Aligning EU Expectations with Global R&D Trends: Opportunities and Recommendations Towards a single global 6G Standard

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1. Background

As the successor to 5G, 6G is expected to bring revolutionary advancements in connectivity, data processing, and service delivery. The integration of artificial intelligence (AI), ultra-low latency communication, and high-efficiency spectrum usage will redefine the way societies and industries interact with digital technologies. The implications of 6G extend far beyond faster internet speeds; they encompass digital sovereignty, economic competitiveness, and environmental sustainability. Countries and regions are investing heavily in research and development to ensure they remain at the forefront of this technological transformation.

For the European Union (EU), 6G has strategic importance as it represents an opportunity to maintain leadership in global telecommunications and a necessity to ensure European digital autonomy in an increasingly interconnected and data-driven world. The EU is actively working to position itself as a key player in this transformation through the Smart Networks and Services Joint Undertaking (SNS-JU). This initiative brings together industry leaders, academic institutions, and policymakers to align research, development, and standardization efforts within a global 6G ecosystem. The SNS-JU aims to secure Europe's leadership in 6G by fostering innovation, supporting early-stage research, and ensuring that European technological priorities influence global 6G governance.

The SNS ICE project has contributed to this effort, ensuring that Europe's technological advancements and policy frameworks contribute to and benefit from global 6G standardization efforts. Through its active participation in global discussions over the last two years, SNS ICE has ensured that the EU's perspectives and regulatory frameworks are considered in shaping the technical and policy foundations of 6G. This policy brief summarises SNS ICE's efforts to bridge the gap between European stakeholders and international organisations, facilitating engagement, knowledge exchange, and strategic collaborations. It also provides a set of tailored recommendations for relevant stakeholder groups to nurture the collaborative ecosystem established over the last years with the aim of further spearheading developments and collaboration between Europe and other global regions.

2. Strengthening Europe's role in the global 6G ecosystem

As Europe firmly believes in the importance of global efforts towards achieving a single global 6G standard, it is essential to strengthen collaboration so that Europe can claim a key role in this evolving ecosystem. Enhancing European competitiveness in the 6G domain requires sustained investment in research, infrastructure, and international collaboration. European initiatives, such as the currently more than 78 SNS-JU Research and Innovation projects, have demonstrated the importance of collaborative research between industry and academia. These projects, involving major European telecom companies and research institutions, are pushing advancements in AI-driven networking and energy-efficient communication technologies. Additionally, investments in semiconductor production are crucial, given the role of specialised chips in enabling high-performance 6G networks. The European Chips Act aims to bolster domestic semiconductor production, reducing reliance on non-European suppliers and ensuring Europe's ability to develop critical network components.

Given the rapid advancements in 6G research worldwide, the EU must reinforce its leadership by focusing on three strategic actions: aligning global Key Performance Indicators (KPIs), establishing strong international partnerships through Memorandums of Understanding (MoUs) and maintaining active participation in global standardization efforts.

2.1 Aligning EU and global KPIs

Aligning global KPIs is essential to ensure that European technological priorities shape international benchmarks for 6G development. Some of the most crucial KPIs include ultra-low latency, energy efficiency, security, and spectrum efficiency. Ultra-low latency is critical for applications such as remote surgery, autonomous vehicles, and real-time industrial automation, where even milliseconds of delay can be detrimental. Energy efficiency is also a key priority, with research focusing on sustainable solutions like energy-harvesting networks, AI-driven power optimisation, and low-energy IoT devices to support Europe's environmental goals. Security remains a fundamental concern, particularly in the era of quantum computing, driving the need for post-quantum cryptography to mitigate emerging cyber threats. Additionally, spectrum efficiency is crucial for managing limited frequency resources, ensuring optimal use of bands to accommodate growing connectivity demands. Active participation in global frameworks such as ITU's IMT-2030 allows Europe to influence these KPIs, ensuring alignment with its technological strengths and policy objectives.

Beyond these KPIs, new and enhanced capabilities for IMT-2030 are shaping the future of 6G. ITU-R distinguishes between six new capabilities and nine enhancements of IMT-2020 standards[1], addressing evolving connectivity needs. Key new capabilities include improved coverage for low-power IoT and critical services, integration of sensing and communication (ISAC) for applications like biomedical imaging and disaster monitoring, and AI-driven network optimisation to handle increasing complexity. Sustainability is also a priority, with a broader focus on economic, societal, and environmental impacts. Additionally, 6G will enhance security, resilience, and reliability, with improvements in latency, connection density, and mobility support for high-speed transport. High-accuracy positioning (1-10 cm) will unlock new possibilities for industrial automation and smart environments. These advancements will enable seamless interoperability across technologies, ensuring a robust and future-proof global communication framework that balances innovation with sustainability and security.

1 Recommendation ITU-R M.2160-0, "Framework and overall objectives of the future development of IMT for 2030 and beyond", November 2023, https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2160-0-202311-I%21%21PDF-E.pdf

2.2 Memorandums of Understanding (MoUs)

Establishing strategic Memorandums of Understanding (MoUs) with key international partners is crucial for strengthening global cooperation in 6G research and technology development. The SNS-ICE project and 6G-IA have played a pivotal role in fostering agreements with major global organisations, ensuring alignment in research, standardization, and policy. Partnerships with the Next G Alliance in the United States focus on AI-driven networks and security protocols, while collaboration with Finland's 6G Flagship program emphasises sustainability and energy efficiency. Agreements with Japan's Beyond 5G Promotion Consortium and South Korea's IMT-2030 Promotion Group facilitate spectrum policy coordination and joint research initiatives, reinforcing a globally harmonised approach to 6G. Additionally, MoUs with Taiwan's TAICS and India's Bharat 6G Alliance contribute to the development of unified global standards, ensuring that research efforts in Europe are effectively integrated into broader international frameworks. These collaborations provide the foundation for cross-border technology trials, joint policy initiatives, and industry-wide standardization efforts, reinforcing Europe's leadership in shaping the future of 6G.

The growing network of MoUs highlights the momentum behind global cooperation in 6G development, expanding beyond traditional telecommunications research to include vertical industries, regulatory bodies, and public-private partnerships. Since 2022, a range of agreements has been established to promote interoperability and strengthen supply chains, covering areas such as secure telecommunications, AI-driven networks, and high-precision positioning. The SNS-ICE project and 6G-IA have also facilitated connections with organisations like ETSI, EIM, and 5G Automotive Association, ensuring that industry-specific requirements are embedded in 6G research. The ongoing alignment with global stakeholders enhances Europe's ability to influence strategic technology roadmaps while fostering a competitive, innovative, and secure 6G ecosystem. Through continuous collaboration, these MoUs support the advancement of cutting-edge technologies, drive regulatory alignment, and establish a shared vision for the next generation of communication networks.

2.3 Participation in global SDOs

» Participation in global standardization bodies is a cornerstone of Europe's 6G strategy. European institutions are actively involved in ITU, 3GPP, ETSI, and IEEE, where they contribute to defining global technical standards and regulatory frameworks. For example, the SNS Joint Undertaking and European national initiatives have strived to align with ITU-R timelines, ensuring regional influence. The ITU-R established a high-level timeline for IMT-2030, setting the foundation for future 6G standardization, with approval processes extending through 2023-2030. Key aspects include sub-Terahertz feasibility studies, performance requirements, and evaluation criteria, leading up to the World Radio Conference 2027, which will define critical frequency bands. The 3GPP is expected to initiate 6G studies in Release 20, with the first specifications likely in Release 21. Additionally, IEEE's WiFi 8 timeline aligns with early 6G deployments, focusing on ultra-high reliability and low latency for advanced applications. The EU is also playing a leading role in advocating for security-by-design principles within 3GPP, ensuring that future 6G networks incorporate robust encryption and threat mitigation strategies. Within ETSI, European researchers are shaping the future of AI-powered network management, developing frameworks that ensure transparency, fairness, and accountability in automated decision-making systems. These efforts ensure that Europe's commitment to privacy, security, and sustainability is reflected in the global 6G architecture.

3. Key technology areas for 6G convergence

To maintain European leadership in 6G, global convergence on key technological priorities and use cases is key to ensuring Europe is aligned with global research and development (R&D) trends and remains at the forefront of next-generation network innovation. As international competition intensifies and technological advancements accelerate a strategic focus on several critical domains is required to guarantee technological sovereignty, influence global 6G ecosystems, and ensure that future networks align with both economic priorities and societal needs.

- **Artificial intelligence**: AI is not just an added feature but is becoming a fundamental building block of 6G networks in the making. AI will drive network automation, optimisation, and adaptive security mechanisms while supporting fully service-based, cloud-native networking and RAN-Core convergence. However, there must be clear governance frameworks to ensure AI is developed and deployed in compliance with European privacy and security laws. Transparent and explainable AI models, alongside trustworthiness architectures, are needed to balance efficiency with ethical considerations, ensuring that AI-native intelligence supports not only technical efficiency but also societal needs.
- **Privacy and security**: such challenges must also be addressed, particularly with the development of quantum communications and post-quantum cryptographic systems. The advent of integrated sensing and communication (ISAC) capabilities in 6G networks introduces additional security concerns, requiring enhanced multilateral trust architectures to maintain data integrity and reliability. The security of cloud-based telecom infrastructure is another crucial concern, especially as the European telecommunications sector faces challenges related to reliance on non-European cloud providers. Ensuring the development of robust encryption protocols, access control mechanisms, and data governance strategies will be critical to preventing dependency and safeguarding Europe's technological sovereignty.
- **3C Networks**: the integration of telecommunications and cloud computing as a basis for Connected Collaborative Computing Networks (3C networks) will be a defining characteristic of 6G. The move toward a fully cloud-native telecom infrastructure will bring greater flexibility and scalability but also requires open and interoperable standards to prevent market fragmentation. Europe is taking significant steps toward establishing a resilient telco-cloud ecosystem, with initiatives such as IPCEI-CIS[2] and Cluster 4[3] aiming to reduce dependency on hyperscalers and ensure European competitiveness in cloud-based telecom solutions. Advancing edge computing solutions will be key to reducing latency and improving real-time processing capabilities, supporting innovative applications such as immersive reality and digital twins.
- **Sustainability**: sustainability is another pressing concern. 6G networks must be designed with energy efficiency in mind, requiring the adoption of new materials, optimised hardware, and intelligent power management systems. AI-driven energy optimisation, alongside cloud-native and distributed edge computing, will contribute to greener network operations by reducing unnecessary data transmission and enhancing resource allocation. The EU is well-positioned to lead in defining sustainability metrics, ensuring that global 6G deployment aligns with environmental goals, while European research and standardization efforts continue to set ambitious targets for energy efficiency.
- **Microelectronics**: semiconductors are a crucial element of 6G development. The ongoing challenges in semiconductor supply chains underscore the importance of establishing a resilient European manufacturing base. Investments in low-power, high-performance semiconductors will not only reduce dependency on non-European sources but also enable Europe to maintain leadership in telecommunications hardware innovation. The launch of the Front-End Module (FEM) initiative aims to develop key semiconductor components to support 6G's high-frequency bands, ensuring that Europe remains at the forefront of hardware innovation.

2 https://competition-policy.ec.europa.eu/state-aid/ipcei/approved-ipceis/cloud_en
3 https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/cluster-4-digital-industry-and-space_en

4. Policy Recommendations

Translating the above-mentioned priorities into concrete actions is fundamental to promoting the EU's 6G vision, strengthening its global competitiveness, and ensuring that European innovations shape the next-generation network landscape. Such attempts stem from a proactive and strategic approach to policy and other actions to foster international R&D collaborations, align stakeholders across academia, industry, and government and reinforce Europe's leadership in advanced telecommunications. This requires a multi-faceted effort to bridge regulatory initiatives, financial investments, and international cooperation to secure Europe's influence in 6G development and deployment.

Policymakers should prioritise enhancing European representation in global standardization bodies such as the International Telecommunication Union (ITU) and the 3rd Generation Partnership Project (3GPP)[4]. A strong presence in these organisations will allow Europe to shape the critical frameworks governing spectrum allocation, cybersecurity, and technical interoperability, ensuring that European interests are reflected in global 6G standards. Furthermore, **expanding funding mechanisms**—such as Horizon Europe, the Digital Europe Programme, and targeted public-private partnerships—will be crucial to sustaining long-term collaborative research initiatives. By increasing financial support for cutting-edge research, Europe can drive innovation in key areas such as AI-native networks, energy-efficient architectures, and advanced security protocols, positioning itself as a leader in 6G technologies. Additionally, **forging strategic partnerships with key international stakeholders through bilateral and multilateral agreements** will facilitate joint R&D programs, cross-border technology trials, and knowledge-sharing initiatives, reinforcing Europe's role in shaping the global 6G ecosystem.

Telecom companies should accelerate efforts to transition toward open and interoperable 6G networks, enabling more flexible and cost-effective network deployment . Participating in international testbeds and pilot programs will help validate 6G capabilities and ensure that European innovations can seamlessly integrate into diverse global markets. Moreover, **telecom operators should actively develop cloud-native and software-defined networking solutions that support the dynamic, decentralised nature of future networks**. By embracing virtualised infrastructure and edge computing, companies can ensure that Europe remains at the forefront of next-generation service provision, driving advancements in ultra-low latency applications, immersive communications, and AI-driven automation.

Research institutions play a crucial role in experimental validation and technological breakthroughs, particularly through the development of large-scale testbeds . These facilities should be leveraged to evaluate real-world performance metrics and optimise 6G technologies before large-scale commercialisation. **Collaboration between research institutions, industry players, and regulatory bodies must be further strengthened to align technological advancements with evolving policy frameworks**, ensuring that European innovations remain both competitive and compliant with global standards. Focus areas such as AI-driven network management, integrated sensing and communication (ISAC), and advanced encryption methodologies require dedicated research efforts to address the complex challenges posed by 6G networks. Additionally, **research institutions should actively contribute to policy discussions, providing expert insights that inform European and global governance structures**. Their advisory role will be crucial in balancing innovation with ethical considerations, data protection, and cybersecurity standards.

For SMEs and startups, access to funding, innovation hubs, and regulatory support is critical to fostering disruptive 6G technologies and enabling breakthrough solutions. Expanding programs that facilitate public-private partnerships, such as the Smart Networks and Services Joint Undertaking (SNS-JU) and national innovation grants, will provide emerging firms with the necessary resources to scale their technologies and commercialise their inventions. **Policymakers must also ensure that regulatory frameworks remain accessible and adaptable, enabling smaller companies to navigate compliance requirements without stifling innovation**. Establishing mentorship and incubation initiatives will further strengthen Europe's entrepreneurial ecosystem, ensuring that startups and SMEs play an active role in shaping the future of 6G. Europe can sustain long-term technological leadership and drive global advancements in next-generation networks by cultivating a thriving innovation landscape that supports new entrants.

4 Note for some standardization organizations like 3GPP the support for enhanced European participation should be focused on large industry players to ensure such funding actually has an impact.

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