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The European HPC Landscape: from PRACE to EuroHPC - a different sort of phase transition

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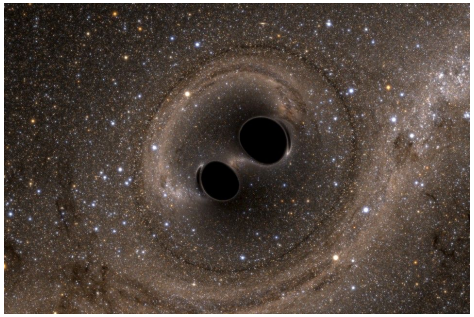
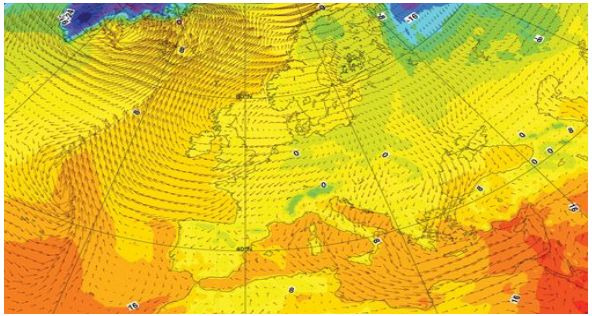
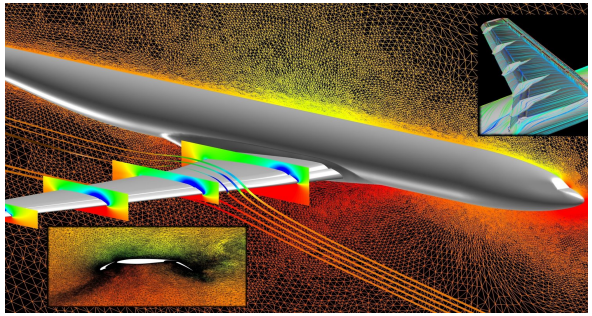
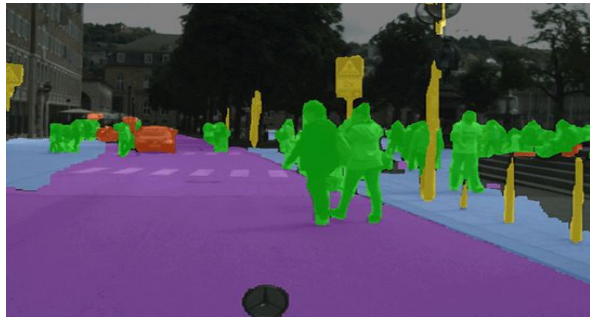
Computing Solves Societal Challenges

from the PRACE Scientific Case for Computing 2018-2026

PRACE's goal is to enable users to tackle these challenges.

Key observations from PRACE Scientific Case

- To be competitive with the rest of the world, *Europe* needs a *European* infrastructure & community for computing, support and research – with the agenda focused on solving the most challenging problems.

- Europe needs to increase investments in hardware & software substantially – we have the scientific & societal challenges that need 50x more resources, and which *can* be solved if investments are realized.

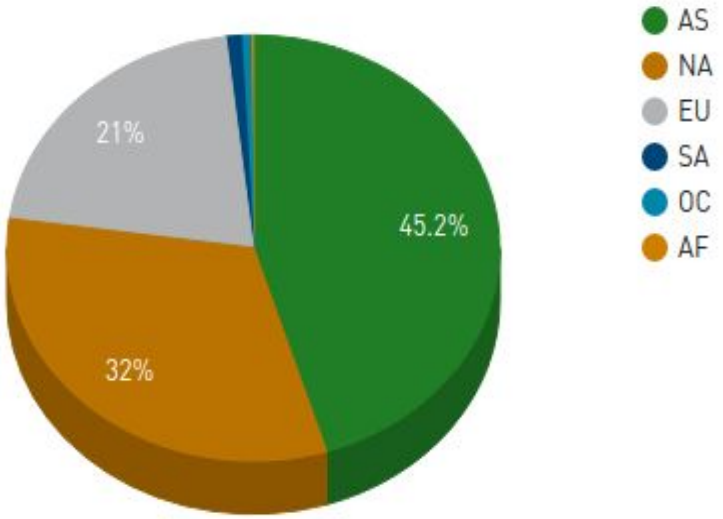
- Investments in hardware should be paired with similar investments in algorithms, software, and workforce education, or the applications will not be able to use next-generation computers.

TOP500 @ISC in 2021 (from E.Strohmaier talk)

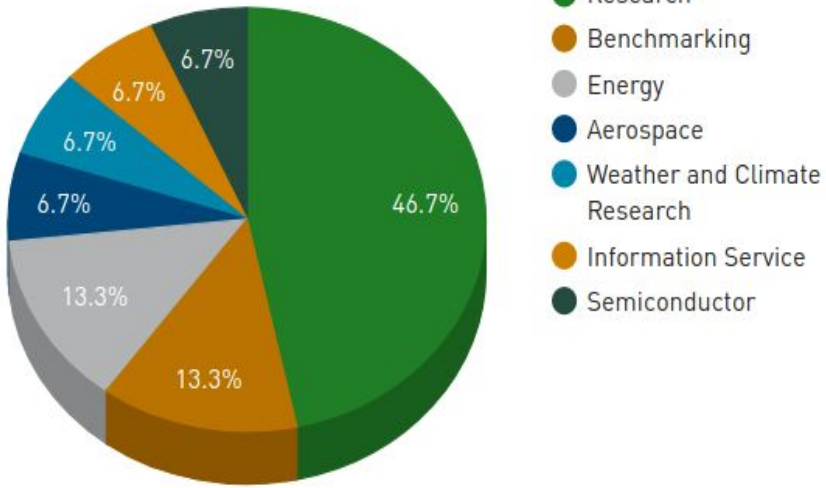
#	T	Site	Manufacturer	Computer	Country	HPCG (Pflop/s)	HPL (Pflop/s)	HPCG/ Peak	HPCG/ HPL
1	1	RIKEN-CCS	Fujitsu	Fugaku Supercomputer Fugaku, A64FX 48C 2.2GHz, Tofu interconnect D	Japan	16.005	442.0	3.0%	3.6%
2	2	Oak Ridge National Laboratory	IBM	Summit IBM Power System, P9 22C 3.07 GHz, Volta GV100, EDR	USA	2.926	148.6	1.5%	2.0%
3	5	NERSC - Lawrence Berkeley National Laboratory	HPE	Perlmutter HPE Cray EX235n, AMD EPYC 64C 2.45GHz, NVIDIA A100, Slingshot-10	USA	1.905	64.6	2.0%	3.0%
4	3	Lawrence Livermore National Laboratory	IBM	Sierra IBM Power System, P9 22C 3.1 GHz, Volta GV100, EDR	USA	1.796	94.6	1.4%	1.9%
5	6	NVIDIA Corporation	NVIDIA	Selene DGX A100 SuperPOD, AMD 64C 2.25GHz, NVIDIA A100, Mellanox HDR	USA	1.623	63.5	2.1%	2.6%
6	8	Forschungszentrum Jülich (FZJ)	Atos	JUWELS Booster Module BullSequana XH2000, AMD EPYC 24C 2.8GHz, NVIDIA A100, Mell. HDR	Germany	1.275	44.1	1.8%	2.9%
7	11	Saudi Aramco	HPE	Dammam-7 Cray CS-Storm, Xeon 20C 2.5GHz, NVIDIA T. V100, IB HDR 100	Saudi Arabia	0.881	22.4	1.6%	3.9%
8	9	Eni S.p.A	Dell EMC	HPC5 PowerEdge C4140, Xeon 24C 2.1GHz, NVIDIA V100, Mellanox HDR	Italy	0.860	35.5	1.7%	2.4%
9	13	Information Technology Center, The University of Tokyo	Fujitsu	Wisteria/BDEC-01 (Odyssey) PRIMEHPC FX1000, A64FX 48C 2.2GHz, Tofu interconnect D	Japan	0.818	2	2%	3.7%
10	40	Japan Agency for Marine-Earth Science and Technology	NEC	Earth Simulator - SX-Aurora TSUBASA SX-Aurora TSUBASA A401-8, Vector Eng. Type20B 8C 1.6GHz, IB HDR 200	Japan	0.748	10	6%	7.5%

An international perspective …. Via Top500.org

Continents System Share



Application Area System Share



Potential & Challenge of Exascale Computing

Exa: 10^{18} operations/second. 1000 times faster and more powerful than current petascale machines.

Realistic simulations of processes in science and industry: precision medicine, regional climate, additive manufacturing, the conversion of plants to biofuels, the relationship between energy and water use, the unseen physics in materials discovery and design, and fundamental forces of the universe …

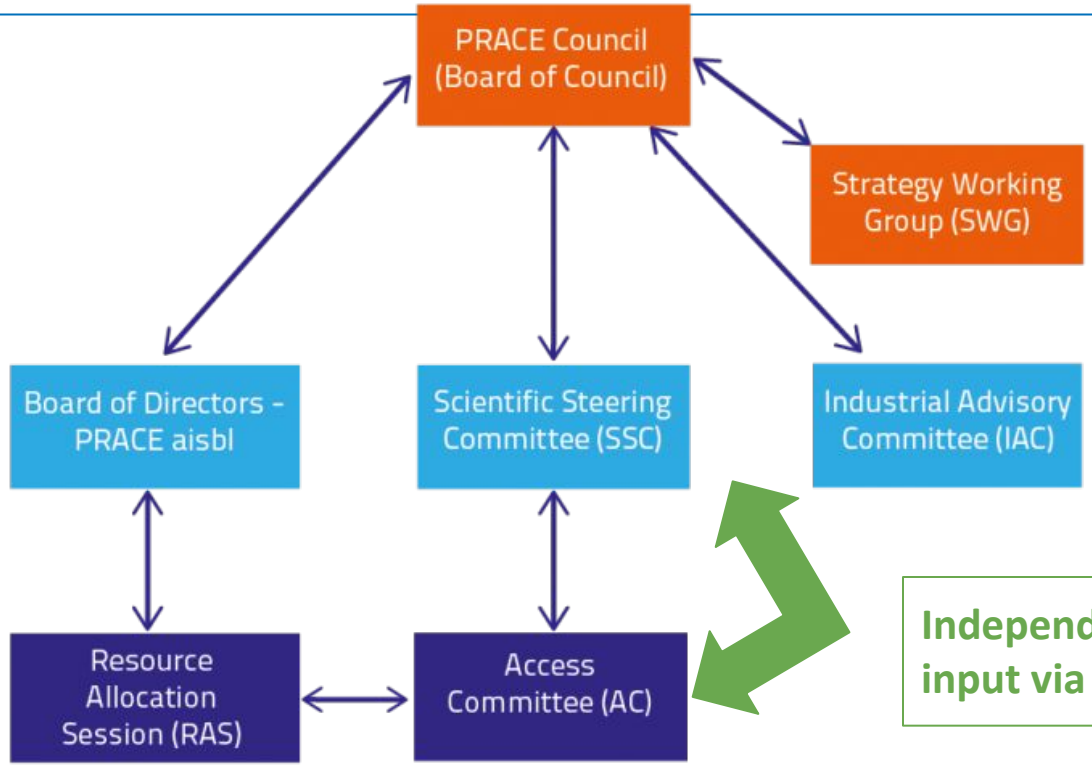
Not business as usual! Codes will not simply scale, significant porting, refactoring and redesign needed; combination of AI-HPC means managing e.g. containers. Enormous quantities of data will be generated and analysed.

The European Landscape: main HPC actors
(not discussing GÉANT, EOSC etc …)

PARTNERSHIP FOR ADVANCED COMPUTING IN EUROPE

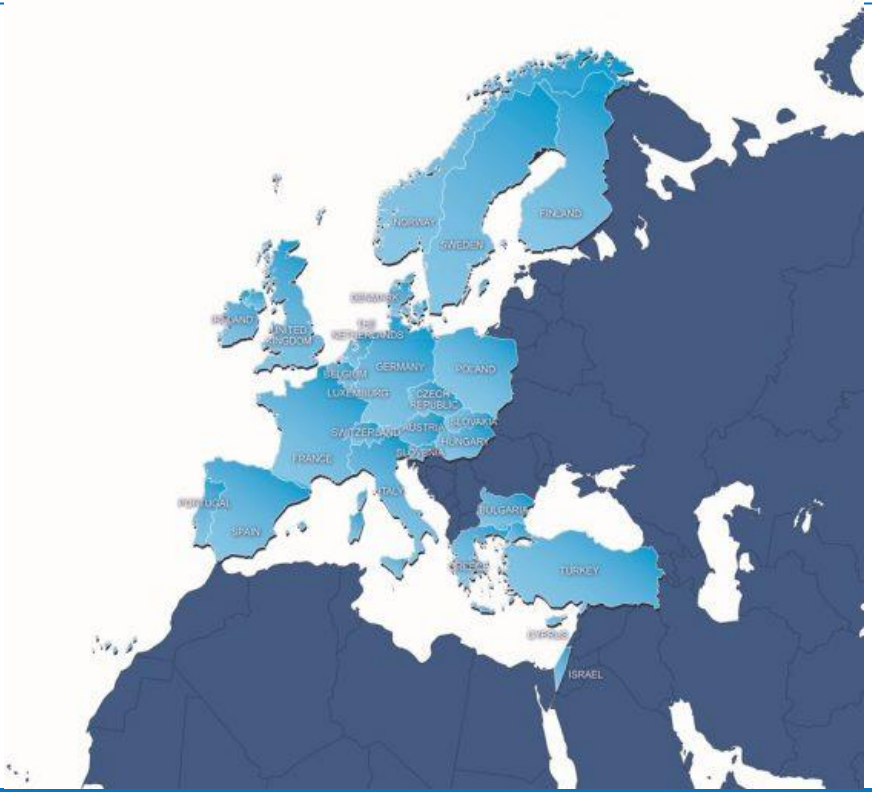
- International, not-for-profit
- 25 member countries - pan-European supercomputing infrastructure enabled by 5 Hosting Members
  - BSC (Spain), CINECA (Italy), ETH/CSCS (Switzerland), GSC (Germany), GENCI (France)
- Access on basis of peer-reviewed (open) science & industry proposals
- Additionally, schools, workshops, PRACE IP …

PRACE Governance



PRACE: Partnership for Advanced Scientific Computing

- Enable high-impact scientific & engineering discovery and R&D.
- Tier-0 computing and data management resources and services through **competitive peer review.**
- Training & education via schools, workshops, seminars.
- Enabled by 5 Hosting Centres.
- **No procurement, no technology development.**



EuroHPC
Joint Undertaking

- Based on 2 EU Council Regulations (2018 & 2021)

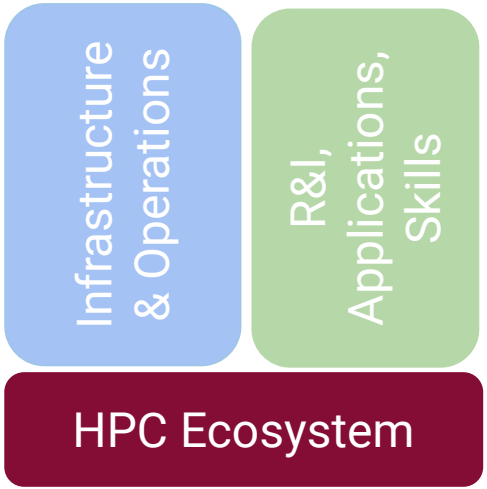
Objectives

- Build and operate a world class integrated HPC and data infrastructure
- Enable member states to improve HPC competency
- Foster HPC skills, education and training
- Develop HPC core technology
  - *European Processor Initiative (EPI)*
  - *Energy efficient HPC*
  - *Quantum Computing*

EuroHPC Joint Undertaking

Participating Members + EU + Private Members (BDVA, ETP4HPC & QuIC)

Mission: establish an integrated world-class computing and data infrastructure and support a highly-competitive and innovative big data ecosystem



Structure of the EuroHPC JU

Intelligence gathering → **Decision making & Advice** → **Implementation**

Stakeholders
[academia, industry]

(a) Users forum
- Science Users
- Users of PRACE and HPC Centres of Excellence
- Industry Users

(b) Technology forum
- PRACE, GEANT
- Tier-0 supercomputing centres
- Industry (ETP4HPC, BDVA PPP, etc.)

Governing Board
Public Members

The decision making Board

Industrial and Scientific Advisory Board

Research & Innovation Advisory Group
[academia & industry advising on Pillar 2 activities]

Infrastructure Advisory Group
[academia & user industry advising on Pillar 1 activities]

Implementation

R&I activities

JU funded

HPC machines

ETP4HPC

BDV BIG DATA VALUE ASSOCIATION

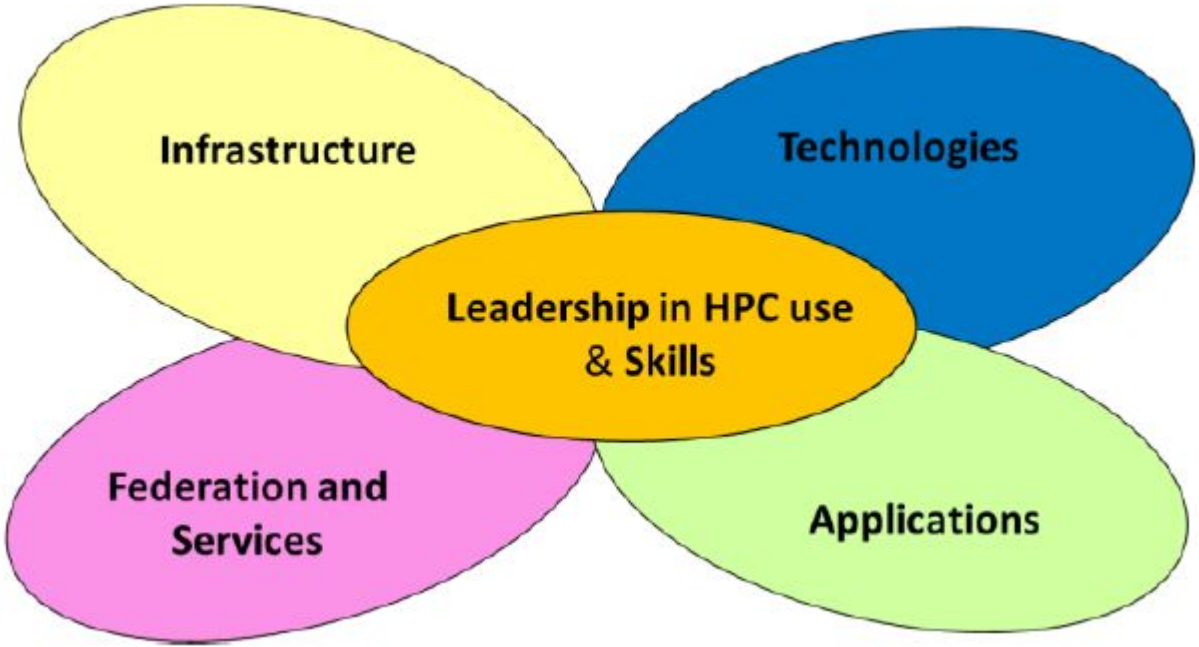
Member State-funded activities

PRACE activities

IPCEI activities

...

Scope and remit of EuroHPC JU



In 2021 EuroHPC planned resources and timelines

Infrastructure and Operations

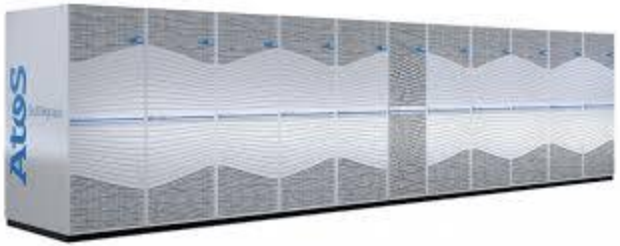
- 5 x petascale machines @ 15-30 petaflops. In operation by Q1 2021. Bulgaria, Czech Republic, Luxembourg, Portugal, Slovenia.
- 3 x pre-exascale machines. In operation Q2/3 2021:
  - CSC - Finland *Cray: 375PF sustained, 552PF peak; GPU, x86, data analytics, cloud container partitions*
  - Cineca - Italy *ATOS-Bull Sequana 249PF sustained, CPU-GPU, DDR5 & local NVM for data analysis*
  - BSC - Spain
- 2 x exascale in operation by 2022-2023. In coordination with EPI (European-based technology) for at least one machine?
- Data I/O, management, storage and security federation for impact: GEANT, EOSC etc

Infrastructure in situ & available

- **Vega** in Slovenia
- **MeluXina** in Luxembourg
- **Karolina** in Czech Rep
- **Discoverer** in Bulgaria
- **LUMI** in Finland

Already planned & underway

Leonardo in Italy



Deucalion in Portugal

Mare Nostrum 5 in Spain

Access

There is an access policy at https://eurohpc-ju.europa.eu/access-our-supercomputers

Some generalities:

- PRACE via its peer review is currently managing the EuroHPC open calls
- Access is for researchers/organisations in participating states, EU and H2020 associated country (includes UK)

Usual requirements:

- Acknowledge resources in related publications
- Contribute to dissemination events (EHPCSW)
- Submit a report at end of resource allocation

Call for regular mode access now OPEN!

Regular access mode continuously open with cut-off dates for review in 2022:

- 4 March 2022 - 10:00 CET
- 1 July 2022 - 10:00 CEST
- 4 November 2022 - 10:00 CET

Allocations for 1 year, possible continuation for 2nd year by application on Vega, MeluXina, Karolina, Discoverer & LUMI.

Serving **research** (75% of resources), **industry** open R&D (20%) and **public sector** (5%)

Benchmark and development access call now open also

System	Architecture	Site (Country)	Total Core Hours	Minimum request core hours
Vega CPU Standard	BullSequana XH2000	IZUM Maribor (SI)	95 million	6 million
Vega CPU Large Memory	BullSequana XH2000	IZUM Maribor (SI)	42 million	4.2 million
Vega GPU	BullSequana XH2000	IZUM Maribor (SI)	4 million	1 million
MeluXina CPU	BullSequana XH2000	LuxProvide (LU)	95 million	6 million
MeluXina CPU Large memory	BullSequana XH2000	LuxProvide (LU)	3.3 million	1 million
MeluXina GPU	BullSequana XH2000	LuxProvide (LU)	16.5 million	1.6 million
MeluXina FPGA	BullSequana XH2000	LuxProvide (LU)	1.6 million	160 thousand
Karolina CPU	HPE Apollo 2000Gen10 Plus and HPE Apollo 6500	VSB-TUO, IT4Innovations, (CZ)	60 million	6 million
Karolina GPU	HPE Apollo 2000Gen10 Plus and HPE Apollo 6500	VSB-TUO, IT4Innovations, (CZ)	6 million	1 million
Discoverer CPU	BullSequana XH2000	Sofiatech, (BG)	104 million	6 million
LUMI-C	HPE Cray EX	CSC (FI)	240 million	12 million

All info at available via PRACE web pages

The EuroHPC Joint Undertaking (JU) Budget

- JU jointly funded by its members with a budget for 2021-2027 of ~€7b.
- Most funding from the EU MFF via contribution of €3b (Digital Europe, Horizon Europe, Connecting Europe). Matching amount expected from Participating States and €900m from Private Members.
- Sept 2020 EC council regulation allows for EuroHPC to continue HPC development for the next decade.
- JU provides support via procurement, research & innovation grants via open calls.

Supporting R&I and Skills

- **Building blocks for the development of exascale HPC ecosystem.**

  European low-power processor and integration with other technology in exascale pilots

- **First deployment of a quantum simulation infrastructure**

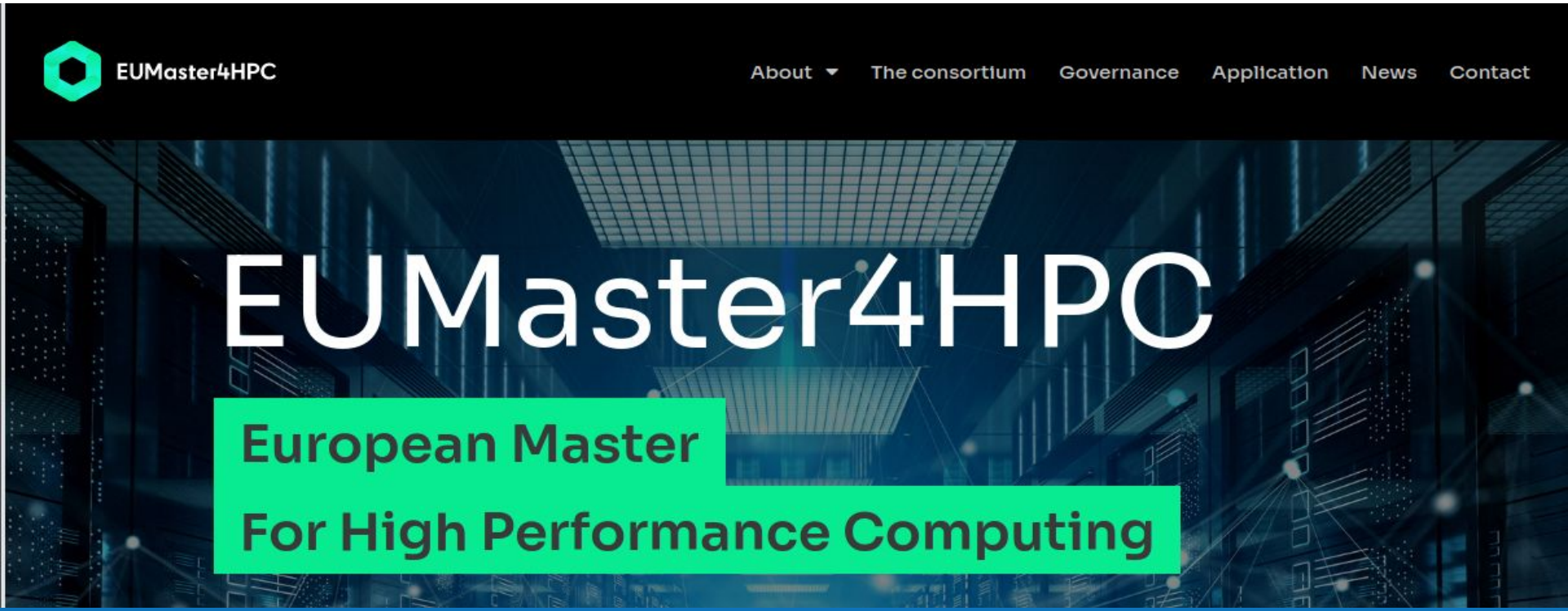
  Providing European science & industry with access to first quantum simulation systems. Acquisition, interconnect with a classical architecture, any cloud, middleware for applications and running.

- **Pilot programme for pan-European M.Sc in HPC**

  Close cooperation w industry, HPC Competence Centre, CoE & PRACE

Education & Training

From https://eumaster4hpc.uni.lu/



Key figures.

From EUMaster4HPC

60
Number of participants

36
Additional supporting partners

17
Countries

Italy, spain, France, Czech Republic, Portugal, Switzerland, Bulgaria, Poland, Germany, Slovenia, Greece, Sweden, Hungary, Turkey, Austria, Luxembourg

7M€
Budget

Potential number of students

1st cohort of 50 students starting September 2022

2nd cohort of 100 students starting September 2023

National Competence Centres

- Central contact points for HPC & related technologies https://www.eurocc0access.eu/
- Funded via EuroCC (33 members coordinated by HLRS)
- Establish NCCs in each participating country
  - Survey & support HPC, HPDA, AI activity & competence
  - Support for exascale cf *ICHEC Academic Flagship*
- Coordinated by **CASTIEL**
  - Bring all participating countries to common (high!) level in HPC
  - Make HPC accessible for users in science, industry, public policy etc

Centres of Excellence & Other Things

- Currently 15 CoE (none in lattice or any fundamental science)
  - Current open call includes “lighthouse” applications …
- 3 R&I projects around EPI selected Feb 2022
- 1st quantum computing initiative launched - HPCQS @ Genci & JSC

A European Lattice Community Identity

- Support & lobbying for ring-fenced “community access track” to EuroHPC resources. Mostly rebuffed by e.g. PRACE SSC and EuroHPC INFRAG but may still emerge
- Townhall meeting in Dublin in March 2020 to discuss a European lattice community identity:
- Pandemic-postponed but Lat22 a good opportunity to reinvigorate activity
- Supported by STRONG 2020

LQCD.eu by EuroLat

PRACE & EuroHPC

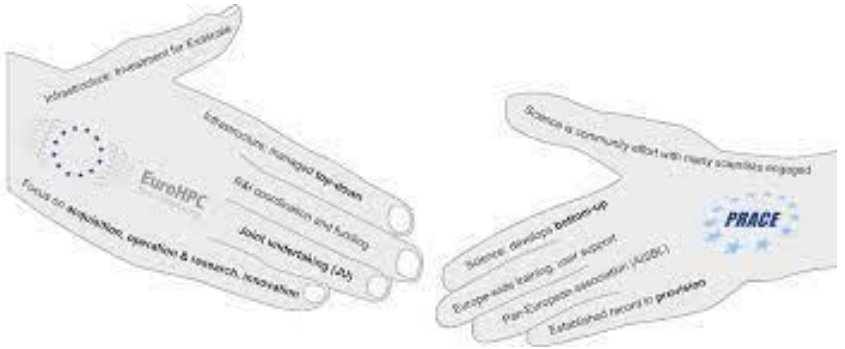
Next steps not yet defined …

PRACE and EuroHPC have missions that complement each other perfectly: While EuroHPC operates from top to bottom with high-level funding instruments, PRACE is a science-driven infrastructure developed as a bottom-up activity. Bringing the two together in a strong partnership will create optimal synergies for the benefit of the European scientific and industrial communities.

Prof. Dr. Dr. Thomas Lippert, Chair of the PRACE Council.

How the PRACE science-based, user-informed ethos will transfer to EuroHPC not yet formalised

Via RIAG & INFRAG it has happened in an ad hoc way so far. No EuroHPC SSC - a strength of PRACE



Summary

- EuroHPC represents a step-change in investment in hardware, technology and skills to support European science and industry, towards a federated infrastructure.
- The future role of PRACE in the EuroHPC landscape not yet defined, including details of future *PRACE* calls (to continue in short term).
- Exascale resources will soon be available and should be award based on scientific merit and technical readiness. This principle must be repeated, supported and amplified - to the EuroHPC governing board, the JU and the EU.
- Future calls may also include a community access as well as e.g. urgent computing as well as PI-led projects.

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Thank You!

HPC: an engine of discovery & innovation

aggregated computing power to deliver much higher performance than from a typical desktop computer or workstation, to solve large-scale problems in complex systems in science, engineering or business.

- Climate modelling & weather, storm forecasting
- Engineering, fluid dynamics, plasma physics
- Fundamental sciences: particle physics & astrophysics
- Life sciences - precision & personalised medicine, drug design & response
- Material science - new materials discovery
- Security - national, personal
- Digital Humanities

Data driving convergence of HPC & AI in traditional and emerging applications