The 5G Infrastructure Association

European Vision for the 6G Network Ecosystem Executive Summary

Date:	2021-06-07		**Version:**	**1.0**

Executive Summary

In the coming decade, 6G will bring a new era in which **billions of things, humans, and connected vehicles, robots and drones will generate Zettabytes of digital information**. 6G will be dealing with more challenging applications, e.g., holographic telepresence and immersive communication, and meet far more stringent requirements. The 2030's could be remembered as the start of the age of broad use of personal mobile robotics.

6G is the mobile network generation that will help us tackle those challenges. 6G will likely be a **self-contained ecosystem of artificial intelligence**. It will progressively evolve from being human-centric to being both human- and machine-centric. 6G will bring a **near-instant and unrestricted complete wireless connectivity**. A new landscape will also emerge for the enterprises, as a result of the convergence that 6G will allow in the fields of connectivity, robotics, cloud and secure and trustworthy commerce. This will radically **reshape the way enterprises operate**.

In short, **6G will be one of the basic foundations of human societies of the future**. To enable a sustainable progress for society, in line with the United Nations Sustainable Development Goals, it is crucial that 6G addresses effectively pressing societal needs, while delivering new functionalities. This (r)evolution must be in line with Europe's primary societal values, in terms of e.g., privacy, security, transparency, and inclusiveness. Digital technologies are also becoming a critical and essential means of ensuring countries' sovereignty. **The development of Europe-based 6G infrastructures and solutions is one of the keys to secure European sovereignty in critical technologies and systems**.

The convergence of 6G with operation technologies raises the prospect of disassociating the location of manufacturing, industrial equipment, assets, and processes, from the actual location of the human operators. This will introduce unprecedented changes in our way of life as it is likely to redistribute the existing balance between urban and rural areas, potentially redefining the role of cities, by reversing the urbanisation trend. The COVID-19 pandemic has already amplified the social and economic significance of ICT infrastructure, in terms of e-working, e-commerce, and e-health. **End-user engagement** will be increasingly important for a smooth acceptance of new technologies like 6G. To ensure that 6G can be inclusive for all people across the world, it needs to be **affordable and scalable**, with a **great coverage everywhere**.

Key features of 6G will include **intelligent connected management and control functions, programmability, integrated sensing and communication, reduction of energy footprint, trustworthy infrastructure, scalability,** and **affordability**.

The 6G architecture should be sufficiently flexible and efficient so as to enable **easy integration of everything**, i.e., a network of networks, joint communication and sensing, non-terrestrial networks and terrestrial communication, encompassing novel AI-powered enablers as well as local and distributed compute capabilities. The use of AI everywhere in the network, where it can be beneficial, i.e., the "**AI everywhere**" principle, will be used to enhance network performance and to provide AI-as-a-Service in a federated network. AI and Machine Learning will help to maintain operation cost-effectiveness of envisioned complex 6G services, such as the interaction on human-digital-physical worlds and Internet of Senses, to automate some level of decision-making processes, and to achieve a zero-touch approach.

Several types of foundational technologies will drive the core development of 6G. Expanding network capacity to approach or even to try and go beyond the Shannon's and Moore's limits will be required for radio themes. Smart optical transport connectivity will allow the network to be always available, intrinsically secure, green, and with flexible scaling. Advances in photonic integration will pave the way for a raft of new IT and networking devices in which optical, radio

frequency, and digital electronic functions, can be combined. Modern security and reliability paradigms ("security by design"), as well as the application of modern software technology, will guarantee the dependability and trustworthiness of the system. New electronic technologies, components and devices, including processors, memories, analogue, radio frequency, digital access and cross-connect systems and analogue to digital converters antennas, packaging and optical components, will be required. The exploitation of properties from quantum mechanics needs to be explored to understand their potential for unprecedented performance in quantum sensing, communication, security, and computing.

Recommendations

Europe's goal shall be to **ensure leadership in strategic areas and find alternate ways of establishing a secure and trusted access to those technologies, where a European supply network cannot be established**. Such an approach would create business opportunities by **making Europe a sovereign, independent, and reliable source for 6G public and private network solutions and services**.

Public and private R&I investment shall focus on key 6G technologies, such as programmability, integrated sensing and communication, trustworthy infrastructure, scalability and affordability, as well as AI/ML, microelectronics (at least in design), photonics, batteries (e.g., for mobile devices), software, and other technologies that may help to reduce the energy footprint. Europe needs programmes to **foster Entrepreneurship with private and public participation**, with an effort in GDP comparable to other markets, complemented with **tax policies for start-ups**, to avoid relocation of promising businesses because of tax savings.

The ultimate completion of 6G requires full interoperability between all entities on all levels, i.e., **global standards**. This would ensure an affordable and scalable 6G system that may be utilized worldwide. Effective standardisation requires sound regulation and governance, which in turn require a **common certification process**, taking into account the growing number of vendors that will develop for an ecosystem (across Europe), plus a **lean process** which would allow verticals to sell their services from anywhere to everywhere.

The deployment of services using new 6G capabilities and the emergence of millions of specialised and localised subnetworks **may require further clarification for what concerns the applicability of net neutrality rules and of the data protection regulation (ePD and GDPR)**, potentially adding a new dimension to the current scope of Net Neutrality. The **emergence of new European players should be supported**, and **sovereignty and security requirements shall be well identified and enforced**. AI-based sophisticated automation to deliver services in 6G networks will require additional regulations, based on **ethics principles that conform to European standards**. The Intellectual Property Regime (IPR) might need to be reconfirmed, taking into consideration the ongoing geopolitical trends.

To compete globally in 6G, **Europe needs a world-class competence pool** in communication protocols and software, virtualization and cloud, cybersecurity, microelectronics (at least in design), photonics, both in industry as well as in academia. Core skills in Science Technology Engineering and Maths and Social Sciences and Arts should be strengthened, as broader and cross-fields knowledge and therefore successful innovations will also benefit from diversity of thoughts. A Responsible Research and Innovation approach should be applied, fostering public engagement and ethics, along with a specific effort to increase the number of female technical experts.

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