Distributed European Infrastructure for Supercomputing Applications

DEISA
Integrating European HPC Infrastructures

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Agenda

Distributed European Infrastructure for Supercomputing Applications

- A European HPC overview
- DEISA objectives and environment
- The DEISA network infrastructure
- Lessons learned
- Conclusion and Summary

HPC as a driving force for research

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- Scientific research is based on the three pillars:
  Theory, Experiment and Simulation
- The tool providing capacity for solving most challenging problems through simulations are supercomputers
- Access to these supercomputer systems is normally restricted to a small group of scientist having access to a national facility
- Providing access to these services for researchers all over Europe independent of national boundaries and with optimal resource utilization is an ongoing challenging task

The ESFRI vision & DEISA

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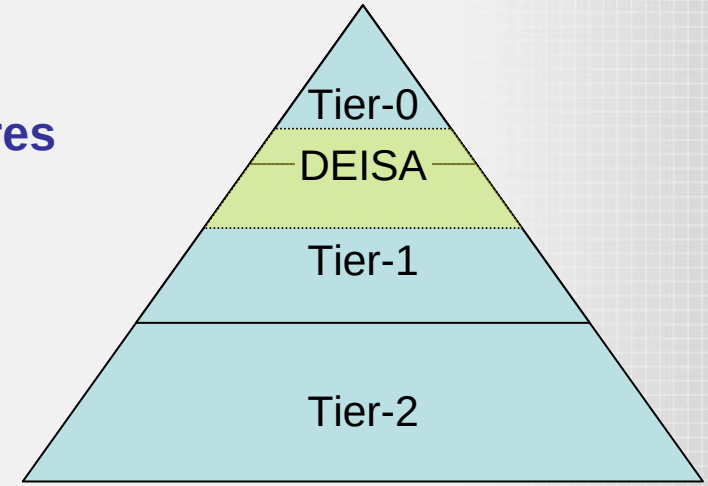
The ESFRI Vision for a European HPC service defined in 2006

- **Research Infrastructures as crucial pillars for the European Research Area**
- **European HPC facilities as the top of an HPC provisioning pyramid having**
  - **Tier-0: 3-5 European facilities**
  - **Tier-1: National facilities**
  - **Tier-2: Regional/ University Centres**

DEISA has started this process in 2004 already defining a virtual European supercomputing center on existing national supercomputer resources



DEISA objectives

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- **contribute to a significant enhancement of capabilities and capacities of high performance computing (HPC) in Europe**
  - ⇨ **integration of leading national supercomputing infrastructures**
- ***deploy and operate a distributed multi-terascale European computing platform*, based on a strong coupling of existing national supercomputers not tied to any specific pre-established technology**
  - ⇨ **operate as a virtual European supercomputing center**
- ***contribute to the deployment of an extended, heterogeneous Grid computing environment for HPC in Europe***
  - ⇨ **interfacing the DEISA research infrastructure with the rest of the European IT infrastructures.**
- **Enabling new science is the only criterion for success.**

DEISA objectives

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- DEISA does not contradict the ESFRI vision for a European HPC service
- It defines itself as a precursor and infrastructure for future European HPC research
- leading the way to European HPC services and
- filling the gap between
  - existing national Tier-1 centers and
  - future Tier-0 facilities

Participating Sites

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BSC	***Barcelona Supercomputing Centre***	**Spain**
CINECA	***Consortio Interuniversitario per il Calcolo Automatico***	**Italy**
CSC	***Finnish Information Technology Centre for Science***	**Finland**
EPCC/HPCx	***University of Edinburgh and CCLRC***	**UK**
ECMWF	***European Centre for Medium-Range Weather Forecast***	**UK (int)**
FZJ	***Research Centre Juelich***	**Germany**
HLRS	***High Performance Computing Centre Stuttgart***	**Germany**
IDRIS	***Institut du Développement et des Ressources en Informatique Scientifique - CNRS***	**France**
LRZ	***Leibniz Rechenzentrum Garching***	**Germany**
RZG	***Rechenzentrum Garching of the Max Planck Society***	**Germany**
SARA	***Dutch National High Performance Computing and Networking centre***	**The Netherlands**

DEISA HPC environment

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23.460 processors and 205 Teraflop in March 2007, changing constantly

IBM AIX Super-cluster

- **FZJ - Juelich, 1312 processors, *8,9 teraflops peak***
- **RZG - Garching, 896 processors, *4,6 teraflops peak***
- **IDRIS, 1024 processors, *6,7 teraflops peak***
- **CINECA, 512 processors, *2,6 teraflops peak***
- **CSC, 512 processors, *2,2 teraflops peak***
- **ECMWF, 2 * 2276 processors, *33 teraflops peak***
- **HPCx, 1600 processors, *12 teraflops peak***

- **BSC, IBM PowerPC Linux system (MareNostrum)**
  10240 processors, 94 *teraflops peak*
- **SARA, SGI ALTIX Linux system**
  416 processors, *2,2 teraflops peak*
- **LRZ, SGI ALTIX system 4096 processors, *26,2 teraflops peak***
  in 2007* *> 60 teraflops peak
- **HLRS, NEC SX8 vector system 576 processors, *12,7 teraflops peak***

DEISA
service and joint research activities

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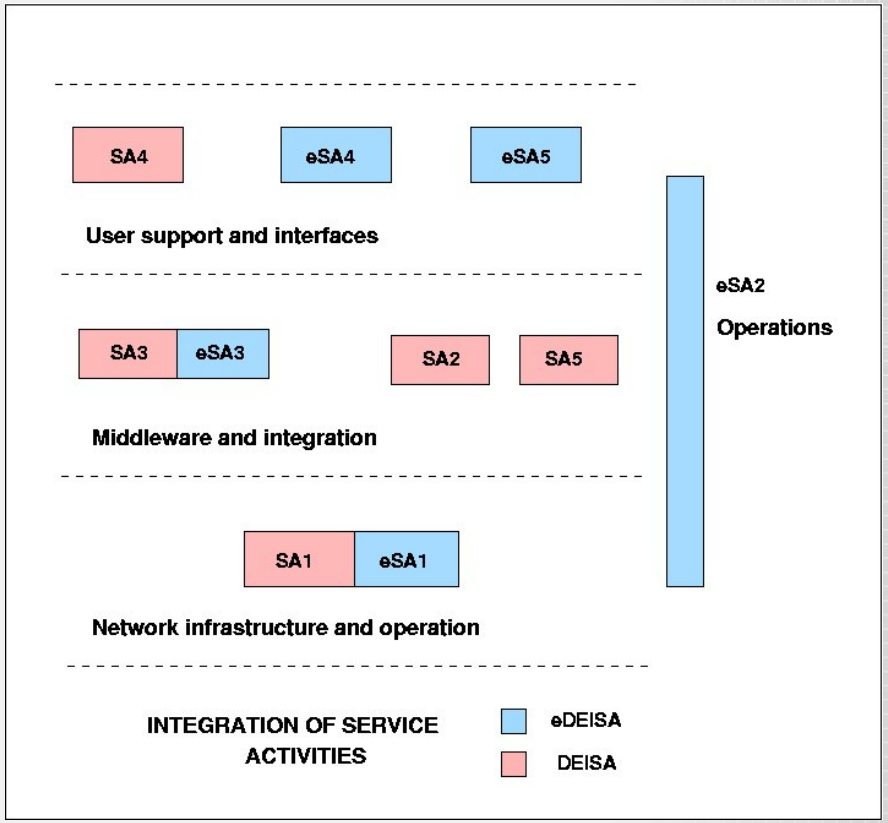
Service Activities

- Network Infrastructure and Operation
- Operation of the Grid Infrastructure
- Data Management with GPFS
- Resource Management
- Applications and User Support
- User Interfaces
- Security



Joint Research Activities

- Material Sciences
- Cosmology
- Plasma Physics
- Life Sciences
- Industrial CFD
- Coupled Applications
- Access to Resources in Heterogeneous Environments

The DEISA facility

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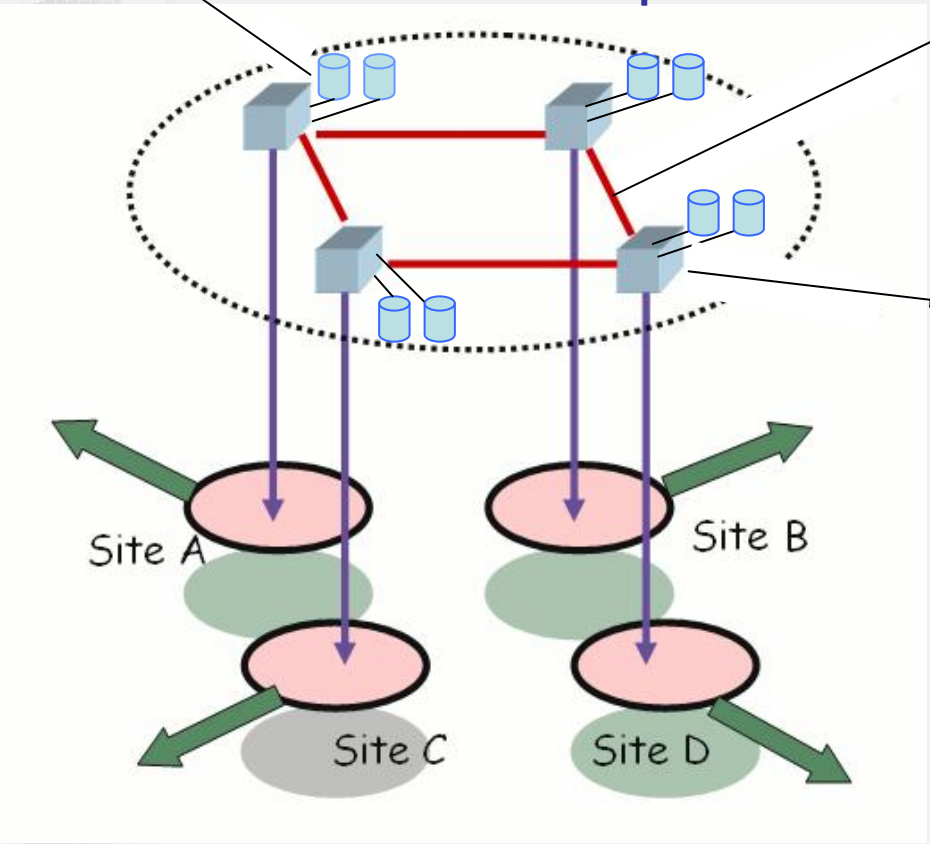
Global distributed, high performance file system with continental scope (GPFS).
File transfer transparent to users.



Dedicated bandwidth network:
GEANT2 and NRENs

National supercomputing platforms:
- BSC – Spain
- CINECA - Italy
- CSC - Finland
- ECMWF- UK
- EPCC - UK
- FZ-JÜLICH - Germany
- HLRS - Germany
- IDRIS - France
- LRZ- Germany
- RZG – Germany
- SARA – The Netherlands

Extended Grid services :
Portals, Web-like services, …
Interfacing the core platform to other virtual organizations.
Grid-middleware used: Unicore and Globus hiding complex environments from end users

DEISA network infrastructure

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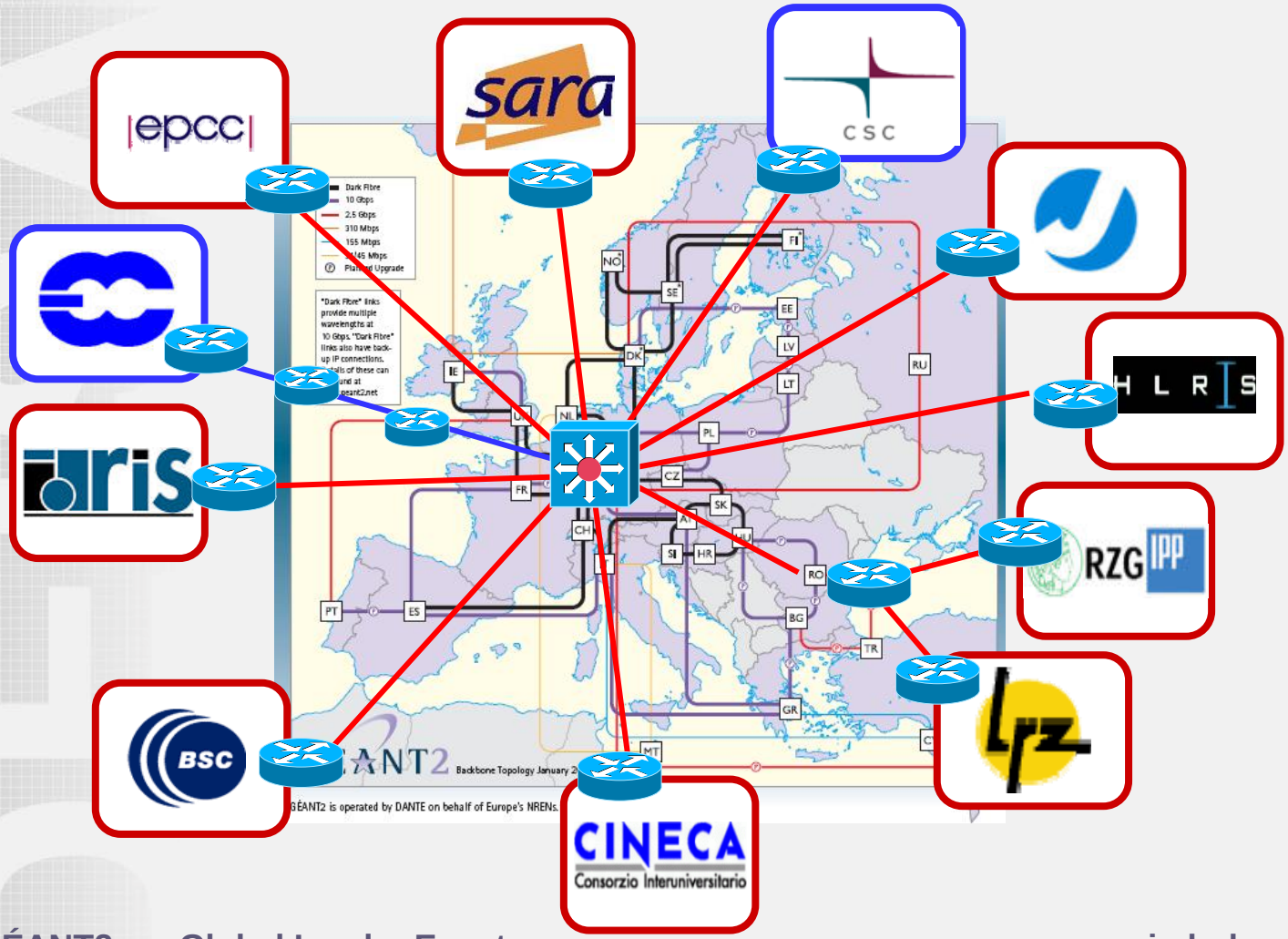

DFN

FUNET

GARR

RedIris

RENATER

SURFnet

UKERNA

Dedicated 10 Gb/s wavelength

1 Gb/s LSP

GRE-Tunnel

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DEISA and its middleware

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Challenging task is to run bigger and more demanding applications.

"Grid enable" applications is not the right way to do (old term "metacomputing" failed because of latency problems)

DEISA uses a different strategy:

- Load balance computational load across national boarders. Huge, demanding apps can be run because of reorganizing workload (freeing resources) by transferring smaller jobs to other sites (MC-LoadLeveler)
- Transparent file sharing through IBM's GPFS
- UNICORE used for accessing the heterogeneous set of computing resources and managing workflow applications
- New middleware will be evaluated in future (e.g. Unicore6 & GTK4)
- Gridftp to access and store data on other non-DEISA storage resources
- Provide high performance access to distributed data sets (DB management software OGSA-DAI or grid storage software SRB)

DEISA Extreme Computing Initiative
enabling leading computational science

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- DECI is the basic service provisioning model for scientific users
- Identification, deployment and operation of a number of « flagship » applications requiring the infrastructure services in selected areas of science and technology.
- European Call for proposals in May-June every year.
- Applications selected on scientific excellence, innovation & relevance with collaboration of HPC national evaluation committees.
- Projects in operation: 27 (2006), 23/5 (2007), 45+ (2008)
- Supported by an Applications Task Force:
  - Enabling and deploying the Extreme Computing applications
  - Hyperscaling of huge parallel applications, data oriented applications, Workflows and coupled applications
  - Production of an European Benchmark Suite for HPC systems in collaboration with the HPC-EUR initiative, to be used in future procurements of European supercomputers.

DEISA lessons learned

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- Operation of a DEISA like production infrastructure opens new management challenges
- Staff members dealing with a problem are thousands of miles apart
- No short cuts, no office next door
- Every small software or hardware modification requires
  - agreement on all sites
  - may lead to dependencies not directly obvious
- Task scheduling, installations, maintenance, and network infrastructure changes have to be planned in advance and agreed on
- A global operations team is mandatory to handle all this issues and to decide on further progress in case of disagreement

DEISA lessons learned (cont.)

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The same applies to network issues

- **Operation and monitoring of network links across several administrative domains is a challenge**
- **GEANT2 and the NRENs have done a good job here providing the infrastructure for DEISA … at least so far**
- **But things are becoming more complicated in the future having virtual organizations building up and being suspended in even shorter time frames**
- **Providing network services for those upcoming and always changing grid infrastructures will become a new challenge**
- **Having a secure and dedicated infrastructure like DEISA allows to rest easy**

But what to improve in future?

DEISA future network requirements

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- **Optical protection of links**
- **Bandwidth on Demand services**
- **Cross Domain link management**
- **…**

I know most of this is already on the way

Conclusion

- Four years of successful operation have shown that the concept implemented in DEISA proceeded very well
- This does not preclude that organizational structures of DEISA may change over time
- But the general idea of DEISA will sustain
- Being a central player within European HPC, DEISA intends to contribute to a global eInfrastructure for science and technology furthermore
- Integrating leading supercomputing platforms with Grid technologies and reinforcing capability with shared petascale systems is needed to open the way to new research dimensions

- This vision can only be achieved with fruitful participation of

GÉANT2 – the Global Leader

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Questions ???