



European Exascale Software Initiative

April 12, 2010

Oxford, UK

Jean-Yves Berthou



LEADING THE ENERGY CHANGE

European Exascale Software Initiative (EESI)

Context in Europe

HPC Eur - European High Performance Computing Initiative, "*The Scientific Case for a European Super Computing Infrastructure*", Petascale Computing in Europe - input for the ESFRI Roadmap process, spring 2006

DEISA, Distributed European Infrastructure for Supercomputing Applications

PRACE, Partnership for Advanced Computing in Europe
(PRACE)

European Exascale Software Initiative (EESI)

Context in Europe

PRACE History and first steps



EU-Grant: INFSO-RI-211528, 10 Mio.



Foreseen: PRACE Tier-0 centres providing HPC-capability service in a legal entity

Context in Europe

PRACE – A Partnership with a Vision

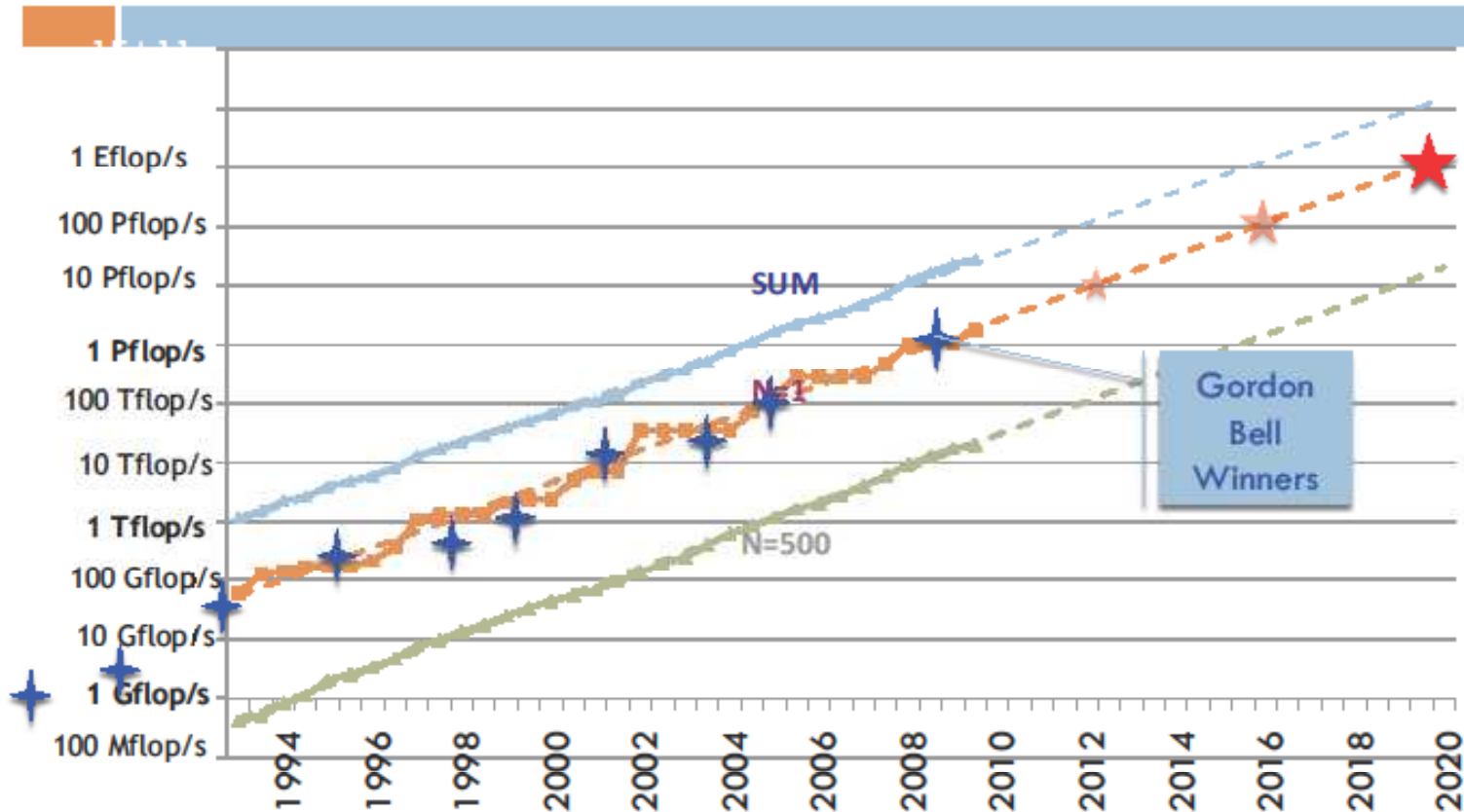
- ▶ Provide world-class HPC systems for world-class science
- ▶ Support Europe in attaining global leadership in public and private research and development

... and a Mission

- ▶ Create a world-leading persistent high-end HPC infrastructure managed as a single legal entity
 - Deploy 3 – 6 systems of the highest performance level (Tier-0)
 - IBM BlueGene/P in Jülich will be the first European Tier-0 system
 - Ensure a diversity of architectures to meet the needs of European user communities
 - Provide support and training

European Exascale Software Initiative (EESI)

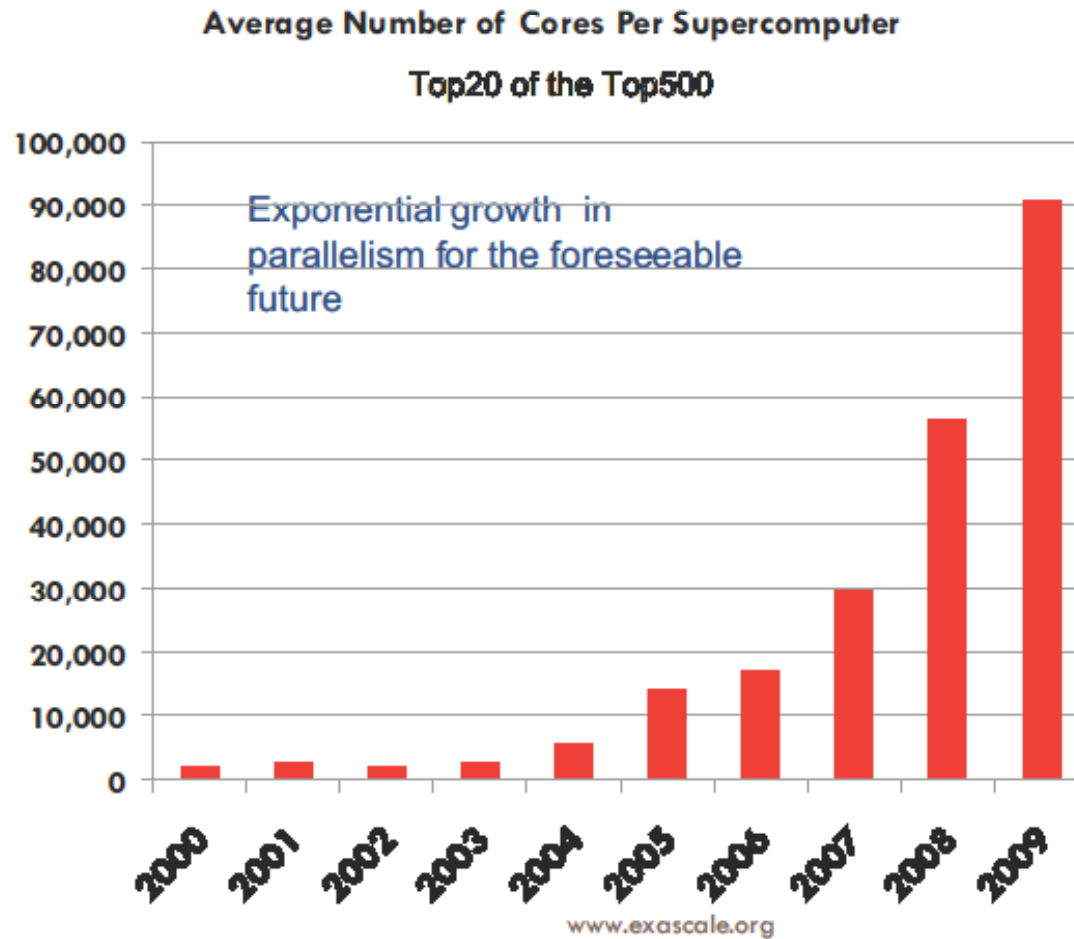
Performance Development in Top500



www.exascale.org

IESP Booth/SC'09, J. Dongarra

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Factors that Necessitate Redesign

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- **Steepness of the ascent from terascale to petascale to exascale**
- Extreme parallelism and hybrid design
 - ▣ Preparing for million/billion way parallelism
- Tightening memory/bandwidth bottleneck
 - ▣ Limits on power/clock speed implication on multicore
 - ▣ Reducing communication will become much more intense
 - ▣ Memory per core changes, byte-to-flop ratio will change
- Necessary Fault Tolerance
 - ▣ MTF will drop
 - ▣ Checkpoint/restart has limitations
- **Software infrastructure does not exist today**

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Exascale Computing

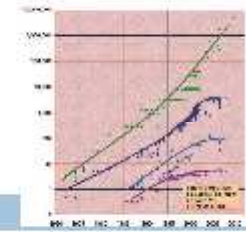
- Exascale systems are likely feasible by 2017±2
- 10-100 Million processing elements (cores or cores) with chips perhaps as dense as socket, clock rates will grow more slowly
- 3D packaging likely
- Large-scale optics based interconnects
- 10-100 PB of aggregate memory
- Hardware and software based fault management
- Heterogeneous cores
- Performance per watt — stretch goal 100 GF/watt of sustained performance $\Rightarrow \gg 10 - 100$ MW Exascale system
- Power, area and capital costs will be significantly higher than for today's fastest systems

Google: exascale computing study



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A Call to Action



- ❑ Hardware has changed dramatically while software ecosystem has remained stagnant
- ❑ Previous approaches have not looked at co-design of multiple levels in the system software stack (OS, runtime, compiler, libraries, application frameworks)
- ❑ Need to exploit new hardware trends (e.g., manycore, heterogeneity) that cannot be handled by existing software stack, memory per socket trends
- ❑ Emerging software technologies exist, but have not been fully integrated with system software, e.g., UPC, Cilk, CUDA, HPCS
- ❑ Community codes unprepared for sea change in architectures
- ❑ No global evaluation of key missing components

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International Community Effort

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- We believe this needs to be an international collaboration for various reasons including:
 - The scale of investment
 - The need for international input on requirements
 - US, Europeans, Asians, and others are working on their own software that should be part of a larger vision for HPC.
 - No global evaluation of key missing components
 - Hardware features are uncoordinated with software development

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IESP Goal

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Improve the world's simulation and modeling capability by improving the coordination and development of the HPC software environment

Workshops:

Build an international plan for developing the next generation open source software for scientific high-performance computing

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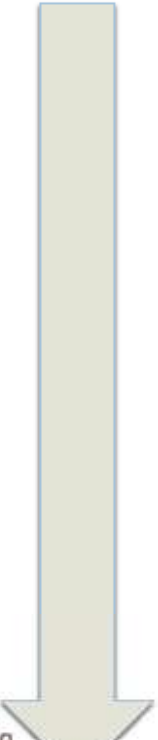
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Where We Are Today:

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- SC08 (Austin TX) meeting to generate interest
 - Funding from DOE's Office of Science & NSF Office of Cyberinfrastructure and sponsorship by Europeans and Asians
 - US meeting (Santa Fe, NM) April 6-8, 2009
 - 65 people
 - NSF's Office of Cyberinfrastructure funding
 - European meeting (Paris, France) June 28-29, 2009
 - 70 people
 - Outline Report
 - Asian meeting (Tsukuba Japan) October 18-20, 2009
 - Draft roadmap
 - Refine Report
 - SC09 (Portland OR) BOF to inform others
 - Public Comment
 - Draft Report presented
- Nov 2008**
Apr 2009
Jun 2009
Oct 2009
Nov 2009
- www.exascale.org
- 

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European Exascale Software Initiative (EESI)

Motivations for launching EESI

Coordinate the European contribution to IESP

Enlarge the European community involved in the software roadmapping activity

Build and consolidate a **vision and roadmap** at the European Level, including applications, both from academia and industry

European Exascale Software Initiative (EESI)

EESI main Goals

Build a **European vision and roadmap** to address the **challenge of performing scientific computing** on the new generation of computers which will provide multi-Petaflop performances in 2010 and Exaflop performances in 2020.

- Investigate how Europe is located, its strengths and weaknesses, in the overall international HPC landscape and competition
- Identify priority actions
- Identify the sources of competitiveness for Europe induced by the development of Peta/Exascale solutions and usages
- investigate and propose programs in education and training for the next generation of computational scientists
- Identify and stimulate opportunities of worldwide **collaborations**

European Exascale Software Initiative (EESI)

EESI main tasks

Coordination of the European participation in IESP

Make a thorough assessment of needs, issues and strategies

Develop a coordinated software roadmap

Provide a framework for organizing the software research community

Engage and coordinate vendor community in crosscutting efforts

Encourage and facilitate collaboration in education and training

Cartography of existing HPC projects and initiatives in Europe, US and ASIA

Coordination of “*disciplinary working groups*” at the European level

• *Four groups “Application Grand Challenges”*

• *Four groups “Enabling technologies for Petaflop/Exaflop computing”*

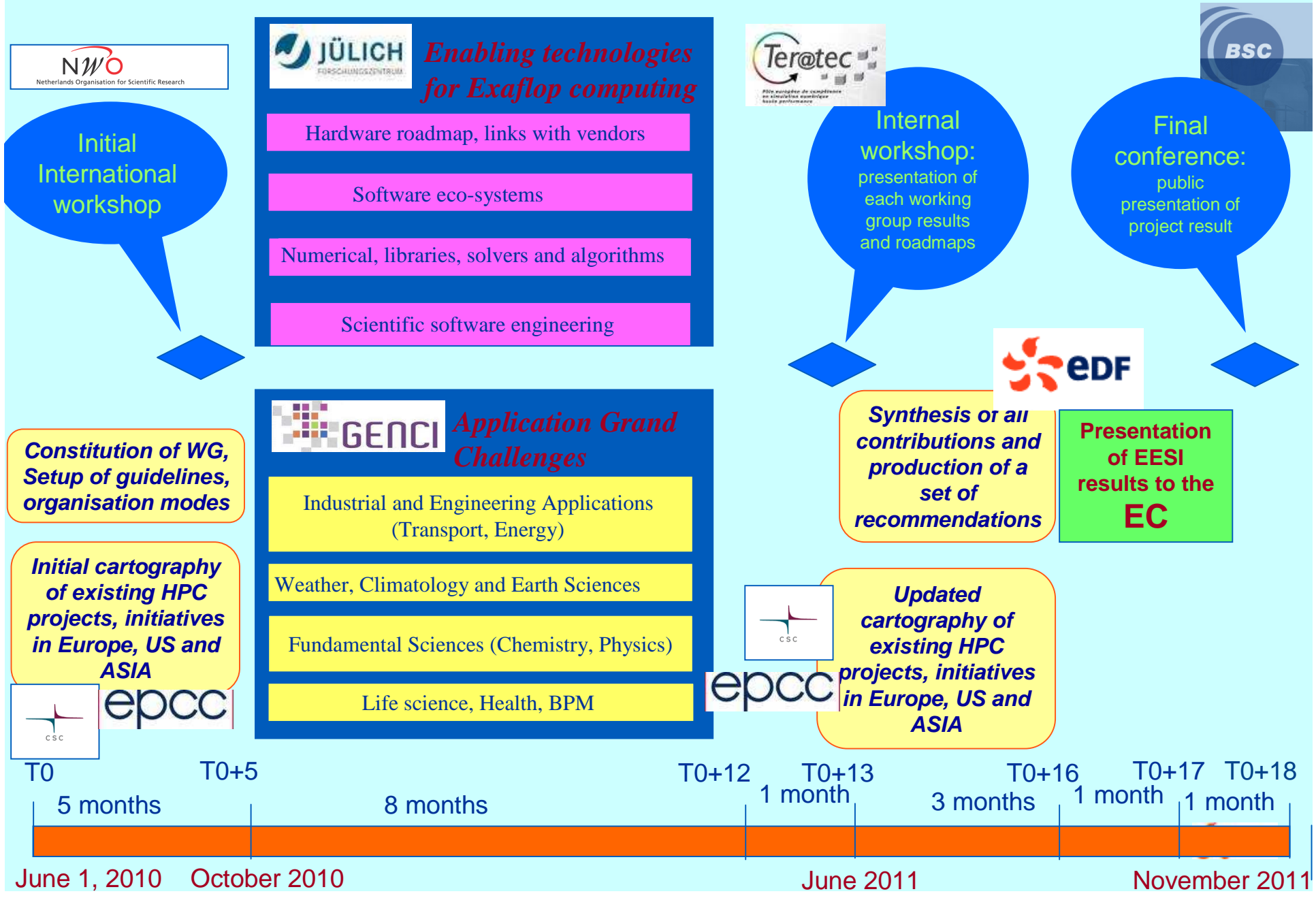
Synthesis, dissemination and **recommendation** to the European Commission

European Exascale Software Initiative (EESI)

EESI expected outputs

A **roadmap** and **set of recommendations** to the funding agencies shared by the European HPC community, on software - tools, methods and applications - to be developed for this new generation of supercomputers.

European Exascale Software Initiative AGENDA



NWO
Netherlands Organisation for Scientific Research

JÜLICH
FORSCHUNGSZENTRUM

Enabling technologies for Exaflop computing

Ter@tec
Pôle européen de compétence en simulation numérique haute performance

BSC

Initial International workshop

- Hardware roadmap, links with vendors
- Software eco-systems
- Numerical, libraries, solvers and algorithms
- Scientific software engineering

Internal workshop: presentation of each working group results and roadmaps

Final conference: public presentation of project result

Constitution of WG, Setup of guidelines, organisation modes

GENCi

Application Grand Challenges

- Industrial and Engineering Applications (Transport, Energy)
- Weather, Climatology and Earth Sciences
- Fundamental Sciences (Chemistry, Physics)
- Life science, Health, BPM

Initial cartography of existing HPC projects, initiatives in Europe, US and ASIA

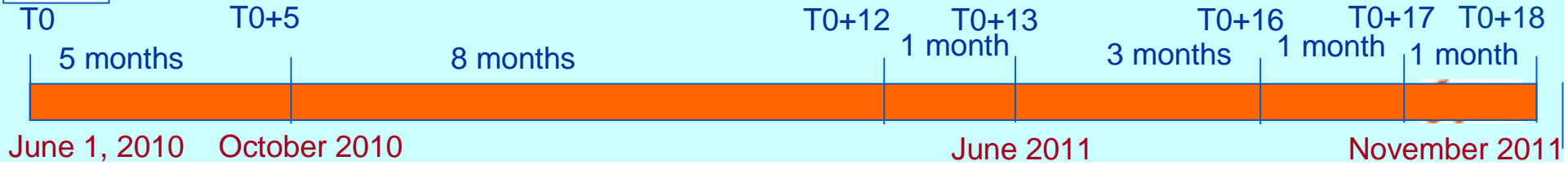
Synthesis of all contributions and production of a set of recommendations

Presentation of EESI results to the EC

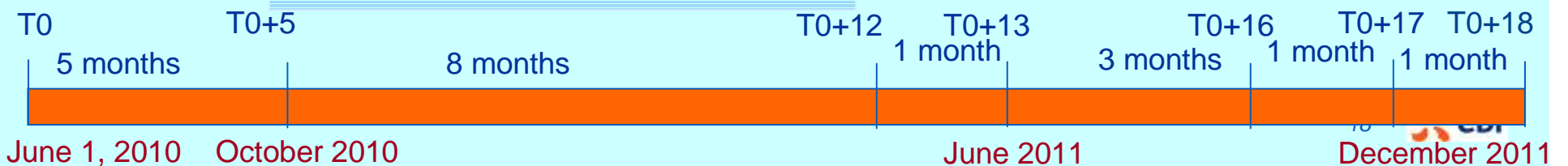
epcc

CSC

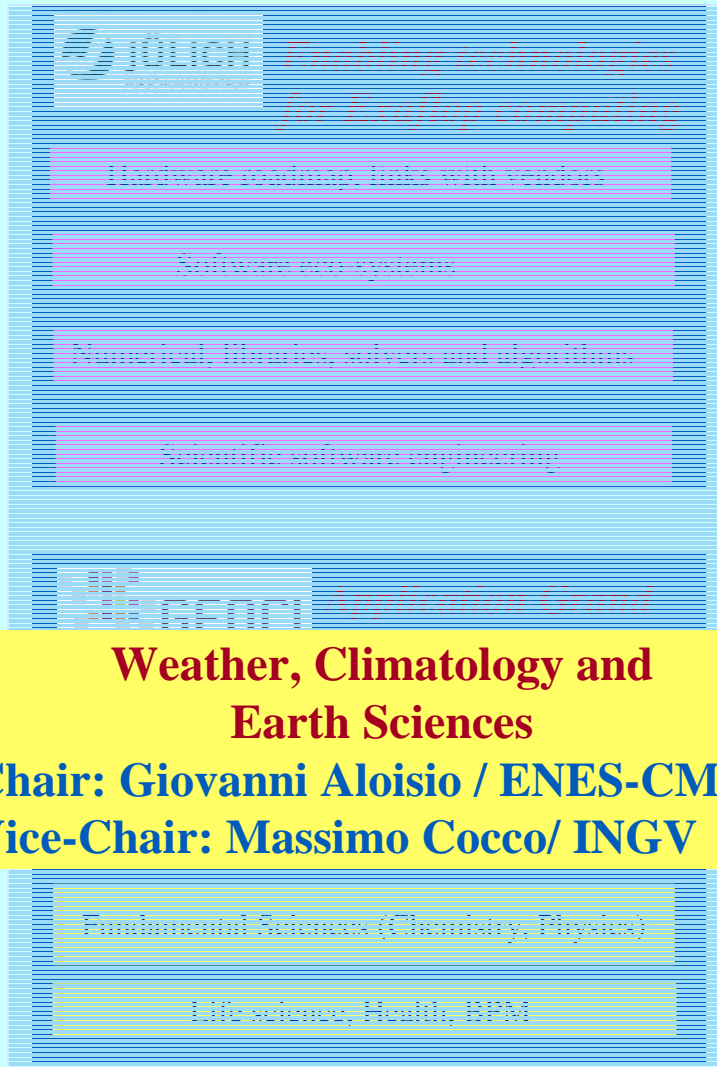
Updated cartography of existing HPC projects, initiatives in Europe, US and ASIA



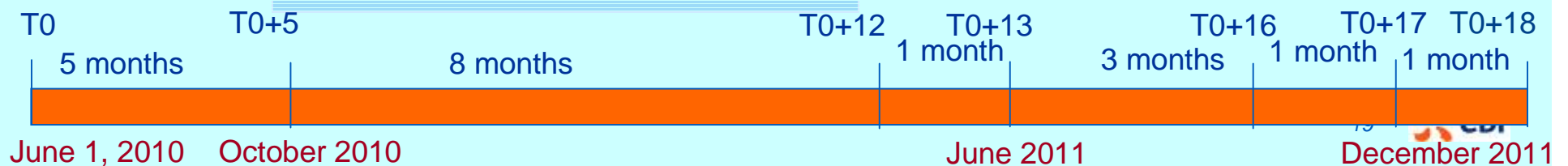
European Exascale Software Initiative AGENDA



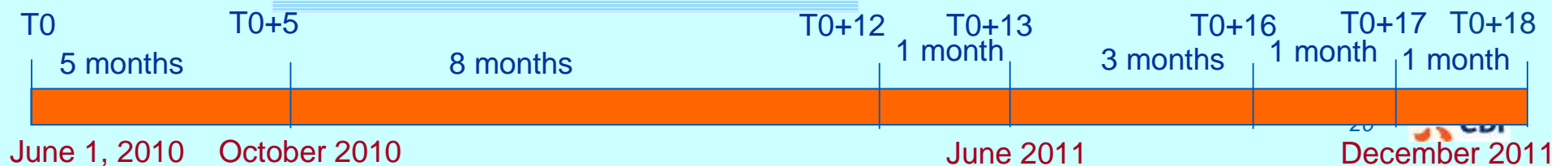
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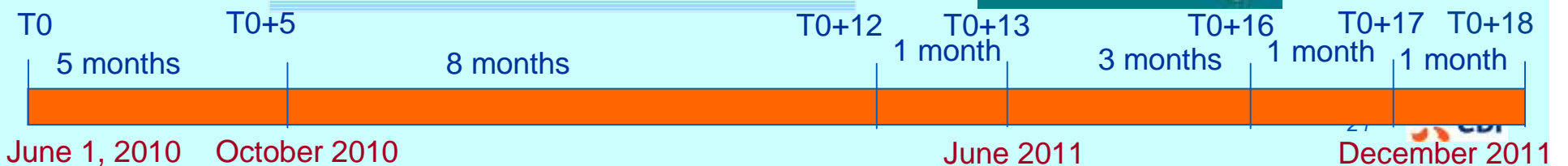
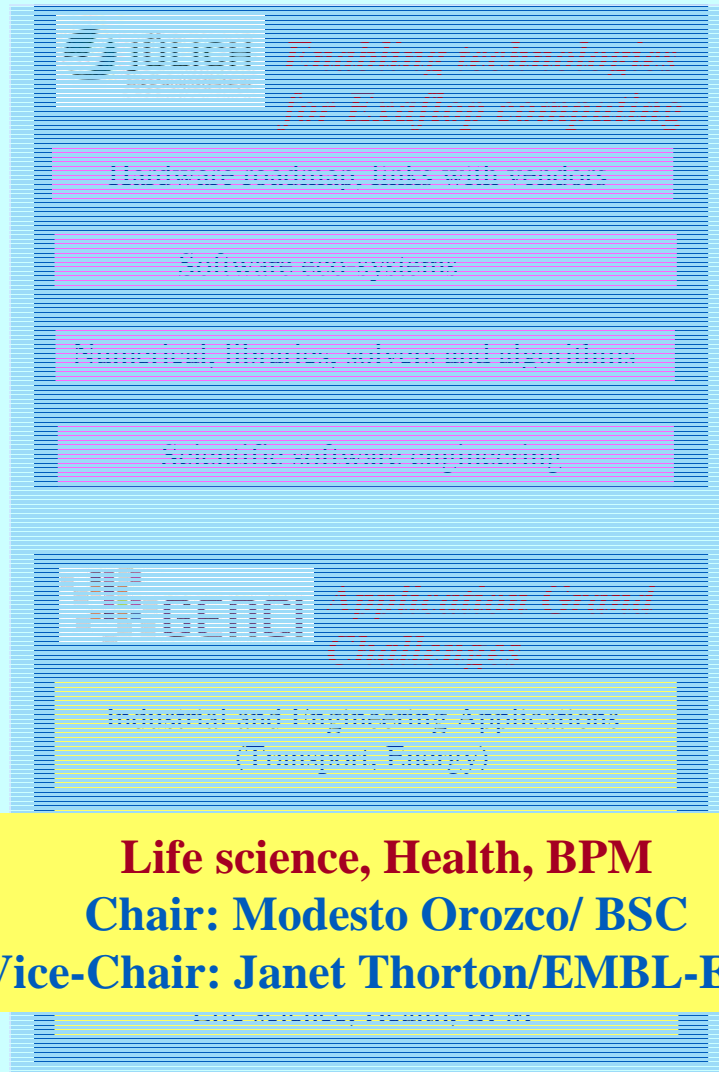
Weather, Climatology and Earth Sciences
Chair: Giovanni Aloisio / ENES-CMCC
Vice-Chair: Massimo Cocco/ INGV



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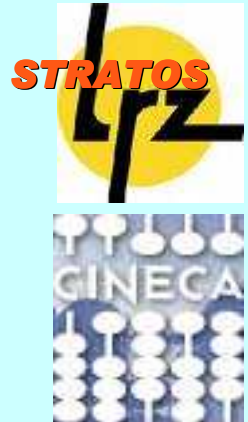
European Exascale Software Initiative AGENDA



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JÜLICH *Enabling technologies*

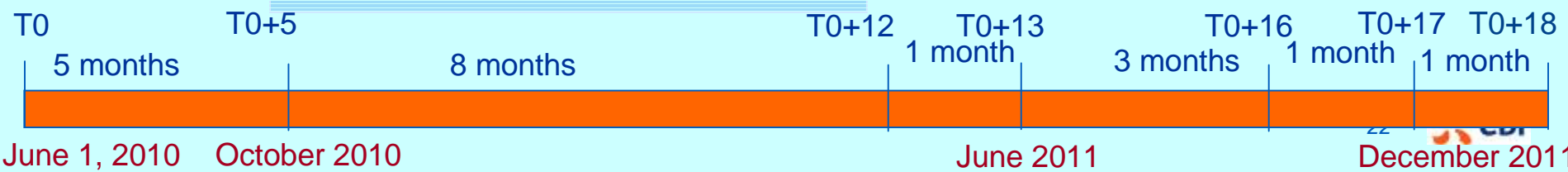
Hardware roadmap, links with Vendors
Chair: Herbert Huber/STRATOS-LRZ
Vice-Chair: Sanzio Bassini/CINECA



Numerical, libraries, solvers and algorithms
Scientific software engineering

INGENIERIA *Application Grand Challenges*

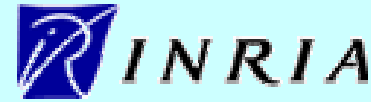
Industrial and Engineering Applications (Transport, Energy)
Weather, Climatology and Earth Sciences
Fundamental Sciences (Chemistry, Physics)
Life science, Health, BPM



European Exascale Software Initiative AGENDA

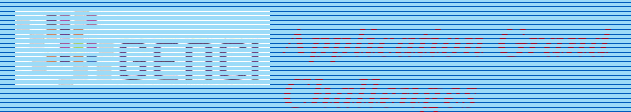


Software eco-systems
Chair: Franck Cappello/INRIA-NCSA
Vice-Chair: Bernd Mohr/JSC



Numerical, libraries, solvers and algorithms

Scientific software engineering

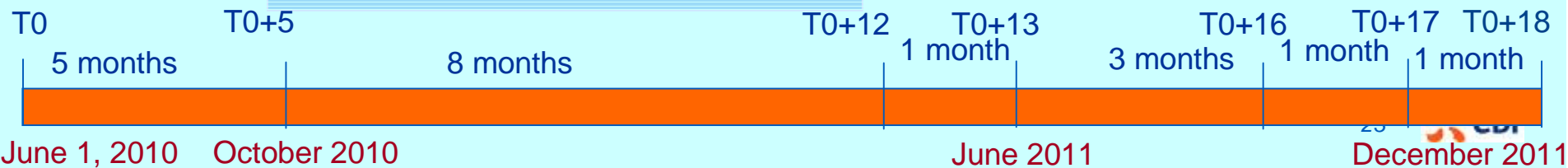


Industrial and Engineering Applications
(Transport, Energy)


Weather, Climatology and Earth Sciences

Fundamental Sciences (Chemistry, Physics)

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European Exascale Software Initiative AGENDA



*Enabling technologies
for Exascale computing*

Hardware roadmap, links with vendors

Numerical, libraries, solvers and algorithms
Chair: Iain Duff/ STFC-Rutherford Appleton Laboratory
Vice-Chair: Andreas Grothey/ Edinburgh University

Scientific software engineering



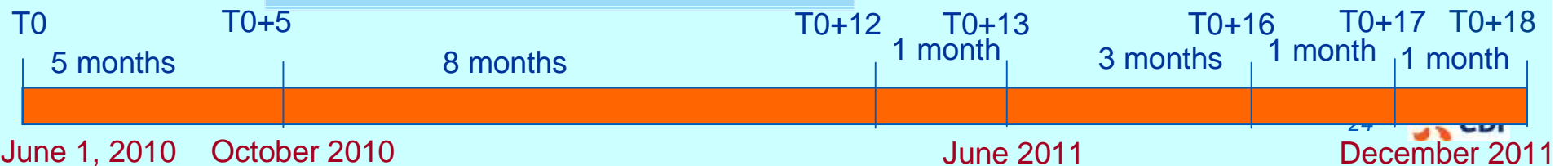
*Application Grand
Challenges*

Industrial and Engineering Applications
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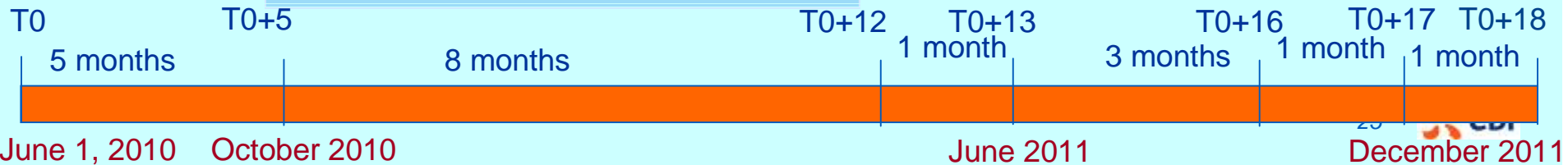
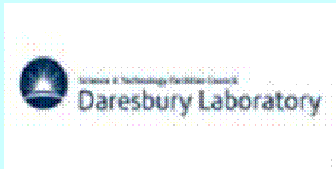
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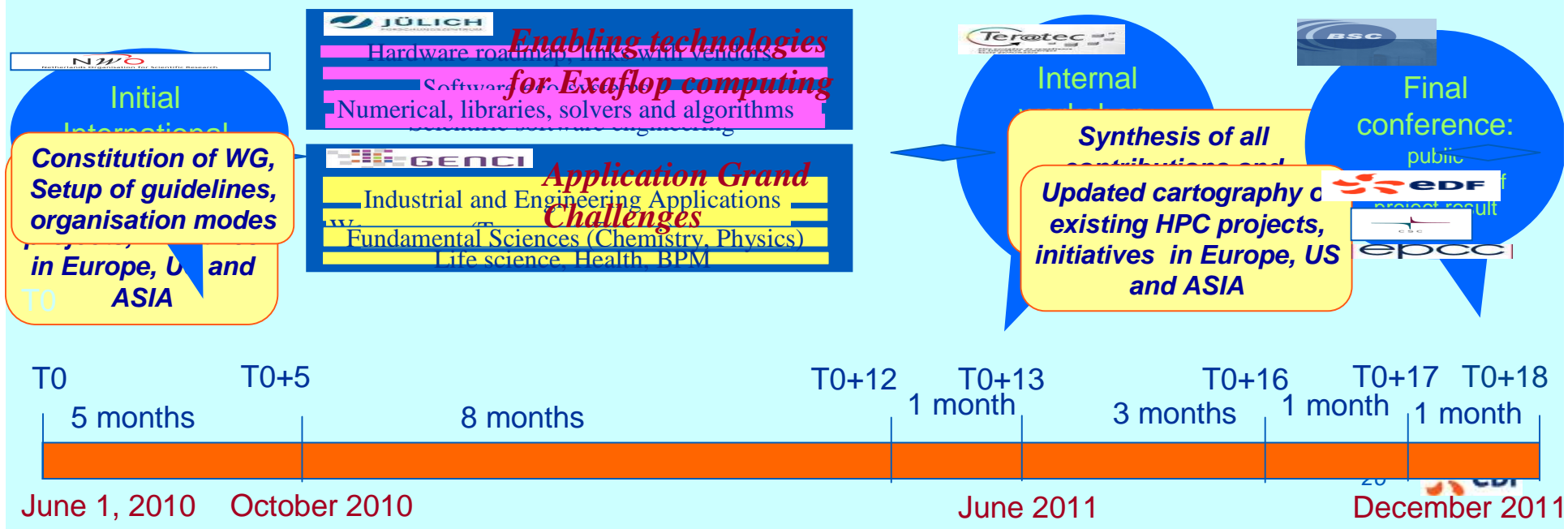
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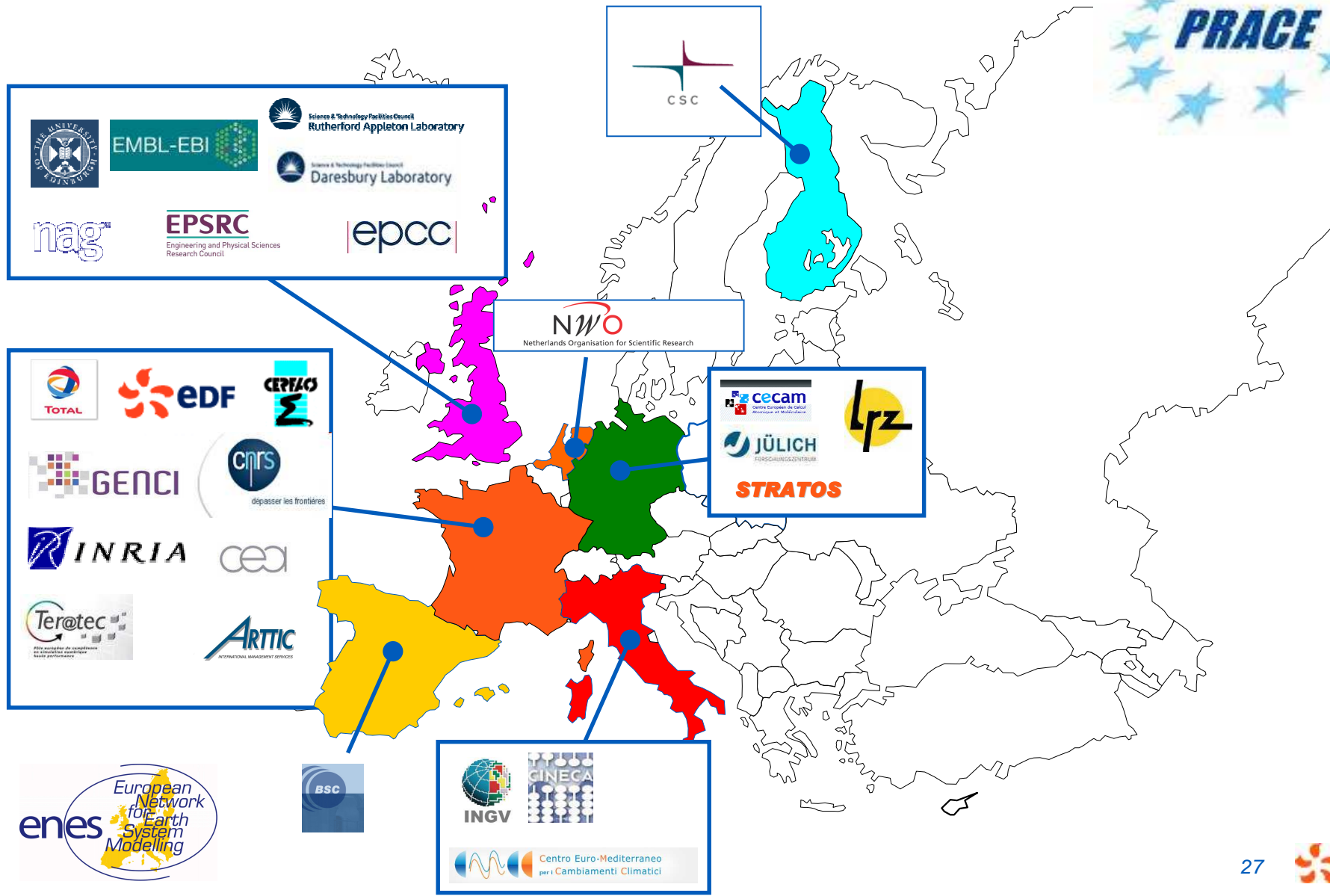
Link with US and ASIA



Joint IESP/EESI workshops: present EESI Working Groups outputs, include inputs from US and ASIA, identification of US, ASIA and European cross actions



EESI Partners In Europe



EESI Partners around the world

