



European Exascale Software Initiative

May, 2010

DEISA PRACE Symposium

May 10, Barcelona - Spain

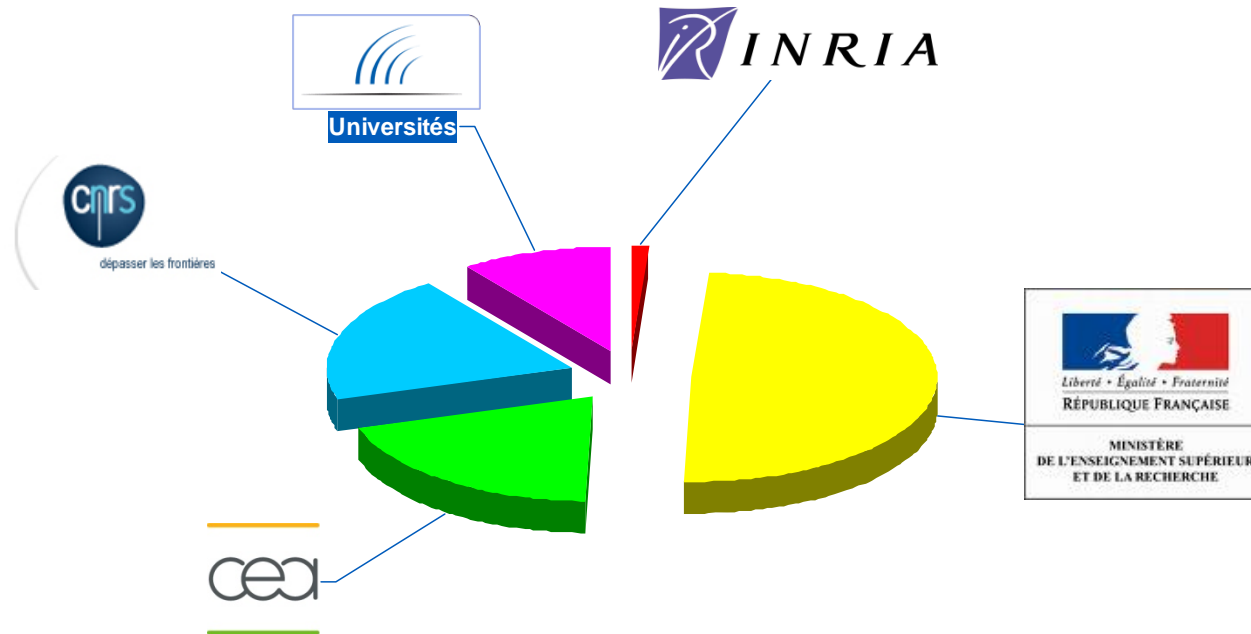
Catherine Rivière :

CEO  GENCI

Jean-Yves Berthou :

EESI Coordinator  EDF

- A national coordination through



- French legal entity : « Société civile » created in 2007
- 5 shareholders
- Approximately 25 M€ annual budget

- **To coordinate principal national supercomputers centers** for civil activities
- **To promote simulation and high performance computing** in fundamental and industrial research
- To promote **the organization of an European HPC area** and to participate to its achievements
-   Partnership for Advanced Computing in Europe
- **To open its equipments** to all interested scientific communities: at **academic** or **industrial**, national, european or **international** levels

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



Distributed European Infrastructure for Supercomputing Applications



Partnership for Advanced Computing in Europe

European Exascale Software Initiative (EESI)

Context in US



International Exascale Software Project

European Exascale Software Initiative (EESI)

IESP Booth/SC'09, J. Dongarra

IESP Goal

10

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

European Exascale Software Initiative (EESI)

IESP Booth/SC'09, J. Dongarra

Where We Are Today:

13

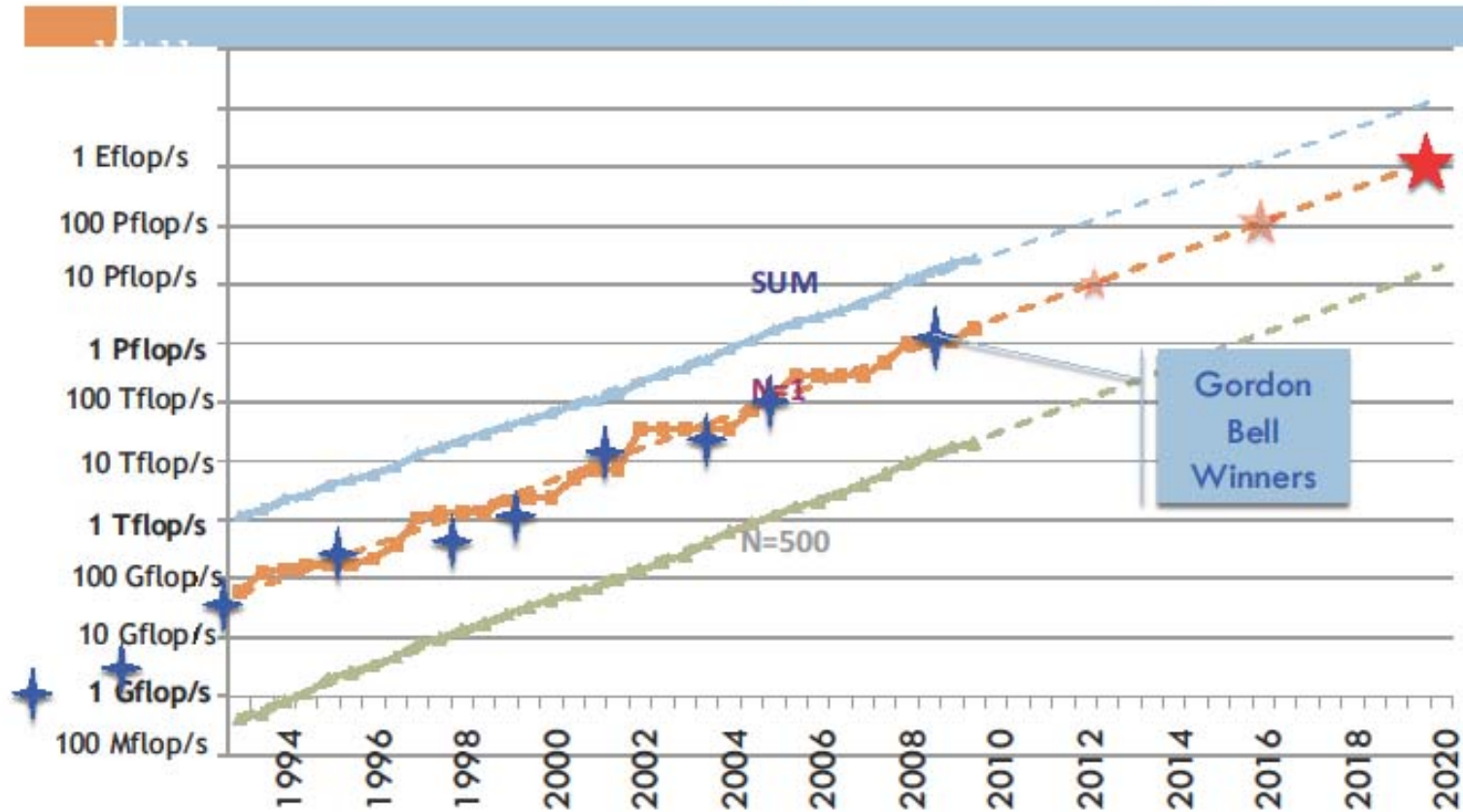
- SC08 (Austin TX) meeting to generate interest **Nov 2008**
- Funding from DOE's Office of Science & NSF Office of Cyberinfrastructure and sponsorship by Europeans and Asians **Apr 2009**
- US meeting (Santa Fe, NM) April 6-8, 2009
 - 65 people
- NSF's Office of Cyberinfrastructure funding **Jun 2009**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

www.exascale.org

European Exascale Software Initiative (EESI)

IESP Booth/SC'09, J. Dongarra

Performance Development in Top500



European Exascale Software Initiative (EESI)

IESP Booth/SC'09, J. Dongarra

Factors that Necessitate Redesign

7

- ❑ **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**

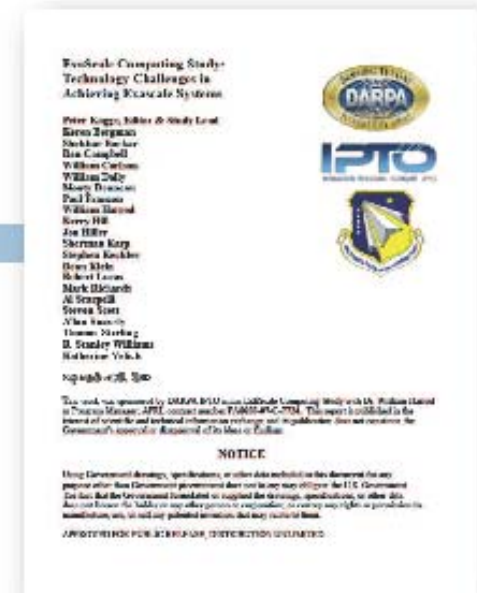
www.exascale.org

European Exascale Software Initiative (EESI)

IESP Booth/SC'09, J. Dongarra

Exascale Computing

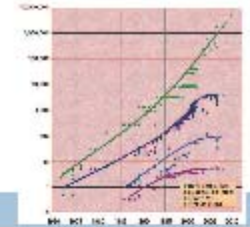
- Exascale systems are likely feasible by 2017±2
- 10-100 Million processing elements (cores or cores) with chips perhaps as dense as socket, clock rates will grow more slowly
- 3D packaging likely
- Large-scale optics based interconnects
- 10-100 PB of aggregate memory
- Hardware and software based 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



European Exascale Software Initiative (EESI)

IESP Booth/SC'09, J. Dongarra

A Call to Action



9

- 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

International Community Effort

11

- 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

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)

Characteristics of the EESI project

Main Goals

Main tasks

Expected outputs

Agenda and involvement of partners

European Exascale Software Initiative (EESI)

Characteristics of the EESI project

Coordination and support action – FP7/Infrastructures
Jean-Yves Berthou : Coordinator

Starting date : 1st of June 2010, for 18 months

Allocated EC contribution : 640 000 euros

Consortium :
10 contractual partners
17 associated participants
11 contributing participants

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

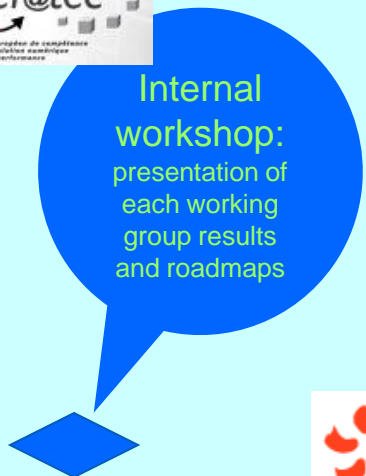
A **roadmap** and **set of recommendations** to the funding agencies shared by the European HPC community, on software - tools, methods and applications - to be developed for this new generation of supercomputers.

European Exascale Software Initiative AGENDA



JÜLICH FORSCHUNGSZENTRUM *Enabling technologies for Exaflop computing*

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



Synthesis of all contributions and production of a set of recommendations

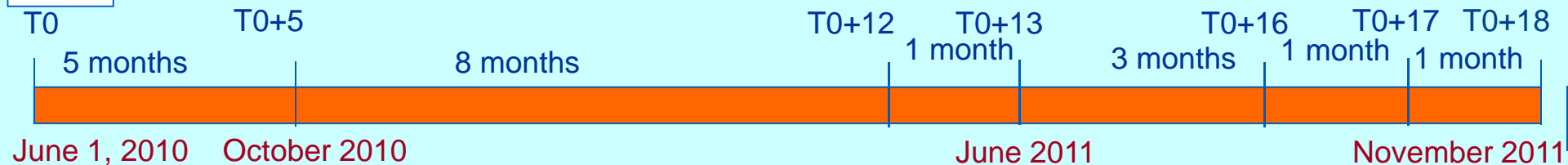
Presentation of EESI results to the EC

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

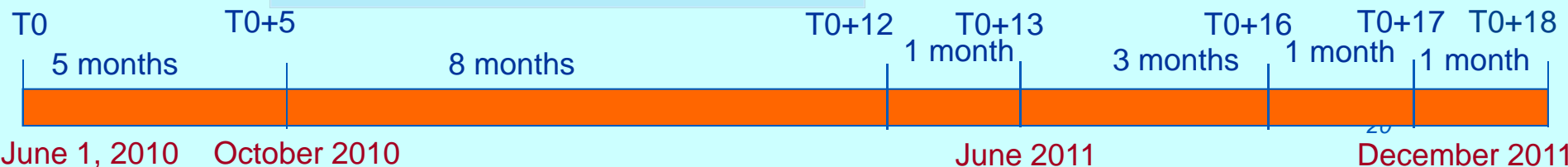
Updated cartography of existing HPC projects, initiatives in Europe, US and ASIA



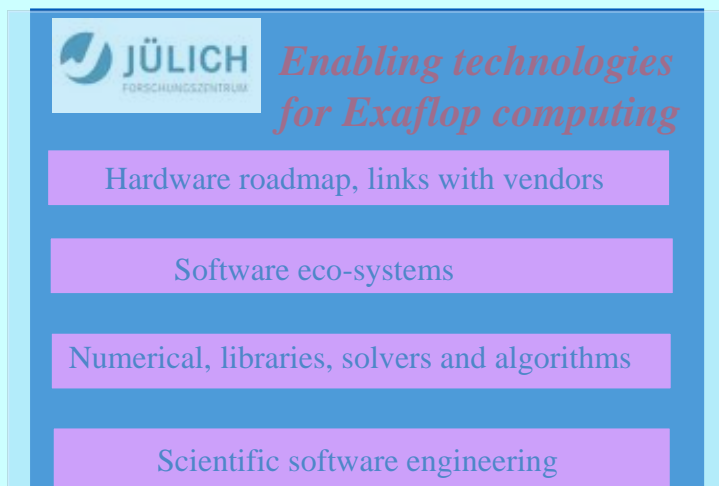
European Exascale Software Initiative AGENDA



**Industrial and Engineering Applications
(Transport, Energy)**
Chair: Philippe Ricoux/TOTAL
Vice-Chair: Jean-Claude André/CERFACS



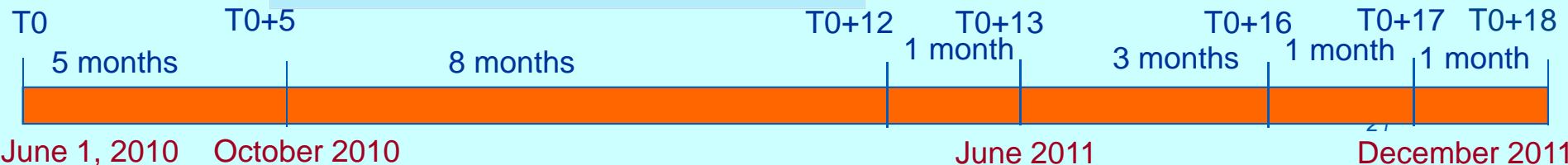
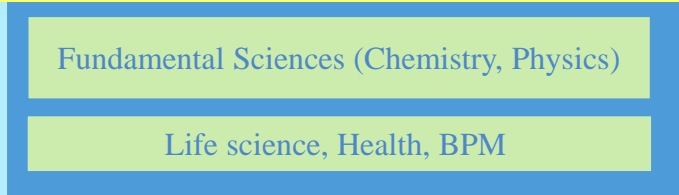
European Exascale Software Initiative AGENDA



GEOCCI *Application Grand*

**Weather, Climatology and
Earth Sciences**

Chair: Giovanni Aloisio / ENES-CMCC
Vice-Chair: Massimo Cocco/ INGV



European Exascale Software Initiative AGENDA



*Enabling technologies
for Exaflop computing*

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



*Application Grand
Challenges*

**Fundamental Sciences
(Chemistry, Physics)**
Chair: Godehard Sutmann/CECAM
Vice-Chair: Jean-Philippe Nominé/CEA




cecam
Centre Européen de Calcul
Atomique et Moléculaire



Life science, Health, BPM



European Exascale Software Initiative AGENDA

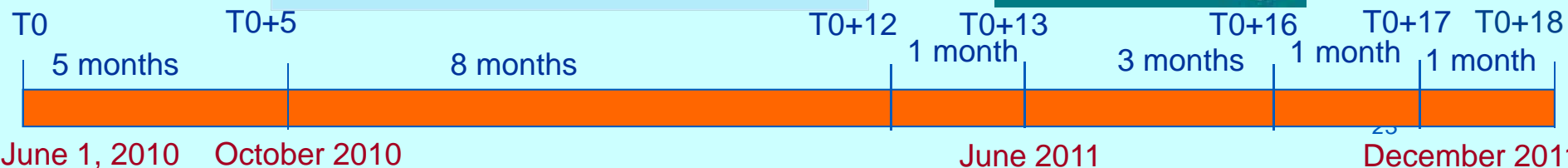
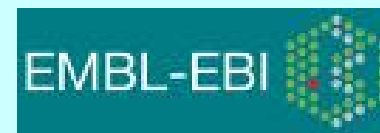
 *Enabling technologies for Exaflop computing*

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

 *Application Grand Challenges*

- Industrial and Engineering Applications (Transport, Energy)

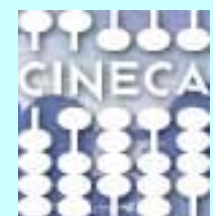
Life science, Health, BPM
Chair: Modesto Orozco/ BSC
Vice-Chair: Janet Thornton/EMBL-EBI



European Exascale Software Initiative AGENDA

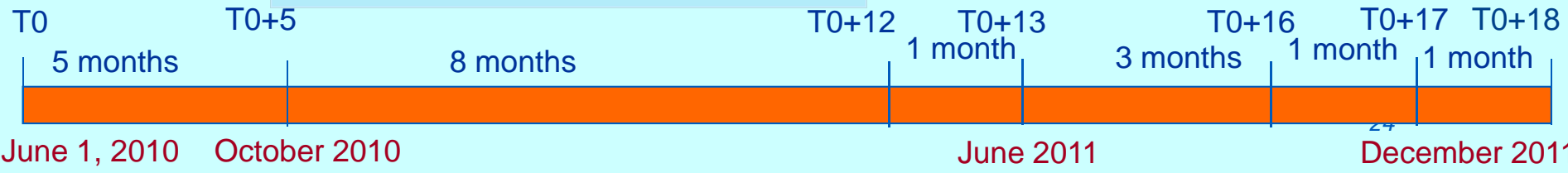


Hardware roadmap, links with Vendors
Chair: Herbert Huber/STRATOS-LRZ
Vice-Chair: Sanzio Bassini/CINECA



Numerical, libraries, solvers and algorithms
Scientific software engineering

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



European Exascale Software Initiative AGENDA



*Enabling technologies
for Exaflop computing*

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

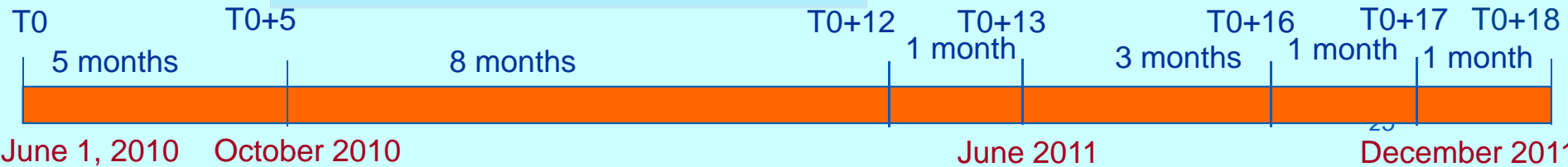


- Numerical, libraries, solvers and algorithms
- Scientific software engineering

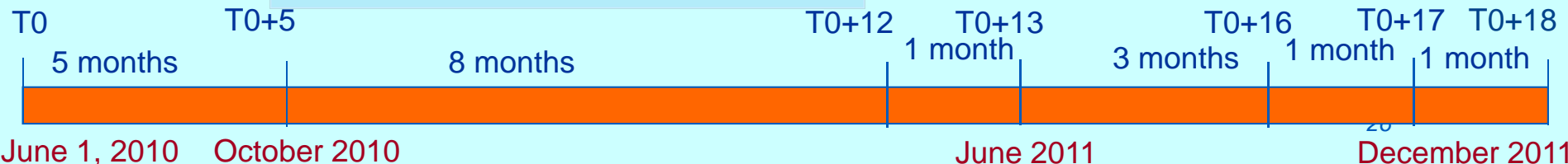


*Application Grand
Challenges*

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



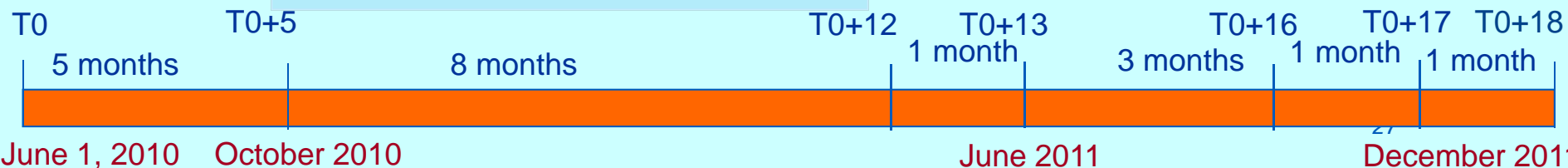
European Exascale Software Initiative AGENDA



European Exascale Software Initiative AGENDA



Scientific software engineering
Chair: David Emerson/STFC-Daresbury Lab.
Vice-Chair: Andrew Jones/NAG



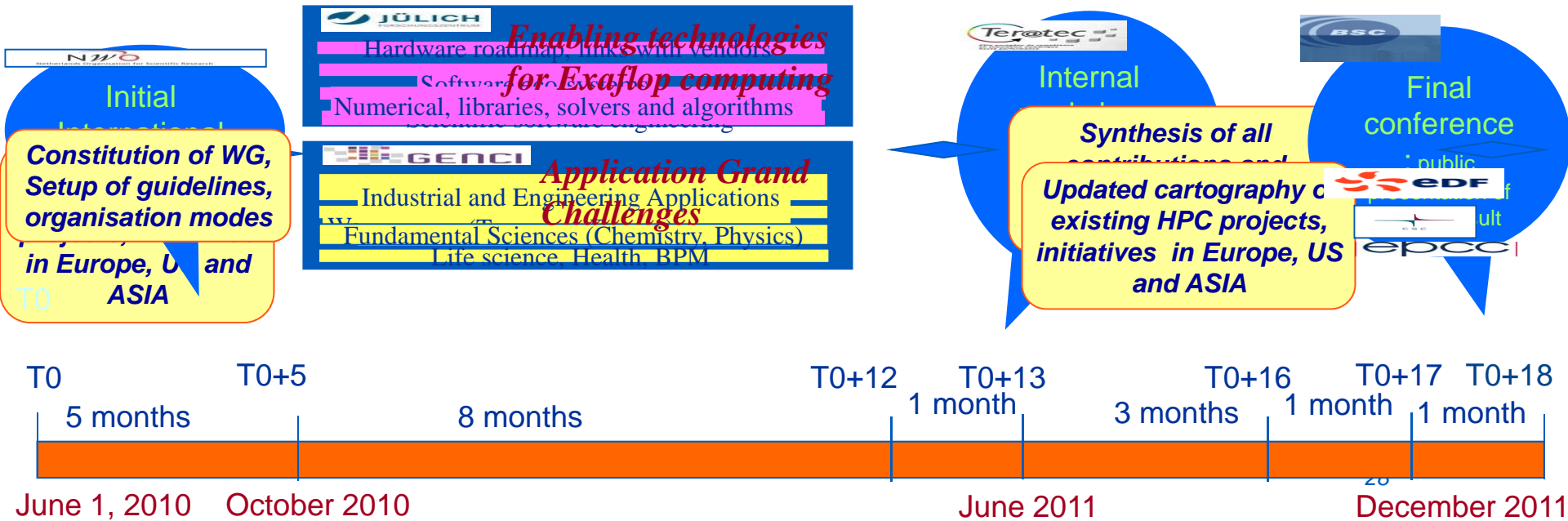
European Exascale Software Initiative AGENDA



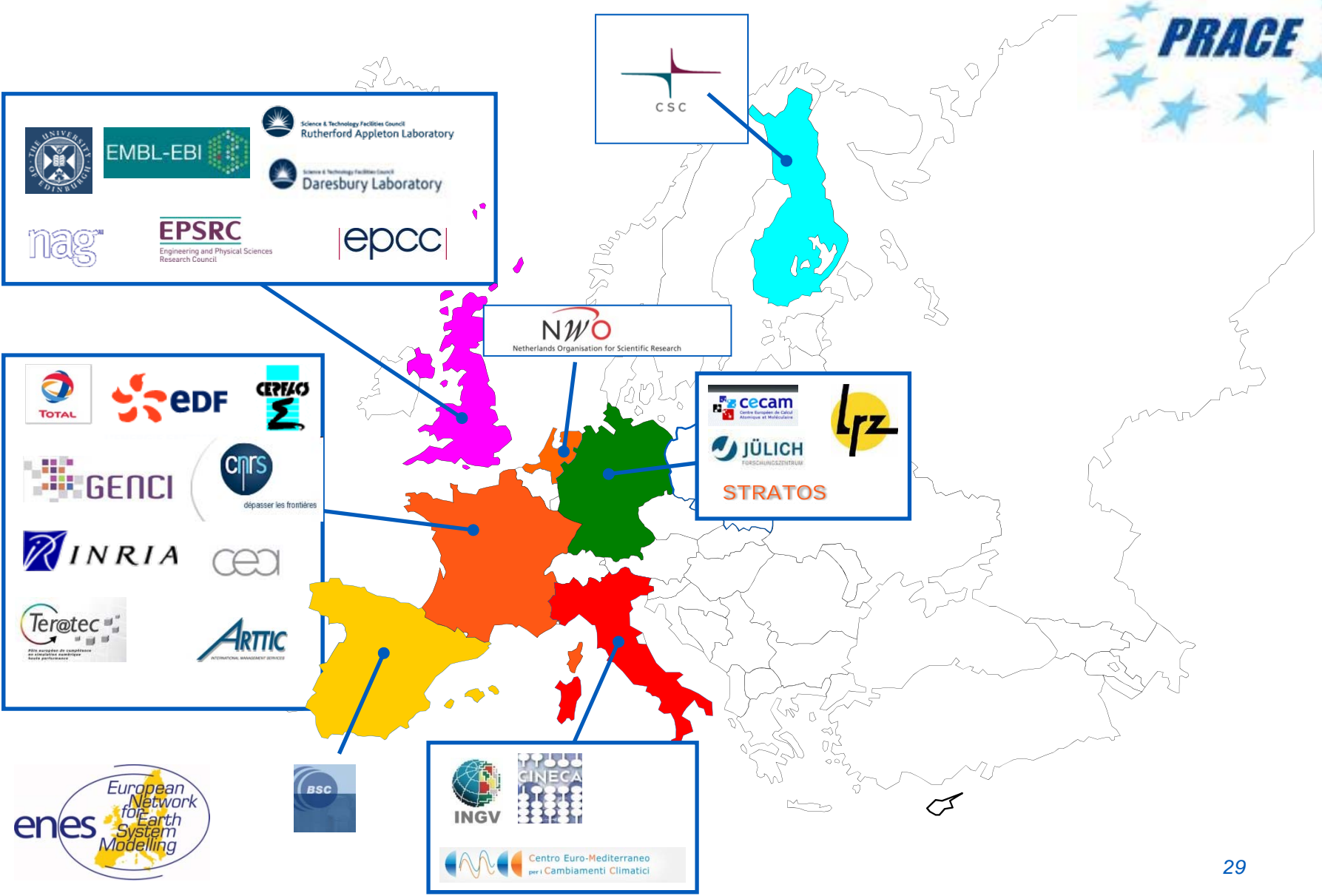
Link with US and ASIA



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

A world map with colored regions: North America (light blue), South America (light blue), Europe (light green), Africa (pink), Asia (light green), and Australia (orange). Red dots are placed on the map to indicate partner locations: one in North America, one in Europe, one in Africa, one in Asia, and one in Australia.

PRACE
Netherlands Organisation for Scientific Research
CNRS
dépasser les frontières

edf
JÜLICH
FORSCHUNGSZENTRUM
Lfz
STRATOS

GENCI
INRIA
cea
ARTIC
INTERNATIONAL MANAGEMENT SERVICES

THE UNIVERSITY of TENNESSEE
KNOXVILLE

cecam
Centre Européen de Calcul Atomique et Moléculaire

CERTAC
enes
European Network for Earth System Modelling

TOKYO TECH
Pursuing Excellence

TOTAL

epcc

EMBL-EBI

INGV

GINECA
BSC
Terotec
Atto computer de computação em estrutura nanométrica baixo desempenho

Science & Technology Facilities Council
Rutherford Appleton Laboratory

Science & Technology Facilities Council
Daresbury Laboratory

nag
Centro Euro-Mediterraneo per i Cambiamenti Climatici

CSC

European Exascale Software Initiative (EESI)

Beyond the elaboration of the European roadmap, the expected impacts are :

To reinforce the **intra European cooperation**

To build a **persistent community** around Exascale software

To stimulate **European competitiveness** by Identifying grand challenges applications with a strong economical, societal and/or environmental impact