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How Supercomputing Technology Can Be a Game-Changer for SMEs

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Abstract

For many entrepreneurs, the terms "supercomputers" or "High-Performance Computing" are primarily associated with academic institutions, theoretical research, or complex graphs understood only by a small group of experts. Some may also link them with services offered by Google or Amazon to businesses, but "available only to those with large budgets."

This publication aims to demonstrate that supercomputers are increasingly becoming a part of the business landscape, and not necessarily just for the big companies. Small and medium-sized enterprises (SMEs), as well as startups, can successfully benefit from them.

By combining a clear explanation of supercomputer capabilities with real-life case studies, the article aims to convince entrepreneurs that HPC is no longer a niche technology, but a real game-changer for SMEs across diverse sectors of the economy. We will discuss:

- how the use of supercomputers can create a unique value proposition and expand the customer base,
- how machine learning and generative AI can scale up business,
- the path to financing access to supercomputers in Europe.

In this paper, we will present two paths for applying for grants: one for entrepreneurs with no prior experience in HPC, and another for those looking to use supercomputers at a more advanced level. We will also provide essential information on the application process, key participation requirements, and the grant application schedule.

Keywords:

High-Performance Computing (HPC); business competitive advantage; Fortissimo Plus project; EuroCC project

1. HPC as a factor of business digitalization and development

Digital transformation is the process of integrating new technologies into various areas of business operations, which leads to better performance [1]. The rapid development of digital technologies and digital reality encourages companies to implement new technologies and at the same time influences their competitive advantage [2,3]. The Resource-Based View theory explains well the importance of introducing technological resources for organizations' digitalization processes and stresses four main criteria: value (how much the technology supports reducing threats and raising opportunities for exploration and market differentiation), rarity (refers to technology scarcity), imitability (defines the requirements needed to implement the technology, such as costs and talent pool), and organization (describes organizational readiness to integrate innovative technology into its strategy) [1]. High-performance computing clearly fulfills the value criterion. HPC can be used to reduce costs, to enter new markets more quickly, and to solve complex problems faster, which increases companies' competitiveness [4]. Currently, when big data and its computation clearly influence organizational operations, parallel computing and machine learning allow real-time analysis and the use of enormous quantities of data [5]. Other important benefits of HPC business applications are [6]:

- the possibility to develop and test specialized services and products,
- time saving,
- prototyping and testing risk reduction,
- technological competences development.

An important advantage of HPC technology is the very wide scope of its applications; supercomputers can be used to recognize cancer cells, test the strength of innovative materials, optimize sound quality, or support agricultural activities [6]. It can be useful in different business fields, such as production (process optimization, raw materials saving, cost and time reduction, storage optimization), R&D departments (sophisticated simulations, time and resource reduction, design optimization, data transformation), marketing (market data processing, product–market fit) [3] or banking (risk analysis or real-time data analysis) [7].

High-performance computing supports the "as a service" model and enables business access to cloud computing and AI solutions. Cloud computing is crucial for companies' agility, fast innovation, and just-in-time procurement [4]. AI is a commonly used business tool focused on increasing speed, personalization, content creation, and decision-making processes.

The organizational component of digital transformation seems to be a challenge, especially in the context of small and medium-sized companies, where flat structures, limited skill pools, and financial resources can be barriers to implementing HPC technology. At the same time, the rarity (HPC) and imitability factors, which do not apply to large companies and corporations (HPC is relatively available and easy to imitate), can define SMEs' strengths and competitive advantage [1].

2. High Performance Computing vs Cloud Computing

How does the use of HPC differ from the more popular cloud computing solutions, given that both models are, in fact, based on providing computing services on demand? Although both models rely on delivering computational resources according to user demand, their purpose, and practical applications differ significantly.

Cloud computing is primarily a model of online access to a wide range of IT services including databases, software, analytics, AI/ML tools, and servers, typically offered under a pay-as-you-go pricing model. Companies most often use cloud computing to build applications, develop IT systems, process data sets, create development environments, run websites, or implement CRM solutions. In contrast, HPC infrastructure is dedicated to tasks requiring extremely high computational power. The primary goal of using supercomputers is not to build applications or run virtual machines for enterprise employees, but to solve complex computational problems that demand intensive process communication and minimal data transfer latency between computing nodes.

It is also worth noting that cloud computing offers lower entry costs and the flexibility to access resources from virtually any location with an internet connection. In comparision, HPC requires more advanced technical expertise but delivers substantially higher performance and precision in executing tasks such as big data processing, engineering simulations, and training large scale AI models.

However, for R&D projects that demand high precision, advanced computations, or low latency communication, HPC becomes the more appropriate solution.

3. Benefits and challenges of HPC use in SMEs

According to the European Union's assumptions, small and medium-sized companies are crucial for Eu-

ropean innovation, competition, and employment, and need to be supported in digital transformation processes, including HPC implementation [3]. The challenges that SME managers and owners face, such as reducing costs, ensuring competitiveness, optimizing processes, increasing turnover, and winning new customers, can be resolved by applying HPC. The triple helix model of collaboration between industry, academia, and public authorities provides the opportunity to create the modern infrastructure and network needed for efficient HPC implementation in SMEs [8] and the realization of the open innovation paradigm in practice [9].

High-performance computing fosters SMEs' innovativeness and competitiveness by [1, 9–11]:

- processing large volumes of data,
- enhancing R&D processes,
- supporting modeling and simulations,
- supporting analysis of industrial and market data,
- supporting new product and service development,
- facilitating prototyping, and
- enabling cost savings.

Research conducted among Portuguese firms [1] confirms that SMEs, which often face the challenge of allocating finances, perceive HPC as a technology supporting process optimization and cost reduction. The use of supercomputing power to support business decisions is equally important, as it transforms the subjective, intuitive approach (characteristic especially for small, flat structures) into a data-driven one.

Interest in investing in HPC adoption in small and medium-sized firms is determined by factors such as readiness for HPC integration with business processes, cloud solutions capacity, and HPC needs [11]. Research conducted in the Montenegrin business ecosystem demonstrated positive attitudes towards HPC among SMEs, based on favorable perceptions of HPC technology and high expectations regarding its crucial impact on new product development, as well as positive marketing and financial effects. The participants expressed full trust and risk acceptance regarding data protection by HPC service providers. The research also identified some challenges that may hinder the digitalization process based on HPC technology, e.g., a low need to perform and scale simulations or to accelerate them significantly. Other challenges associated with HPC are presented in Figure 2. The most limiting factor for the SME sector is the workforce skills gap, related to relatively small teams and the lack of awareness, skills, and experience in advanced computational techniques and HPC technology [1, 12].

This makes projects focused on educating and training potential HPC users a vital challenge for HPC providers. A proper education strategy, including raising digital innovation awareness, creating a supportive HPC ecosystem, delivering training, and ensuring customer onboarding, can bring benefits not only for supercomputing centers but above all for the business efficiency and competitiveness of SMEs [12].

4. Business support through Fortissimo Plus

Entrepreneurs can access HPC resources on a commercial basis. However, it's important to note that startups and small and SMEs can use European computing power for free thanks to the EuroHPC JU initiative, which forms a pan-European supercomputing ecosystem. This includes advanced computing infrastructure (pre-exascale and exascale supercomputers) and a support network for research, industry, and the public sector.

One of the project supporting business in utilizing the computing power of supercomputers is the Fortissimo Plus project (FF+) [13]. The project aims to facilitate and popularize High-Performance Computing and Artificial Intelligence technologies (including generative AI). Fortissimo Plus helps companies increase innovation and competitiveness by providing access to advanced supercomputing resources and technical and business support. The main aim of the project is to strengthen the European innovation ecosystem, support the digital transformation of SMEs, and promote the use of supercomputers in various sectors of the economy. FFplus allows companies to run business experiments and R&D projects using HPC and AI, leading to the deployment of new products, services, or processes based on data analysis, modelng, simulations, and advanced data processing. The initiative also offers grants, runs open calls, and spreads success stories demonstrating the advantages of adopting these new technologies.

Within the project, entrepreneurs can participate in annual competitions through two tracks:

- Business Experiments (Type 1): for those just starting with HPC without experience in this area. Participants can receive up to €200,000 in funding (up to €150,000 per organization) for a project lasting up to 15 months.
- Innovation Studies (Type 2): for companies already experienced with HPC or needing advanced AI support. This track enables more complex R&D projects (including generative AI), funding up to €300,000 (up to €150,000 per entity) for up to 10 months.

Type 1 Business Experiments can focus on AI technologies, High Performance Data Analytics (HPDA), or Big Data. Funding applications may be submitted in consortium with other entities. In the case of business exper-

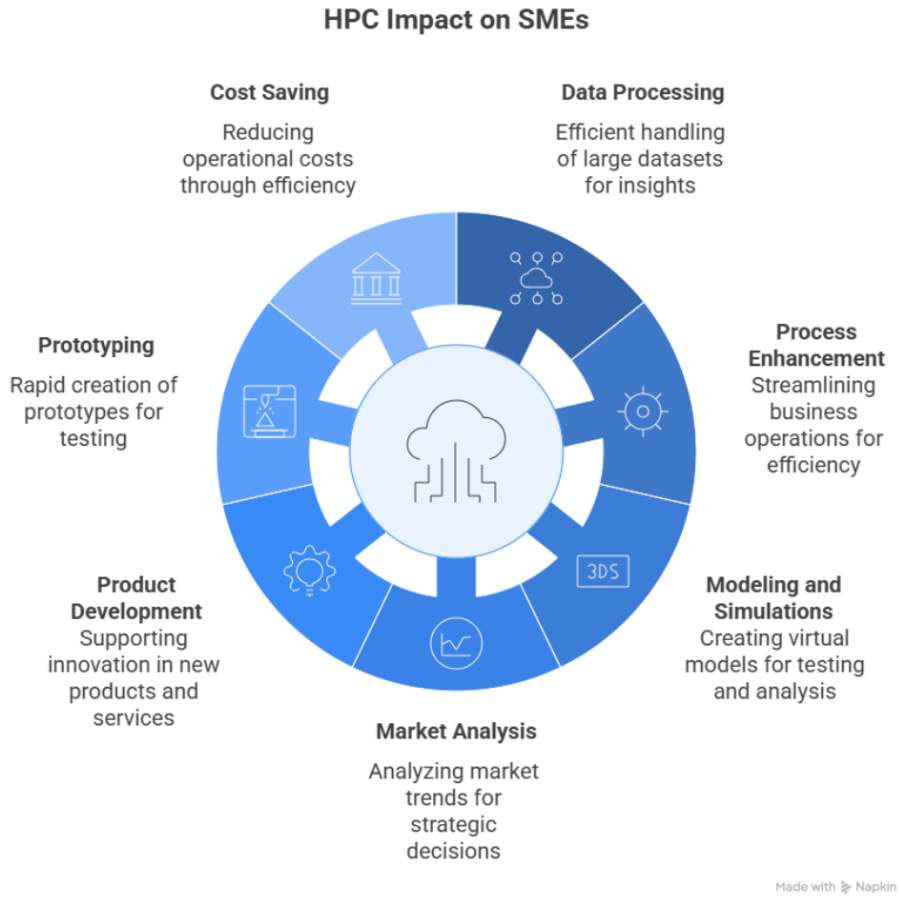

Figure 1: HPC impact on SMEs

iments, the primary participant must have no prior experience with HPC. The technology used to solve SME business problems may come from various fields, primarily numerical simulation, AI, or HPDA.

Type 2 Innovation Studies focuses on small and medium-sized enterprises or startups with high expertise in generative artificial intelligence but lacking extensive computing infrastructure. Within the Fortissimo Plus project, proposals are expected to address the business challenges of European SMEs across various application domains, with priority given to companies whose implementation of advanced HPC services will have the most significant business impact. SMEs with an academic profile or those conducting activities with only potential long-term effects are outside the scope of the call.

Under the Fortissimo project, eligible costs mainly include personnel expenses. These cover employees under employment contracts and individuals working under other civil law contracts or seconded by third parties, provided they perform duties under conditions similar to full-time employees, and the results of their work belong to the beneficiary. These costs must be calculated based on actual expenditures and cannot exceed standard rates applicable to similar positions within the organization.

Eligible costs also include the purchase of licenses for specialized software (excluding office software licenses), legal access to necessary data sets, and travel expenses incurred solely in connection with project implementation. Only depreciation of devices essential to task completion is allowed for equipment, while purchasing personal computers or laptops is not eligible. Consulting costs may be covered only if related to technical or engineering support - business consulting and management services are not reimbursed.

Applications are assessed by external, independent experts, taking into account:

- impact: industrial relevance (including potential societal relevance), exploitation plans, and alignment with the call's objectives,
- excellence: soundness of concept, innovation, and quality of the work plan,
- quality of the consortium: both overall and individual proposers' capability to carry out the proposed work,
- resources: effective and justified deployment of resources.

Entrepreneurs can apply for grants in partnership with other companies or research institutions, which al-

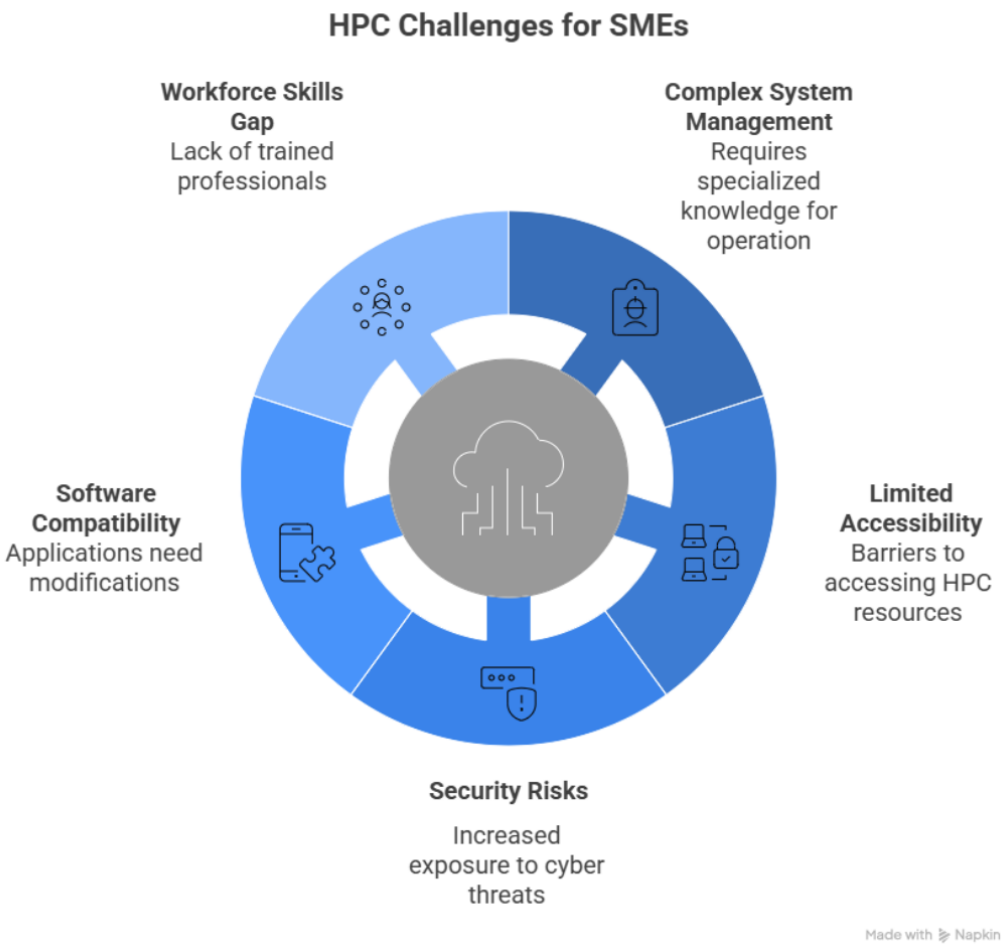

Figure 2: HPC challenges for SMEs

Figure 3: Fortissimo Plus project

lows entities without their own HPC or AI competencies to carry out projects by collaborating with experts. This is significant for business planning to use the computing power of supercomputers, but it lacks the necessary expertise in this area. Academic staff can provide essential support to the project by applying their knowledge to solving complex technological challenges and identifying the most effective ways to utilize available HPC resources - thanks to skills such as code optimization, adapting software to supercomputer infrastructure, and expertise

in programming languages and parallel programming tools. The role of the scientific institution can be a crucial part of the substantive side of the project: developing algorithms, tools, testing methods, or analyzing results - all of which are subsequently implemented by companies. As a result, SMEs can more easily test and implement advanced technology in practice.

Thanks to the computing power and large memory availability of HPC, new possibilities open for rapid prototyping, modeling, and simulations that previously took weeks or months. HPC is essential for companies aiming to maintain a competitive edge in the fast-moving world of technology and innovation.

5. Fortissimo Plus and EuroCC projects

In many ways, the objectives of Fortissimo Plus align well with what the EuroCC2 project has to offer. Both operate within the EuroHPC JU, a European program and organization coordinating the development of supercomputers and HPC expertise in Europe. Fortissimo provides SMEs and startups with grants to carry out activities using computing resources primarily offered by EuroHPC. At the national level, EuroCC centers help to create an ecosystem of HPC skills and infrastructure, as well as support entrepreneurs in the use of supercomputing power. In addition, small and medium-sized enterprises and startups - FFplus service users - can receive assistance in preparing applications for access to computing infrastructure, as well as learn from national EuroCC how to apply their solutions. Therefore, companies can contact their local EuroCC to find the best options, learn more about the capabilities of their own HPC system, and get guidance from experts. Fortissimo Plus and EuroCC enrich the European digital innovation ecosystem by offering companies funding, creating solutions, and sharing knowledge on how to solve problems.

6. How HPC is used to develop business ideas?

To illustrate the potential applications of HPC in business, the following examples of the real use of HPC in SME business activities are presented [13][1]. They were implemented as parts of Fortissimo Plus project.

[1]examples of HPC use come from the FF4EuroHPC project or past Fortissimo projects editions https://www.ff4eurohpc.eu/en/success-stories/

6.1. Improvement of productivity in aquaculture

In aquaculture, fish growth and mortality are strongly dependent on variable environmental conditions (tides, temperature, salinity, nutrients), which cause losses reaching millions of euros. To minimize losses and maximize production, it is crucial to quickly and accurately analyze fish growth and welfare data. The "Improvement of Productivity in Aquaculture" project used HPC and artificial intelligence for centralized, rapid analysis of millions of pieces of production, genetic, and environmental data. Thanks to this, the company to develop the ACUATIA - software for collecting, visualizing, and analyzing data from fish farms, generating personalized AI models and providing real-time predictions.

Figure 4: Improvement of productivity in aquaculture

During the project implementation, the following technologies were used: HPC, AI, and edge computing. These technologies, when applied to data analysis, allowed for a better understanding of the factors influencing fish behavior, welfare, and growth. These tools enabled the improvement of a decision-making tool for aquaculture managers, which serves both as software for data collection and visualization and as an expert system for creating customized artificial intelligence models that allow for predictive and real-time data analysis.

The business impact for aquaculture is direct and significant; the faster growth of the fish, through optimized aquaculture management, means that the appropriate sales-weight is reached 2 months early. This also has a positive environmental impact; the reduction of the sale age by 2 months leads to a proportional reduction in saltwater consumption, oxygen usage, and electricity consumption. Furthermore, because of the new accurate and faster growth pre-

dictions, the commercial department has more reliable information about the fish that they can offer to their customers, and stock breaks (highly undesirable), are prevented [14].

Business benefits of the "Improving Productivity in Aquaculture" project:

- 30% reduction in predictive model error through HPC,
- shortening the time to production in new user facilities or new procedures by 50%,
- business know-how for data-driven decisions for aquaculture farmers,
- 7% improvement in fish growth for the end user.

6.2. Multi-head additive manufacturing with optimal HPC thermal stabilisation

Within the "Multi-Head Additive Manufacturing with Optimal HPC Thermal Stabilisation" project, the possibility of significantly improving the quality and dimensional stability of products created by 3D printing using multiple print heads was investigated. The key challenge was thermal stability during the process, which affected the finished parts' accuracy and mechanical properties. As a result, a closed, heated printer chamber was developed and constructed from a steel frame and plexiglass windows, enabling work with advanced engineering materials such as high-strength mechano-chemical polymers. The new design improved production quality and strengthened commercial potential for manufacturing larger 3D printers.

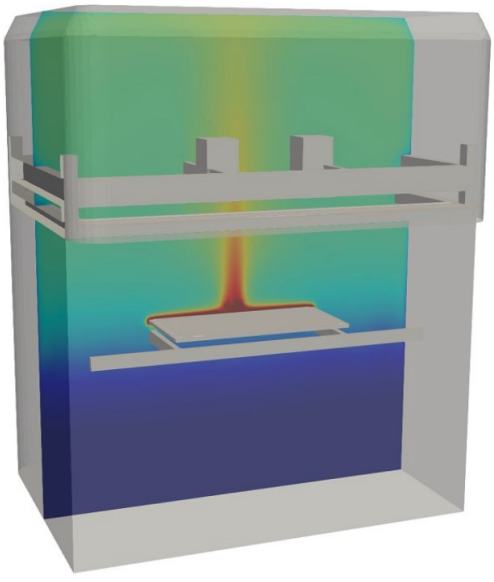

Figure 5: Multi-Head Additive Manufacturing with Optimal HPC Thermal Stabilisation

High-Performance Computing was used to simulate thermal and mechanical effects in real time. This enabled optimization of the design prior to its physical implementation. This approach significantly lowered the risk of design mistakes and expensive revisions, leading to a much more efficient production process.

The solution was to predict the impact of heat on the structure and motion system of the 3D printer using a numerical simulation model for the 3D printer that was built from scratch. First, the 3D geometry files for the different parts were generated and boundary conditions and material parameters were set up. To avoid high costs for HPC licenses, the open-source CFD simulation code OpenFOAM was used for scaling. Different simulations were performed incorporating the unsteady process while the printer chamber heats up and the different parts move. The final CFD simulations that were performed on the HPC architecture had a run time of 3-4 days. This means that they can be used in the development and production process of new machines or to find the correct temperature setting.

Additionally, several tests on 3D printers were performed to validate the numerical simulations. During these tests, the exact temperature values inside the chamber were measured and then compared with the results of the numerical simulations [15].

This case study is an excellent example of how HPC can drive innovation in industry, especially in advanced manufacturing, where precision and tight control over production parameters are needed, far beyond what traditional methods can achieve.

Business benefits of the "Multi-Head Additive Manufacturing with Optimal HPC Thermal Stabilisation" project:

- shortening of product delivery time to the customer by 30-50%,
- cutting costs in production by 15-30%,
- greater accuracy of 3D printers is expected to increase sales by 20-30%,
- creation of jobs for new, highly skilled employees.

7. Supercomputers and Large Language Models

One area where the use of HPC is particularly important is the development of Artificial Intelligence (AI). Creating and refining AI models requires conducting thousands of experiments and enormous computing power, which can be a barrier for smaller teams. The use of supercomputers allows for more efficient and faster testing, as exemplified by Large Language Models (LLMs). This is a type of artificial intelligence that uses natural human language to perform tasks. Models analyze and create content, imitating human language based on the data they were trained on, that is, based on the content

they were provided with.

To use an LLM, companies don't have to build their models from scratch, which is extremely expensive and time-consuming, even when using HPC infrastructure. There are ready-made LLMs available on the market that can be used, often tailored to a given industry or service type. Generic models we are using daily are often insufficient for specialized use, so they are personalized (so-called tuning) using supercomputers, and that's why they often give wrong answers and hallucinate. For example, the medical sector can fine-tune a model using patient data, test results, medical literature, and therapeutic guidelines to determine the most effective cancer treatment or heart disease diagnostics. Automating tasks using LLM programs also facilitates summarizing symptoms of a given disease or the required medication list.

Specialized language models can also support companies in their day-to-day tasks. On one hand, LLMs used by HR teams can evaluate candidate applications, support recruitment, and create personalized training programs based on employee data analysis. They also help determine the most effective career paths. On the other hand, in industries such as finance, retail, and e-commerce, LLMs, by analyzing large data sets and customer behavior patterns, can detect potential fraud attempts and warn of suspicious incidents in real time. HPC-based solutions support making decisions in demanding markets, where forecasting prices and risks requires variable data modeling.

Furthermore, LLMs automate and support customer service by quickly responding to inquiries about products, orders, or complaints. Models can also summarize conversations and emails, analyze technical issues, and adapt emotions and style to the customer's situation or mood. Examples of such applications include chatbots and virtual assistants.

In logistics and retail companies, models help forecast demand, manage warehouses, and analyze product availability, considering factors such as seasonality and delivery times. In the financial industry, LLMs help forecast market behavior, thus supporting investment advisors. While they do not eliminate risk, they are a valuable source of insights and guidance.

8. Towards an exascale future

The marked acceleration in the development of new technologies in recent years, particularly in the field of machine learning and artificial intelligence, will also enable increased use of high-performance computing resources by startups and SMEs, which will lead to the development of their competitiveness [16]. This is becoming increasingly feasible thanks, among other things, to the expansion of HPC infrastructure owned by large technology companies and, in Europe, the implementation of AI Factory initiatives [17]. These nineteen projects, funded by the European Union, aim to develop supercomputing infrastructure primarily dedicated to Artificial Intelligence that will be made accessible to small and medium-sized enterprises, as well as other entities such as government administrations and local authorities, on preferential terms. The AI Factories initiative is intended to democratize Artificial Intelligence adoption and HPC utilization among European entities.

One of the fundamental prerequisites for utilizing supercomputers in the business world is the development of skills in leveraging HPC infrastructure, as well as the creation of innovative solutions by the business workforce. Key competencies in this context include data management, parallel programming, and an understanding of system architectures, which enable the maximization of supercomputer potential. At the same time, as highlighted in the 2025 report: 'Solving Europe's AI talent equation: Supply, demand and missing pieces' [18] , highly specialized engineering skills in artificial intelligence (so-called level 2) remain relatively underdeveloped. This shortage of deep expertise in artificial intelligence limits the development and implementation of advanced applications, particularly in sectors seeking to push technological boundaries. Gaps in these competencies are particularly evident among representatives of small and medium-sized European enterprises, in contrast to large companies, which can afford to hire specialized staff and provide them with ongoing training in changing trends [19, 20].

Initiatives that can help fill this skills gap in Europe include National Competence Centers (NCCs), currently operating in 33 countries. Their mission is to increase the capacity for advanced computing for the benefit of science, industry, and public administration by strengthening knowledge, skills, and the exchange of experience. Key forms of support offered by NCCs include free courses, training, webinars, and workshops on the effective use of supercomputing resources, HPC application development, artificial intelligence, machine learning, large-scale data analysis, as well as coding courses, parallel programming training, and courses on specialized applications.

Similar support, although more strongly focused on AI-oriented HPC applications, will also be provided by the Factories. Beyond the computing infrastructure itself, they will offer a comprehensive portfolio of services, including training and consulting activities, designed to help enterprises leverage supercomputers to develop their business potential. This model can be described as "HPC-as-a-service" combined with additional services.

Such an approach is particularly valuable given the skills gap among professionals trained in traditional HPC who lack experience with modern AI frameworks and GPU-accelerated computing.

9. Summary

Supercomputers, increasingly accessible and used by entrepreneurs, not only enable business benefits such as saving time and resources, but also contribute to the development of technological competencies within business teams. As a result, they are becoming an important factor in building a competitive advantage for individual companies and, in turn, fostering economic growth at the national level.

Through calls for proposals organized by EuroHPC JU [21], it is possible to obtain HPC resources for the production, testing, or benchmarking phase of planned solutions. Calls are announced several times a year, depending on resource availability and allocation periods. In addition, starting in April 2025, extra calls specifically for AI projects are launched as part of the so-called AI Factories. These calls are decided much faster - sometimes in as little as two business days - and are simpler than the traditional process calls.

Besides free access to HPC infrastructure, the European Union supports SMEs and startups in business development by offering the Fortissimo Plus grant program. Entrepreneurs can also obtain support under the EuroCC initiative, which, in addition to resources, supports entrepreneurs by raising awareness of High Performance Infrastructure and providing specialized training.

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