



ETP4HPC

HPC technology European HPC ecosystem

ORAP forum, March 2016



ETP4HPC and HPC EC plan

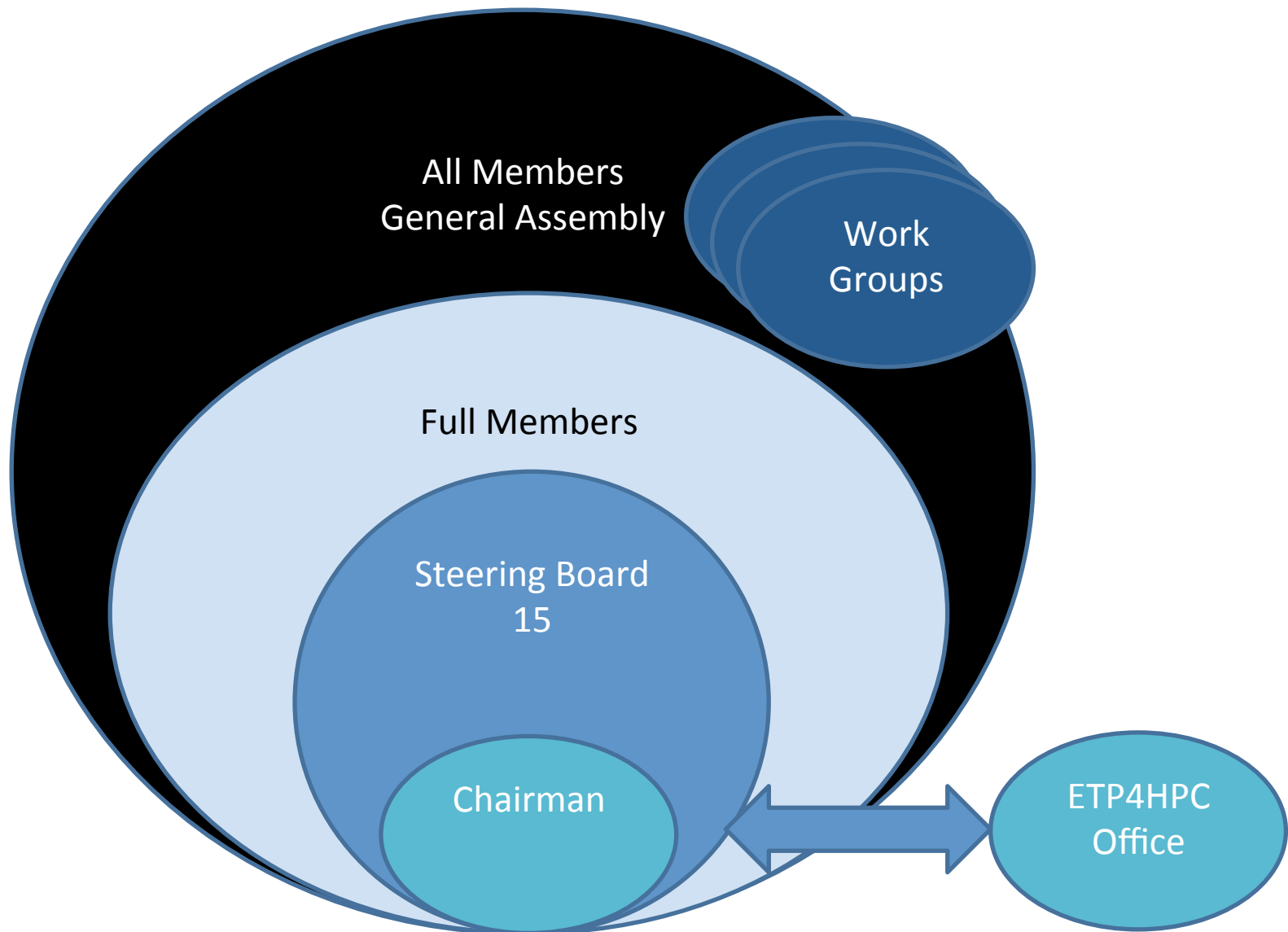
ETP4HPC

- Association gathering the HPC technology R&D players of Europe
- Dutch association
- Objective

**“To build a globally competitive
European world-class HPC
technology value chain”**

ETP4HPC members

- **72 organizations** involved in HPC technology research based in Europe:
 - 24 Associated / 48 Full members
 - 24 SMEs (Full+Associated)
 - 26 RTO/Full+ 4 Associated
- Full members : 48



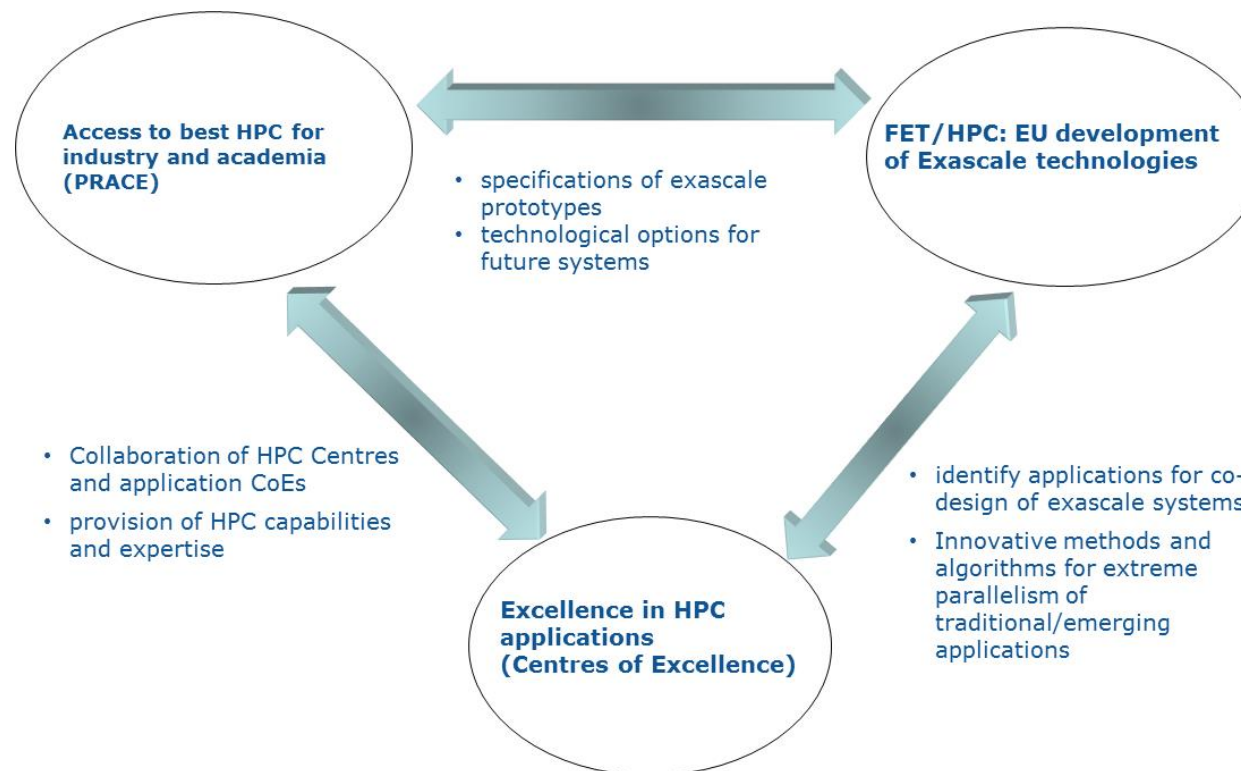
A bit of history

- 2004: first attempts at designing and building a **European HPC Research Infrastructure** (HPCEUR, HET), which resulted in the creation of PRACE in 2010
- 2010: meetings of experts representing EC and European stakeholders to define a **global policy**
- 2011: the creation of ETP4HPC
- Actions in FP7
 - PRACE Preparatory Phase and first Integrated Projects
 - Supports action : EESI and EESI2
 - Calls for Exascale computing in WP2011 and WP2013



The EC Communication

- High-Performance Computing: Europe's place in a Global Race issued in Feb 2012
- Policy based on 3 pillars



The HPC Public Private Partnership

- Mutual commitment
 - European Commission
 - HPC as a priority in Horizon2020
 - Funding of 700 M€
 - ETP4HPC
 - Investment to match EC funding in R&D
 - Effort to maximise impact on European industry
- Partnership board
 - strategy setting
 - impact monitoring



EUROPEAN COMMISSION
PRESS RELEASE

Brussels, 17 December 2013

EU industrial leadership gets boost through eight new research partnerships

The European Commission today launched eight contractual Public-Private Partnerships (PPPs) of strategic importance for European industry. The partnerships will leverage more than 4.6 billion of investment, to be allocated through calls for proposals under Horizon 2020, the new EU programme for research and innovation. Each euro of public funding is expected to trigger additional investments of between three and 10 euro to develop new technologies, products and services which will give European industry a leading position on world markets. [\(EN\) \(ES\) \(FR\)](#)

European Commissioner for Research, Innovation and Science Miroslav Kozma said: "Europe needs industry to innovate to create income and jobs. New technologies and products, such as green cars, energy efficient buildings and cleaner manufacturing processes, are essential to address societal challenges such as climate change, energy and resource efficiency. We want these contractual PPPs to have a substantial impact on the competitiveness of the EU industry, on sustainable economic growth and the creation of new high-skilled jobs in Europe."

Vice President Herve Frosch, Commissioner responsible for the Digital Agenda, said: "This is a great opportunity for Europe. These PPPs will maintain our global lead in robotics, artificial intelligence, high performance computing, bioeconomy and give us a head start in smart cities, intelligent transport, education, entertainment, media and other promising markets. Combined with a comprehensive industrial strategy, the PPPs will ensure vigorous European leadership and a better future for all."

The eight contractual Public-Private Partnerships are:

- **Factories of the Future (FoF)**, to support the manufacturing industry through the development of sustainable production technologies and systems. [\(Link to factsheet\)](#)
- **Energy-efficient Buildings (EeB)**, to increase the competitiveness and energy efficiency of the construction industry. [\(Link to factsheet\)](#)
- **European Green Vehicles Initiative (EGVI)**, to develop a competitive and resource-efficient transport system with significantly less CO₂ emissions. [\(Link to factsheet\)](#)
- **Sustainable Process Industry (SPI)**, to make the process industry more resource- and energy-efficient. [\(Link to factsheet\)](#)
- **Robotics**, one of the key enabling technologies for our future prosperity and an essential element of many sectors, from energy and health, to everyday products like CO₂ cleaners and mobile phones. [\(Link to factsheet\)](#)
- **Robotics**, a key driver of industrial competitiveness and essential to address key societal challenges in areas such as demographic change, health and well-being, food production, transport and security. [\(Link to factsheet\)](#)
- **High Performance Computing (HPC)**, which plays a pivotal role in stimulating European economic growth and advancing European science. [\(Link to factsheet\)](#)
- **Advanced 5G networks for the Future Internet (5G)**, to stimulate the development of networked internet infrastructure to ensure advanced ICT services for all sectors and users. [\(Link to factsheet\)](#)

The contracts setting up the PPPs were signed today by the Commission and chairpersons of specially-created industrial research and innovation associations, representing more than 1,000 large and small enterprises across Europe.



The Horizon 2020 HPC projects

- First call of Horizon2020

- 19 research projects and 2 support actions
- Most projects started in Sept-Oct 2015 for 3 years
- Total effort : 94 M€ for R&D projects

- Summary:

- 170 organisations involved in this effort
- Project distribution
 - 9 HPC core technologies and architectures
 - 5 Programming methodologies, environments, languages and tools
 - 0 APIs and system software
 - 5 New mathematical and algorithmic approaches

15,7%	industry
0,2%	non EU
68,9%	research
15,3%	SME

FETHPC1 call in WP2014-2015 of H2020

Acronyme	Titre
ExaNoDe	European Exascale Processor Memory Node Design
ExaNeSt	European Exascale System Interconnect and Storage
NEXTGenIO	Next Generation I/O for Exascale
Mont-Blanc 3	Mont-Blanc 3, European scalable and power efficient HPC platformbased on low-power embedded technology
SAGE	SAGE
MANGO	MANGO: exploring Manycore Architectures for Next-GeneratiOn HPC systems
ECOSCALE	Energy-efficient Heterogeneous COmputing at exaSCALE
EXTRA	Exploiting eXascale Technology with Reconfigurable Architectures
ESCAPE	Energy-efficient SCalable Algorithms for weather Prediction at Exascale
ComPat	Computing Patterns for High Performance Multiscale Computing
ExCAPE	Exascale Compound Activity Prediction Engine
NLAFET	Parallel Numerical Linear Algebra for Future Extreme-Scale Systems
INTERTWINE	Programming Model INTERoperability ToWards Exascale (INTERTWinE)
greenFLASH	Green Flash, energy efficient high performance computing for real-time science
READEX	Runtime Exploitation of Application Dynamism for Energy-efficient eXascale computing
ALLScale	An Exascale Programming, Multi-objective Optimisation and Resilience Management Environment Based on Nested Recursive Parallelism
ExaFLOW	Enabling Exascale Fluid Dynamics Simulations
ANTAREX	AutoTuning and Adaptivity appRoach for Energy efficient eXascale HPC systems
ExaHyPE	An Exascale Hyperbolic PDE Engine

Architecture and Compute Topics

Architecture of future HPC platforms will deal with:

- Energy efficiency
 - 1 ExaFLOP in 20 MW
- Heterogeneity
 - Name your device, please.
- Reconfigurability
 - If you have named FPGA in the previous point...
You most probably want to reconfigure it, right?
- Resource balance
 - Mostly balance compute throughput, memory and network bandwidth
- Co-design driven
 - And now you want to balance also for CFD, QCD, MD, ...
- Integration and reliability
 - 50K+ compute nodes... Heterogeneous...
 - How to detect failures? How to survive with them?

Interconnect, Memory, Storage, Data-Intensive Real Time topics

- System architecture for Exascale and data-centric HPC
 - Very Tightly Coupled Data & Computation
 - Codesign using accelerators and FPGAs
- Develop a new server architecture using next generation processors and memory advances
 - Integration of NVRAM technologies in the I/O stack
 - Extreme compute power density
 - Develop the systemware to support their use at the Exascale
- New applications and use cases emerging for HPC
 - Real-time, data-intensive, and energy efficiency

Programming Models, Algorithms and Mathematics topics

- Programming models
 - Innovative Programming Models for Exascale
 - Enhanced MPI and PGAS: the incremental approach
- Interoperability and autotuning
 - Interoperability of programming models: the "+" issue
 - Autotuning for energy efficiency and green HPC
- Algorithms and Maths
 - Computational Fluid Dynamics for Exascale
 - Multiscale Applications
 - Machine learning
 - Solvers

CoEs – Centres of Excellence in Computing Applications



Acronym	Title
EoCoE	Energy oriented Centre of Excellence for computer applications
BioExcel	Centre of Excellence for Biomolecular Research
NoMaD	The Novel Materials Discovery Laboratory
MaX	Materials design at the eXascale
ESIWACE	Excellence in Simulation of Weather and Climate in Europe
E-CAM	An e-infrastructure for software, training and consultancy in simulation and modelling
POP	Performance Optimisation and Productivity
COEGSS	Center of Excellence for Global Systems Science

Material science

- Material design at Exascale
 - led by users CNR Modena E Molinari



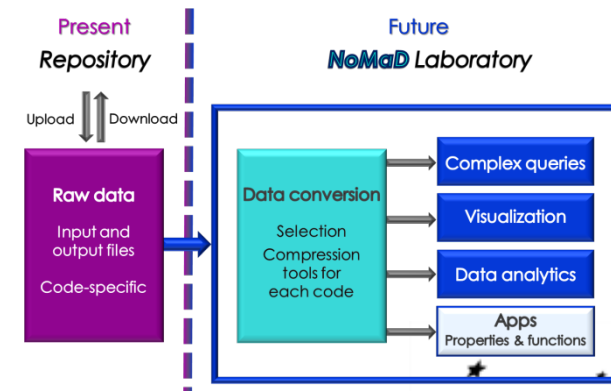
key code developers in quantum materials simulations



- ECAM
 - Existing distributed CECAM community
 - Simulations all the way from atomic scale to continuum level (including biological systems, soft materials)
 - Open to exa-scale, but not main driver - still plenty of important work to do at peta-scale in our disciplinary areas



- NOMAD : Novel Material Discovery
 - Data base, research tools, visualization, analytics



Earth science

- ESiWACE



- managed by DKRZ
- improve the efficiency and productivity of numerical weather and climate simulation
- addressing challenges : scalability, usability, exploitability

- CoeGSS : Centre of Excellence for Global Systems Science



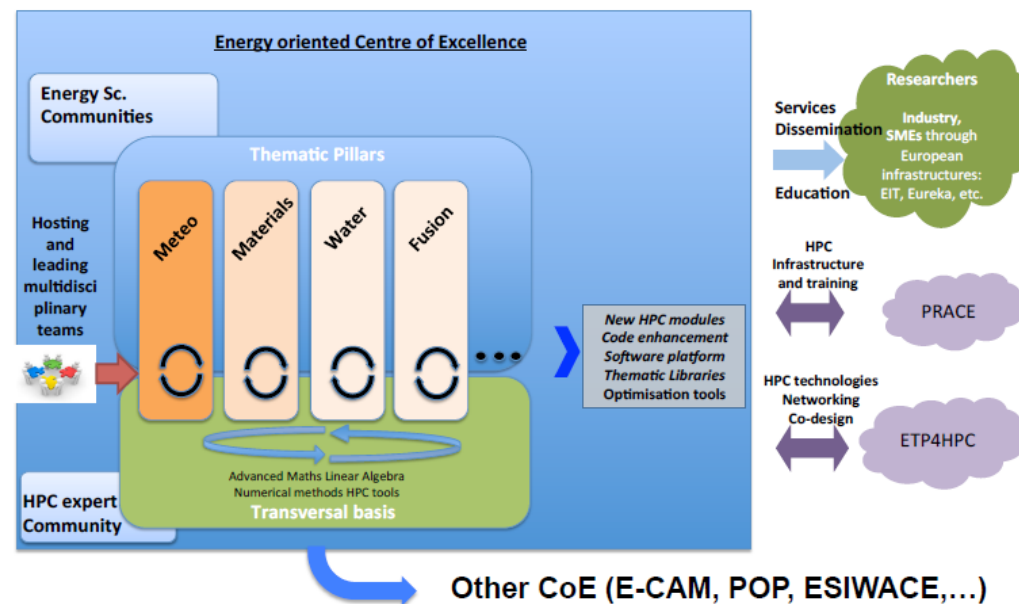
- managed by HLRS and University of Potsdam
- Build up a broad simulation service portfolio on synthetic populations
- Create demonstrators to simulate and analyse : Pandemics, Urbanization, Social Habits, Green Growth



Energy

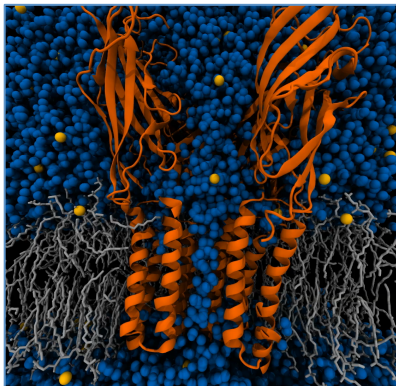


- Energy oriented Center of Excellence
 - managed by CEA
 - production, storage and distribution of energy
 - models for weather, material, water, fusion

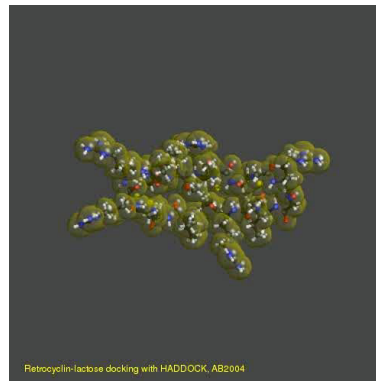


Bioscience

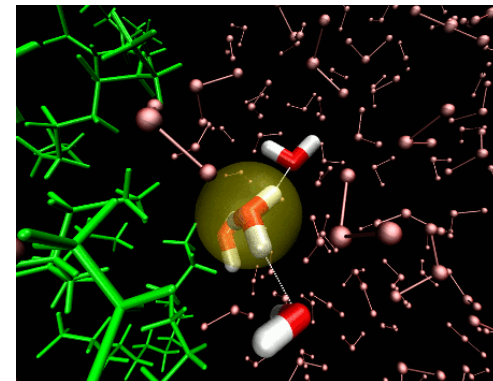
- BioExcel : Center of Excellence for Biomolecular Research
 - managed by KTH
 - Improve the performance, efficiency and scalability of key codes
 - GROMACS (Molecular Dynamics Simulations)
 - HADDOCK (Integrative modeling of macro-assemblies)
 - CPMD (hybrid QM/MM code for enzymatic reactions, photochemistry and electron transfer processes)



MD simulations
/GROMACS/



Docking
/HADDOCK/



QM/MM
/CPMD/

Transversal



- POP : Performance Optimization and Productivity
 - managed by BSC
 - Services provided
 - Precise understanding of application and system behavior
 - Suggestion/support on how to refactor code in the most productive way
 - For academic AND industrial codes and users

? Application Performance Audit

- Primary service
- Identify performance issues of customer code (at customer site)
- Small Effort (< 1 month)

! Application Performance Plan

- Follow-up on the service
- Identifies the root causes of the issues found and qualifies and quantifies approaches to address the issues
- Longer effort (1-3 months)

✓ Proof-of-Concept

- Experiments and mock-up tests for customer codes
- Kernel extraction, parallelization, mini-apps experiments to show effect of proposed optimizations
- 6 months effort

Support actions

- EESI and EESI2

- run by European experts from 2008 to 2015
- important recommendations covering technology, applications, algorithms
- <http://www.eesi-project.eu/>

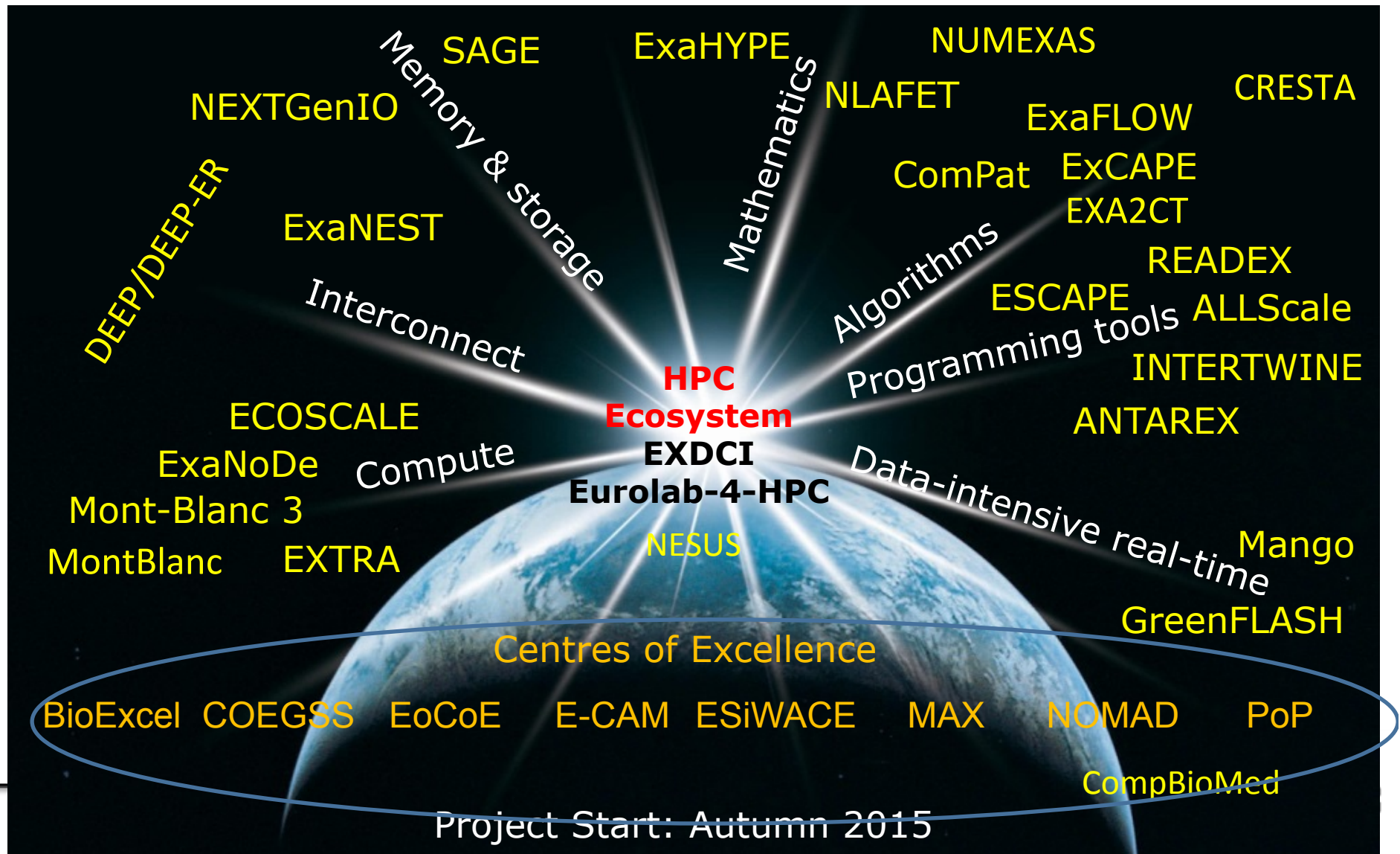


- EXDCI

- managed by PRACE and ETP4HPC
- started in Sept 2015
- supporting:
 - roadmap : technical (SRA), scientific cases
 - cross cutting topics : technical topics, training, SMEs
 - international cooperation
 - monitoring



The European HPC Project Landscape



More in progress

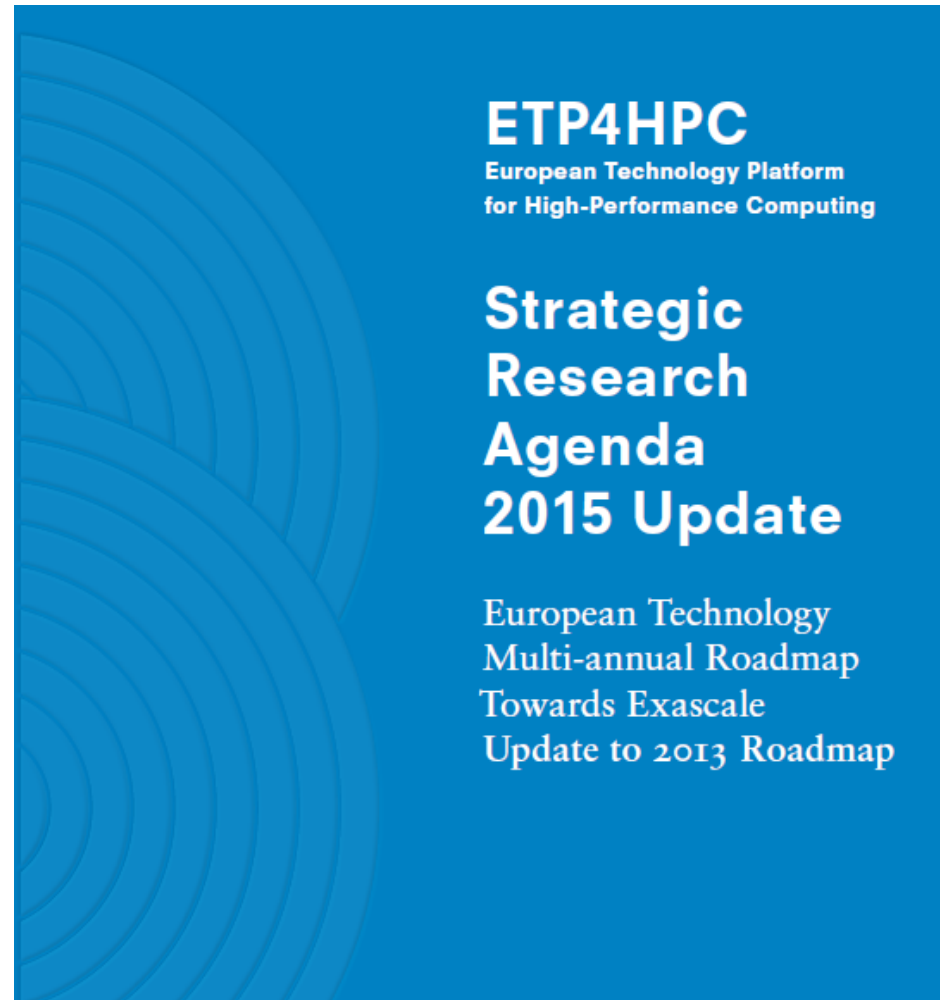
- 2 calls in Work Programme 2016-2017
 - **FET HPC 1 2016** : Co-design of HPC systems and applications
 - budget : 41 M€ - deadline : 27 September 2016
 - **FET HPC 2 2017** : Transition to Exascale Computing
 - 5 subtopics :
 - High productivity programming environments for exascale
 - Exascale system software and management
 - Exascale I/O and storage in the presence of multiple tiers of data storage
 - Supercomputing for Extreme Data and emerging HPC use modes
 - Mathematics and algorithms for extreme scale HPC systems and applications working with extreme data
 - budget : 40 M€ - deadline : 26 September 2017
- On-going discussion on Work Programme 2018-2020 of Horizon2020



Strategic Research Agenda SRA

a multi-annual roadmap towards
Exascale High-Performance Computing Capabilities

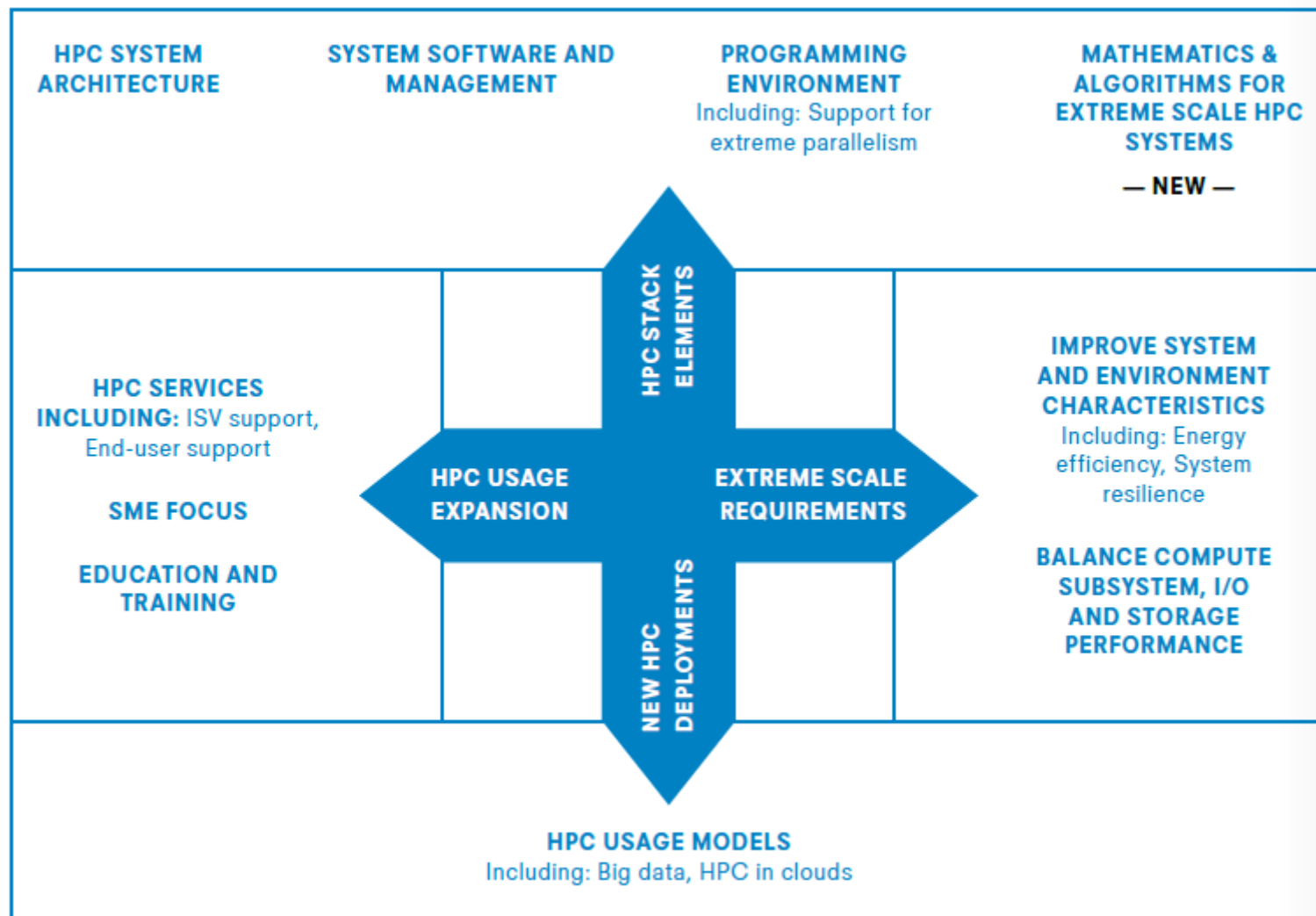
www.etp4hpc.eu/sra



Priorities

- There is a demand for R&D and innovation in both extreme performance systems and mid-range HPC systems
 - Scientific domain and some industrial users want extreme scale
 - ISVs and part of the industry expect more usability and affordability of mid-range system
- The ETP4HPC HPC technology providers are also convinced that to build a sustainable ecosystem,
 - their R&D investments should target not only the exascale objective (too narrow as a market)
 - an approach that aims at developing technologies capable of serving both the extreme-scale requirements and mid-market needs can be successful in strengthening Europe's position.

4 dimensions of the SRA



Transversal issues to be addressed

- Three technical topics:
 - Security in HPC infrastructures to support increasing deployment of HPDA
 - Resource virtualisation to increase flexibility and robustness
 - HPC in clouds to facilitate ease of access
- Two key elements for HPC expansion
 - Usability at growing scale and complexity
 - Affordability (focus on TCO)

How was the SRA been built?

8 Workgroups covering the 8 technical focus areas:

SRA 2015 technical focus areas

- HPC System Architecture and Components
 - Energy and Resiliency
 - Programming Environment
 - System Software and Management
 - Big Data and HPC usage Models
 - Balance Compute, I/O and Storage Performance
 - Mathematics and algorithms for extreme scale HPC systems
 - Extreme scale demonstrators
-
- 48 ETP4HPC member orgs/companies involved in these workgroups
 - Members named 170 individual experts to contribute, 20-30 per working group

HPC System Architecture, Storage and I/O: milestones

M-ARCH-1: New HPC processing units enable wide-range of HPC applications.	2018
M-ARCH-2: Faster memory integrated with HPC processors.	2018
M-ARCH-3: New compute nodes and storage architecture use NVRAM.	2017
M-ARCH-4: Faster network components with 2x signalling rate (rel. to 2015) and lower latency available.	2018
M-ARCH-5: HPC networks efficiency improved.	2018
M-ARCH-6: New programming languages support in place.	2018
M-ARCH-7: Exascale system energy efficiency goals (35kW/Pflops in 2020 or 20 kW/Pflops in 2023) reached.	2020-2023
M-ARCH-8: Virtualisation at all levels of HPC systems.	2018
M-ARCH-10: New components / disruptive architectures for HPC available.	2019

M-BIO-1: Tightly coupled Storage Class Memory IO systems demo.	2017
M-BIO-2: Common I/O system simulation framework established.	2017
M-BIO-3: Multi-tiered heterogeneous storage system demo.	2018
M-BIO-4: Advanced IO API released: optimised for multi-tier IO and object storage.	2018
M-BIO-5: Big Data analytics tools developed for HPC use.	2018
M-BIO-6: 'Active Storage' capability demonstrated.	2018
M-BIO-7: I/O quality-of-Service capability.	2019
M-BIO-8: Extreme scale multi-tier data management tools available.	2019
M-BIO-9: Meta-Data + Quality of Service exascale file i/o demo.	2020
M-BIO-10: IO system resiliency proven for exascale capable systems.	2021

Extreme-Scale Demonstrators

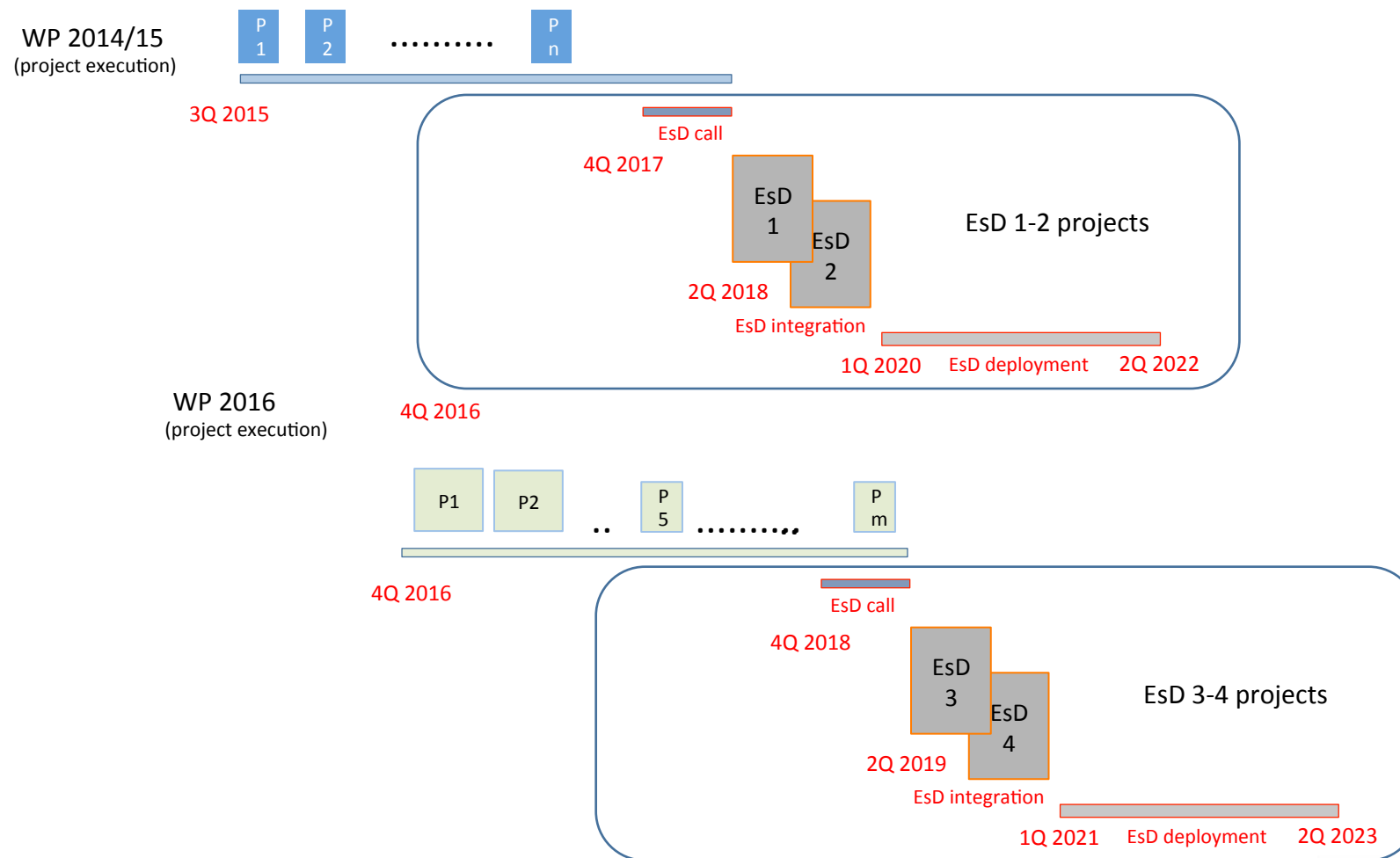
- Characteristics

- Complete prototype HPC systems
- high enough TRL to support stable production
- using technologies developed in the previous projects
- based on application – system co-design approach
- large enough to address scalability issues (at least 1/10 of top performance systems)

- Two project phases:

- phase A : development, integration (of results from R&D projects) and testing
- phase B : deployment and use, code optimisation, assessment of the new technologies

Extreme scale Demonstrators call-integration-deployment schedule



Next SRA-related events – some thoughts

- **HPC summit/May 2016**
 - needs to be focussed primarily on the EsD topic (we need to make some progress here), not so much on the dissemination
 - at this event the three pillars for the EsD mission (CoE, HPC centres and the FETHPC1 project speakers) need to get together...
- **ISC16**
 - might be a general dissemination and discussion event
 - by then we have some feedback hopefully
 - depending on how much progress we make with BDVA we could set up a few "focussed discussions", e.g. on HPC and HPDA, EsDs, some statistics on the feedback received, news on influences from latest application trends....etc.



Coming up initiatives

IPCEI

IMPORTANT PROJECT
OF COMMON
EUROPEAN INTEREST
(IPCEI)

ON
HIGH PERFORMANCE COMPUTING
AND
BIG DATA ENABLED APPLICATIONS
(IPCEI-HPC-BDA)

European Strategic Positioning Paper



- Initiative led by Member States
 - LU (leader), FR, SP, IT
 - Important Project of Common European Interest
 - objective so important that some regulations can be overridden : aggregation of fundings from EC sources, national sources and private origine to support the project, state aids regulations, competition regulation
- Topic : HPC and big data enabled applications
 - 3 pilars : technology, infrastructure, large scale pilots
 - smart mobility, industry 4.0, smart space, smart agriculture, smart cities, fin tech
- Budget foreseen : 6 B€

New EC communication

- « European Cloud Initiative – Building a competitive data and knowledge economy in Europe »
- 3 directions :
 - European Open Science Cloud
 - European Data Infrastructure
 - Widening access and building trust

New ETP4HPC activities

- Working group Energy Efficient
 - how to address this issue globally, international discussion on EE
- Working group Software
 - addressing issues as : scalability, integration, reuse, software engineering for parallel programs
- Contact group industrial users
 - increase the exchange on technological evolution impact and industrial requirements
- Interlock with Big Data cPPP



Conclusion

Summary

- Horizon2020 HPC plan is put in place
- You can comment on the current SRA
<http://www.etp4hpc.eu/strategic-research-agenda/>
- You are welcome to participate in WG or other activities
- We hope that new initiative will accelerate HPC development in Europe



THANK YOU!

For more information visit

www.etp4hpc.eu

contact: [**office@etp4hpc.eu**](mailto:office@etp4hpc.eu)



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