Exascale: challenges and benefits

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Computing power is commonly measured in flops, currently the most powerful computers in Europe are at the petascale level (10^{15} flops). Five experts shared their views on the need for exascale computing capabilities for science and industry and expressed how important it is for Europe to be a leader in achieving this challenge.

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Speaker:

Filip Velickovski and Simonas Bulota

Our first speaker Jean-Yves BERTHOU from ANR, France presented an overview of the challenge: exascale means computing at a level 1000 times more than the top computers today, meaning the capability to manage both big data (extabytes) and extreme computing (exaflops). The main stakeholders and user community would be: climate scientists, astrophysicists, medical and bio-researches working in genomics, but it is not only scientists that will benefit. He argues there would be great gains in European industrial applications; a direct example given is the aerospace industry. One important message in the discussion was as we work towards the exascale level, we will need to develop new software and application paradigms, new supporting technologies for memory management, energy efficiency, and cooling, all of these being grand research challenges.

Michael RESCH - the second panellist from HLRS Stuttgart, Germany - gave specific examples of problems that would require an exascale infrastructure: “How do I best treat a broken leg”, “What is the best personalized drug therapy to treat my specific condition”, “What will happen to the climate in the future for different CO2 emission scenarios?” All these problems are not purely research driven, they have direct consequences in the economy, politics, and societal health. He made the analogy between his trip from Stuttgart to Vilnius by metro, air plane and taxi, and the different level of infrastructures needed to support scientific projects. He advocated for policy makers to establish

general rules in High-Performance Computing (HPC) infrastructure.

The next speaker - Catherine RIVIERE from GENCI, France, highlighted that suppliers of HPC cycles should listen more what user needs, not to just seek the idea of HPC. The roadmap of the Partnership for Advanced Computing in Europe (PRACE) for the exascale is built in 3 phases. After development activities of the system including the challenges related to the integration of multi-petaflop systems, comes the optimization of software to higher performance and collaboration between the developers and users of large systems, in order to optimise applications. Catherine also highlighted that the emergence of the exascale will make possible the resolution of complex problems which are currently impossible to solve with a reasonable time to solution. It will for instance be possible to propose customised health treatments based on the analysis of the patient's genome and targeting the drug specifically for this.

Thomas LIPPERT from Forschungszentrum Jülich, Jülich Supercomputing Centre, Germany, presented the HPC needs of the human brain flagship project. Without HPC it’s impossible to model and represent how brain stores information, there is some theories but no experimental proof so far. It’s believed that by using HPC it would be possible to re-engineer a brain's communication protocol and apply it to smaller devices even handheld, it would be like having a brain inspired device in your pocket. The speaker also mentioned that HPC could make big improvements
in future neuroscience, future medicine and future computing. However, these benefits can’t be achieved without a powerful computing infrastructure.

Maryline LENGERT from the European Space Agency, Italy presented a complementary viewpoint of computational power through the development of the pan-European cloud computing infrastructure Helix Nebula. It is a new, pioneering partnership between big science and big business in Europe that is charting the course towards the sustainable provision of cloud computing - the Science Cloud. The partnership brings together leading IT providers and three of Europe’s leading research centres, CERN, EMBL and ESA in order to provide computing capacity and services that elastically meet big science’s growing demand for computing power. Of course it’s not limited only to science. This is really big opportunity for public and IT sector to work closely. Maryline had an interesting example about earthquake modelling for whole earth using Helix Nebula system, facilitating the co-operation with the civil engineering HPC communities who through simple changes in infrastructure in poor countries could delay the time of collapse, thus savings people's lives.
The audience raised questions about the funding of HPC and business model of it. What are the commonalities of challenges between communities using the cloud and those using HPC? What effort do we need to sustain the development of the applications and the change of the mathematical models? There was also a discussion about the number of the exascale machines to be hosted in the EU and the way they will be used.

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