PARTNERSHIP FOR ADVANCED COMPUTING IN EUROPE

PRACE, Workshop on Aviation Research Infrastructure in Europe

Sergi Girona, Chair of the Board of Directors

Brussels, 26/02/2013

PRACE at a glance

530M euros of funding for the **2010-2015** period

25 member states, including **4 Hosting Members**
(France, Germany, Italy, Spain)

218 scientific

projects **enabled**

PRACE

>5 billion core hours
granted since 2010

15 Pflop/s of peak performance on **6 world-class systems**

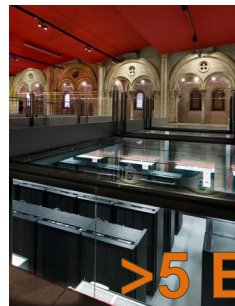**Open R&D** access for **industrial users**

**Necessity to increase
links with industrial users**

PRACE's achievements in 2 years

In 2012, PRACE is providing nearly 15 Pflop/s (Tier-0 competencies)

MareNostrum: IBM IDPX at BSC, >48000 cores

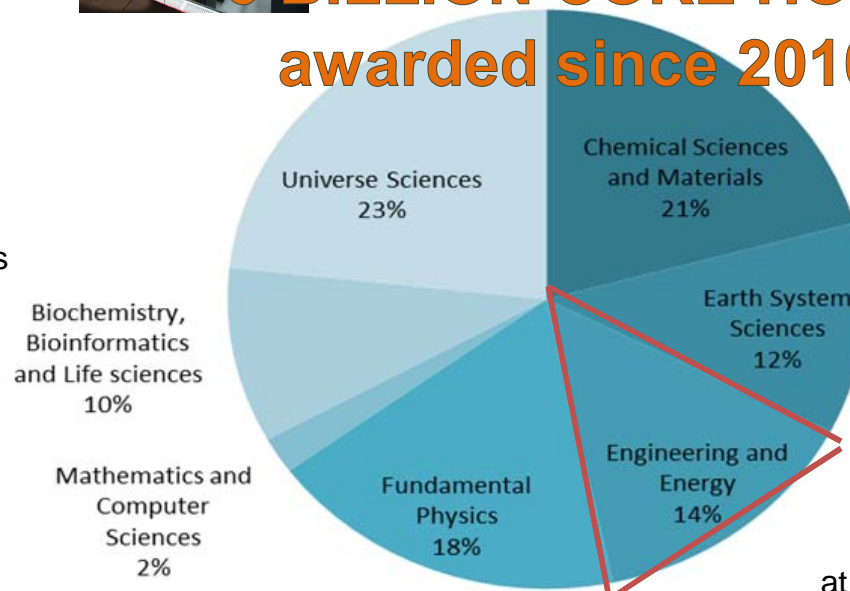**JUQUEEN:** IBM BlueGene/Q at GCS partner FZJ, >456000 cores

>5 BILLION CORE HOURS awarded since 2010

FERMI: IBM BlueGene/Q at CINECA, >163000 cores

CURIE: Bull Bullx at GENCI partner CEA >80000cores.

Pie chart:
- Chemical Sciences and Materials 21%
- Earth System Sciences 12%
- Engineering and Energy 14%
- Fundamental Physics 18%
- Mathematics and Computer Sciences 2%
- Biochemistry, Bioinformatics and Life sciences 10%
- Universe Sciences 23%

SuperMUC: IBM IDPX at GCS partner LRZ, >155000 cores

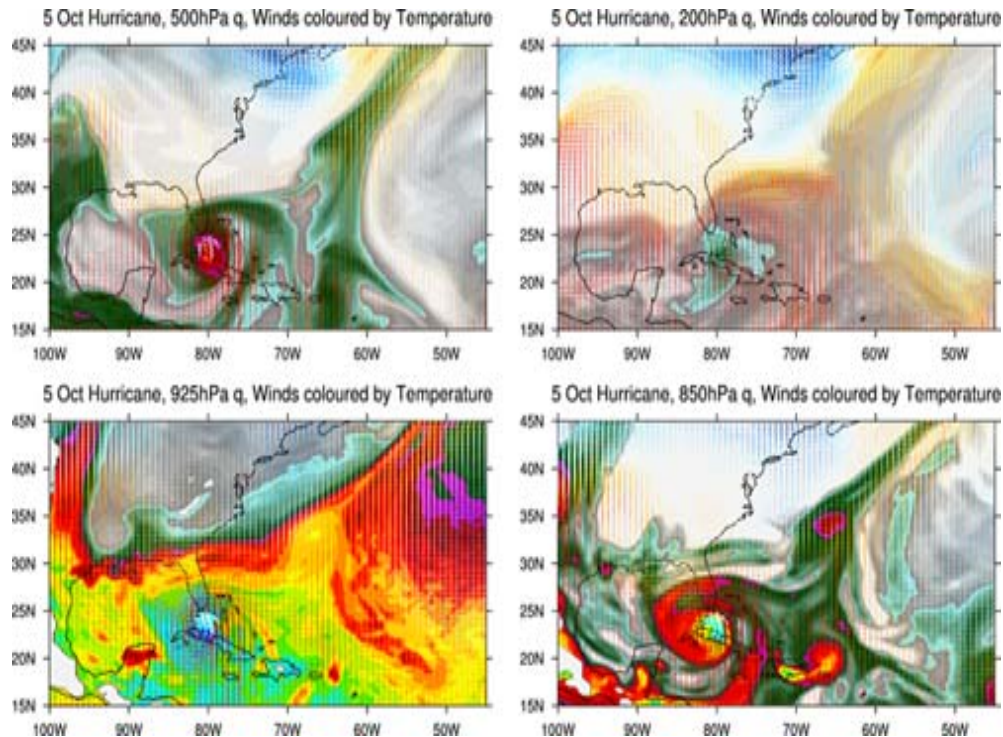**HERMIT:** Cray at GCS partner HLRS, >113000 cores

PRACE boosts Science

Example : Climate

144 million core hours on Hermit (Germany) for **UK -** UB

→ PRACE will give to UK Met a 3 years advance in the development of their models

5 Oct Hurricane, 500hPa q, Winds coloured by Temperature

5 Oct Hurricane, 200hPa q, Winds coloured by Temperature

5 Oct Hurricane, 925hPa q, Winds coloured by Temperature

5 Oct Hurricane, 850hPa q, Winds coloured by Temperature

Team : Prof. Pier Luigi Vidale (NCAS-Climate, Dept. of Meteorology, Univ. of Reading and UK Met Office, Exeter, UK.)

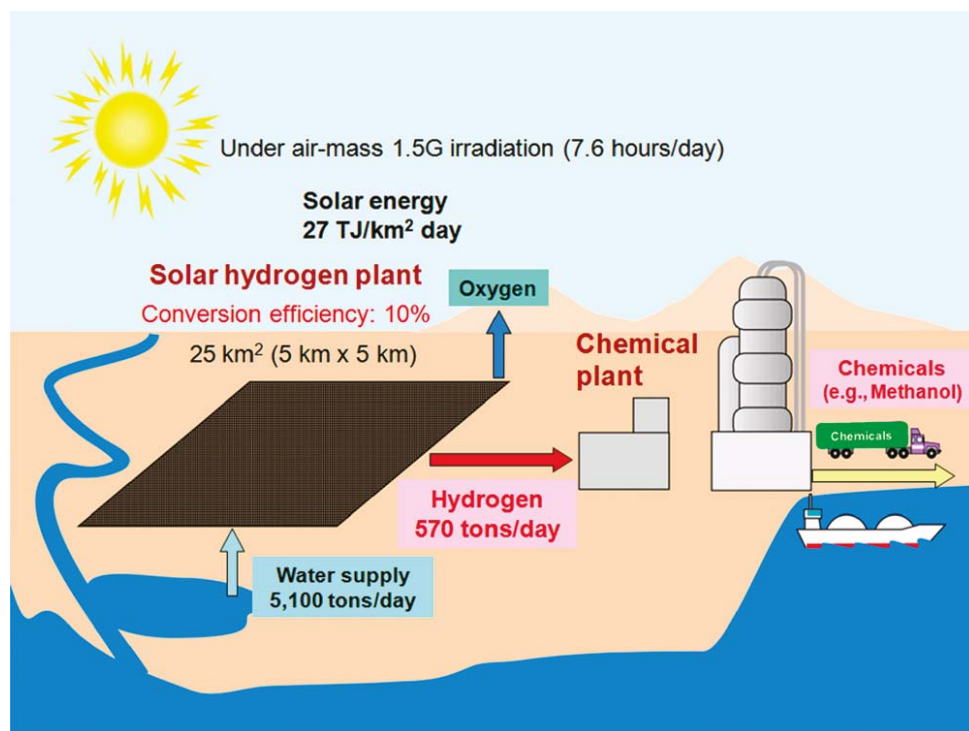**Goal :** to develop high resolution global weather & climate models (12km)

Credits: ProF. Pier Luigi Vidale, Univ. Reading, U.K. *Cray XE6 System Hermit in GCS @HLRS also in* NATURE Climate Change July 2012

PRACE boosts Science

Example : Chemistry and Materials

37 million core hours on GENCI (France) for **Spain –** U.Barcelona

Conversion of solar energy into chemical energy producing a fuel is possibly the most promising means to meet future energy demands

Under air-mass 1.5G irradiation (7.6 hours/day)

Solar energy
27 TJ/km² day

Solar hydrogen plant
Conversion efficiency: 10%

25 km² (5 km x 5 km)

Oxygen

Chemical plant

Chemicals (e.g., Methanol)

Chemicals

Hydrogen 570 tons/day

Water supply 5,100 tons/day

Team : Prof. Carme Rovira (Parc Cientific de Barcelona, Computer Simulation and Modeling Laboratory)

Goal : Transforming water into hydrogen and oxygen with the help of sunlight: storing solar energy into chemical energy

Credits: Prof. Carme Rovira – Parc Cientific de Barcelona, Computer Simulation and Modelling Laboratory.

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Recommendations from PRACE Scientific Case

1 **The need for HPC infrastructure at the European level**

Europe should continue to provide a world-leading HPC infrastructure to scientists in academia and industry, for research that cannot be done any other way.

2 **Leadership and Management**

Leadership and management of HPC infrastructure at the Europe level should be a partnership between users and providers.

3 **A Long-Term Commitment to Europe-Level HPC**

A commitment to Europe-level HPC infrastructure over several decades is required to provide researchers with a planning horizon of 10–20 years and a rolling 5-year specific technology upgrade roadmap.

4 **Algorithms, software and tools**

There is an urgent need for algorithm and software development to be able to continue to exploit high-end architectures efficiently to meet the needs of science, industry and society.

5 **Integrated Environment for Compute and Data**

Europe-level HPC infrastructure should attach equal importance to compute and data, provide an integrated environment across Tiers 0 and 1, and support efficient end-to-end data movement between all levels. Its operation must be increasingly responsive to user needs and data security issues.

6 **People and training**

Europe's long-term competitiveness depends on people with skills to exploit its HPC infrastructure. It must provide ongoing training programmes to keep pace with the rapid evolution of the science, methods and technologies, and must put in place more attractive career structures for software developers to retain their skills in universities and associated institutions.

7 **Thematic Centres**

Thematic centres should be established to support large long-term research programmes and cross-cutting technologies, to preserve and share expertise, to support training and to maintain software and data.

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PRACE begins links with industries

PRACE's Industrial Advisory Committee (IAC)

- To gather strategic expectations of industries
- To advise PRACE on the directions that best suit industrial needs
- To help to stimulate the use of HPC and numerical simulation by industry
- 1st meeting before June 2013

## European Technology Platform for HPC (ETP4HPC)

- To give the industry key directions on the development of competitive technology and applications

- PRACE is observer at the ETP's Steering board
- PRACE brings the users' needs

Open R&D model from Jan. 2012
Access to leading-edge resources

❑ **2 yearly Regular Calls open to industry**

- Access is free of charge, based on scientific excellence only, but with commitment to publish results in publicly available media

- On the 5th PRACE call : 6 industrial applicants for 2 awarded projects
  - HydrOcean : 5 Mh on HERMIT
  - Cenaero : 14 Mh on JUQUEEN
- Private-public labs have been heavy users of PRACE resources since the 2010 like
  - Aachen University, Institute of Aerodynamics : 88Mh on HERMIT, in combustion for automotive
  - CERFACS : 24 Mh on CURIE, in aerodynamics and combustion for aeronautics (with SAFRAN Group)
  - CORIA : 48 Mh on CURIE, in combustion for aeronautics (with SAFRAN Group)
  - Lund University (Sweden) : 20 Mh on CURIE, in combustion for automotive, …
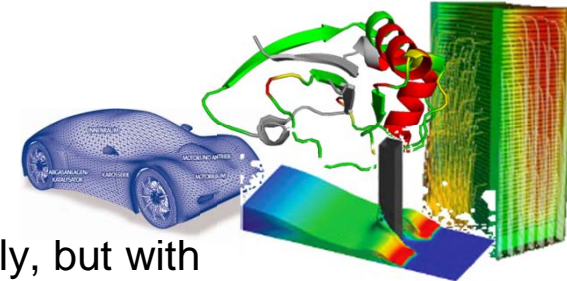
➔ The next call was open last week, February 2013

❑ **Permanent Preparatory Access call**

- Assess the scalability and port the codes ➔ preparation for future regular calls
- Big companies (PSA, Renault, CS) as well as SMEs (ARIA) or private-public labs

Open R&D model from Jan. 2012
Access to high-value services

❑ **Access to new knowledge enabled through PRACE**
- Big science may be usable by industry in advance
- PRACE as a catalyzer of technological transfer ?

❑ **Training**
- Specific courses targeting industrial users are programmed in the 6 PRACE Training Centers
- The online training portal is accessible by everyone

❑ **Code enabling**
- The implementation projects work at developing Open Source codes for industry
  - Computational Fluid Dynamics : OpenFoam
  - Uncertainties analysis : URANIE, …
- Real industrial test cases are used in the process
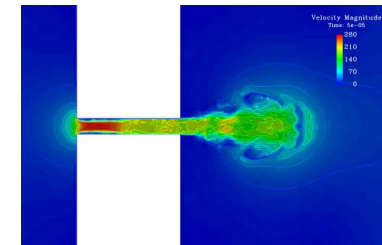
❑ **Information, Promotion and Networking**
- PRACE Industrial Seminars
  - A cumulated attendance of more than 400 people representing 114 companies
  - Good mix of large companies and SMEs, from various industrial domains
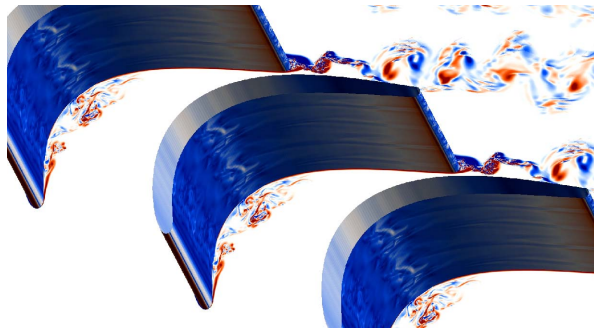- PRACE Industrial Award

PRACE Open Competition
Most Innovative European Industrial HPC Application

5th PRACE Industrial Seminar
April 15-16, 2013, Stuttgart, Germany

PRACE projects awarded related to aviation (aerodynamics, acoustics, combustion)

- ❑ **REFIT - Rotation effects on flow instabilities and turbulence (46 Mh)**
- ❑ **Large-Eddy Simulation of high-frequency instabilities under transcritical conditions (8,5 Mh)**
- ❑ **MS-COMB: Multi-Scale Analysis and Numerical Strategies for the Simulation of Premixed Turbulent Combustion in Realistic Geometries (5 Mh)**
- ❑ **Structure of turbulence in supersonic boundary layers at high Reynolds number (50 Mh)**
- ❑ **High-fidelity simulations of multiscale-generated turbulence (5,5 Mh)**
- ❑ **SIMAC - Simulation of ignition mechanisms in annular multi-injector combustors and comparison with experiments (15 Mh)**
- ❑ **JNFLAC - Jet-noise reduction by fluidic active control (15 Mh)**
- ❑ **PAdDLES - p-Adaptive Discretisations for LES in turbomachinery (14,2 Mh)**
- ❑ **X-VAMPA: Cross validation and assessment of numerical methodologies for the modeling of primary atomization (11 Mh)**

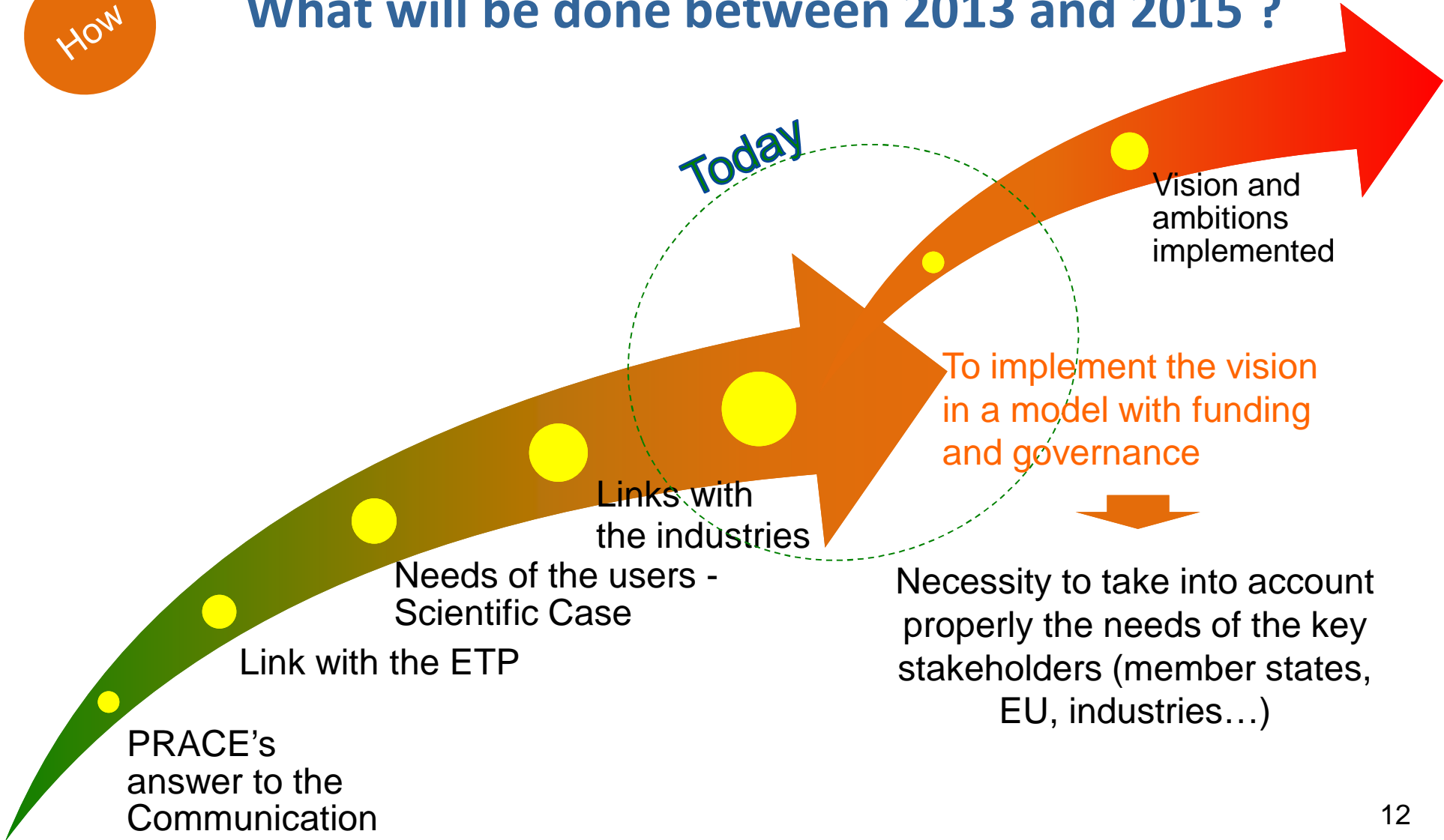# PRACE projects awarded related to aviation (aerodynamics, acoustics, combustion)

❑ **Cenaero was our first pilot and our first real industrial user**
   - ❑ During the pilot phase they developed high resolution methods for turbo machinery LES and DNS.
   - ❑ Current codes are using classical URANS methods which have some constraints in term of accuracy, instabilities prediction and transition modeling PRACE pilot for the industrial offer the JUGENE system at GCS@FZJ on up to 16k cores for optimising and scaling out the code (optimisation of the solver, hybrid parallelisation, mpi and i/o optimisation) and performing DNS simulations on a low pressure turbine. 2M cpu hours for this pilot on JUGENE.

❑ **Other research centers like Cenaero, CERFACS, CORIA, ONERA, Ecole Centrale, KTH, Technische Universität Darmstadt or University of Rome (some of them direct collaborations with industrial users like Safran)**
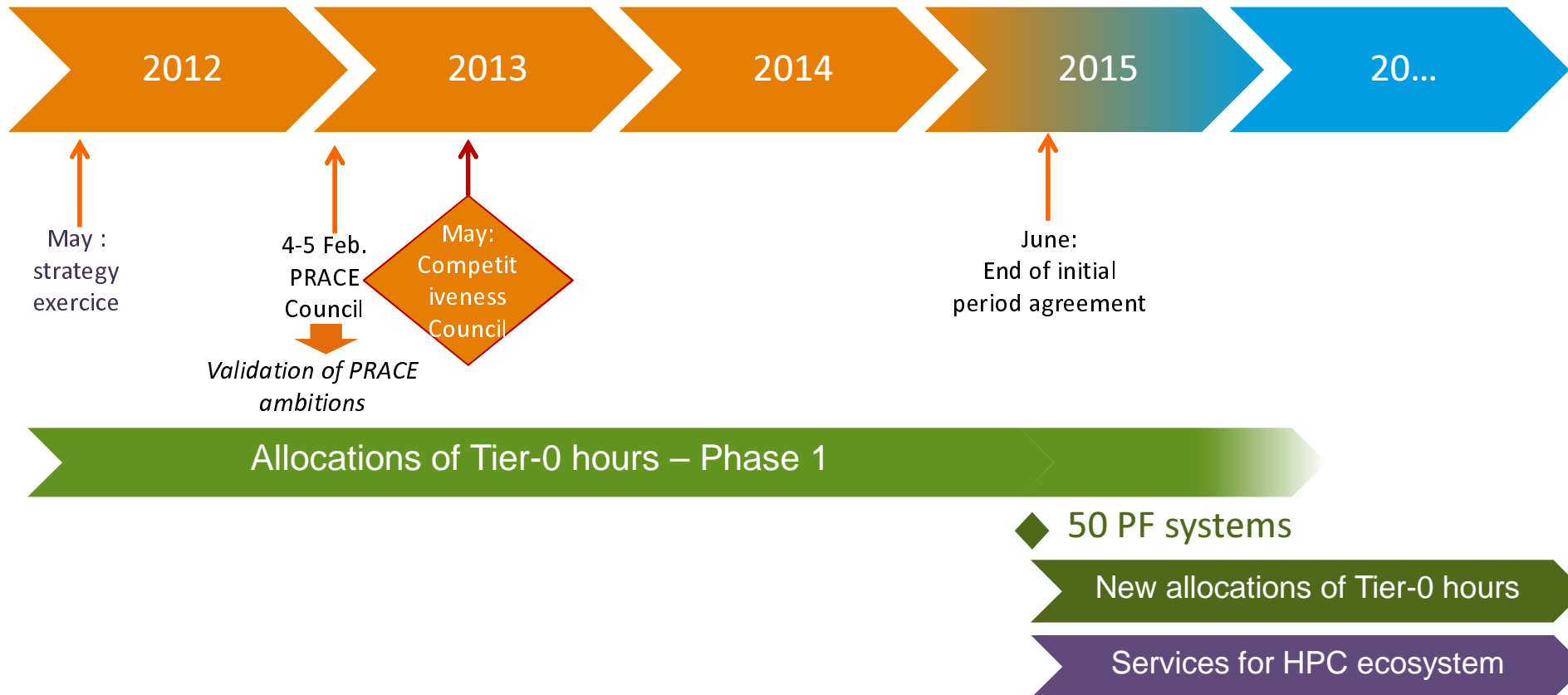
How

What will be done between 2013 and 2015 ?

Today

Vision and
ambitions
implemented

To implement the vision
in a model with funding
and governance

Links with
the industries

Needs of the users -
Scientific Case

Necessity to take into account
properly the needs of the key
stakeholders (member states,
EU, industries…)

Link with the ETP

PRACE's
answer to the
Communication

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Why

Milestones of PRACE AISBL 2.0 Strategy

| 2012 | 2013 | 2014 | 2015 | 20... |

May : strategy exercice

4-5 Feb. PRACE Council

Validation of PRACE ambitions

May: Competitiveness Council

June: End of initial period agreement

Allocations of Tier-0 hours – Phase 1

◆ 50 PF systems

New allocations of Tier-0 hours

Services for HPC ecosystem

How

PRACE 2.0 Strategy for 2015-2020

Provide an infrastructure for science and industry
- To maintain Europe as Science world class contributor
- By offering access to leading edge HPC platforms opened to all disciplines and countries in Europe

Provide an high quality service
- With at least one supercomputer in each major architectural class
- To support world-leading science

Attract, train and retain competences
- To attract, train and retain highly skilled and innovative workforce in science and engineering
- To share knowledge and expertise

Lead the integration of an highly effective HPC ecosystem
Including :
- A) scientific and industrial communities,
- B) national HPC centres and their support for the PRACE systems,
- C) training and software development efforts

PRACE begins to offer services to the industry

## Access to leading edge resources

- To assess the scalability on a wide number of HPC architectures
- To give access to HPC resources based on scientific excellence, free of charge, alone or in collaboration with labs

Access to high value services

- Training (PRACE Advanced Training Centers, opened to industrial users)
- Code enabling (Open Source codes for industry, …)
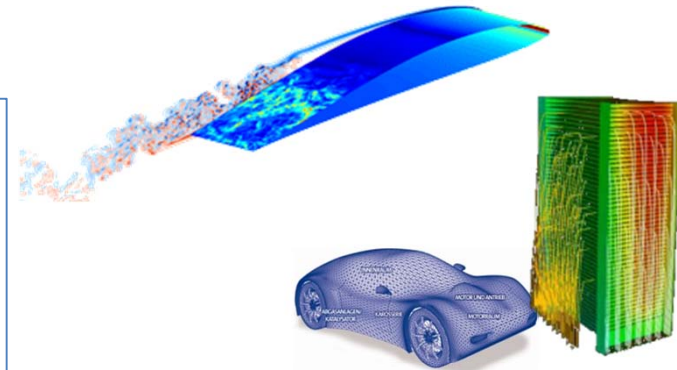
- To foster technology transfer between academia and industry

- To access to the competences enabling to build new methodologies (multiscale, multi physics, disruptive, uncertainties…)

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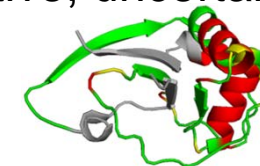
Amplify services beyond Open R&D

❑ **Pre-Competitive R&D**
- Like an Open R&D model, but with more time to publish results (2 or 3 years), so to gain competitive advantage in the meantime
- Possibility to not publish at the end and pay for the compute hours used

➡️ Pilot with interested companies ?

❑ **SHAPE : SMEs HPC Adoption Programme for Europe**
- In complement of national initiatives in France, Germany, Italy, UK, …
- Evangelize SMEs who want to engage in numerical simulation and HPC
- Support them with services up to a proof-of-concept :
  - Training in PRACE centers
  - Expertise, both in HPC and in domain-specific problems
  - Access to resources to demonstrate a real industrial case

➡️ Pilot with supply chains in one or two selected fields ?

Thank you very much for your attention!

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