



EUROPEAN CLOUD COMPUTING - THE WAY AHEAD -



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+ INTRODUCTION

At a time where the physical world is being increasingly encountered virtually, the need for instant availability of ICT resources is met by data storage and computing power on the cloud. **Cloud computing is crucial to guarantee the whole society can still function and citizens can access health care, education and many other fundamental services.** As reported by recent market studies and reports [1], while the COVID-19 emergency has tested major Cloud Service Providers (CSPs) worldwide, the pandemic also offered a powerful push to cloud computing adoption and deployment. As businesses and public organisations are **accelerating their digital transformation** and transition to a **remote workforce**, it is evident how important the cloud is for continuity of operations across many market sectors. **Entertainment, e-commerce** and above all **remote education** and **health care** have affected the cloud industry and how the providers are responding to the sudden and major increase in demand for cloud solutions and services. Also, in the **scientific search** for vaccines, treatments, and testing, many initiatives depend on machine learning and artificial intelligence (AI) tools, which, in turn, are relying on the availability of cloud computing resources. While highlighting the robustness of the public cloud, the situation induced by the pandemic also emphasizes **several major challenges** that need to be faced.

First of all, **big international providers**, already dominating the market on a global scale, such as Google Cloud, Amazon Web Services, Microsoft Azure, IBM and Alibaba, **are becoming even stronger**, at least in the short term, which clearly indicates the pressure on policy makers, legislators and antitrust bodies to make sure Europe stays a truly open and competitive market. This is of utmost importance specially **to protect micro-enterprises and small and medium-sized enterprises** (SMEs), often suffering from unfair and unbalanced cloud computing contract terms [2]. In addition, **major security and privacy concerns** are becoming even more pressing, especially when “delegating” important aspects of our lives to the cloud such as the education of our children, our healthcare, our work and even our social life. With more people logging in remotely, the risk from home routers, computers, and IoT devices, which may not be well protected from malware, viruses, and other attacks, is growing. Such remote workplaces can provide dangerous gateways to personal data; hence enterprise networks must guard against new intrusion channels. The problem is that many people confronted with cloud technologies and solutions **lack the experience, the skills, or the technical support** to troubleshoot, monitor, and patch their now critical personal cyber-infrastructure. This is likely to change even faster than expected in light of the current accelerated digital transformation needs, but the major obstacle will still be the lack of resources to be invested for such a “digital upgrade” to effectively take place. As a matter of fact, in addition to compliance to GDPR, which is a clear challenge both for providers and clients [3], the cost and effort of cloud adoption are clear showstoppers especially for SMEs as well as small public administration and healthcare organisations - cloud uptake in Europe is still slow: 1 company in 4, only 1 in 5 for SMEs [4].

This affects both the cloud clients (demand side), as well as the organisations (both private and public) offering innovative solutions, services and applications largely relying on the cloud (supply side).

+ NEXT GENERATION EUROPEAN CLOUD

WHAT MAKES IT SO DIFFICULT?

Lack of cloud infrastructure and service providers. According to a recently published European Commission (EC) report [5] identifying obstacles that keep the single market from integrating further, the lack of high-speed internet networks and cloud infrastructure hinders business operations on the single market. This represents a serious threat to the exploitation of cloud computing in Europe. In particular, the lack of reliable, energy-efficient, trusted, and secure cloud infrastructure and service providers has an impact on the development of services, particularly on the update of cloud computing.

Talent/skills gap in cloud technologies. Cloud computing is a key technology, which requires advanced digital skills to support European self-sustainability in each vertical sector of relevance. Europe evidently experiences difficulties not only in training and retraining, but also in retaining talent in this field.

Lack of guidelines for cloud infrastructure and service providers. The EC has put in place key regulatory principles for cloud service providers (General Data Protection Regulation (GDPR), Regulation on Free Flow of non-personal Data, NIS Directive, EU Cybersecurity Act) and has been working to develop European compliance tools to raise the level of security and trust. Moreover, ongoing work includes industry-led codes of conduct around data protection and data portability and preparatory work for a European security certification scheme for cloud service providers. Although these are important guidelines for the cloud computing ecosystem, a horizontal framework with clear rules for cloud infrastructure and service providers is still missing.

Lack of clarity and transparency of cloud computing contract terms. In business to business relations, several difficulties are reported when it comes to cloud computing. A recent EC study [6] showed that 24% of companies using cloud computing services encounter issues related to lack of clarity and transparency of contract terms (21%) and limited liability of the provider (16%). The study estimated that, considering a usage rate of cloud computing of 16% and an incidence of contract-related problems at 24%, about 582,924 micro, SMEs suffered from these problems across the EU during the period 2016-2017. Given cloud computing uptake is expected to grow significantly during the next few years, incidents of contract-related problems will probably increase, too. These contractual ambiguities might impair the fast adoption of cloud computing technologies in Europe.

Insufficient policy making initiatives. The continued advancement of the European Cloud Computing vision will require significant actions at the policy forefront: the EC is already dedicating large efforts to uniform policies and regulations across Europe. Some of these policies are key for the cloud industry, which would benefit from their uniform interpretation and application, but the truth is that single nations may apply EC policies differently in their legislation, leaving the door open for different interpretations that can limit the ability to create a Digital Single Market. This is the case, for example, in the public sector, where limited interoperability regulations are in place so that concrete regulations become specific to single member states or even, in some cases, to specific regions.

+ EUROPE AT WORK!

A COMPREHENSIVE AND FORWARD-LOOKING PERSPECTIVE

Among the core priorities for the upcoming **Multiannual Financial Framework (MFF)** of the European Union covering the 2021-2027 period, the EC has identified as a key objective the necessity to ensure **“a Europe fit for the digital age”** in which digital technologies and solutions are strongly rooted in the **core European values**, spanning fundamental individual rights to market openness and environmental sustainability. This is reflected in the **European strategy for data** [7] that specifically indicates how *“the digital transformation of the EU economy depends on the availability and uptake of secure, energy-efficient, affordable and high-quality data processing capacities, such as those offered by cloud infrastructures and services, both in data centres and at the edge.”*

This was also clearly re-iterated by the recent EC announcement about the **Recovery Plan for Europe** [6], which states the necessity to invest in “technologies such as artificial intelligence, cybersecurity, data and cloud infrastructure, 5G and 6G networks, super- and quantum computers, as well as blockchain” as essential building blocks of a stronger Digital Single Market.

In this respect, the EC is promoting important actions along two main streams:

1) Investment (plan is currently 2 billion Euro) in EU cloud computing capacities via a High Impact Project (HIP) on European data spaces and federated cloud infrastructures, based on the federation of secure, scalable, energy-efficient and trustworthy edge and cloud infrastructures (Infrastructure-as-a-service, Platform-as-a-

service and Software-as-a-service). This HIP is an essential part of a wider set of strategic investments in new technologies, e.g., high-performance/quantum computing, cybersecurity, 6G networks, to ground Europe’s industrial future[8] and ensure the overall development of our economy and society. By leveraging on relevant initiatives and outcomes of previous EC projects, including GAIA-X, SUNFISH, EGI, HELIX-NEBULA, EOSC, etc., the goal of the HIP is “to provide competitive and seamless access and use of cloud infrastructures based on the rollout of cross-border cloud federations”[9]. Ongoing work within DG CONNECT focuses on the definition of a reference architecture for cloud federation and the plan is to converge to a memorandum of understanding with member states by Q3 2020, starting with those that already have cloud federation and data sharing initiatives. As a follow up, through the “Cloud Federation as a Service” project (see Digital Europe Programme, DEP, Draft Orientations for the preparation of the work programme(s) 2021-2022), the plan is to ensure the deployment of a federation of pan-European cloud services to enable the provision of services of general interest both of 1) a public nature focusing on public services and health services, and 2) an economic nature focusing on transport, energy and environment services - in close synergy with Health, Clean Planet and Smart Cities actions proposed within the DEP - provided by SMEs using AI, HPC, cloud or blockchain to deliver such services. This will contribute to ensure the creation of a cloud services marketplace for EU users, both from the private and public



sector, by Q4 2022. The marketplace will facilitate access for potential users (in particular the public sector and SMEs) to cloud processing, software and platform service offerings that comply with a number of requirements in areas like data protection, security, data portability, energy efficiency and market practice. Participation in the marketplace for service providers will require the use of transparent and fair contract conditions.

2) Cloud Governance Criteria. To ensure access to competitive, secure and fair European cloud services, the EC has been investing in several policy and regulation-driven initiatives that, besides the GDPR, include the Free Flow of non-personal Data Regulation, FFDR [10], and the Cybersecurity Act [11], which encompasses the ENISA ad hoc Working Group on Cloud Services [12]. These initiatives aim at addressing the differences among applicable laws across Europe for data localisation and the absence of an EU-wide cloud security certification scheme. Article 6 of the FFDR states that porting of data shall be facilitated by Cloud Service Providers (CSPs) through the adherence to a self-regulatory code of conduct, indicating also the need for “certification schemes that facilitate the comparison of data processing products and services for professional users, taking into account established national or international norms, to facilitate the comparability of those products and services”. This is further elaborated in the Cybersecurity Act, that aims to “create a framework for European Cybersecurity Certificates for products, processes and services that will be valid throughout the EU”, which will “enable their users...to ascertain the level of security

assurance and ensure that these security features are independently verified”. The ENISA CSP Certification working group [13] delivered its final recommendations to the EC in June 2019 [14]. As a follow up, the EC requested ENISA “to prepare a cybersecurity certification candidate scheme for cloud services, taking into account existing and relevant schemes and standards” [15], accompanied by the CSP CERT recommendations as a baseline for the EU-wide cloud security certification scheme on which a dedicated working group [16] has been activated. All certification schemes will be in principle voluntary and aim to generate trust in the consumers of cloud services [17]. In particular, by Q2 2022, the EC plans to bring together a “cloud rulebook” elaborating on the different applicable rules for cloud services, offering a compendium of existing cloud codes of conducts and certifications on security, energy efficiency, quality of service, data protection and data portability. This in addition to facilitating the development of common European standards and requirements for the public procurement of data processing services.

A transversal (to all planned research, innovation, deployment, and policy-driven efforts) challenging priority, is the need to **foster adoption of green computing principles to the whole lifecycle of cloud computing delivery** that, as already highlighted by a number of studies and reports [18], including the Green Paper **Cloud Computing in Europe** [3] produced by the H-CLOUD H2020 project¹ in April 2020, is essential to transition to a carbon-neutral digital society. While on the one hand the cloud improves energy consumption, it also risks growing the carbon footprint of the IT

¹ <https://www.martel-innovate.com/ec-projects/h-cloud/>

sector [19]. According to a recent Greenpeace report, despite the gains in energy efficiency realized through cloud adoption, potential obstacles must be considered as a shift to cloud infrastructure occurs [20]. In this respect, energy-efficient and trustworthy edge and cloud infrastructures (by 2025 80% of all data is expected to be processed in smart devices closer to the user- **edge computing**) will be fundamental for the

sustainable use of cloud and edge computing technologies. As highlighted by the **EC Study on energy-efficient cloud computing technologies and policies for an eco-friendly cloud market** [22] several parameters and Key Performance Indicators require more work and validation for more effective and systematic monitoring and optimisation of resource consumption.

+ THE ROAD TO EUROPEAN-LED CLOUD COMPUTING

The EC is fostering increased cloud computing research and innovation efforts in **Horizon Europe** as the cloud is an essential element grounding the **Next Generation Internet²** vision that is at the core of an open, inclusive, secure, and trustworthy digital society and economy, where data can be more safely exchanged and more effectively monetised [10]. Through **secure federation of cloud across Europe and availability of both edge and cloud**

computing[21], the plan is to empower a computing continuum that is forecasted to be an indispensable cornerstone to realise the goals of the EC Data Strategy, Digital Strategy and Industrial Strategy while adopting **green principles** in the whole lifecycle of cloud computing delivery in the transition towards a carbon-neutral (if not carbon-negative) society by 2050.

To stay tuned on the next steps and be able to participate in the European Cloud Computing initiatives, join the community via the Horizon Cloud portal - www.h-cloud.eu



Only by coordinating public and private research, industry, policy and regulations efforts it will be possible to ensure sustainable and impactful progress of our societies and economies.

² <https://ngi.eu>

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