Formal acts adopted this morning by the Commission.

Why we need to act and why now?

- European scientists and industry increasingly process their data outside the EU because their computing and data needs are not matched by the computation time available in the EU. This threatens privacy, data protection, commercial trade secrets, and ownership of data in particular for sensitive applications. HPC is too strategic to fully depend on foreign capabilities and supply.
- In June 2012, the EU had four HPC systems in the world top ten. Today the fastest supercomputer in the EU (Marconi, in Italy) is ranking 14 worldwide and is about 12 times slower than the top system in China.
- Despite efforts and investments made so far, the EU does not have the best supercomputers in the world and the existing ones are based on non-European technology. Europe needs to be among the leading countries in the HPC world race.

What is the Commission planning?

- The initiative that will be presented in January builds upon the EuroHPC declaration, launched in Rome in March 2017 and already signed by 13 countries (France, Germany, Italy, Luxembourg, the Netherlands, Portugal, Spain, Belgium, Slovenia, Bulgaria, Switzerland, Greece, and Croatia).

- The aim of the cooperation – "EuroHPC joint undertaking" – will be to foster high-performance computing infrastructure for the EU covering the full value chain from technology components to systems and machines, and to applications and skills. The goal is to acquire, first, pre-exascale supercomputers by 2020, and thereafter exascale supercomputers (capable of at least a billion billion - 10^{18} - calculations per second) based on EU technology by 2022-2023. The objective is to have EU exascale supercomputers in the global top three by 2022. At present, the EU does not have any HPC machine in the world's top 10.
- Access to the EuroHPC infrastructure will be granted to all participating countries under fair and transparent principles with detailed conditions yet to be determined.

- The cooperation will be composed of public and private members: the European Union (represented by the Commission), the 13 countries which have already signed the EuroHPC Declaration, representatives from HPC and Big Data stakeholders, including academia and industry. Other members can join the joint undertaking at any moment, provided their financial contribution.

- The EuroHPC cooperation is a legal and funding instrument which enables pooling of national resources and investments and joint procurement and ownership of HPC infrastructure. The joint undertaking will provide financial support in the form of procurement or research and innovation grants to participants following open and competitive calls.
- The EuroHPC cooperation is foreseen to start operating in 2019 and will remain operational under the current proposal until the end of 2026.

HPC, what it is about?

- High-Performance Computers are able to process large amounts of data and perform complex calculations thousands of times faster than a normal computer. It helps to reduce calculation times for complex forecasts and tests by days and in some cases by weeks.
- HPC capabilities are used to solve and address scientific, engineering and societal challenges for the benefit of the industry, researchers, the public sector and the citizens.
- The next technological challenge for HPC is the exascale performance: a machine able to do 10^{18} (a billion of billion) calculations per second.
- The term pre-exascale is used to refer to a class of systems that are about five to ten times slower than exascale supercomputers. Such machines will be available on the market by around 2020.

Why is HPC important?

- HPC is at the core of major advances and innovation in many areas such as health, personalised medicine, climate change, renewable energy, sustainable agriculture, automotive, aerospace, cybersecurity and defence.

- HPC has huge potential for creating jobs and is key factor for the digitisation of industry and its competitiveness. A EuroHPC environment will provide European industry, and in particular SMEs, with a better access to supercomputers to develop innovative products.
- HPC helps significantly to develop a fully functional Digital Single Market.
- In Europe every Euro invested in HPC has already generated close to EUR 870 in revenues for businesses and EUR 69 in profit[1].
- 97% of the industrial companies using HPC consider it indispensable for their ability to innovate, compete and survive[2].
- Industrial sectors that leverage HPC could add up to 2-3% to Europe's GDP in 2020 by improving their products and services[3].
- HPC is the backbone of a vibrant data economy. A EuroHPC infrastructure will allow the EU to make the most of it while ensuring a high level of data protection, privacy and security.

  HPC is also changing the way research is performed and knowledge is shared, as part of a transition towards an 'Open Science', which makes research more open, global, collaborative, creative and closer to society.
- Real application example: car production cycles can be reduced from 60 months to 24 months.

What value would be added at EU level given that several MS already have their capacity?

- Many Member States have developed their own HPC strategies and investment plans. But the scale of the resources and financial investments that are needed to realize a sustainable exascale level HPC infrastructure has now become so important that no single country in Europe has the capacity to sustainably build it in timeframes that are compatible with those of our competitors. Therefore, the EU Member States need to coordinate their HPC investment strategies and pool the resources.
- So far, at European level, HPC investments remain largely uncoordinated and compared to its competitors from USA, China or Japan, Europe is clearly underinvesting in HPC with a funding gap of EUR 500-750 million per year.

- The EuroHPC cooperation will enable Member States to coordinate together with the Commission their HPC investments and strategies. Without the necessary action to ensure the development of the whole HPC ecosystem (from technology components to systems and machines, and to applications and skills) and coordination and pooling, long term negative effects are to be expected, both on the digital economy but also for Europe's data sovereignty and scientific and industrial leadership.

How HPCs are different from the huge server farms à-la-google/amazon?

- Supercomputers are designed to run and solve large scientific and industrial simulations that are computationally so demanding that they cannot be performed using general-purpose computers. Server farms are optimized to handle a very large number of small and computationally light tasks. While single components used in the two cases might be very similar, the system architectures and design points are very different.

Why will the Joint Undertaking be placed in Luxembourg?

The Commission's main datacentres are in Luxembourg (Betzdorf and Windorf). Our financial and HR systems as well as pan-European systems supporting the Single Market, climate policy, health and food safety or structural funds are placed there. Most of our data experts (DG Connect's HPC unit, the AI & Robotics unit and the whole data directorate) work in Luxembourg. This means that a big part of our IT expertise is already in Luxembourg and it makes sense to pick Luxembourg also as the location of the administrative part of this Joint Undertaking.
The other Joint Undertakings (e.g. ECSEL in the area of microelectronic components) are in Brussels, hence it is a nice opportunity to create a Joint Undertaking also at another official Commission location.

How much does a supercomputer cost?

The total cost of ownership of a supercomputer (including building and operating costs for five years) would be for a EU pre-exascale machine (which we want to purchase under the Joint Undertaking by 2020) in the range of EUR 200 to 250 million, whilst the cost for an exascale machine would be at least twice as much.

How much does the Commission invest?

The Union's financial contribution will cover administrative and operational costs and be up to EUR 486 million, through budgetary commitments made in the current Multiannual Financial Framework (MFF) and more specifically in both Horizon 2020 and Connecting Europe Facility (CEF) programmes (100 million from CEF; the rest from H2020).

What is the link between supercomputers and quantum technologies?

Whilst the race to exascale supercomputing follows the route of further improving the performance of traditional supercomputers, many actors predict that such increase will one day come to an end. Post-exascale computing will have to rely, at least partially, on other

architectures and features. This is why radically new ways to perform computations are being envisaged. Quantum computing, i.e. devices that exploit quantum effects to perform computations, is the most promising of them.

Quantum Computing is supported as part of the Quantum Technologies FET Flagship initiative of the European Commission. Today, quantum computers are only embryonic, as they allow to perform operations only on a few quantum bits (QuBits). In order to perform meaningful operations, hundreds or thousands of QuBits would be necessary and scalability is still an issue. But the prospects of this technology are immense and this is why all big economies invest in that new race to quantum computing. It is however believed that a general-purpose quantum computer with speed advantage over traditional supercomputers will not appear before 5-10 years, and that the first workable quantum computing devices will be plug-ins for standard supercomputers in order to accelerate specific types of computations. HPC and quantum computing devices are therefore very likely to be integrated together in the future. This is why big players of HPC are also investing in Quantum Computing.