The Partnership for Advanced Computing in Europe | PRACE

Stéphane Requena

Member of the Board of Directors | PRACE aisbl

HPC & Data Analytics : a major stake : HPC, a transverse and strategic tool for the management of big data

For Science

Climate

Astrophysics

Energy

Chemistry

Materials

Life Sciences

Humanities

For innovation

Automotive

Aeronautics

Pharma

Oil & Gas & Renewables

Personlized/ Precision Medecine

For decision making

Natural risks

biological and epidemiological risks

Industrial risks

Security

www.prace-ri.eu

The context : the road to Exascale

▶ Expected in

   ▶ 2019/20 for China

   ▶ 2021/22 for US and Japan

   ▶ 2022/2023 in Europe

   (EuroHPC)

▶ BUT : No more focus

   on peak performance

▶ Systems 50 to 100x

   faster than 2017

   ones on **real apps**

Projected Performance Development

Source top500.org

Performance — 10 EFlop/s, 1 EFlop/s, 100 PFlop/s, 10 PFlop/s, 1 PFlop/s, 100 TFlop/s, 10 TFlop/s, 1 TFlop/s, 100 GFlop/s, 10 GFlop/s, 1 GFlop/s, 100 MFlop/s

Lists — 1995, 2000, 2005, 2010, 2015, 2020

● Sum ▲ #1 ■ #500

| Country	Value
DENMARK	41
GERMANY	35
SPAIN	30
AUSTRALIA	29
ITALY	28
JAPAN	26
UK	20
FRANCE	19
NIGERIA	18
BRAZIL	17
USA	12
RUSSIA	11
S. AFRICA	10
CANADA	10
MEXICO	10
CHINA	8
INDIA	8

Strong constraints on energy : 20 to 30MW
• Free flops but moving data will cost
• Strong impact on HW/SW : dense architectures, deep memory hierarchies, more //, resiliency….
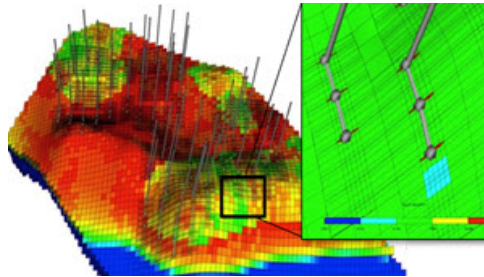
Programmability !
Support to users !

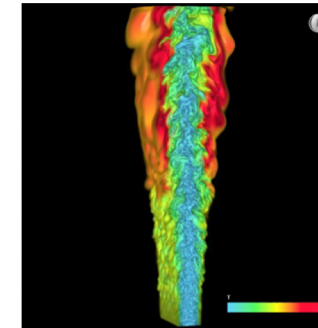# The context : Convergence between HPC, Big Data and AI

▶ ## Explosion of computational data
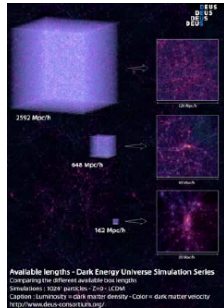
Cosmology
DEUS project
150 PB raw data

HiFi turbulent
DNS combustion
S3D : 1PB / 30mn

Reservoir modeling
of gigamodels 350 TB/run

Climate CMIP exercices

Status CMIP5 data archive:
- 1.8 PB for 59000 data sets stored in 4.3 Mio Files in 23 ESGF data nodes
- CMIP5 data is about 50 times CMIP3

Extrapolation to CMIP6:
- CMIP6 has a more complex experiment structure than CMIP5.
- Expectations: more models, finer spatial resolution and larger ensembles
- Factor of 20: 36 PB in 86 Mio Files
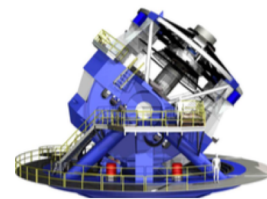- Factor of 50: 90 PB in 215 Mio Files
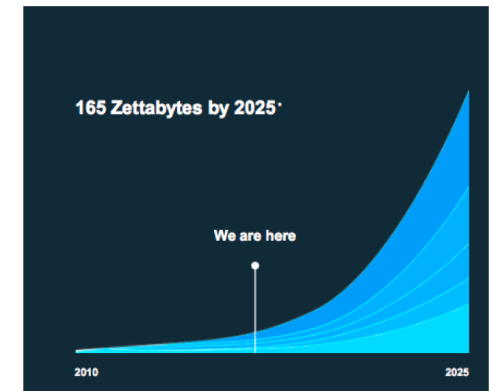
▶ ## And instrumental data

LOFAR/SKA
4 EB/yr raw

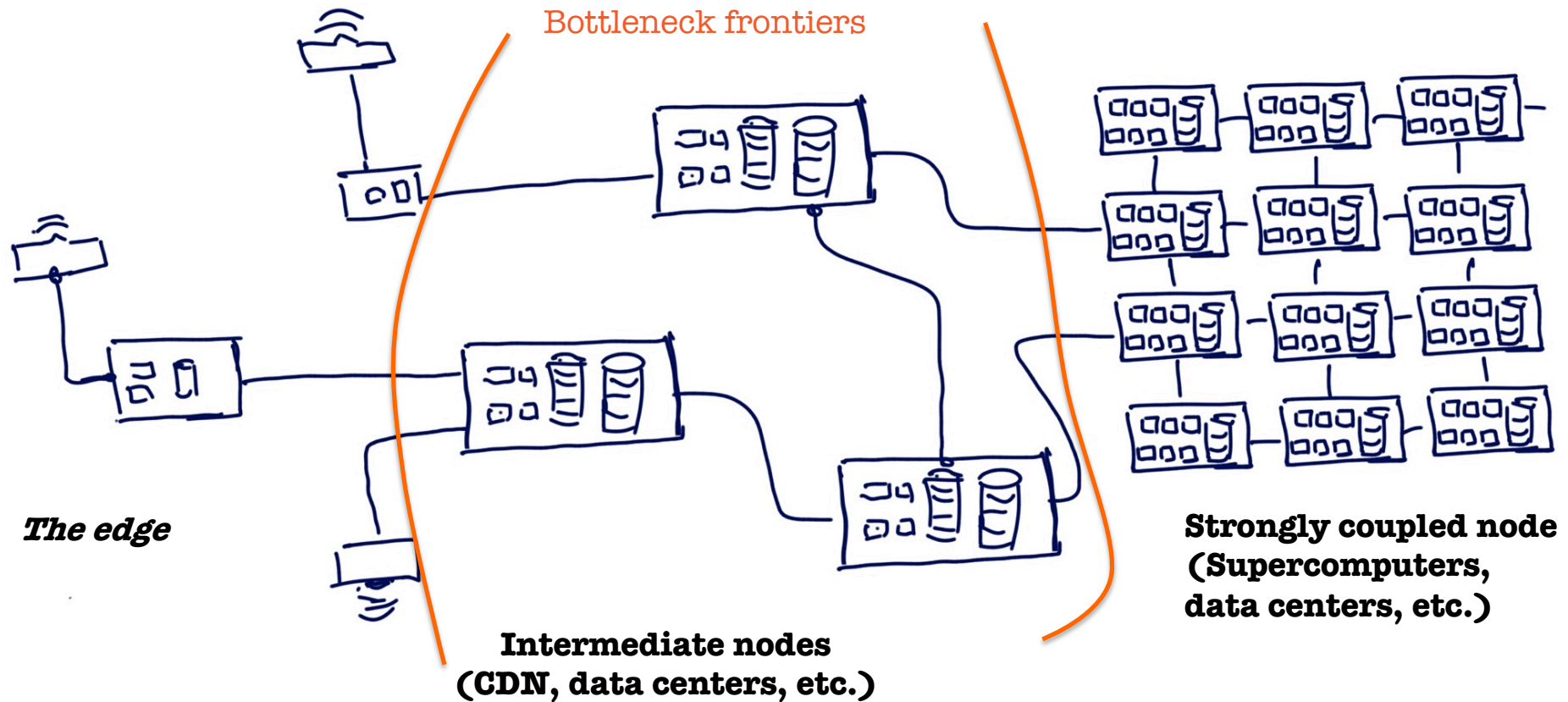COPERNICUS/SWOT
4 PB/d raw

LSST/EUCLID
20 PB/night raw

Japan array

Network of
seismic sensors
100 TB/yr

165 Zettabytes by 2025*

We are here

2010   2025

Internet & IoT

Complex workflow and data logistic to map onto the set of systems

Bottleneck frontiers

The edge

Intermediate nodes (CDN, data centers, etc.)

**Strongly coupled node (Supercomputers, data centers, etc.)**

▶ Challenges : cohabitation of SW stacks, containers, security, smart resource managers, elastic/interactive access, end to end workflows, edge computing (at the source), …

▶ Development of **new services, co design** and **user support**

Sources

exdci

A fast moving international context : Toward a scientific and economical competition

Massive investments for Exascale

China
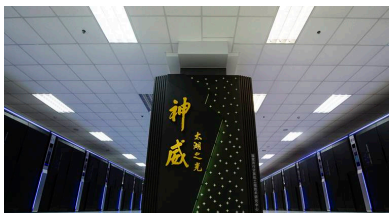
Led the HPC race during 5 yr Sunway Taihulight **#2** in top500 (93 PF sustained with in-house components)
13rd 5-year plan :
➔ Exascale in 2019

USA

National Strategic Computing Initiative (NSCI)

NSCI : US leadership for Exascale
Public/private partnerships involving all the federal agencies
➔A 5 billion $ over 10 years
Exascale in 2021

Europe

PRACE

ETP 4 HPC
THE EUROPEAN TECHNOLOGY PLATFORM FOR HIGH PERFORMANCE COMPUTING

The European Cloud Initiative: a call for a coordinated European action

A 3 pillar vision for the European HPC ecosystem
- **Technology with ETP4HPC**
- **Infrastructure with PRACE**
- **Applications with Centers of Excellence**
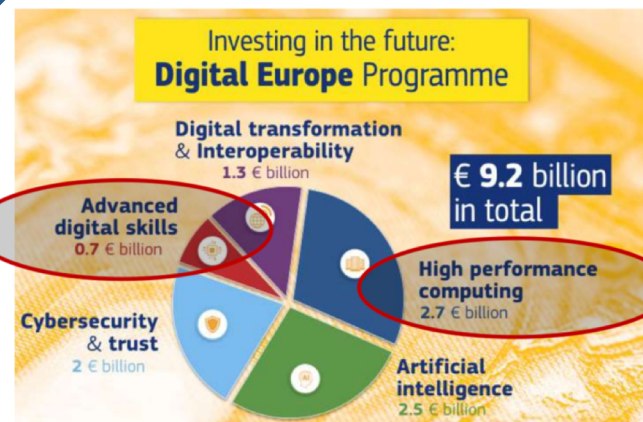→ **European Open Science Cloud** and **Data Infrastructure** initiatives

Japan

Exascale in 2021
(investment >**1 billion euros**)

EUROHPC JU

Infrastructure & Operations
R&I: Tech,Apps &Skills
HPC Ecosystem

- **Mission**: Establish an integrated world-class supercomputing and data infrastructure and support a highly competitive and innovative HPC and Big Data ecosystem
- **Objectives**
  1. ***An integrated world-class supercomputing and data infrastructure***
     - 2 pre-exascale + 2-3 petascale by 2020; 2 exascale by 2022/2023 (1 EU tech); post-exascale infrastructure by 2027
     - federation of HPC infrastructures at European level
     - hybrid HPC/Quantum infrastructure
  2. ***Research and innovation for a HPC and Big Data ecosystem***
     - an integrated European HPC R&I agenda
     - independent HPC technology supply
     - excellence in HPC applications and use
     - HPC Competence Centres, training/skills, outreach

Investing in the future:
Digital Europe Programme

Digital transformation & Interoperability
1.3 € billion

€ 9.2 billion in total

Advanced digital skills
0.7 € billion

High performance computing
2.7 € billion

Cybersecurity & trust
2 € billion

Artificial intelligence
2.5 € billion

PRACE | members

Hosting Members
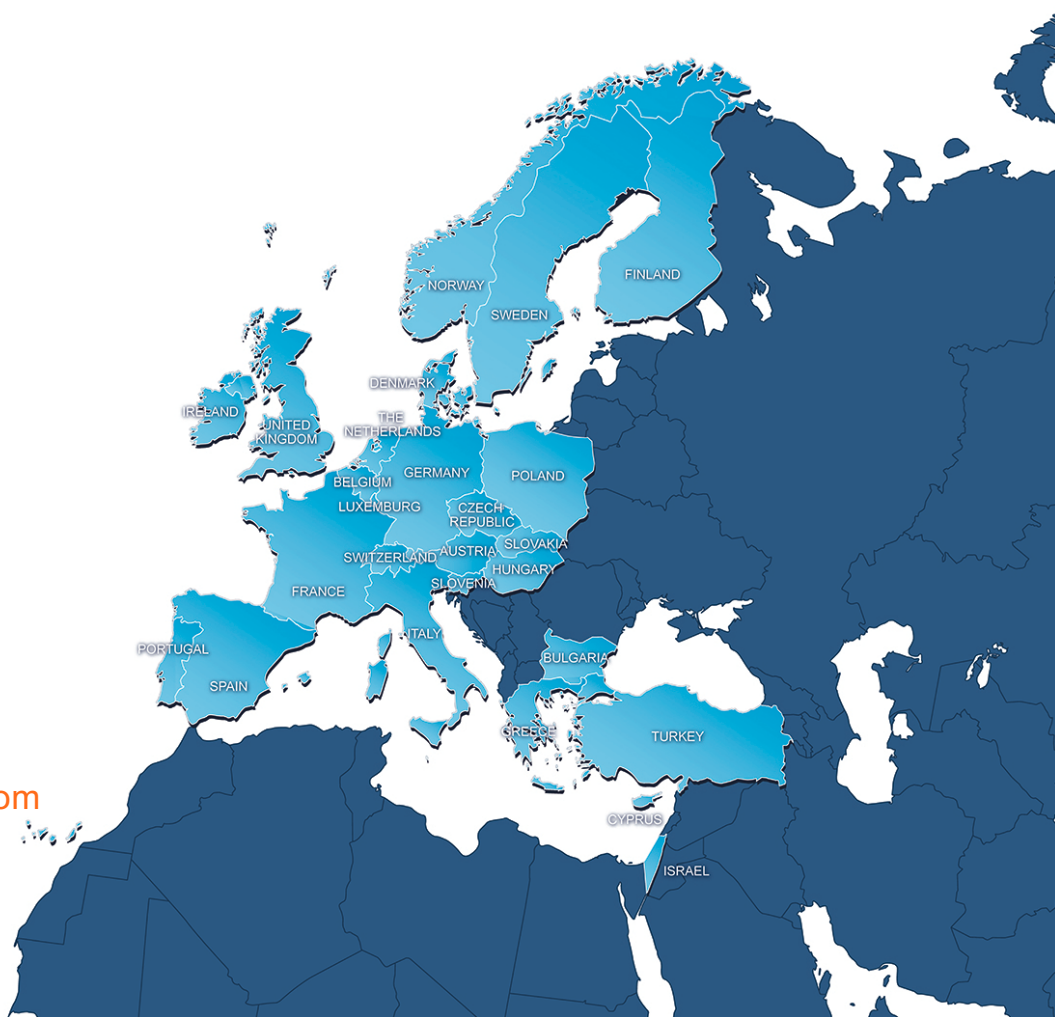- France
- Germany
- Italy
- Spain
- Switzerland

General Partners (PRACE 2)
- Austria
- Belgium
- Bulgaria
- Cyprus
- Czech Republic
- Denmark
- Finland
- Greece
- Hungary
- Ireland
- Israel
- Luxembourg
- Netherlands
- Norway
- Poland
- Portugal
- Slovakia
- Slovenia
- Sweden
- Turkey
- United Kingdom

Observers
- Croatia
- Romania

The Partnership for Advanced Computing in Europe | PRACE

PRACE | what we do

▶ Open access to world-class HPC systems to EU scientists and researchers

▶ Variety of architectures to support the different scientific communities

▶ High standards in computational science and engineering

▶ Peer Review at European level to foster scientific excellence

▶ Robust and persistent funding scheme for HPC supported by national governments and European Commission (EC)

▶ Support the development of intellectual property rights (IPR) in Europe by working with industry and public services

▶ Collaborate with European HPC industrial users and suppliers

PRACE | achievements

▶ 652 scientific projects enabled

▶ > 19 000 000 000 (thousand million) core hours awarded since 2010

▶ Of which 63% led by another PI nationality than the HM

▶ R&D access to industrial users with >50 companies supported

▶ >11 500 people trained through PRACE Training

▶ ~110 Petaflops of peak performance on 7 world-class systems

▶ 26 PRACE members, including 5 Hosting Members
(France, Germany, Italy, Spain and Switzerland)

▶ PRACE is the only e-infrastructure Landmark on the ESFRI Roadmap 2016

PRACE | Tier-0 Systems in 2018

NEW ENTRY 2018
JUWELS (Module 1): Bull Sequana
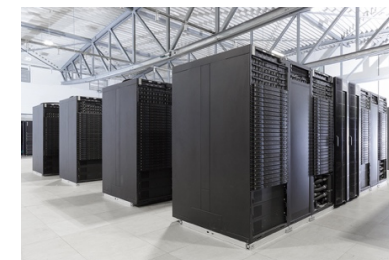GAUSS @ FZJ, Jülich, Germany
#23 Top 500
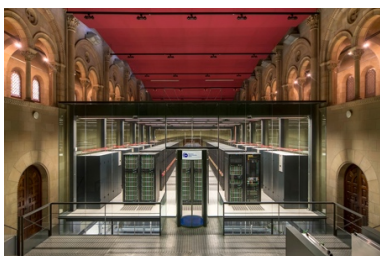
MareNostrum: IBM
BSC, Barcelona, Spain
#22 Top 500

Piz Daint: Cray XC50
CSCS, Lugano, Switzerland
#6 Top 500

SuperMUC : Lenovo
cluster   GAUSS @ LRZ,
Garching, Germany #57
Top 500   **NEW ENTRY soon** SuperMUC NG

Hazel Hen: Cray
GAUSS/HLRS,
Stuttgart, Germany
#27 Top 500

NEW ENTRY 2018
JOLIOT CURIE : Bull Sequana
GENCI/CEA, Bruyères-le-Châtel,
France #34 Top 500

MARCONI: Lenovo
CINECA, Bologna, Italy
#18 Top 500

Close to 110 Petaflops cumulated peak performance

PRACE | current services

Towards End-Users

Access

Tier-0 systems (open R&D)
- Project Access
  1-3 years
- Preparatory Access
  Type A, B, C, D

Tier-1 systems (open R&D)
- DECI Programme

Support

Application Enabling & Support
- Preparatory access Type C
- Preparatory access Type D
  - Tier-1 for Tier-0
- SHAPE
- HLST support

Training
- Training Portal
- PATC, PTC
- Seasonal Schools & on demand
- International HPC Summer School
- MOOC

- Code Vault
- Best Practice Guides
- White Papers

Communication, Dissemination, Outreach
- Website
- Public Relations
- Scientific Communication
- Summer of HPC

Events
- PRACEdays
- SC, ISC, ICT, ICRI, DI4R, …

Operation & Coordination of the common PRACE Operational Services
- Service Catalogue
- PRACE MD-VPN network
- Security

HPC Commissioning & Prototyping
- Technology Watch, PCP
- Infrastructure WS
- Best Practices
- UEABS

Towards PRACE Partners

PRACE | access

Criterion: Scientific Excellence
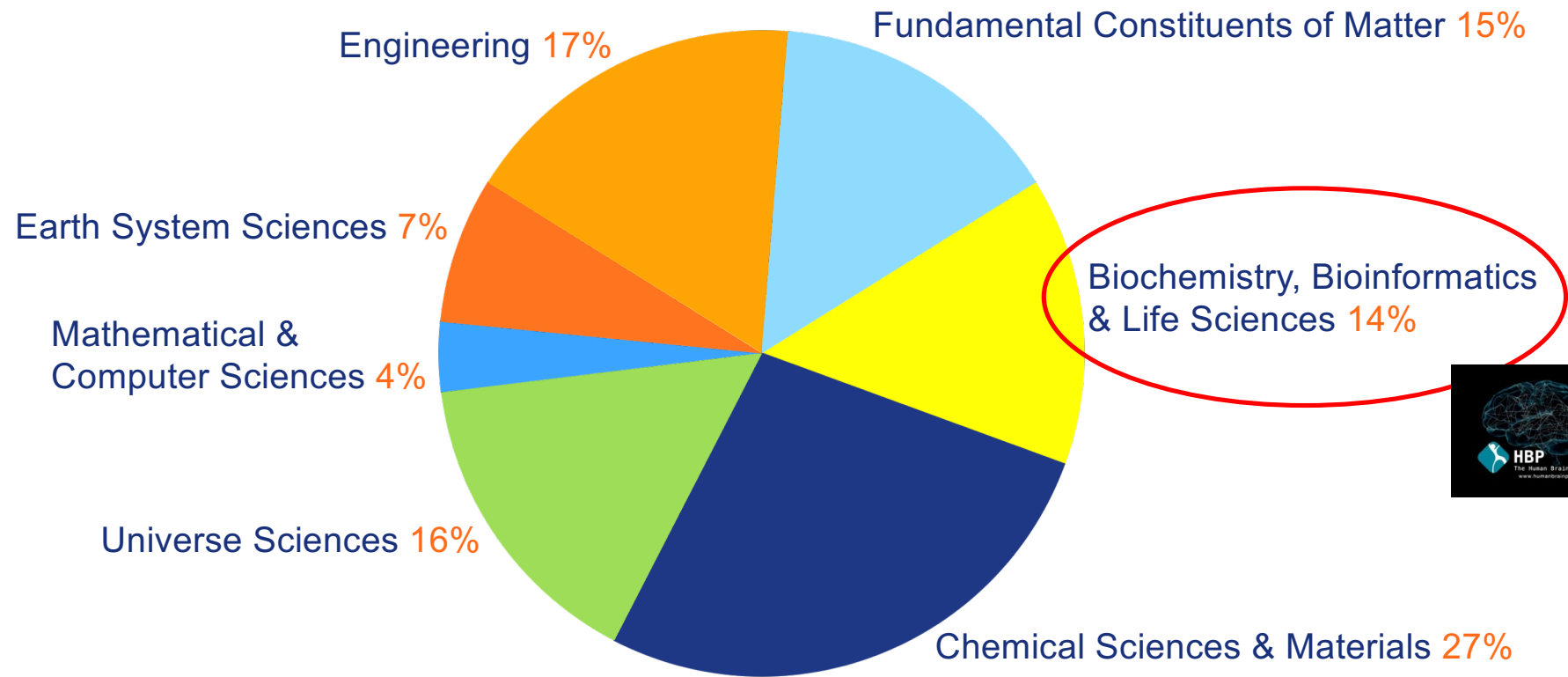
▶ Free-of-charge, obligation to publish results at the end of the award period

▶ Project Access (bi-annual calls)
  ▶ For a specific project; award period 1 to 3 years
  ▶ For individual researchers and (international) research groups (PI has to come from a PRACE 2 supporting member)
  ▶ Requires to demonstrate technical feasibility of project

▶ Preparatory Access
  ▶ Optionally with support from PRACE experts
  ▶ Prepare proposals for Project Access
  ▶ SHAPE projects receive Preparatory Access

▶ DECI

▶ 0,5% of resources for CoEs

PRACE | support to science

Criterion: Scientific Excellence

Engineering 17%

Fundamental Constituents of Matter 15%

Earth System Sciences 7%

Biochemistry, Bioinformatics & Life Sciences 14%

Mathematical & Computer Sciences 4%

Universe Sciences 16%

Chemical Sciences & Materials 27%

HBP
The Human Brain Project
www.humanbrainproject.eu

PRACE | support Human Brain Project

Close to 300M core hours allocated to 4 HBP research teams on 4 different Tier0 systems at CINECA, JUELICH and GENCI
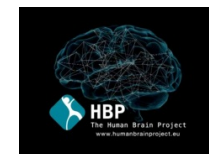
TOWARD A REALISTIC MODEL of cerebellum network

→ Simulation Realistic cerebellar multi scale network reconstruction

- Cerebellum, part of the central nervous system, involved in n known neurodegenerative diseases, such asfrontotemporal dementia, psychosis, Alzheimer and Parkinson diseases
- 62 million core hours allocated on JUQUEEN (Germany) and Joliot Curie (France)
- Use of NEST and NEURON multi scale neuron network applications
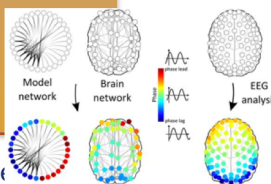
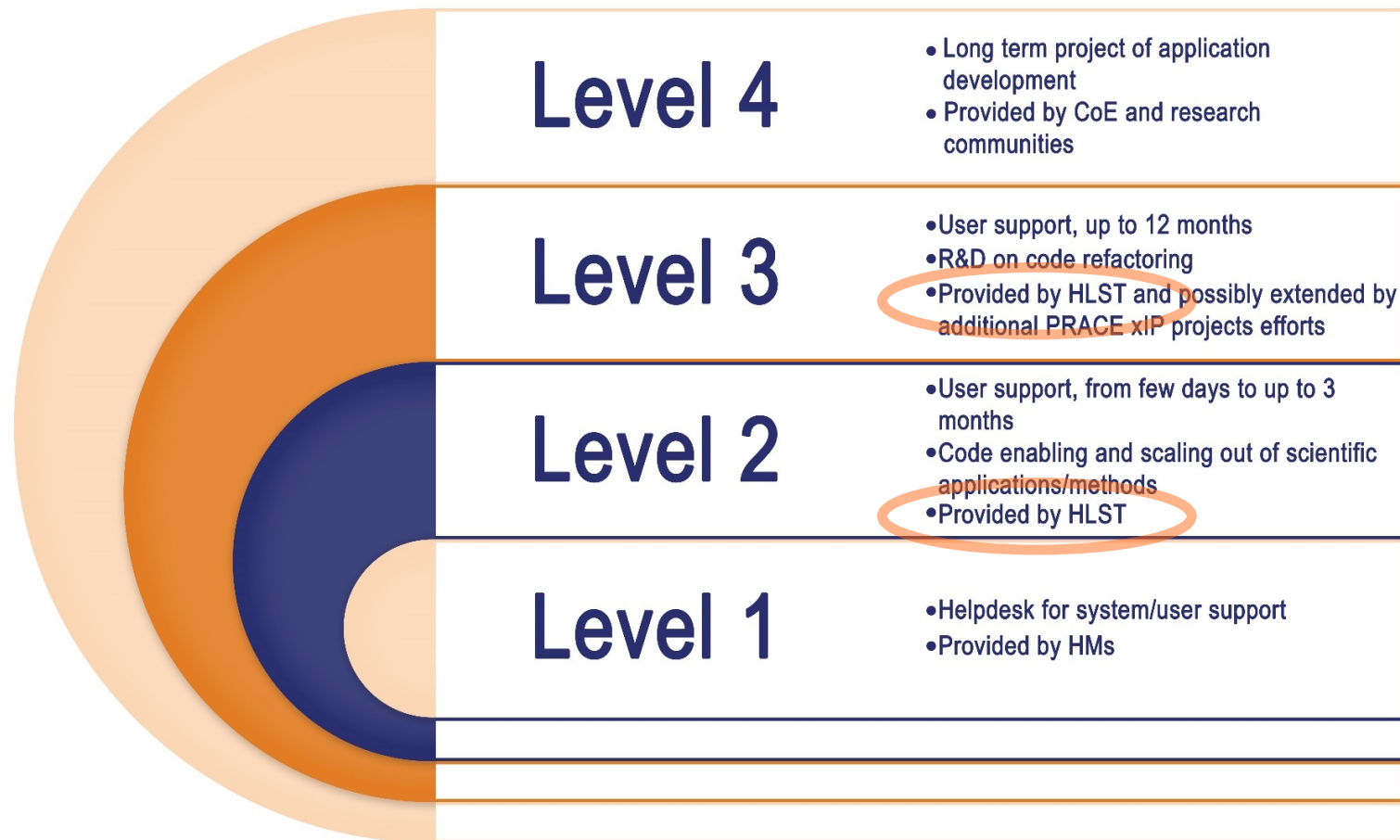## CURING NEUROLOGICAL DISEASES

Record for French biophysicists

→ Simulation of the transport of the nervous impulse from neuron to neuron in the human brain

- 140 million hours for 2 years (56 million hours on Curie in France and 84 million hours on SuperMUC in Germany)
- Simulations by molecular dynamics (MD)
- "Electrophysiology - Atomistic modeling" Project
- Looking for new treatments of neurological diseases such as epilepsy

PRACE | high-level support teams (HLST)

Level 4
- Long term project of application development
- Provided by CoE and research communities

Level 3
- User support, up to 12 months
- R&D on code refactoring
- Provided by HLST and possibly extended by additional PRACE xIP projects efforts

Level 2
- User support, from few days to up to 3 months
- Code enabling and scaling out of scientific applications/methods
- Provided by HLST

Level 1
- Helpdesk for system/user support
- Provided by HMs

PRACE | support to industry

Criterion: Scientific Excellence

Access to systems

▶ Calls open to industry
  ▶ Commitment to publish results
▶ Continuous Preparatory Access
  ▶ For scalability and porting

Access to services

▶ HPC knowledge
▶ Training
▶ Code enabling
▶ Information, Promotion, and Networking

▶ SME HPC Adoption Programme in Europe
  ▶ Equip European SMEs with expertise to take advantage of the innovation possibilities of HPC
  ▶ Increasing competitiveness
  ▶ Enable development of new products or services
  ▶ Create new business opportunities

PRACE | training

a sustained, high-quality training and education service for the European HPC community

Different levels of training

- Basic, intermediate, advanced HPC
- Parallel programming
- Accelerators
- Performance/energy optimisation

Domain-specific topics

- Simulation software
- Visualisation
- Data intensive computing

10 PRACE **Training Centres** across Europe

PRACE **Training Events** : Seasonal Schools, International HPC Summer School, On-demand training events

PRACE Training and Events portal

Code Vault
Massive Open Online Courses (**MOOCs**)

Summer of HPC
(Programme for undergraduate and postgraduate students)

EDI in the Political Landscape

▶ **Digitising European Industry strategy** as the political framework

  ▶ Announced in April 2016 by the
    European Commission President Juncker

▶ **European Cloud Initiative** | ECI

  ▶ [see COM(2016)178]

  ▶ Aim

    ▶ *Strengthen Europe's position in data-driven innovation*

    ▶ *Improve its competitiveness and cohesion*

    ▶ *Help create a Digital Single Market in Europe*

  ▶ Provide European science, industry and public authorities with

    ▶ *a world-class data infrastructure to store and manage data;*

    ▶ *high-speed connectivity to transport data; and*

    ▶ *ever more powerful High Performance Computers to process data.*
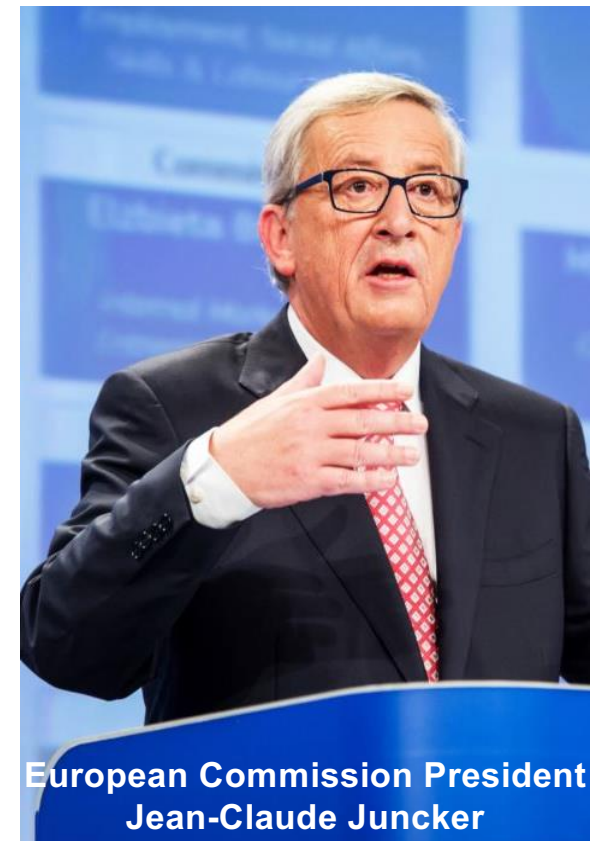
**European Commission President
Jean-Claude Juncker**

EDI in the Political Landscape (2)

▶ Two components of ECI

  ▶ European Open Science Cloud | EOSC

  ▶ European Data Infrastructure | EDI
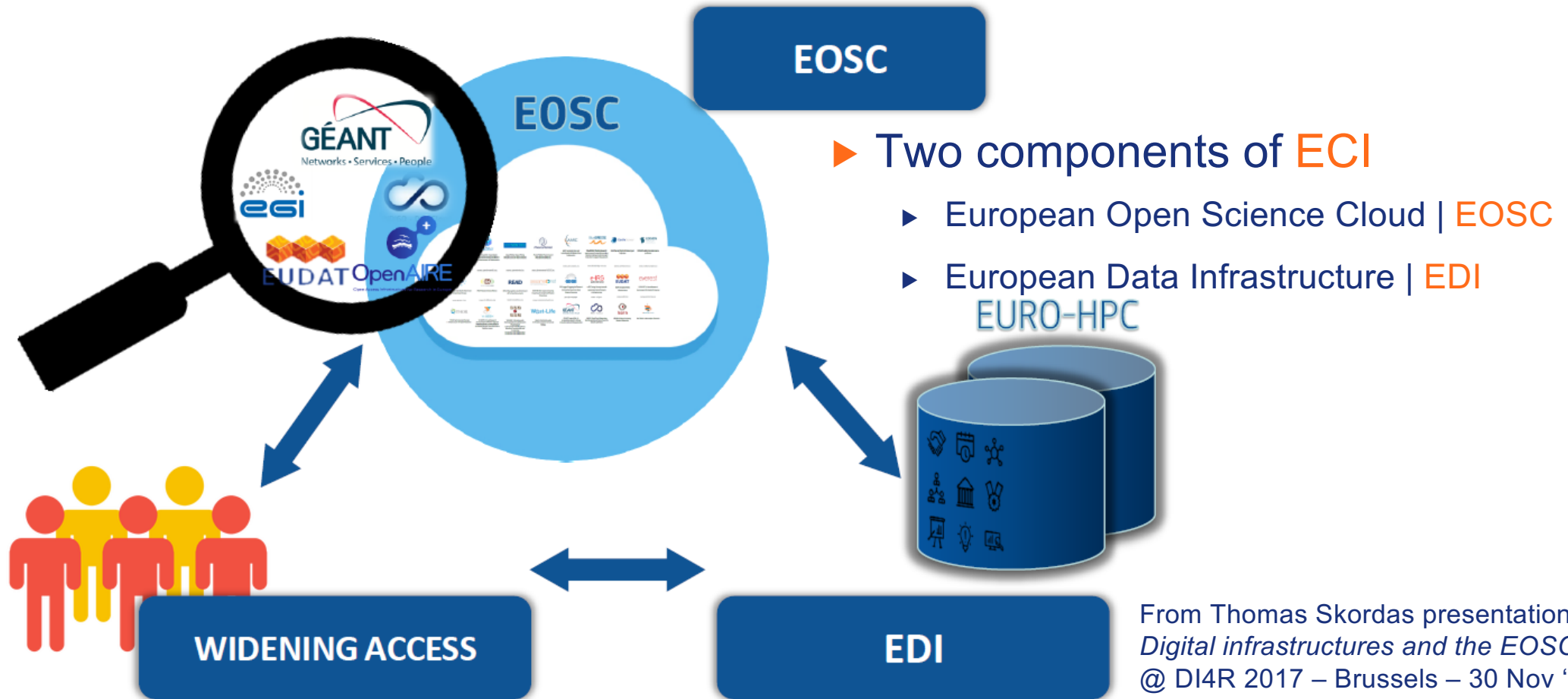
From Thomas Skordas presentation
Digital infrastructures and the EOSC
@ DI4R 2017 – Brussels – 30 Nov '17

EDI | European Data Infrastructure

▶ High Performance Computing (HPC)
  ▶ Powerful supercomputers
  ▶ To solve complex computational problems or data intensive tasks

▶ High Performance Data Analytics (HPDA) and management
  ▶ Link with large scale instruments
  ▶ Collaboration with data initiatives / infrastructures in Europe
  ▶ High-bandwidth networks

▶ Effectively access and process large datasets

▶ User base
  ▶ Initial focus on the scientific community
  ▶ Enlarge to industry and public sector

→ PRACE – GÉANT analysis and road mapping

Towards EDI | challenges

▶ Target Exascale building up on PRACE success

▶ Towards a data-centric approach

▶ Extend services towards industry and to public sector

▶ Enhance integration of the Tiers and connect to EOSC

new converged HPC / AI services	new Data services
new services to industry	new network services
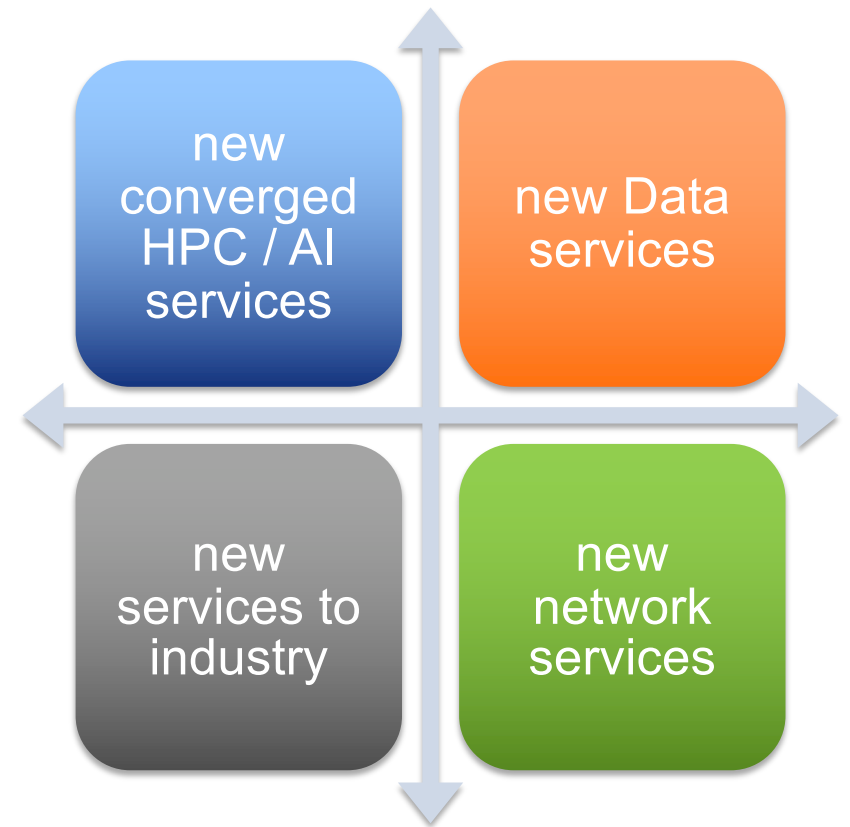
Towards a **data-centric** approach

▶ Handle the large volume of data generated

▶ Offer computing capacity to large scale scientific instruments

▶ Extend to new computing needs (HPDA, AI, …)
  ▶ Supported by the convergence of HPC and Big Data
  ▶ Scalable & interactive, federated data services from EUDAT and FENIX

▶ Anticipated key role of the networking services
  ▶ AAI
  ▶ SDN
  ▶ …

On going pilot call for PRACE call 18th
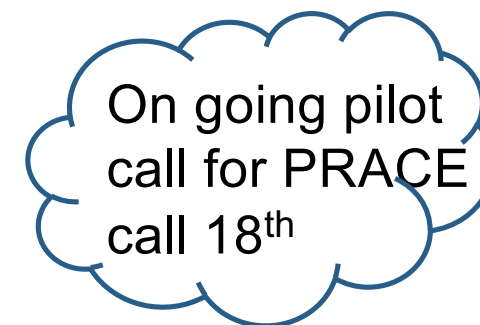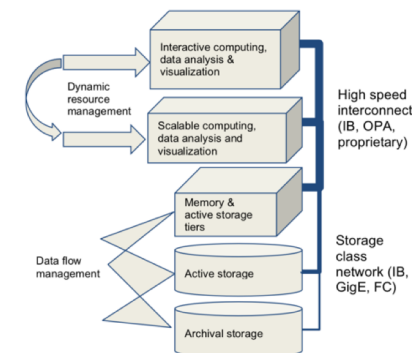
THANK YOU FOR YOUR ATTENTION

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