



EuroHPC JOINT UNDERTAKING
DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT
UNDERTAKING No 24/2021

Approving the Multi-Annual Strategic Plan 2021-2027

THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING,

Having regard to Council Regulation (EU) 2021/1173 of 13 July 2021 on establishing the European High Performance Computing Joint Undertaking (hereinafter “EuroHPC, Joint Undertaking”) and repealing Regulation (EU) 2018/1488 (hereinafter "Regulation")¹,

Having regard to the Statutes of the EuroHPC, Joint Undertaking annexed to the Regulation (thereinafter "Statutes") and in particular to Article 1(o), 7(4)(a), 7(5)(a), 7(6)(a), 7(7)(a), 13, 14 and 18 thereof,

WHEREAS

- (1) Article 1(o) of the Status provides that the EuroHPC Joint Undertaking shall define the multiannual strategic programme;
- (2) The EuroHPC Joint Undertaking’s Industrial and Scientific Advisory Board which is made up of the Infrastructure Advisory Group (INFRAG) and the Research and Innovation Advisory Group (RIAG), has provided the relevant input.
- (3) Input was also provided by the Members of the Governing Board of EuroHPC Joint Undertaking and their experts during a number of discussions organised on the Joint Undertaking’s future Strategic Orientations by the staff of the EuroHPC Joint Undertaking between April 2021 and June 2021.
- (4) During 22nd Governing Board meeting, the Governing Board agreed on the Multi-Annual Strategic Plan and

¹ OJ L 256, 19.7.2021, p. 3–51

HAS ADOPTED THE FOLLOWING DECISION:

Article 1

The Governing Board approves the Multi-Annual Strategic Plan 2021-2027 annexed to this decision.

Article 2

This Decision shall enter into force on the date of its adoption.

Done at Luxembourg, on 21 October 2021.

For the Governing Board

[signed]

Thomas Skordas

The Interim Chair

Annex: Multi-Annual Strategic Plan 2021-2027



EuroHPC Joint Undertaking

Multi-Annual Strategic Plan (MASP 2021 -2027)

Revision Status		
0.0	First Draft, based on Strategic Orientations	GB discussion: 3-4 June 2021
0.1	Comments included from CH, DE, ES, SE, DK, IE, FI, EC,	July 2021
0.2	Second Draft based on feedback provided	August 2021
0.3	Third draft based on feedback provided	GB meeting 16/09/2021
1.0	Final version	October 2021

EuroHPC Joint Undertaking

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EuroHPC Joint Undertaking

Multi-Annual Strategic Plan (MASP 2021 -2027)

1. Introduction

1.1. Context

The EuroHPC Joint Undertaking (JU) was established on 28 September 2018 by Council regulation No 2018/1488, published in the Official Journal of the EU on 8 October 2018 and entered into force on 28 October 2018.

When the EuroHPC JU was created at the end of 2018, it became fully operational, but was still part of the Commission. It adopted and implemented its first work programme and established itself as a successful model of a public-private partnership involving the European Union, twenty-six Member States, and four associated countries from outside the EU.

The Executive Director was appointed on 15 May 2020, took up office on 16 September 2020, and the Governing Board confirmed autonomy of the EuroHPC JU on 23 September 2020 when it confirmed that all autonomy criteria were met.

Despite the challenges presented by the COVID-19 pandemic, the EuroHPC JU met most milestones in 2020 as set out in its Annual Work Programme and required to achieve financial autonomy.

To date, the EuroHPC JU has already demonstrated that it is the right legal and financial instrument to address the shortcomings of the European HPC landscape and encourage Member States and EU funds to be pooled together to create European value for the Union as whole. Indeed, coordination of the HPC strategies of the Union and the Member States has already led to:

- Pooling of resources and investments;
- Procurement of seven world-class HPC supercomputers addressing user needs and demands;
- A structured and focused research and innovation agenda aligned with the overall ambition of creating a world-class HPC ecosystem;

The approval of the new Council Regulation sets out the updated mission of the EuroHPC JU and adapt the JU's funding streams to be in line with the new multi-annual financial framework (MFF) of the Union (2021 – 2027). As a result, the JU's scope and the variety of its activities will be extended and will build on the good practices established by EuroHPC JU during its first two years of existence.

1.2. Multi-Annual Strategic Plan (MASP 2021-2027) - process

This Plan has been developed in line with the updated mission set out in the Council Regulation² and the Commission Staff Working Document³ on the new EuroHPC JU.

Input was provided by the JU's Industrial and Scientific Advisory Board which is made up of the Infrastructure Advisory Group (INFRAG) and the Research and Innovation Advisory Group (RIAG). Both papers are included in the annex to this report.

Input was also provided by the Members of the Governing Board of EuroHPC JU and their experts during a number of discussions organised on the JU's future Strategic Orientations by the staff of the JU between April 2021 and June 2021.

The draft Plan was presented to the EuroHPC JU Governing Board on 3-4 June for an initial discussion. The consolidated Plan will be presented on 16 & 17 September 2021.

Once adopted, it will form the basis for the preparation of future Annual Work Programmes during the next MFF period (2021-2027). Proposed calls and actions mentioned in this Plan will be presented in the Annual Work programme.

Where appropriate and in order to reflect the evolving HPC context, this document will be updated.

1.3. Vision, mission and strategy

1.3.1. The Vision and mission

Supercomputing, numerical simulation, artificial intelligence (AI) and high-performance data analytics (HPDA) are essential and strategic for European countries for understanding and responding to the increasing challenges that their citizens will be faced with in the years to come. These technologies will also continue to play an essential role in ensuring continued leadership of European science, industry (including SMEs), security, and economic development.

The challenge now is not only about the deployment of current technology and its associated (human) expertise, but also about future exascale and post-exascale supercomputing technologies, including the emerging domain of quantum computing., as well as the connectivity and access to data.

Equally, the JU needs to ensure that an easy to use set-up of the EuroHPC systems and support resources are made available for academic, public sector and industrial users

² COM (2020) 569

³ SWD(2020) 179

Together, these resources will be essential for many applications that today's supercomputers cannot address. Examples include early detection and prevention of diseases, new therapies, understanding the functioning of the human brain, forecasting climate change, or accelerating the design of new materials, medicines, airplanes or cars. Mastering these critical technologies, including modelling in combination with data management (DM) and artificial intelligence (AI), is essential for large-scale simulation as well as processing, analysing, and using the quintillions of bytes created every day. These technologies, for example, are key for ensuring that European researchers from both academia and industry reap the full benefits of data-driven science and forge the path to grand scientific discoveries.

They are also essential for a large number of users from the public and private sectors for serving many social, scientific, and industrial domains. In the last year, HPC resources have helped accelerate the search for therapeutics to confront the COVID-19 pandemic. Access to HPC resources plays a valuable role in quickly identifying solutions to complex societal emergencies.

European citizens are already benefiting from such applications. Personalised medicine, for example, already increasingly relies on simulations to understand the nature of diseases, diagnose them rapidly and develop customised treatments. Supercomputing has also a growing impact on industry by significantly reducing product design and production cycles, accelerating the design of new materials, minimising development and manufacturing costs, and increasing resource efficiency.

By 2027, the EuroHPC JU will establish a world-leading hyper-connected and federated HPC service and data infrastructure ecosystem in Europe, and will ensure that the EU is in a position to produce innovative and competitive HPC solutions based on European components, technologies and knowledge. Energy-efficiency and environmental sustainability will also be taken into consideration.

In practice, EuroHPC JU should develop, deploy, maintain, and extend in the Union a world leading federated, secure and hyper-connected supercomputing, quantum computing service and data infrastructure ecosystem; support the (development) and production of innovative and competitive supercomputing systems based on a supply chain that will ensure components, technologies and knowledge limiting the risk of disruptions and the development of a wide range of applications optimised for these systems; widen the use of this supercomputing infrastructure to a large number of public and private users, and support the twin climate and digital transition as well as the development of key skills for European science and industry.

1.3.2. The Strategy

The Multi-Annual Strategic Plan (MASP 2021-2027) vision is based on the strategy set out in the new Council Regulation.

“In essence, the new Regulation is a continuation of the existing initiative established under Council Regulation (EU) 2018/1488, introducing modifications to adapt the Regulation to the next multiannual financial framework (MFF) Programmes, but also to reflect the priorities of the Commission, and to make it possible for the Joint Undertaking to use funding from the new MFF programmes for 2021-2027. These programmes are Horizon Europe (HEP), the Digital Europe Programme (DEP) and the Connecting Europe Facility (CEF). This funding will be essential for Europe to reach this next supercomputing frontier of exascale computing. It will allow the Union to equip itself with a world-class federated, secure and hyper-connected supercomputing and quantum computing service and data infrastructure, and to develop the necessary technologies, applications and skills for reaching exascale capabilities, which is currently foreseen around 2023-2025 and post-exascale around 2025-2027, while promoting a world-class European HPC and quantum computing innovation ecosystem.”⁴

Building on this, the Infrastructure Advisory Group (INFRAG) and the Research and Innovation Advisory Group (RIAG) have provided input on the strategy.

INFRAG recommends that new strategy of the JU should be:

‘Essentially, EuroHPC JU should aim to facilitate easy and secure access to an integrated, world-class supercomputing and data infrastructure and to develop and support a highly competitive and innovative high-performance computing ecosystem (...). As such, EuroHPC Multiannual Strategic Agenda - EuroHPC supercomputing infrastructure should be the strategic instrument for European leadership in the global digital science and economy for the next generation supercomputing and data driven digital era and beyond. The strategy and actions should be based primarily on the requirements of the users. It is important to recognize that the numerous user groups, like academic researchers, scientists working in SMEs or large companies, or researchers in governmental organisations have different requirements with respect to supercomputer hardware, software, support services, and IT security. These divergent needs should be addressed by a federated European supercomputing infrastructure that ensures access to all EuroHPC systems based on the same level of quality. The selection of systems and services has to be well balanced, particularly with regard to specialized systems like quantum or neuromorphic systems, but also high throughput and “number crunching” machines. A large and fast-increasing request will come from data-driven computing applications and technologies. Due to the fact that the

⁴ Commission Staff Working Document SWD (2020) 179: The Commission’s Staff Working Document analyses the evolution of key socio-economic and technological drivers and of user requirements affecting the future evolution of HPC and data infrastructures, technologies and applications in the EU and worldwide. It describes the role HPC will play in the near future for the digital transformation of Europe, and the creation of a single European data space. Finally, it provides evidence of the importance of the EuroHPC Joint Undertaking’s activities, and of the impact that its continuation will have on an increasing number of critical technologies and applications in the next decade, notably for European excellence in low-power processor technologies and in AI.

federated supercomputing infrastructure will be essential for the European economy and European industry, science, and society at large, the infrastructure has to be resilient, powerful, secure, affordable, and competitive at the international level. This is a challenge, but also a big chance for European suppliers and users. The focus of all EuroHPC activities should be on innovation: in science, in industry and also in public services to strengthen the collective European economy and society. The recommendations are based on the last edition of the INFRAG MSA and take into account the first implementation steps of the JU and early lessons learned. The structure of the document follows the 5-pillar concept of the new regulation of the EuroHPC JU.'

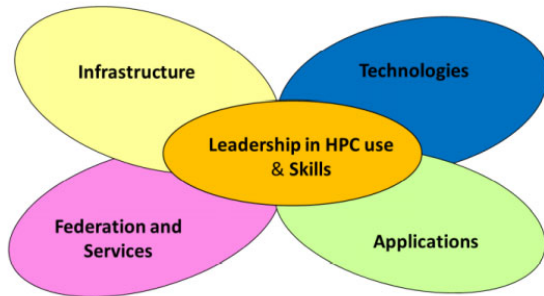
RIAG recommends that the new strategy of the JU should be:

'Today, the European HPC ecosystem is unbalanced, with significant leadership limited to the HPC software stack and major deficiencies in the HPC hardware stack. To achieve European digital sovereignty in the near future, EuroHPC JU technology initiatives should be focused on providing a boost to the (re)generation of European HPC technology research and industry, especially in HPC-specific areas where there are clear gaps. One of the fastest ways to achieve this goal is to leverage our strengths and extend those capabilities. We see European technology leadership today, based on open platforms like the Linux OS, toolchain, runtimes, frameworks, and libraries, up to the HPC application layer. This enables rapid development and extension of software systems (...). Combining our European strengths with global trends, we can accelerate the path to digital sovereignty by creating the European Open Stack (EOS), establishing an open ecosystem for computing encompassing both hardware and software and fostering the development of co-designed systems required to advance European and global HPC. This ambitious vision will enable European independence and encourage additional investments. The EOS will produce Intellectual Property (IP) rights and standards that enable innovation and accelerate the European research and development that is already globally competitive, at all levels in the HPC system stack.'

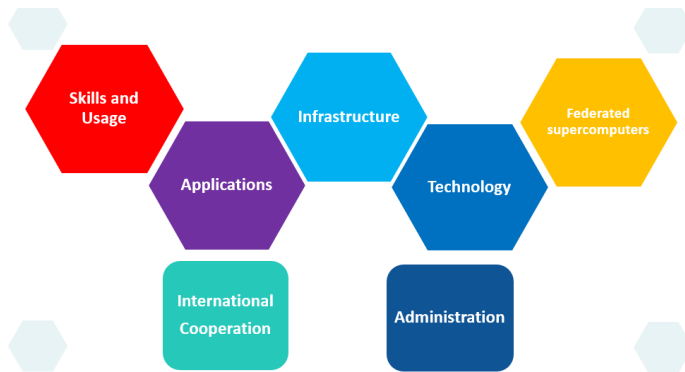
Furthermore, there is a need to have a better understanding of exactly who the users of the HPC systems will be and what their requirements will be in the future.

The Plan will therefore set out the strategy to build a European HPC value chain. Originally, the Commission had proposed to organise into 5⁵ pillars of activity:

⁵ The final Regulation refers to 7 pillars: Infrastructure, Technologies, Federation and services, Applications, HPC use and skills, International Cooperation and Administration.



In line with the new Regulation, EuroHPC JU proposes to add two more pillars – International Cooperation and JU Administration.



Although activities in each pillar will be described separately, it is clear that they each pillar is interlinked with the others and that the whole ecosystem needs to be considered as a whole.

1.4. Objectives

The Council Regulation (2021/1173) states in recital 16

‘Pursuing a common strategic Union vision in High Performance Computing and quantum computing is essential for realising the ambition of the Union and of its Member States to ensure a leading role in the digital economy. The objective would be to establish in Europe a world-leading hyper-connected, federated and secure High Performance Computing and quantum computing service and data infrastructure ecosystem, and to be in a position to produce innovative and competitive High Performance Computing and quantum computing systems based on a supply chain that is more resilient and will ensure the availability of components, technologies and knowledge, limiting the risk of disruptions Recital 15 of Council Regulation (2021/1173) explains that ‘in order for the Union and its Member States to achieve leadership in key digital technologies such as High Performance Computing and quantum computing, they

should invest in next generation low-power and energy efficient supercomputing technologies, innovative software and advanced supercomputing systems for exascale and post-exascale computing and quantum computing, and for innovative supercomputing and data applications.'

1.5. Programmes and national and private member funding

1.5.1. EU Programmes

The activities of the Joint Undertaking will be structured in one administrative pillar and six technical pillars addressing respectively the infrastructure activities, the activities federating the supercomputing services, the technology related activities, the supercomputing applications related activities, the activities to widen the usage and skills, and the international cooperation activities.

The Multi Annual Financial Framework (2021-2027) had allocated funding to implement this strategy in three specific work programmes with following indicative budget EU Funds allocated to EuroHPC JU activities:

Digital Europe Programme (DEP): EUR 1.981.300.000

- Infrastructure pillar
- Connecting and federating of supercomputing services pillar
- Widening usage and skills pillar

The Digital Europe Programme (DEP) is a new programme and will allow for co-funding with member states of new and upgrading of new supercomputers, ensuring access to these HPCs, building on the federation of supercomputing services, and deployment, and usage of the HPC ecosystem. It will also be used to deploy HPC skills and training in the European Union.

DEP will be used to fund the infrastructure pillar, part of the federation of supercomputing services pillar and the widening usage and skills pillar.

Connecting Europe Facility (CEF2) : EUR 200.000.000

- Hyperconnectivity
- Data connectivity

The Connecting Europe Facility (CEF) Programme will be used to fund the remaining activities of the federation of supercomputing services pillar, i.e. the interconnection of the High Performance Computing, quantum computing and data resources, as well as the interconnection with the Union's common European data spaces and secure cloud infrastructures. (e.g. GAIA-X.) The Connecting Europe Facility will support connectivity and, where relevant cybersecurity activities.

Horizon Europe Programme (HEP) : EUR 900.000.000

- Technology pillar
- Application pillar
- International Cooperation

The Horizon Europe (HE) Programme will continue to focus on R&I activities co-funded with member states in the areas of technology, applications and international cooperation. The Horizon Europe Programme will be used to fund the technology pillar, the application pillar and the international cooperation pillar.

In addition, the newly adopted Recovery and Resilience Facility will support the digital transition. Member States are requested by the Commission to ensure a high level of ambition when defining reforms and investments enabling the digital transition as part of their recovery and resilience plans. The Regulation requires that each recovery and resilience plan include a minimum level of 20% of expenditure related to digital. This includes, for instance, investing in the deployment of in HPC and connectivity. According to the new regulation, these contributions cannot be counted as national contribution to the budget of the JU.

1.6. National and private member contributions

1.6.1. National contributions

The Participating States shall make a total contribution that is commensurate to the Union's contribution. Participating States may complement the Joint Undertaking's contribution in different actions, within the applicable maximum reimbursement rate set out in HEP, DEP, and CEF2 regulations. The JU will provide an online platform to ensure that reporting of national financial contributions and in-kind contributions are reported in a transparent and efficient way, in line with the requirements set out in the new Regulation

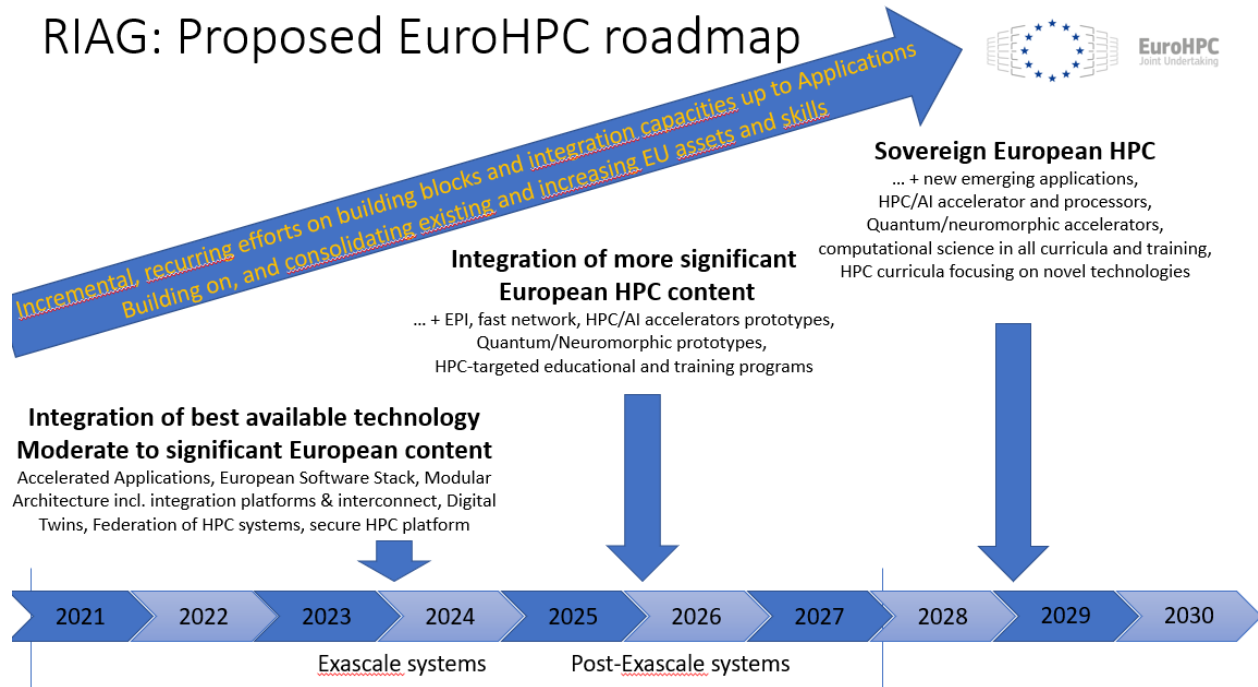
1.6.2. Private member contributions

Private Members will also provide funding – in kind contribution to projects in line with HEP and DEP rules.

The JU will provide an online platform to ensure that reporting of private member in-kind contributions are reported in a transparent and efficient way, in line with the requirements set out in the new Regulation.

1.7. Proposed Roadmap

RIAG: Proposed EuroHPC roadmap



The roadmap proposed by RIAG has provided a useful contribution to this plan. Progression is foreseen from “Best available technology” to “Integration of more significant European content”.

1.7.1. Milestones and Financial Perspectives

In short, the JU’s activities will be coordinated across the seven different pillars. Each year, the Governing Board of the EuroHPC-JU will approve an annual work plan that will implement identified milestones and actions which will form the different outputs of the strategy.

It is important to ensure that the outputs of each R&I call are deployed and disseminated, and that proper usage and take up of the HPC infrastructure, technologies and applications are monitored. Progress on different projects will be presented through events and other communication activities, the EuroHPC-JU website, and the JU ‘s Annual Activity Report.

The JU will operate from 2021 until 31 December 2033, in order to exercise its responsibilities with regard to grant implementation until the last indirect actions launched have been completed and with regard to finalising the activities related to the operation of the EuroHPC JU supercomputers.

2. Pillars of Action

2.1. Infrastructure

In line with the new Regulation, the JU will organise activities for the acquisition, deployment, upgrading and operation of the secure, hyper-connected world-class supercomputing, quantum computing and data infrastructure, including the promotion of the uptake and systematic use of research and innovation results generated in the Union.

The following table is indicative and summarises the acquisition strategy for the 2021-2027.

Indicative Overview of HPC system acquisitions (2021-2027)

	2021	2022	2023	2024	2025	2026	2027
HPC Infrastructure	Call for Hosting Entities	Several mid-range HPCs (peta and pre-exascale) systems and 2 high-end (exascale) systems				One or more high-end HPC systems (exascale and post-exascale) system and an industrial mid-range system	
Quantum Infrastructure	Call for Hosting Entities	Quantum simulators and 1st generation of experimental quantum computers				2 nd Generation of experimental quantum computers	

HPC infrastructure :

- i) From 2022, the JU will acquire and deploy two top leading-class exascale supercomputers owned by the EuroHPC JU. At least one exascale supercomputer should be built with technology based on HPC technology development in Horizon-2020, Horizon Europe, and EuroHPC emerging processor and accelerator technologies
- ii) From 2022, the JU will acquire and deploy mid-range supercomputers complementing the top-ranked systems above. These supercomputers will be co-owned by the EuroHPC JU and Member States. For these supercomputers hosting entities can choose short running innovation partnerships to acquire systems that are tailored to their needs.
- iii) From 2026, The JU will acquire a second top leading-class post-exascale EuroHPC supercomputers owned by the EuroHPC JU. This procedure will begin at least four years before the machines are operative to allow the codesign between the providers and hosting entities, guaranteeing the presence of as much European technology as possible.

- iv) The JU will also support the acquisition and deployment of an industrial supercomputing and data infrastructure for industrial users in cooperation with and co-funded by private members of EuroHPC-JU; adhering to industry specific requirements for increased security, data protection and availability.

Quantum Infrastructure:

The following actions need to be synchronised to research and development activities on quantum computing to be undertaken within Horizon Europe.

- i) From 2022, the JU will start equipping major computing centres with the best available European quantum computers, some interconnected with high-end HPC machines as accelerators for specific applications, accessible via the cloud;
- ii) From 2023, the JU will procure state of the art and fully programmable quantum simulators
- iii) From 2025, deploy the second generation of quantum computers (based on processors of at least 200 high fidelity qubits) as stand-alone systems or hybridised with high-end HPC machines and accessible via the cloud.

Access to the EuroHPC JU Supercomputing services:

- i) At the end of the 2021, the JU will launch an open call for procurement for expertise to organise calls to give access for HPC services to public users
- ii) Implementation of agreed access time policy for HPC will be ongoing during 2021-2022.
- iii) From 2022, the JU will develop commercial/industrial access services in cooperation between JU, Hosting Entities and Competence Centres. These services should be connected to the ongoing Commission activities to create European data spaces and Gaia-X.

2.2.Connected and federated Supercomputers

The JU will develop a federated, secure and hyper-connected European HPC and data infrastructure with midrange supercomputers and at least two high-end (i.e. exascale or beyond) exascale systems (integrating as much as possible European technology and expertise/knowledge such as CPUs, accelerators and high-performance interconnect developed in Europe.) that is accessible to researchers from academia, industry (including SMEs), and the public sector.

The infrastructure will be designed in highly flexible configurations tailored to a wide range of services, application and user needs and based on user requirements, following a co-design approach. It will progressively integrate the most advanced computing generation systems—pre-

exascale, exascale and post-exascale—and will include new kinds of technologies such as neuromorphic computing, quantum simulators, and future quantum computers. Associated data infrastructures will also be connected, allowing each category of users to manage its own data storage. It will provide a federated and coordinated access to all European supercomputers, data repositories, knowledge and will also be the place where users will get access to the latest future technology to support innovate solutions. Thanks to the HPC federated ecosystem, every industrial user, especially SMEs, will get appropriate support, including access to the whole of European expertise, know-how, and tailored training services, such as Centres of Excellence and Competence Centres. This also includes a close cooperation with other European activities like EOSC for science or GAIA-X which has a focus on industrial and commercial services.

To do this, a number of steps need to be taken:

- In 2021, the JU with the support of INFRAG will start developing a road map with EuroHPC-Centres to interconnect securely the federated supercomputing (including quantum machines).
- From 2022, the JU will launch a call to interconnect securely the federated supercomputing (including quantum machines).
- From 2022, the JU will launch a call to develop secure service platforms for user industries that are connected to European data spaces/Gaia-X.
- From 2022, the JU will develop plans with stakeholders in order to federate national and European HPC (including quantum machines) and data resources into a common platform. In parallel, it will adapt a supercomputing and data infrastructure in highly flexible configurations tailored to a wide range of application and computing needs of users. Finally, it will develop specific access and HPC-based services based on European common data spaces in areas of public interest.

2.3. Technology

The competitiveness of the European HPC infrastructure depends on the performance and availability of the most modern technologies. The infrastructure's overall performance depends not only on the performance of the supercomputers, but also on the stability and interoperability of each individual component. With large increases in digital networking, data and information are becoming increasingly valuable, in many cases eclipsing raw computing power. It is essential that state-of-the-art cyber security technologies protect data at all layers and provide secure access and use of the systems⁶.

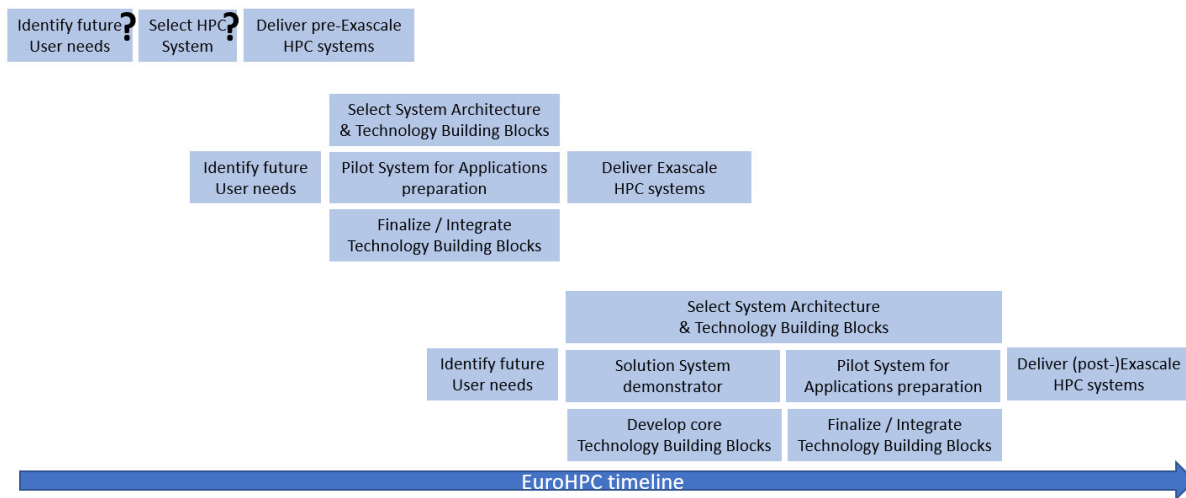
⁶ With thanks to INFRAG for this input

A number of assumptions were made regarding HPC technologies research and innovation that the JU will invest in.

Firstly, as RIAG suggests, the technology should be based on the principle of co-design.

Secondly, the approach must be based on establishing what end-users need. A building block approach to the whole R&D cycle could be envisaged. The figure below provided by RIAG is a helpful explanation of how this could be organised. It is important to be open to non-European suppliers in this process to foster competition and a diverse set of possible solutions. However, IP gained in that process needs to stay in Europe.

Coordinate “Research & Innovation” and “Infrastructure” programmes



Thirdly, HPC technologies research and innovation must be state-of-the art, cover all aspects of technology and reinforce strategic autonomy/sovereignty (as indicated in Council Regulation (2021/1173). Furthermore, it must guarantee early access to European technologies and lead in development of European IP.

HPC technologies that are developed through the EuroHPC JU calls must be energy efficient, innovative and able to perform and compete globally, be production ready and ready to be deployed in industrial and SME settings.

These technologies need to take into account new usage models such as hybrid computing and the European Digital Twin initiatives. Technologies will need to take into account big data analytics, AI, Neuromorphic and quantum computing.

The plan therefore proposes an iterative and modular approach where calls are launched to define building blocks and their interfaces, to develop these technology building blocks (hardware and software) and to integrate them innovative HPC architectures for exascale and post-exascale systems.

Early on the technology development should be tied to big industrial use cases (e.g. digital twins, simulation, data analytics; see applications) to make sure the development addresses a broader European market and contributes to the digital sovereignty beyond scientific HPC. This ensure close co-design of suppliers with potential customers (the HPC centres that procure) and users (the users of machines in the centres). These use-cases should be vertical to the European Open Stack (EOS).

Parallel to that, small calls that explore new types of architecture and building blocks will be launched.

The role of EuroHPC JU will be to coordinate and support codesign in the R&I hardware and software activities and ensure that activities meet ‘user requirements’ and deployment of these technologies.

EuroHPC JU will assess the different ‘technology readiness level’ (TRL) in order to assess which technologies to invest in. It will focus on developing a European Open Stack whose standards and interfaces will be part of the requirements in the HPC procurements. The European Open Stack (EOS) includes:

- Hardware technologies such as low-power processors, accelerators, interconnects will be supported. In particular, the JU in a joint effort with the Key Digital Technologies Joint Undertaking will support the development of low power GPP processor and accelerator technologies. These developments do not only target the state-driven supercomputer-market but primarily broader, industry-driven markets. Processor development will be driven by industry use cases in cloud and server markets.
- Software Stack including operating system, compilers and runtimes and workflow frameworks and performance analysis tools (as part of the EOS) should foster the ease of use and compatibility of the EuroHPC machines from the user perspective.
- Integration of technology building blocks, based on modular principles, coordinating resource management across layers of the Software Stack into novel HPC architectures
- Technologies and systems for the interconnection of classical supercomputing systems with other, often complementary computing technologies, such as neuromorphic or quantum computing technologies.

- Technologies for operation and security of HPC systems that take also take industrial needs into account.
- Emerging computing paradigms and their integration into leading supercomputing systems, including High Performance Computing, AI and quantum computing systems
- Tools for deployment of industrial-oriented HPC infrastructure and associated software environments and service platforms for industrial innovation.

Work to assess user needs will begin end of 2021. The newly-created ‘User Forum’ along with RIAG and INFRAG will provide advice on the future HPC services. In parallel, the JU will assess the types of funding model that can be used to develop a fully co-designed R&I strategy.

Between 2022-2025, calls will be launched which will take each building block in HPC hardware and software from innovation to deployment. This activity will be closely coordinated with ongoing development of applications will be considered in the next section.

2.4.Applications and HPC Centres of Excellence

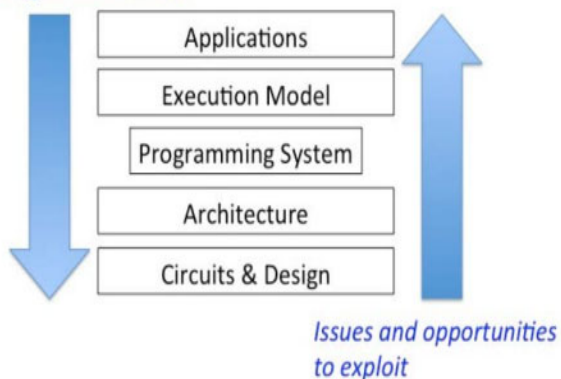
The success of any technological infrastructure is determined by its impact on science, industry, and society, and not on the achievement of any theoretical flop-rate or the scaling of individual jobs to the entire system. The impact is measured by the outputs and results of the development of innovative, efficient applications that fully exploit available HPC technology. To date, Europe has an enviable track record in application development and is world-leading in many academic and industrial domains. European HPC users are not a homogeneous body, but span a broad spectrum of skills, knowledge and experience in developing and using HPC applications. The challenges now faced are centred around preparing existing applications (academic and commercial) for the known EuroHPC architectures and designing new algorithms and applications that run and scale to match future hardware development.

This pillar aims at achieving excellence and maintain European world-leadership in HPC applications that are key for European science, industry and the public sector. Scientific and industrial HPC codes, applications and software packages in key areas for Europe will be codesigned, developed, ported and optimised to fully exploit the performance of current and future computing systems.

- Support for HPC-powered codes, applications and tools in all phases (such as in co-design, development, porting, re-structuring, optimisation, up scaling, re-engineering, etc.) in critical domains for extreme scale computing and data performance.
- Development of large-scale industrial pilot testbeds and platforms for HPC applications and services, including HPDA and AI-focused ones, addressing the feasibility, scaling, and

demonstration of secure HPC environments in key industrial sectors⁷. It will be key to engage with big data user industries⁸ for the design of use cases and their uptake in industry.

*Analysis of applications to devise
the most efficient solutions*



It will be key to ensure that Centres of Excellence (CoEs) continue to develop HPC applications and, with novel algorithms, codes and tools optimised for future generations of supercomputers. Further development and sharing of methodologies for analysis and parallelisation should constitute a transversal spine to sustain a holistic multi-domain applications scope.

A Call will be launched in 2021. The JU will launch activities which will select and prioritise application domains and also focus on porting and migration applications, in coordination, where appropriate, with the EuroHPC procurements.

In addition, it is important to note that the CoEs do not cover all HPC communities (notable examples are Astro- and Particle physics) and indeed their users communities have diverse HPC requirements, not all necessarily at exascale.

To promote co-designed applications for public and private users that exploit the capabilities of high-end supercomputers and their convergence with advanced digital technologies (2022 -2023)

⁷ Input provided by INFRAG

⁸ Big Data Value Association (BVDA) is a private partner of EuroHPC-JU.

2.5. Usage and Skills

2.5.1. Usage

To support current and future HPC users and to ensure short term that there are the desired spreading and increase of usage of the existing HPC-machines, the JU could launch pilot projects, which will both drive the use-case and the technical toolbox needed. These Pilot Projects will contribute to mapping and better understanding the competence gaps and barriers for widening the usage of HPC.

Pilot projects could be 'co-designed' with support of the by the proposed 'User Forum', RIAG and INFRAG.

Competence Centres

It is essential to extend the use of supercomputing to a wider range of scientific and industrial users, for instance by helping SMEs develop innovative business cases using supercomputers and providing them with training opportunities and critical HPC skills they need. Investment in national HPC Competence Centres will ensure a wide coverage of HPC activities and expertise in the EU and will provide specific services and resources for industrial innovation (including SMEs);

The HPC Competence Centres were created in 2020 and need to be strengthened in 2022 in order to prioritise and support exchange of best practices, the sharing of existing libraries of HPC codes and access to upgraded HPC application codes. Furthermore, HPC Competence Centres and HPC Hosting Entities need to work together to facilitate access to large-scale High-Performance Computing enabled pilot demonstrators and test-beds for big data applications and services in a wide range of scientific and industrial sectors. In addition, it will be critical to ensure ongoing ongoing collaboration with HPC Competence Centres work and HPC Centres of Excellence in order to provide user input into the development of technologies and applications.

To summarise, Competence Centres will facilitate access to the best HPC and data intensive codes and tools in the most innovative scientific and industrial applications available now and in the future across Europe, in collaboration with Centres of Excellence and Digital Innovation Hubs This includes federating capabilities, exploiting available competences, and ensuring that application knowledge and expertise has the widest geographical coverage in the Union. A more detailed description of the different activities to be undertaken will be developed by the JU.

2.5.2. HPC Skills

The development of a skilled workforce is one of the most sustainable investments in HPC with long lasting impact in a rapidly changing environment. HPC skills are required to exploit available infrastructure, federated resources and services, technologies and applications. In order to

enhance Europe's competitiveness, boost its technological and data autonomy, and strengthen European innovation, the European HPC ecosystem made up of the JU, Member States, HPC research institutes, the Centres of Excellences and the Competence Centres need to work together to generate a highly knowledgeable, world-leading scientific and industrial community.

In this respect, a major goal of building the European HPC ecosystem led by the JU is maintaining and widening leadership and usage of HPC.

Furthermore the JU will need to develop commercial and business models, developing a streamlined and robust procurement pipeline based on technological sovereignty, acquiring the corresponding resilience in procuring supercomputers, and training and education.

For the development of a European HPC ecosystem, a significant increase in HPC skilled workforce that is diverse, gender balanced and able to use their know-how to support the design of European HPC technologies and applications is important.

EuroHPC JU will support the development of digital skills, professional training and education, attracting human resources to HPC and increasing Europe's workforce skills and engineering knowledge (2022 onwards). It will empower a diverse group of people (including PhD and Post-docs) to work in HPC and its convergence with advanced digital technologies such as data analytics, AI, cybersecurity, etc. Such actions could include for example: Master's programmes in HPC and computational science; short-term HPC training courses; job placements/traineeships from industry to academia and vice versa involving the use of HPC in real environments; HPC hackathons, hands-on schools and training through research in advanced laboratories, etc.

The JU will also invest in short-term, industry-specific training, for example combined with consultancy and trial use of HPC infrastructures through national points. For end-user SMEs, this could include hands-on training and solving real use cases, developed in cooperation with the competence centres, (and possibly Digital Innovation Hubs – DIHs) and SME-tailored courses and support offerings like staff exchange programmes with research and academia.

In addition, the CoEs for HPC applications will offer specialised training for HPC specialists, application developers, advanced users of HPC applications and related topics.

More actions will be considered to develop and retain a European talent pool in HPC and develop viable and rewarding career paths for research software engineers and other key roles. Support must come at national (potentially through EuroCC) and European level for the full ecosystem of users and developers.

Furthermore, investment in skills for emerging technologies such as quantum computing should be considered to support work in mathematics and physics as well as development of novel hardware.

2.6. International Cooperation

In line with the external policy objectives and international commitments of the Union, defining, implementing and participating in activities relevant to the promotion of international collaboration in supercomputing to solve global scientific and societal challenges, while promoting competitiveness of the European HPC supply and user ecosystem:

The JU will assess different types of cooperation with third countries such as world class HPC ecosystems like US and Japan. Cooperation with these will benefit the European ecosystem and users most. Each activity will need to be approved by the Governing Board based on external EU foreign and public policy considerations. Lastly, it will monitor closely activities related to the HPC sector as well as evolving user needs outside the European Union.

2.7. Administration: Legacy (2018-2021) and transition actions

As soon as the first Work Programme is adopted, EuroHPC JU will:

- begin recruitment to strengthen its team in line with the agreed Establishment Plan set out in the new EuroHPC JU regulation and develop associated policies to be able to attract and retain qualified staff in Luxembourg
- transition the JU's governance framework from the old EuroHPC JU to the new EuroHPC JU (including RIAG and INFRAG)
- integrate new funding streams (Horizon Europe, DEP and CEF2) into JU processes in line with the rules set out in the EU Financial Regulation.
- start discussions with participating states on their annual national contributions
- develop a strategy to recruit new Private Members
- prepare a plan to set up a User Forum with commercial and public users of HPC services. work with PRACE and GEANT and other key actors in the HPC Community on future activities, where relevant and issues of joint interest are identified.
- further build EuroHPC JU's robust legal and financial framework

In addition, EuroHPC JU will continue to work on legacy activities and

- manage the existing HPC assets in cooperation with the Hosting Entities implement an access policy . Continue consultation activities on commercial Access to HPCs.
- manage the ongoing R&I projects and ensure proper dissemination of results
- defend the JU on ongoing court cases

- report on the outcomes of the R&I calls, procurements and associated KPIs
- report on auditing and risk assessment: produce annual accounts, update procedures and assist the European Court of Auditors, Council of Ministers and European Parliament in the annual Budget Discharge.
- draft and implement a new communication dissemination and outreach strategy
- further develop and implement internal control, administration, processes and policies

2.8. Activities with other Joint Undertakings and EU activities

EuroHPC JU will work very closely with the European Commission to ensure that its activities are undertaken in close cooperation and coordination on the activities of the EU Quantum Flagship, Digital Earth, EOSC, GAIA-X, EuroQCI, AI, Data Spaces etc...

Furthermore, EuroHPC JU will work closely with our sister JU, the newly created Key Digital Technologies JU (formerly ECSEL JU) and the newly created Cybersecurity Competence Centre and network (CCCN). Lastly, it will monitor closely activities related to the IPCEI on microelectronics.

3. Annexes

Infrastructure Advisory Group (INFRAG) Input



EuroHPC INFRAG -
Multiannual Strategic

Research and Innovation Advisory Group (RIAG) Input



EuroHPC JU RIAG
MSRIA 2021-2022 v11

Commission Staff Working Document



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