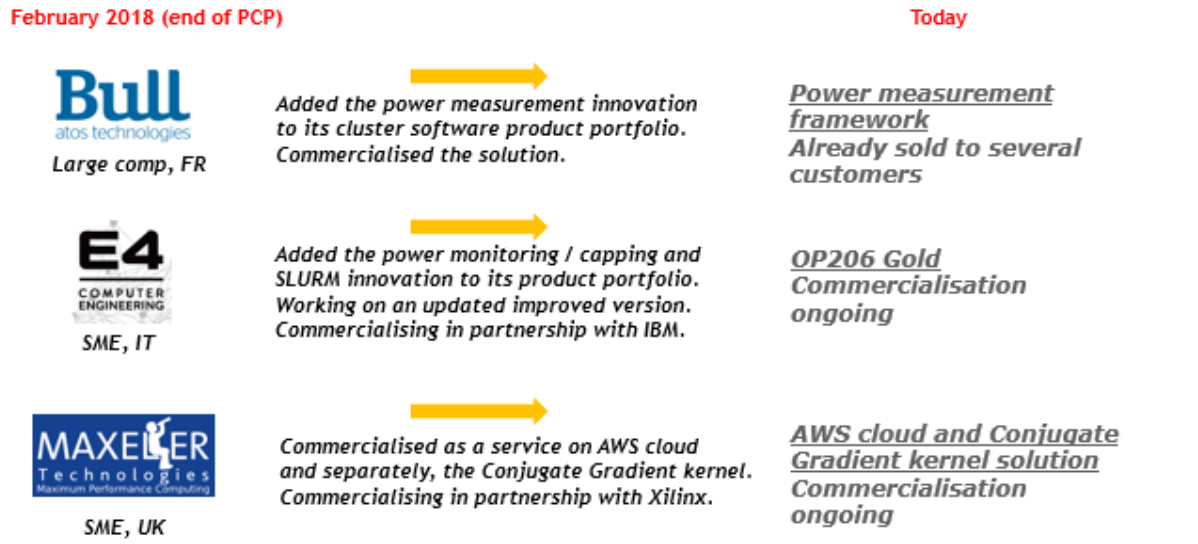
High Performance Computing is of vital importance for applications that require large computing power in several areas[1] like including cybersecurity, energy, environment and healthcare, as it makes it possible to run particularly complex calculations and modelling on very large datasets. For example, modelling the effects of climate change or finding the best molecules for creating a COVID-19 vaccine requires thousands and thousands of calculations.

Kick-starting EU cooperation: Joint steering of solution development through Pre-Commercial Procurement (PCP)

1) PRACE 3 IP pre-commercial procurement – Improving energy efficiency

However, running these heavy computing applications consumed tons of energy. Therefore, in July 2014 five leading supercomputing centers around Europe joined forces and started the **PRACE3IP pre-commercial procurement**[2] to reduce the **energy consumption of supercomputers**: CINECA (IT), Juelich Supercomputing Centre (DE), GENCI (FR), EPCC (UK), CSC (FI).

Five companies were selected in phase 1 to make a solution design: Bull/ATOS, E4 computer engineering, Eurotech, Megware and Maxeler Technologies. Three of these companies successfully completed a prototype in phase 2 and tested their product in phase3 in the supercomputing centers: Bull/ATOS, E4 computer engineering and Maxeler Technologies. The 9 €M PCP accelerated key R&D activities on high-energy efficiency supercomputing and delivered three pilot solutions that used different technology approaches to improve the energy efficiency of HPC.



The PCP helped both large companies and SMEs accelerate the energy efficiency of HPC solutions.

Impact on company R&D and innovation behaviour

"We have participated in other collaborative R&D projects before. Compared to this, PCP is more helpful for us because it gives us more freedom to innovate, and pushes us more to establish collaboration with technology providers, with European universities and with the community of PRACE users, and gives us a lot more precise vision of the future need of the PRACE Community."

Piero Altoè, Marketing & Business Development Manager, E4 Computer Engineering spa (SME that participates in the FP7 funded PRACE 3IP PCP project on energy efficient supercomputing: http://www.prace-ri.eu/pcp/).

"We received similar positive feedback from all three vendors, big or small, in the PCP."

Philippe Segers, Project Manager at GENCI (GENCI is public procurer in the buyers group of the PRACE 3IP PCP)

[1] https://ec.europa.eu/digital-single-market/en/news/high-performance-computing-best-use-examples

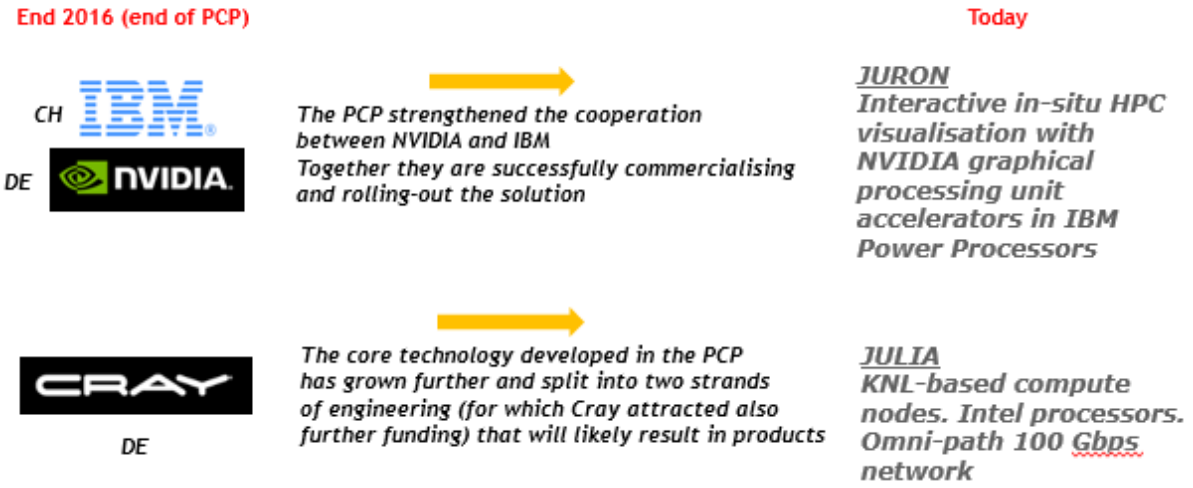
[2] Info about the PCP on the PRACE3IP project website: http://www.prace-ri.eu/pcp
Contract award notice for the PRACE3IP PCP: https://ted.europa.eu/udl?uri=TED:NOTICE:129522-2017:TEXT:EN:HTML

2) Human Brain Project pre-commercial procurement – Improving interactivity and memory

Complex big data analysis also requires supercomputers with a large memory capacity and a higher level of interactivity. A subset of the procurers from the PRACE3IP PCP therefore started another PCP, which was executed in 2014-2016 as part of the Human Brain Project (HBP): Juelich Supercomputing Centre (DE) in collaboration with Swiss National Computing Center CSCS (CH), Barcelona Supercomputing Center (ES), CINECA (IT) and other HBP partners.

The Human Brain Project PCP[3] delivered innovations for specific High Performance Computing requirements for brain simulation, including **interactive supercomputing** and **large memory capacity**.

Three vendor consortia competed on the solution design in Phase1 of the HBP PCP: Cray, Dell / Partec / Extoll, IBM / NVIDIA. **Two vendors successfully completed** the prototype and testing phases 2 and 3 of the PCP: Cray and IBM / NVIDIA consortium. Both performed all R&D in Europe and deployed pilot systems based on their solutions, which are now **deployed and widely used for brain research**. HBP accelerated the development of interactive computing and large memory capabilities for HPC. It opened up business opportunities for participating companies to partner with other HPC players on the market and to commercialise their solutions.



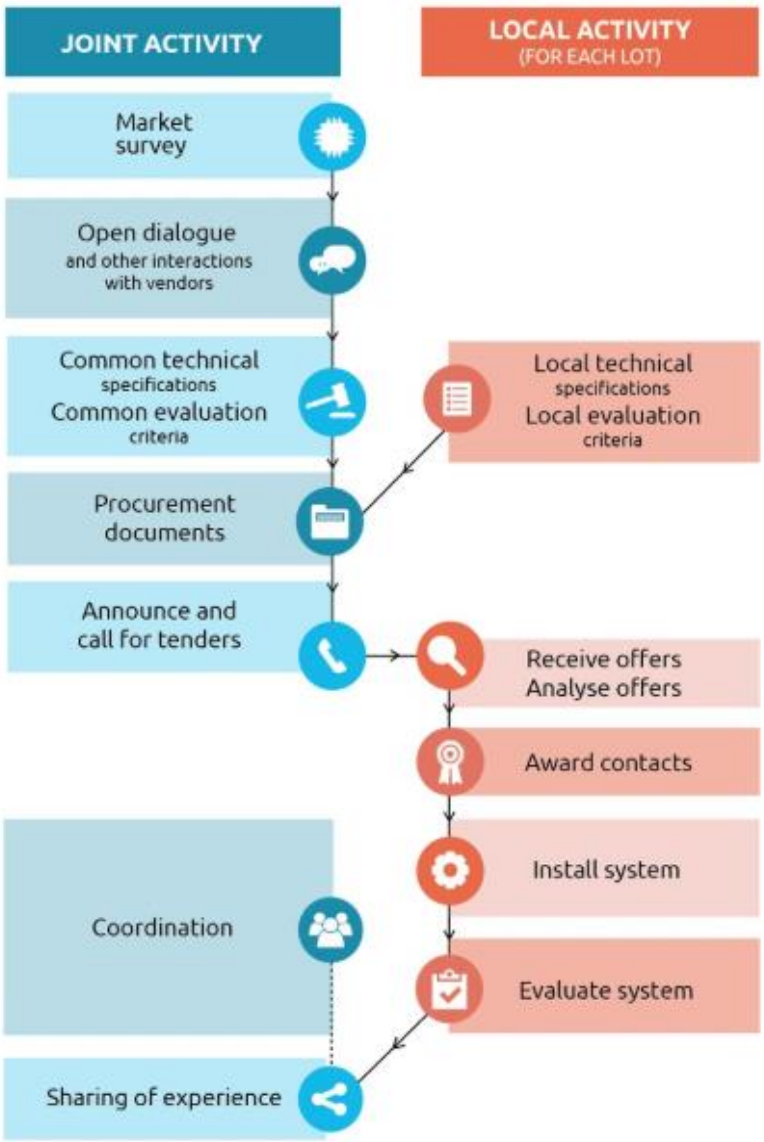
Deepening EU cooperation: Coordinated deployments through Public Procurements of the Innovative solutions

The good cooperation in the PCPs continued with another first of a kind. The centers started coordinating also for the first time their roadmaps to procure the deployment of more powerful and more energy efficient HPC solutions.

1) PPI4HPC –Improving performance and system versatility without increasing power consumption

In 2018, four countries took the lead: CINECA (IT), Juelich Supercomputing Centre (DE), CEA and GENCI (FR), Barcelona Supercomputing Center (ES). The 73 €M joint procurement **PPI4HPC (Public Procurement of Innovative solutions for HPC)**[4] aimed to realise a significant upgrade of the European HPC infrastructure towards future exascale systems. The most prominent common technical challenge was to increase significantly the performance of the systems compared to currently installed supercomputers without increasing **power / energy consumption**. This had to be combined also with achieving **higher versatility** of supercomputers to enable new types of applications involving processing of extreme-scale data volumes, enable data analytics through novel methods like deep learning, enable in-situ remote visualisation and computational steering.

[3] Contract notice of the HBP PCP: https://ted.europa.eu/udl?uri=TED:NOTICE:151006-2014:TEXT:EN:HTML
[4] PPI4HPC project website: https://www.ppi4hpc.eu



The procurers agreed to procure solutions that outperform existing solutions on a number of aspects: performance and total-cost-of-ownership, programmability and usability, versatility, system stability, power and energy-efficiency, and compute density. The proposed solutions had to comprise one or more innovative components or one or more architectural innovations. To improve the impact on the market, the partners worked on **common technical specifications** based on a set of topics of common interest, including: Energy efficiency and power management, Data management, Programming environment and productivity, Data centre integration, Maintenance and support, System and application monitoring, Security.

Before the procurement, the procurers jointly conducted an open market consultation[5]. The lead procurer, GENCI, launched the joint procurement as a **competitive dialogue** under French procurement law[6]. A **framework contract with four independent lots / specific contracts** was used (1 lot/specific contract per procurer was awarded under each procurer's national / local law).

This lead to the award of contracts for systems that have meanwhile or are being deployed at four different sites throughout Europe:

- CEA/GENCI deployed a versatile supercomputer (Bull/ATOS) supporting both, highly scalable computing applications and high-performance data analytics and machine learning applications
- CINECA is deploying a supercomputer from IBM including technology from E4, which is optimised for compute-intensive applications with a peak performance of 32 PFlop/s
- BSC is deploying a new high-performance storage infrastructure from IBM that is able to scale to more than 100 PByte as a single file space
- JSC is deploying a supercomputer with a peak performance of 16 PFlop/s from Bull/ATOS that is optimised for data-intensive applications and therefore features a large memory and storage capacity

Based on a set of common and site-specific requirements, suppliers were specifically asked to integrate new innovations into the offered solutions. This included:

[5] Announcement of the PPI4HPC OMC: https://ted.europa.eu/udl?uri=TED:NOTICE:256030-2017:TEXT:EN:HTML&src=0
[6] Contract notice PPI4HPC: https://ted.europa.eu/udl?uri=TED:NOTICE:202138-2018:TEXT:EN:HTML&src=0

- Solutions for measuring and steering energy consumption to allow for dynamic optimisation of hardware parameters such that energy is reduced with minimal impact on performance
- Integration of water-cooled power supplies that improves Power Usage Effectiveness (PUE) by reducing the energy needed for cooling the system
- New solutions for integrating non-volatile memory technologies into HPC systems to enable much faster and more flexible access to storage
- Innovative software components that facilitate easy integration of tape technology in a way that data is transferred to tape transparently to the user

By defining common needs that had to be addressed across all lots, a strong incentive was created for each supplier to focus on these common needs. The success of this strategy could be identified in the received bids. The PPI4HPC project also created an opportunity for suppliers, which developed solutions during preceding PCPs, to bring these solutions to market. Three of the systems, which will be deployed as a result of this PPI, will comprise technology developed within the PRACE-3IP PCP.

The PPI4HPC joint procurement is expected to have the following impact:

- The ongoing upgrade of a distributed HPC infrastructure (PRACE) according to the needs of scientists and engineers in Europe will add 62 PFlop/s of compute performance and lead to new science results, in particular in areas related to grant challenges like climate research, energy research, new materials and health.
- All procured solutions improve energy efficiency and will therefore lead to energy savings.
- The tendering process and associated documentation of PPI4HPC have established a European best practice model that is being currently followed in the procurement procedures of the EuroHPC Joint Undertaking (the most important initiative at EU level in HPC), in particular for the acquisition of three top world-class pre-exascale supercomputers in 2020.

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2) ICEI PPI – Deploying federated interactive compute and large scale data services across Europe

In 2018, the ICEI (Interactive Computing E-Infrastructure)[7] project continued procurements for **wider deployment of solutions developed in the HBP PCP across an enlarged buyers group**. The buyers in the ICEI PPI are Juelich Supercomputing Center (DE), CSCS (CH), BSC (ES), CEA (FR), CINECA (IT). The aim is to deliver e-infrastructure services that will be federated to form the Fenix infrastructure.

ICEI is implementing different public procurements with a total volume of about 30 €M. Part of the ICEI procurements contain new services and are procured by one ICEI member for of the wider buyers group. Others concern equipment and are procured individually by the ICEI procurers. Some ICEI procurements[8] have already awarded contracts to vendors that participated also in the HPB PCP. Other ICEI procurements are still ongoing.

[7] Project website ICEI / FENIX project: https://fenix-ri.eu/

[8] Procurements launched under the ICEI project:
https://ted.europa.eu/udl?uri=TED:NOTICE:79563-2020:TEXT:EN:HTML&src=0
https://ted.europa.eu/udl?uri=TED:NOTICE:28400-2020:TEXT:EN:HTML&src=0
https://ted.europa.eu/udl?uri=TED:NOTICE:588572-2019:TEXT:EN:HTML&src=0
https://ted.europa.eu/udl?uri=TED:NOTICE:588569-2019:TEXT:EN:HTML&src=0
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https://ted.europa.eu/udl?uri=TED:NOTICE:558350-2019:TEXT:EN:HTML&src=0

Lessons learnt

From PPI4HPC as well as the related projects (the PRACE-3IP PCP, the Human Brain Project PCP and the ICEI PPI) the procurers learned the following lessons:

- A right articulation of PCP and PPI can really be an efficient way to pull innovations to the market that are tailored to customer needs.
- The particular attention to innovations in the different procurement procedures lead to new capabilities and improved versatility of the available solutions that go far beyond increase of raw compute performance.
- Organising procurement procedures jointly resulted in a significant transfer of best practice examples between the involved partners and as a consequence a much higher quality of the tender documents (e.g. exchanges of best practices for estimating total cost of ownership).
- The efforts need to run procurements jointly or in a coordinated manner quickly amortise because the knowledge can be reused in subsequent new (joint) procurement procedures.

More structured, long-term and wider cooperation: setting up a Joint Undertaking

The next logical step following the previous projects was to look for a more efficient way to continue the cross-border procurement cooperation. As it took quite some time and effort to set up a governance structure every time a new joint or coordinated procurement had to be set up, creating a more lasting structure for the future was needed to speed up things. In addition, other countries had shown an interest as well to join the cross-border HPC procurement cooperation.

In 2018, the European Commission and Member States established a dedicated legal and funding entity, the EuroHPC Joint Undertaking (JU) [9], to coordinate future HPC procurements and R&I activities across Europe. The European Commission governs the joint undertaking jointly with the following countries that have chosen to become members of the Joint Undertaking: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Montenegro, the Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, and Turkey.

The EUROHPC JU enables European countries to coordinate their supercomputing strategies and investments together with the EU. EuroHPC is the backbone for a € 1 billion joint procurement cooperation that underpins Europe's future HPC ecosystem.

The aim is to ensure the acquisition and deployment of a world-class supercomputing infrastructure in the EU, and the development in Europe of a strategic technological capability for digital sovereignty in HPC covering the whole value chain (from components to systems and machines, and to applications and skills) and coordination. The EuroHPC JU is developing a clear strategy for innovation procurement of exascale machines based on competitive European technologies. By developing the prospect of creating a lead market for exascale technology in Europe, the EuroHPC JU will help European suppliers to take the risk to develop such machines on their own.

EuroHPC has already started the procurements[10] for the acquisition of eight world-class HPC systems to be deployed in the EU in 2020 and 2021. This boost in supercomputer capacity is now powering Europe's search for computing intensive applications, such as the search for a COVID-19 vaccine[11], for example in the Exscalate4CoV project[12].

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https://ted.europa.eu/udl?uri=TED:NOTICE:218289-2019:TEXT:EN:HTML&src=0
https://ted.europa.eu/udl?uri=TED:NOTICE:13726-2019:TEXT:EN:HTML&src=0
https://ted.europa.eu/udl?uri=TED:NOTICE:505394-2018:TEXT:EN:HTML&src=0

[9] https://eurohpc-ju.europa.eu/ , https://ec.europa.eu/digital-single-market/en/eurohpc-joint-undertaking

[10] https://ted.europa.eu/udl?uri=TED:NOTICE:563382-2019:TEXT:EN:HTML&src=0
https://ted.europa.eu/udl?uri=TED:NOTICE:142868-2020:TEXT:EN:HTML&src=0

[11] https://ec.europa.eu/newsroom/dae/item.cfm?item_id=674335
https://ec.europa.eu/digital-single-market/en/news/using-european-supercomputing-treat-coronavirus
https://sciencebusiness.net/network-updates/bsc-uses-bioinformatics-ai-and-supercomputer-fight-against-coronavirus
https://insidehpc.com/2020/03/european-hpc-ecosystem-supports-the-fight-against-covid-19/

[12] https://www.exscalate4cov.eu/