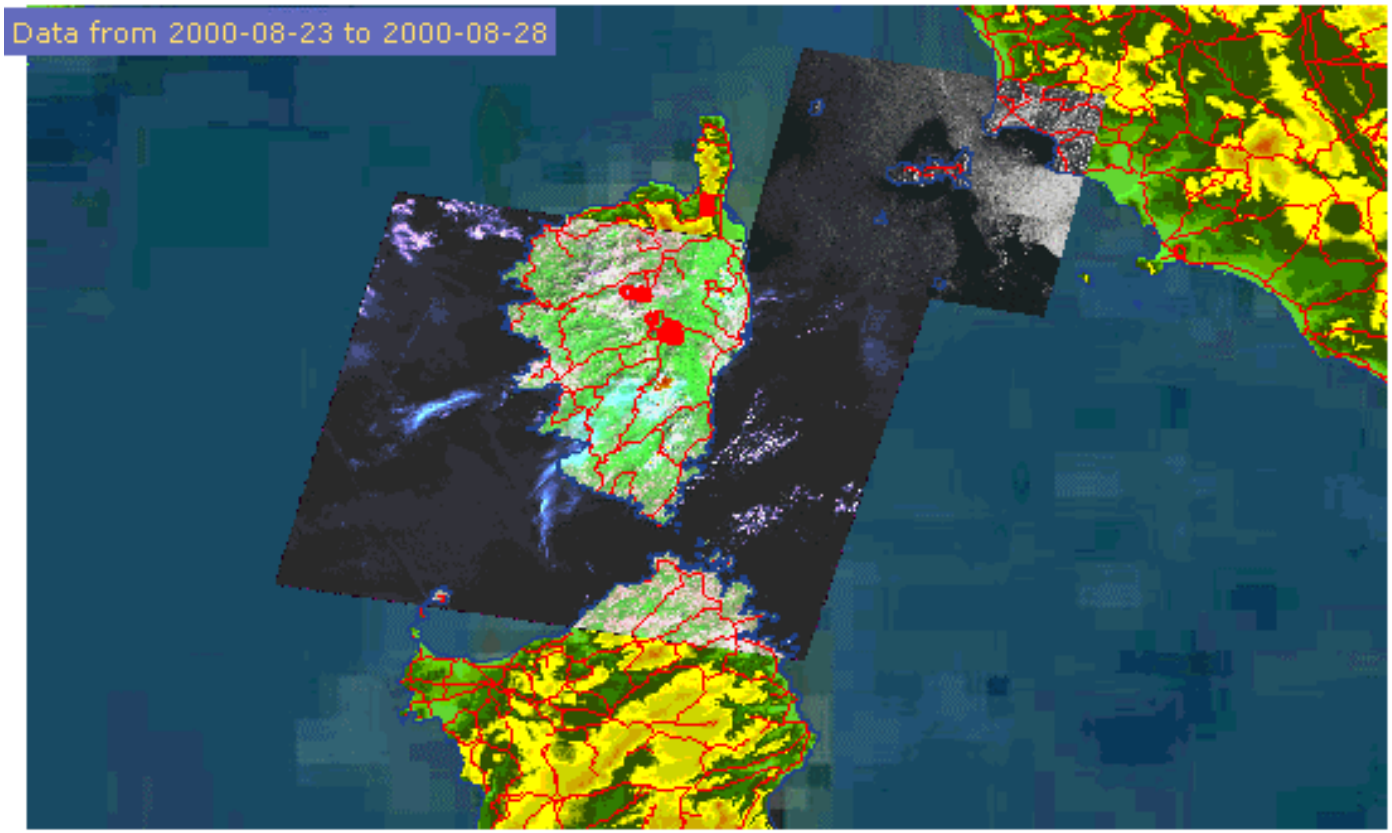
ENVISAT

INFEO (international)

Demon-stration of Web map user interface



Multi-Mission Web Mapping results



- **Example: burn scars over Corsica**
- **7 combined GIS & EO satellite layers(Landsat, ERS)**
- **Real-time from 4 servers (ESA, NOAA, Canada, Netherlands)**

Other ESA Initiatives

- **Virtual Insitutes for Internation Space Station Utilisation**
- **PLANCK/IDIS: High-rate data transfer to Multiple sites of 1-GB Maps**
  - **includes: MPS, Garching, Paris, OAT/Trieste, Cantabria**
- **Helio-seismology data retrieval: Daily Solar Images**
- **Satellite-based augmentation of network and core services for GRID Apps**
- **Concurrent Design Facility**
- **ESA Virtual Archive**

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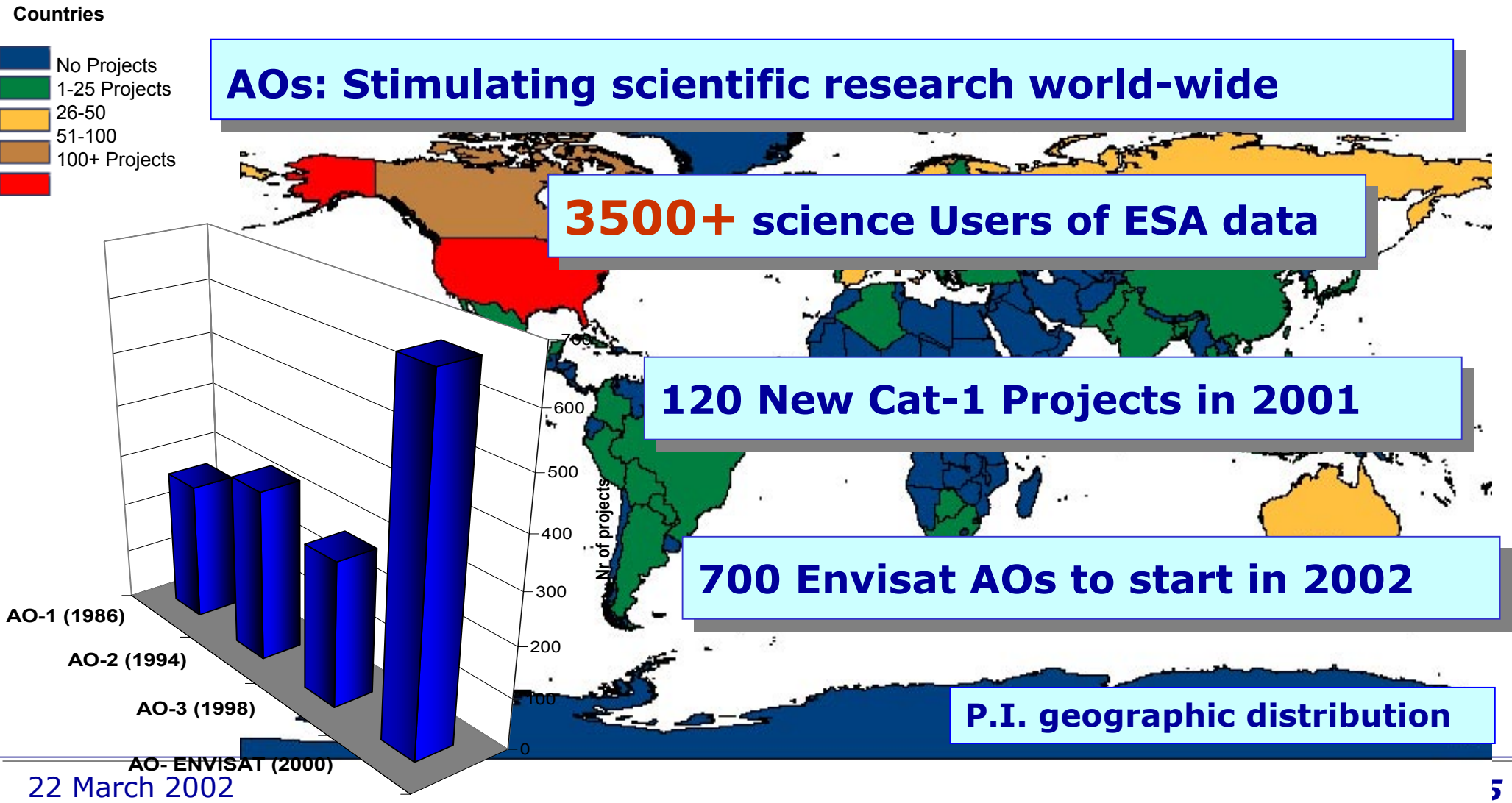
ESA GRID future perspectives

- **Provide a more responding GRID architecture model for Space Applications**
- **Invest in Building Blocks to Create a set of Attractive Tools. (make Grid "touchable")**
- **Involve "educational" and General Public Institutions (e.g. Planetaria) to jump on the Band Wagon!**

Preparation of an ESA internal "GRID labeled" programme is an issue

Stimulating new researchs (EO example)



Ideas for EIROFORUM GRID WG

- **Foster Relations in various domains to achieve a common European Grid Infrastructure**
- **Coordinate Studies and their results for the benefit of other domains**
- **Promote e-collaboration across disciplines**
- **Involve and examine Industrial Readiness in Europe**
- **Involve Pressure Groups to make the necessary resources available.**