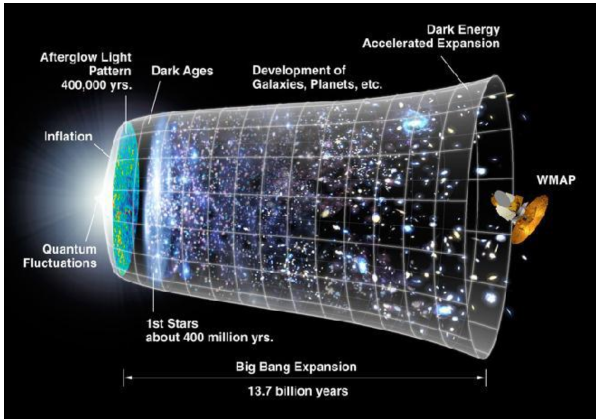
ADASS 2010 BOSTON

ASTRONOMICAL DATA ANALYSIS SOFTWARE AND SYSTEMS XX

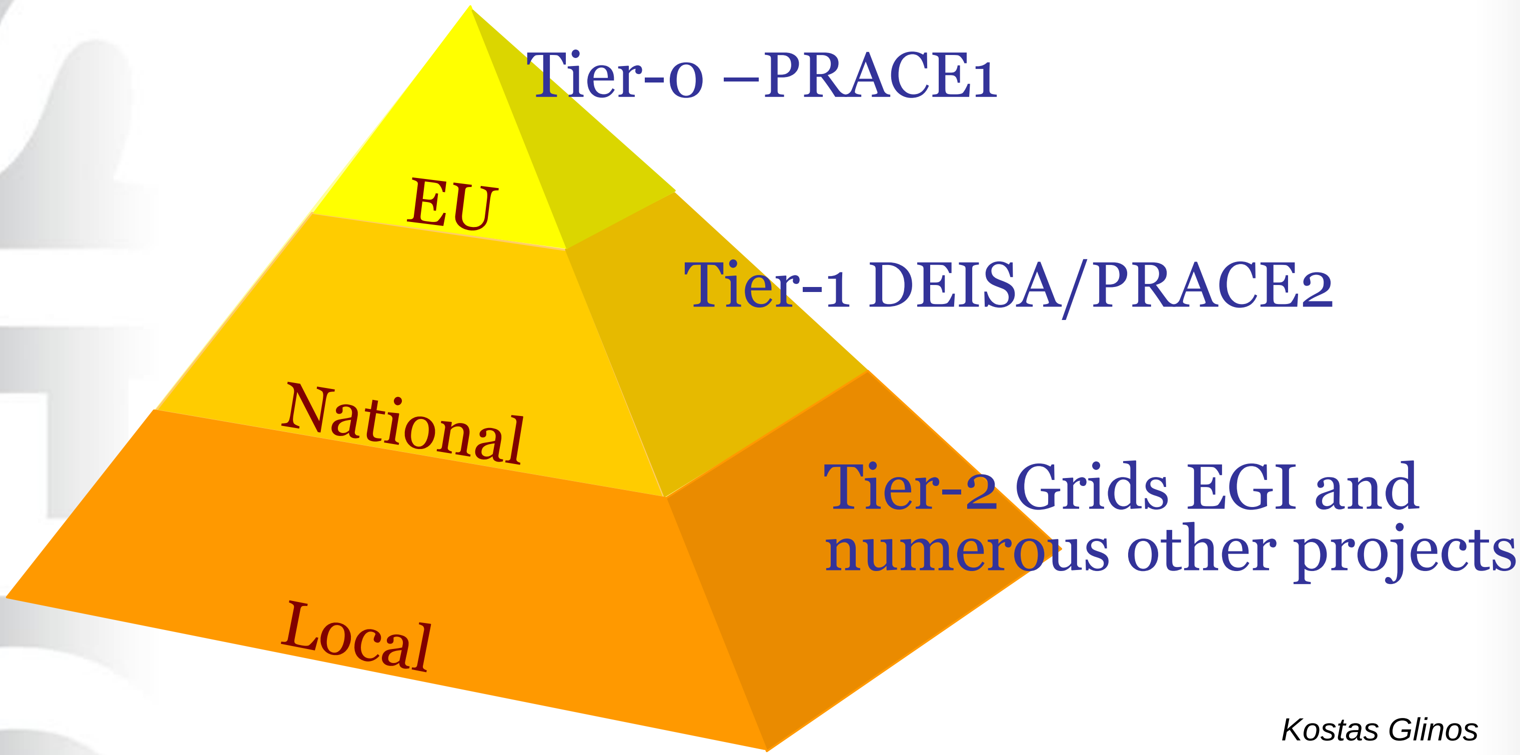
Big Science on DEISA and PRACE

A European HPC Ecosystem

Wolfgang GENTZSCH
The DEISA Project
Max-Planck-Institute for Plasmaphysics, Garching, Germany



European HPC Eco-System



Kostas Glinos

European Commission, 2010

PRACE – A Partnership with a Vision

- Provide world-class HPC systems for word-class science
- Support Europe in attaining global leadership in public and private research and development

… and a Mission

- Create a world-leading persistent high-end HPC infrastructure managed as a single legal entity
  - Deploy systems of the highest performance level (Tier-0)
  - Ensure a diversity of architectures to meet the needs of European users
  - Collaborate with vendors and ISVs on strategic HPC technologies
  - Provide support and training

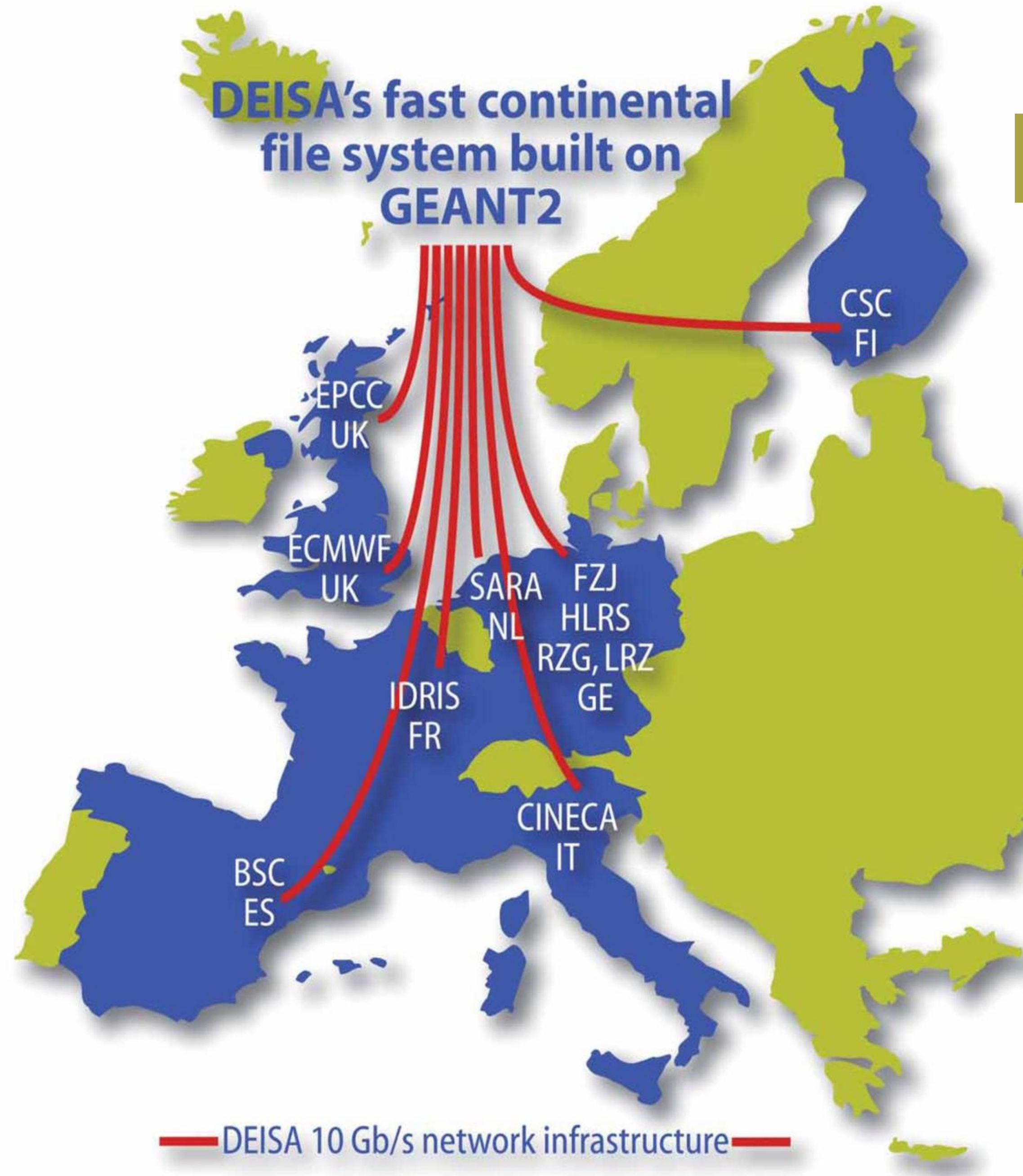
The PRACE Initiative

- **2007 April, 16:**
  Memorandum of Understanding signed by 14 European member states in Berlin
- **2008: France, Germany, Spain, UK, and The Netherlands reconfirmed their commitment for establishing a European HPC Research Infrastructure**
- **2009: Italy became a Principal Partner in September**
- **2009: 6 new European member states have joined the PRACE initiative (Bulgaria and Czech Republic joined in September)**
- **20 Partners have committed to accede the PRACE Association until June 30.**

PRACE Status and Current Activities

- Preparatory Phase Project ended in June 2010 after 2 ½ years
  - Contracts for legal entity prepared
  - 400 Mio € funding for the next 5 years secured from France, Germany, Italy, Spain
  - Decisions about additional 200 Mio € from The Netherlands and UK expected soon
  - Architectures for Tier-0 systems identified
  - IBM Blue Gene/P in Gauss@Jülich selected as first Tier-0 system

- The first Implementation Phase Project started in July 2010



Distributed European Infrastructure for Supercomputing Applications

DEISA

Six years of operation

Most powerful European Supercomputers for most challenging projects

Grand Challenge projects performed on a regular basis

Top-level Europe-wide application enabling

Virtual Science Community Support

Unified Access and Use of HPC Resources

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Access via Internet

single sign-on (based on X.509 ‘Grid‘ certificates)
gsi-ssh -> D-ssh
Unicore, gridFTP

DEISA Common Production Environment

Different Software Environments

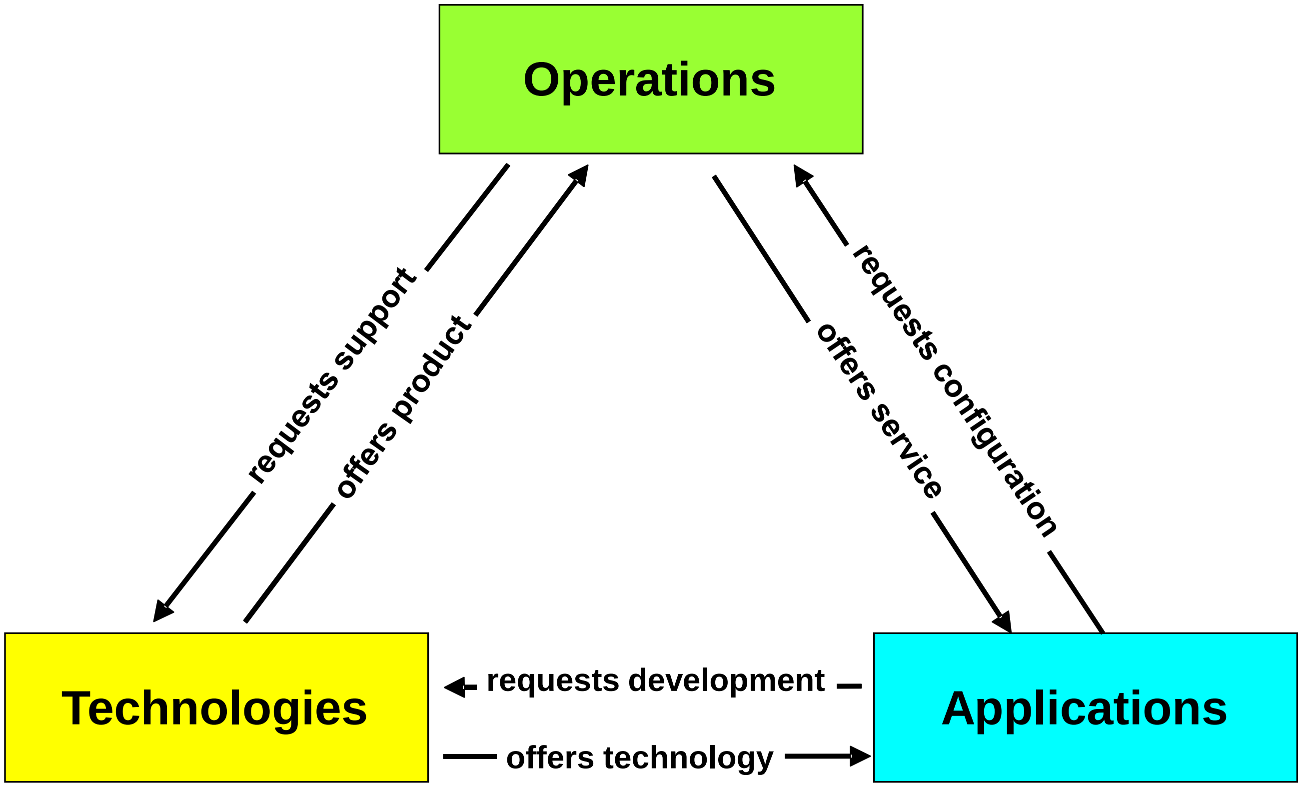
SE A1	SE B1	SE C1	SE D1	....	SE E1	SE B2	SE C2

Different SuperComputers - Compute elements and interconnect

Dedicated 10 Gb/s network – via GEANT2

DEISA highly performant continental global file system

Categories of the Orchestrated DEISA services



DEISA Service Layers

Multiple ways to access	Workflow managemnt	Common production environmnt	*Presen-tation layer*
Single monitor system	Job rerouting	Co-reservation and co-allocation	*Job manag. layer and monitor.*
Data staging tools	Data transfer tools	WAN shared File system	*Data manag. layer*
Unified AAA	**DEISA Sites**	Network connectivity	*Network and AAA layers*

DEISA UNICORE Infrastructure

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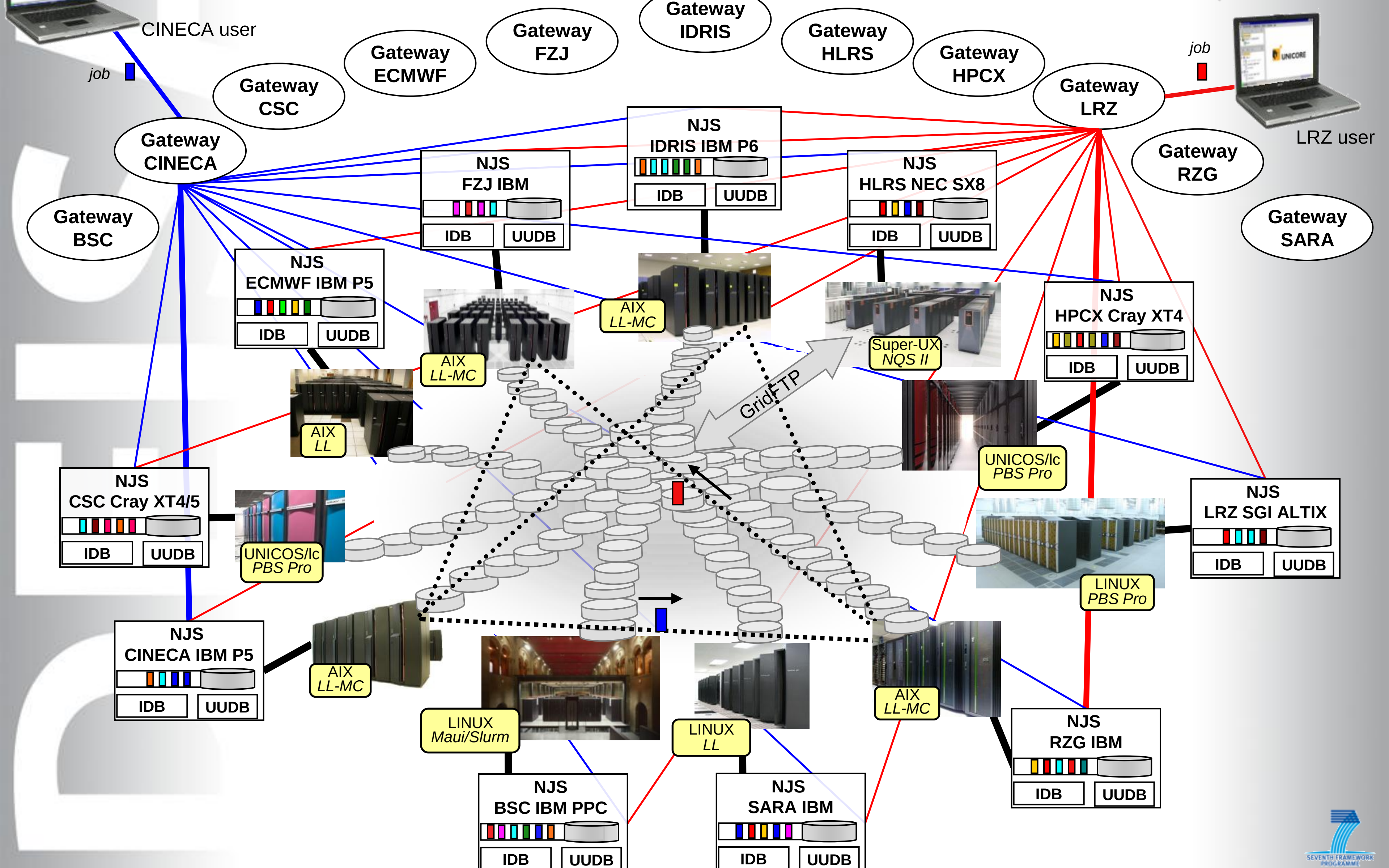

UNICORE 6 Architecture

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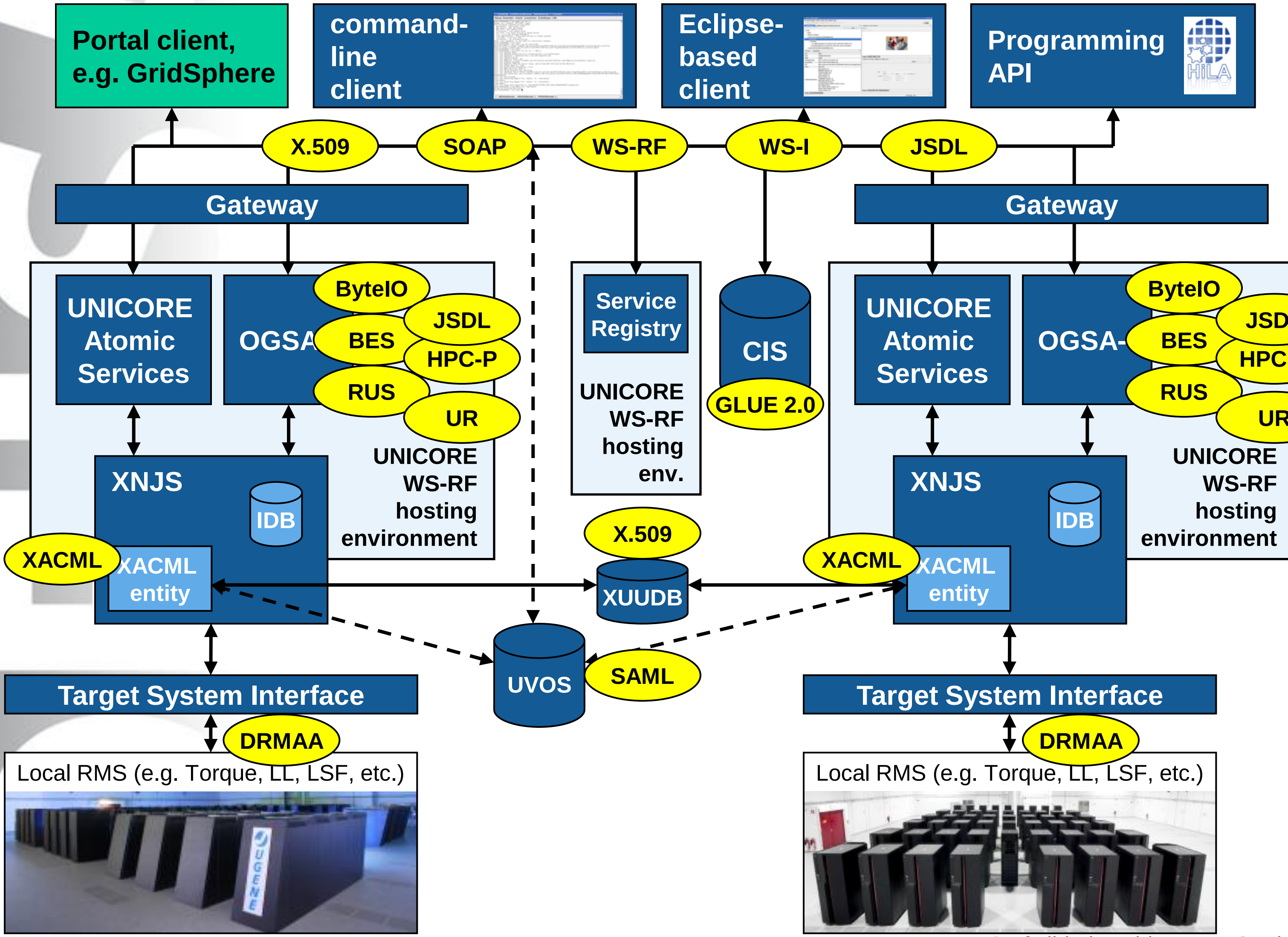

scientific clients and applications

authentication

emerging standard interfaces

Grid services hosting

job incarnation & authorization

parallel scientific jobs of multiple end-users on target systems

DEISA Global File System

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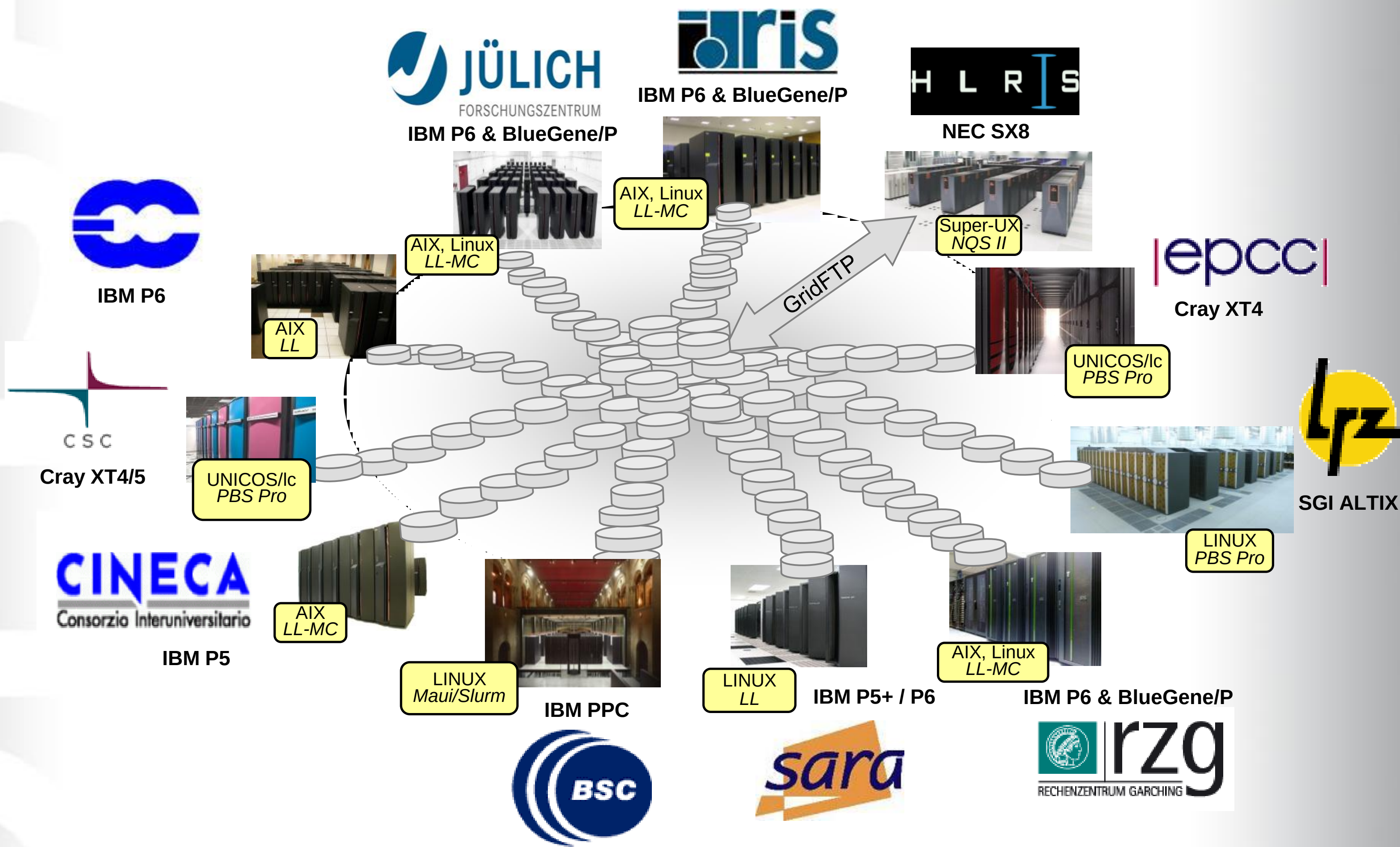
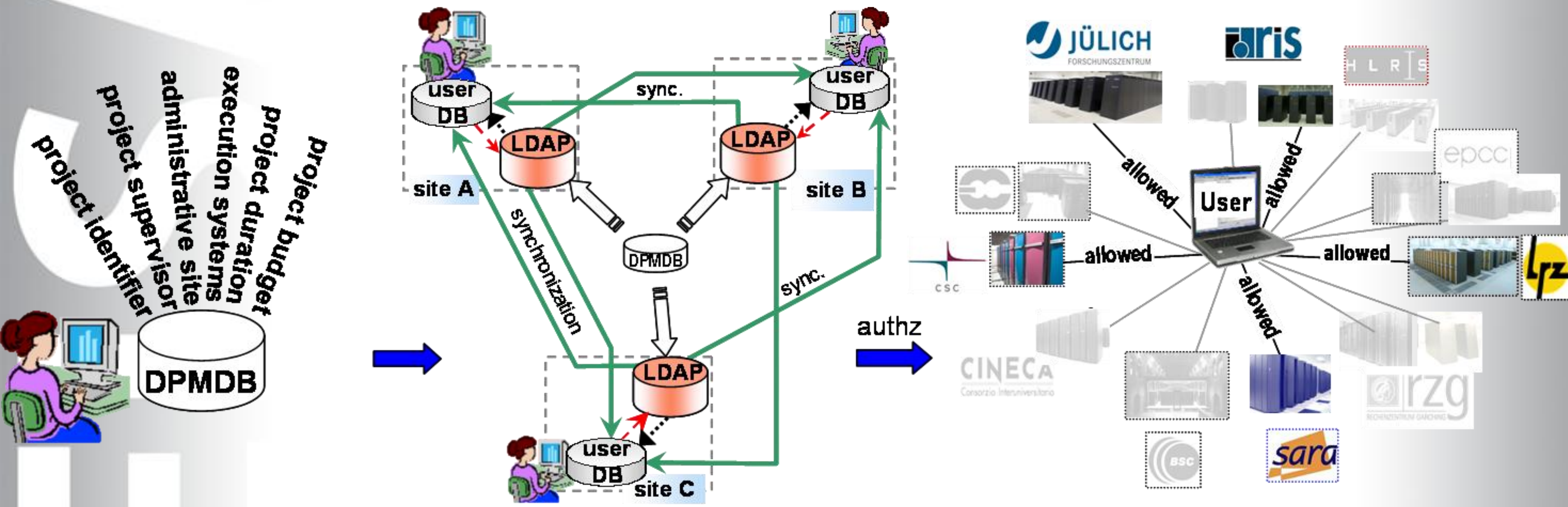


Global transparent file system based on the Multi-Cluster General Parallel File System (MC-GPFS of IBM)

DEISA User Administration System (DUAS)



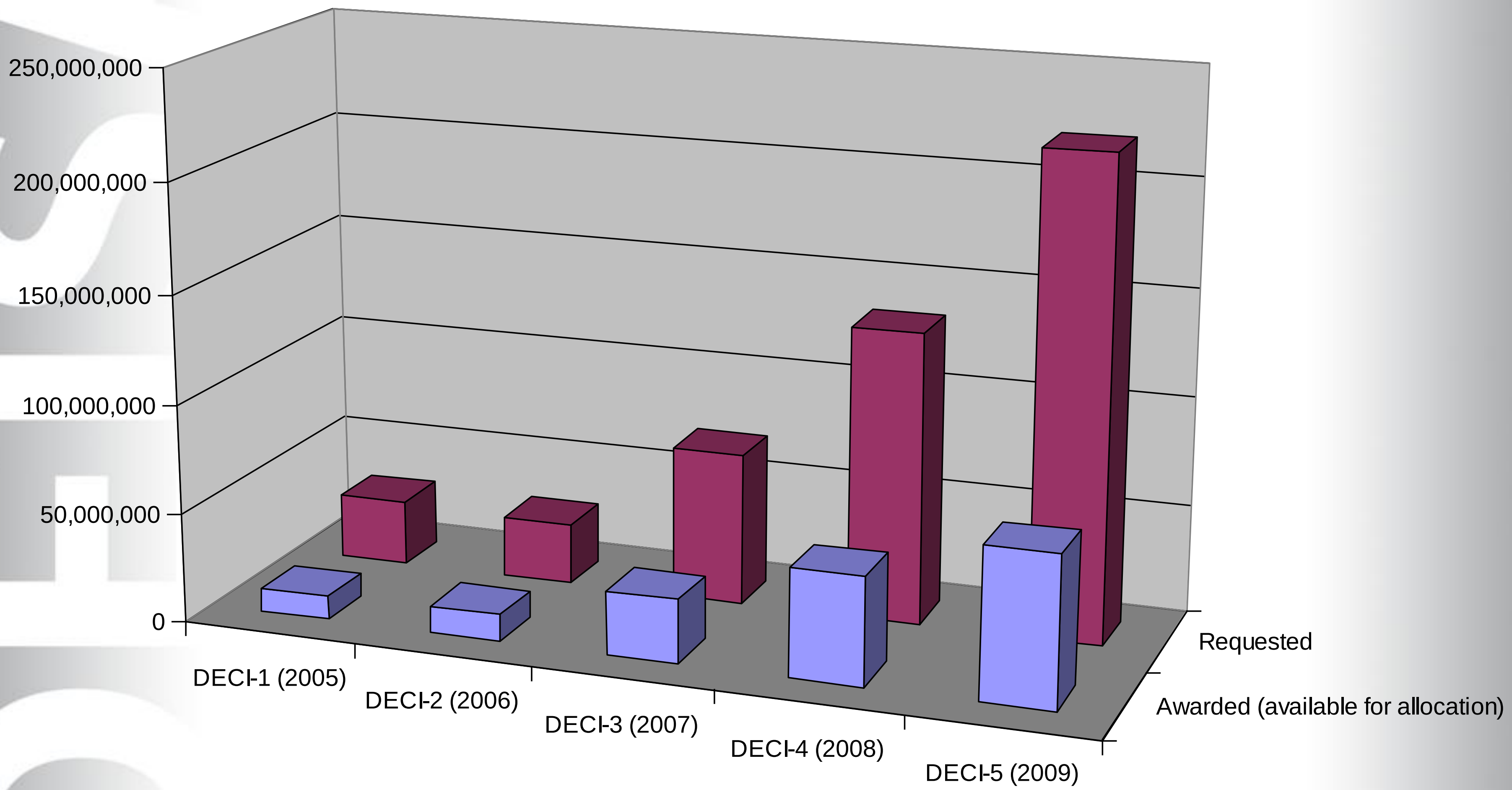
a) DEISA Project Administration b) Federated User Administration c) Authorized Access to HPC Resources

Basic information about projects of users and virtual communities is provided by the central DEISA Project Management Database (DPMDB). This information can be used by the sites to synchronise their local user administration systems and LDAP directories.

DEISA Extreme Computing Initiative (DECI)

- DECI launched in 2005: complex, demanding, innovative simulations requiring the exceptional capabilities of DEISA
- Multi-national proposals encouraged
- Proposals reviewed by national evaluation committees
- Projects chosen on the basis of innovation potential, scientific excellence, relevance criteria, and national priorities
- Most powerful HPC architectures for most challenging projects
- Most appropriate supercomputer architecture selected

CPU requested in DECI proposals



Demand for CPU increasing at a faster rate than supply

Astrosciences
on the DEISA Infrastructure

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- Modelling of turbulent astrophysical flows
- Galaxies–intergalactic medium interaction
- Planck satellite simulations
- Simulating the Local Universe
- Turbulent, active, and rotating stars
- Simulating Type Ia supernovae

Modelling of Turbulent Astrophysical Flows

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- Aim: perform highly resolved adaptive mesh refinement (AMR) simulations of supersonic turbulence
- Idea: trigger the refinement by monitoring flow properties e.g.rotation of the velocity field and the rate of gas compression
- New method: FEARLESS, Fluid mechanics with adaptively refined large eddy simulations
- 16 to 126 CPUs of the DEISA SGI Altix at SARA

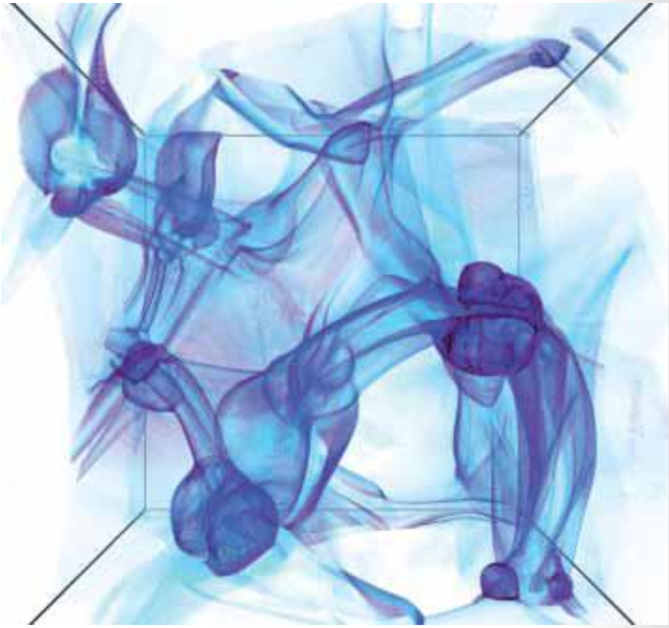

Figure: Magnitude of the vorticity in an AMR simulation of forced supersonic turbulence.

The sheet-like structures indicate the formation of strong shock fronts while turbulence is still developing.

Wolfram Schmidt, University of Würzburg, Germany

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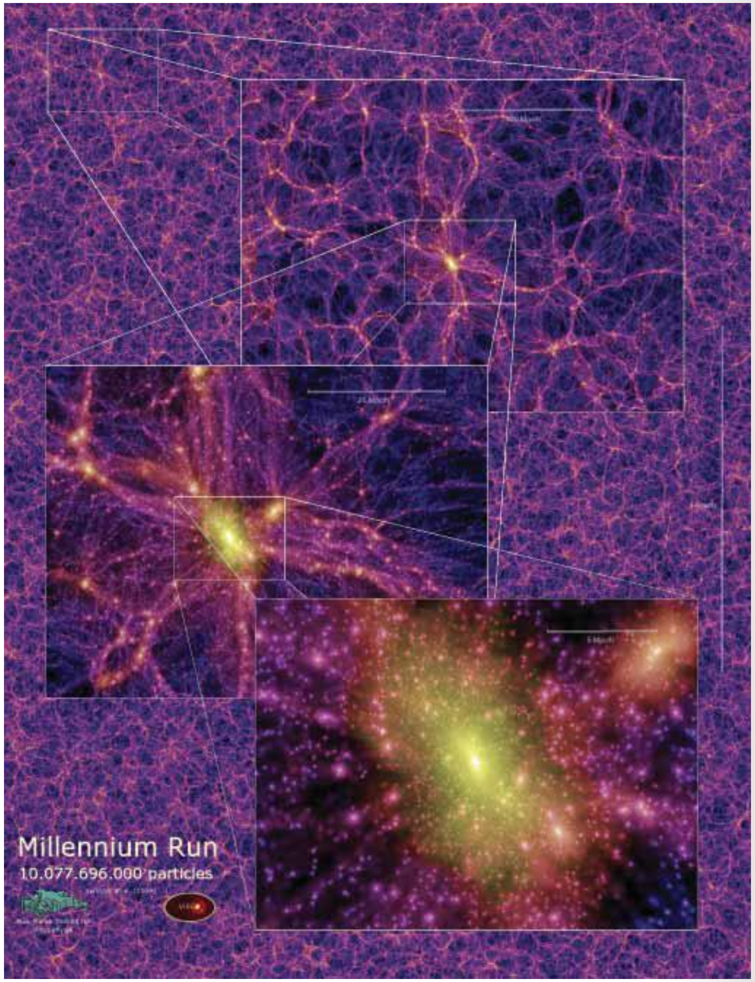
Galaxies-Intergalactic Medium Interaction Calculation, GIMIC

Simulations provide insight in how Galaxies form, and allow detailed analyses on how Galaxies interact with surrounding intergalactic medium

Figure: The image shows the projected density field of a slice through the Millennium simulation. Overlaid panels show successive zooms by a factor of 4, centred on a large dark matter halo.



Simon White and Carlos Frenk, Max Planck Institute for Astrophysics, Germany, and University of Durham, UK, a project of the Virgo Consortium

Planck Satellite Simulations

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DEISA's supercomputing framework was used to perform several simulations of the whole mission of the Planck Spacecraft's Low Frequency Instrument, LFI.

To understand the effects derived from the optical behavior of Planck receivers

The LFI is an array of 22 tuned radio receivers that will operate at –253 C on board the Planck spacecraft. The LFI will image the sky at three frequencies between 30 and 70 GHz.

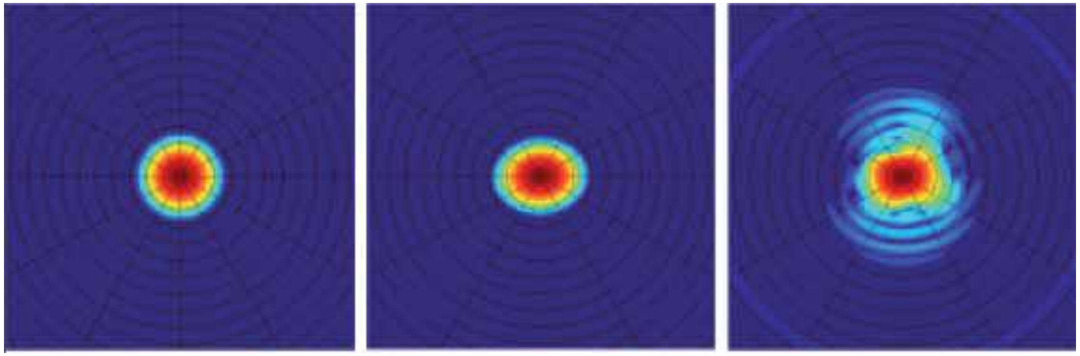

Figure: Simulated response of the LFI-28 beam, observing the sky at the frequency of 30 GHz. From left to right: ideal beam response (circular); response non-ideal at the first order (elliptical); realistic response (on the basis of laboratory measurements). © Fabio Pasian

Fabio Pasian, Istituto Nazionale di Astrofisica - Osservatorio Astronomico di Trieste, Italy, Hannu Kurki-Suonio, University of Helsinki, Finland, and Samuel Leach, International School of Advanced Studies, Trieste, Italy

Simulating the Local Universe

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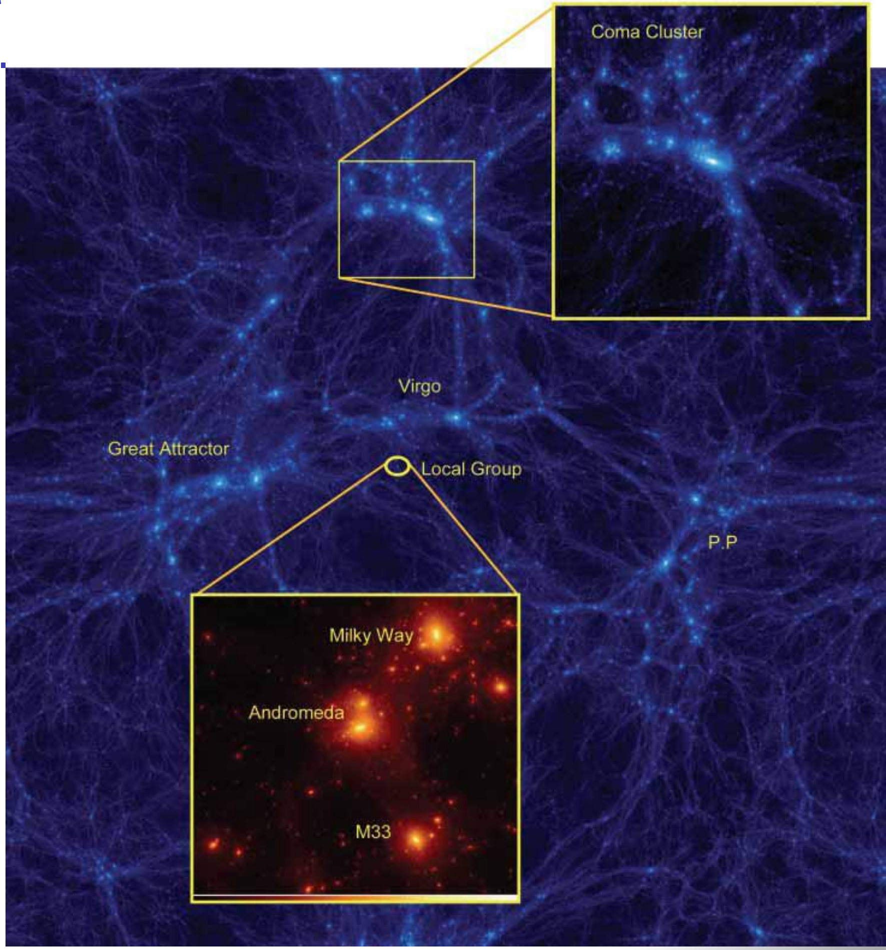
The SIMU-LU project simulated the formation and evolution of a system similar to our own Galaxy and ist closest neighbor: the Adromeda Galaxy.

Figure: Dark matter density distribution of the Local Universe simulation. The boxsize is 160 Mpc. Several objects of the real universe are identified. The circle shows the position of the Local Group. A blown up panel shows the detailed structure of the simulated Local Group.

The resolution of this small region of 2 Mpc radius is equivalent to having a total of 40963 (70 bln) particles in the whole box, which translates in a dynamical mass range of more than 106.



Gustavo Yepes, Univ Autónoma de Madrid, Spain. Stefan Gottlöber, Astrophysikalisches Institut Potsdam.
Anatoly Klypin, New Mexico State University, USA. Yehuda Hoffman, Racah Institute of Physics, Israel.

Turbulent, Active, and Rotating Stars

Interaction of convection, rotation, and magnetic field in stars.

Project STARS: Highly non-linear and turbulent 3D MHD solar dynamo model at low magnetic Prandtl number.

For the first time, dynamo action in a turbulent convection sphere at low magnetic Prandtl number was achieved in solar context.

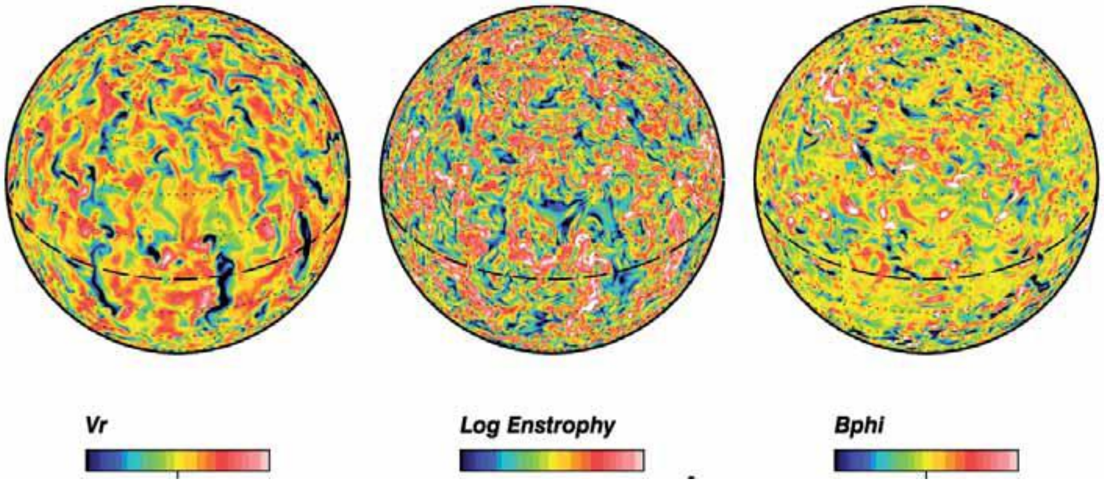


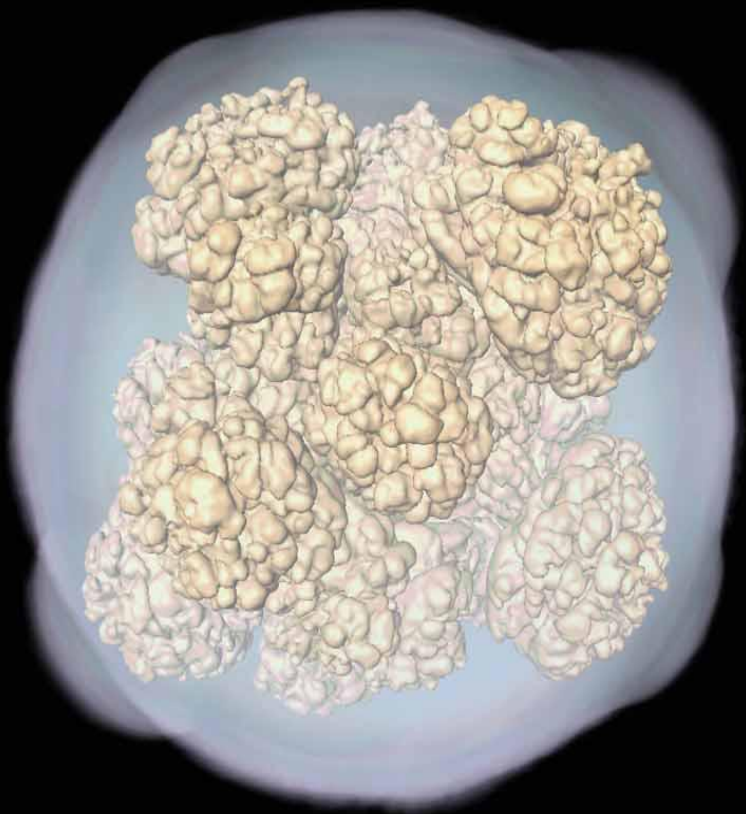
Figure: Snapshot of radial velocity, log of enstrophy and toroidal magnetic field in the bulk of the highly turbulent convection zone. Highly intermittent convection and magnetic fields are observed in this low Pm simulation of the solar convective envelope. We note the high degree of vorticity present in the down flows. ©Allan Sacha Brun, CEA-Saclay, France

Simulating Type Ia Supernovae

A sound theoretical understanding of the explosion mechanism is one of the great challenges of Astrophysics.

New insights into the explosion mechanism have been gained by constructing numerical models of Type Ia Supernovae explosions and by comparing the results with detailed observations of nearby Type Ia Supernovae.

Snapshot from a Type Ia supernova explosion simulation carried out within the DEISA framework on the Edinburgh HPCx cluster. The volume rendering of the logarithm of the density indicates the exploding White dwarf star and the turbulent thermonuclear flame is represented by the iso-surface.



Friedrich Röpke and Wolfgang Hillebrandt, Max-Planck-Institut für Astrophysik, Garching, Germany

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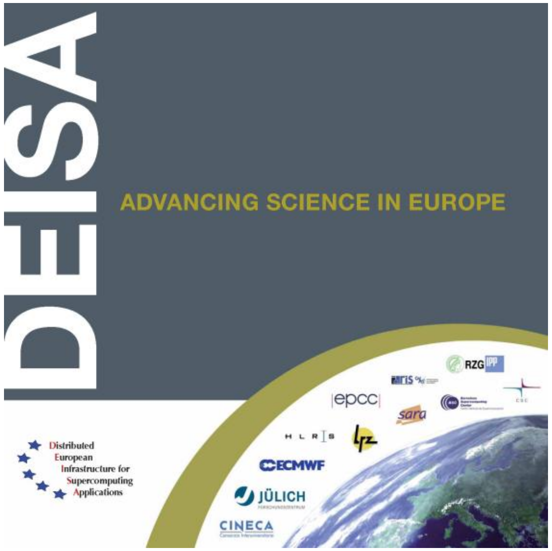

Thank You for your attention

Gentzsch @ rzg.mpg.de