Draft proposal for a

European Partnership under Horizon Europe

Smart Networks and Services

Version 30 June 2020

Summary

The European communication networking and services sector is proposing the Smart Networks and Services Partnership to secure European leadership in the development and deployment of next generation network technologies and services, while accelerating European industry digitization. It will position Europe as a lead market and positively impact the citizens' quality of life, while boosting the European data economy and contributing to ensure European sovereignty in critical supply chains.

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5G-IA and the Networld2020 European Technology Platform launched a Smart Networks and Services Task Force to prepare this Partnership proposal in Horizon Europe. AIOTI joined the Task Force. Additional contributors are from Cispe.cloud and the NESSI European Technology Platform. All these organizations appreciate the work of the Task Force and approved this report.

About this draft

In autumn 2019 the Commission services asked potential partners to further elaborate proposals for the candidate European Partnerships identified during the strategic planning of Horizon Europe. These proposals have been developed by potential partners based on common guidance and template, taking into account the initial concepts developed by the Commission and feedback received from Member States during early consultation[1]. The Commission Services have guided revisions during drafting to facilitate alignment with the overall EU political ambition and compliance with the criteria for Partnerships.

This document is a stable draft of the partnership proposal, released for the purpose of ensuring transparency of information on the current status of preparation (including on the process for developing the Strategic Research and Innovation Agenda). As such, it aims to contribute to further collaboration, synergies and alignment between partnership candidates, as well as more broadly with related R&I stakeholders in the EU, and beyond where relevant.

This informal document does not reflect the final views of the Commission, nor pre-empt the formal decision-making (comitology or legislative procedure) on the establishment of European Partnerships.

In the next steps of preparations, the Commission Services will further assess these proposals against the selection criteria for European Partnerships. The final decision on launching a Partnership will depend on progress in their preparation (incl. compliance with selection criteria) and the formal decisions on European Partnerships (linked with the adoption of Strategic Plan, work programmes, and legislative procedures, depending on the form). Key precondition is the existence of an agreed Strategic Research and Innovation Agenda / Roadmap. The launch of a Partnership is also conditional to partners signing up to final, commonly agreed objectives and committing the resources and investments needed from their side to achieve them.

The remaining issues will be addressed in the context of the development of the Strategic Research and Innovation Agendas/ Roadmaps, and as part of the overall policy (notably in the respective legal frameworks). In particular, it is important that all Partnerships further develop their framework of objectives. All Partnerships need to have a well-developed logical framework with concrete objectives and targets and with a set of Key Performance Indicators to monitor achievement of objectives and the resources that are invested.

Aspects related to implementation, programme design, monitoring and evaluation system will be streamlined and harmonised at a later stage across initiatives to ensure compliance with the implementation criteria, comparability across initiatives and to simplify the overall landscape.

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[1] https://www.era-learn.eu/documents/final_report_ms_partnerships.pdf

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1 Context, objectives, expected impacts

1.1 Context and problem definition

1.1.1 Introduction

In its Communication of 29 January 2020 on a cybersecurity toolbox, the European Commission has announced its intention to propose a European Partnership on 6G under Horizon Europe with industry stakeholders. This proposal is the industrial response to this call [1].

5G networks will revolutionize all aspects of our everyday life and will have a **significant impact in the worldwide economic development**, being an essential component of the digital transformation several horizontal and vertical industries are undergoing. As the President of the European Commission (EC), Mrs. Ursula von der Leyen, said [2] "*This digital transition is helping us to redesign our economy, make our industry more competitive and find new solutions to societal challenges. We have to make the most of the opportunities this creates while preserving the high privacy, security, safety and ethical standards that Europeans expect."*

5G networks have already laid the foundations for powerful transformations in the network infrastructures, to support a diverse set of advanced services and applications across different vertical market segments, including transportation.

The **European Research and Innovation (R&I) efforts have played a key role** so far in the design and development of 5G networks.

Commercial rollouts of 5G are only at their beginning since the first 5G releases. However, networks have followed an evolution cycle, from one generation to the next, that roughly lasts a decade. The same evolution is expected to take place for the next generation of networks. Already, related announcements, in other parts of the world, advocate such a development. Since the success of GSM networks, Europe has been at the forefront of the telecommunications' market. As the European Commissioner **Mr. Thierry Breton** [3] has recently said: "*Europe has everything it takes to lead the race in 5G*" and "*…without even waiting for the end of 5G roll-out, I want us to* ***start working on 6G, which will go even further in terms of bandwidth and speed****, with Terahertz frequencies".*

These principles have also been clearly reinforced by the Commission, in the "A Europe fit for the Digital Age" framework context as well as within the "European Green Deal" [4], [5] ambitious plans, where 5G networks have been recognized as one of the potential technology enablers to achieve the UN Sustainable Development Goals (SDGs) and maximize the impact of policies to deal with environmental issues.

According to the Digital Economy and Society Index [6], ubiquitous connectivity of high quality is one of the five main indicators for measuring Europe's digital performance and it is considered as one of the main social rights in the EU [7]. Under the connectivity objectives for the European Gigabit Society, by 2025 all European households need to have access to at least 100 Mbps (upgradable to Gbps) [8]. As highlighted in recent times when digital is not any more an option, but a necessity, **availability of high-speed, inclusive, ubiquitous and affordable networks is a necessary precondition for enabling remote work, access to education, health care and public services, as well as to a variety of online goods and services.** Also, such networks become an essential instrument to ensure open access to information for and communication among all citizens.

The **traffic in communication networks is currently growing exponentially** with about 50 % per year. This trend is forecasted to continue during at least the next 3 – 5 years [9], [10]. Video, augmented, and virtual reality applications are driving this traffic growth, which results in capacity challenges. Also, the Covid-19 crisis has proven the strategic importance of communication capacity, resiliency and availability for prolonged periods of time to provide continuous operation of our society during a far-reaching lockdown.

Next generation connectivity will revolutionize our lives in different dimensions. First, it will improve the efficiency of operation and optimize energy consumption in areas such as smart buildings, smart manufacturing, smart transportation etc. Second, it will improve all citizens quality of life in terms of assisted living, tele-working, online learning, availability of specialized services like tele-medicine or e-government. It is also a game changer for consumers and digital businesses alike. In many companies including innovative SMEs, it will allow for new business models, based less on selling items, but charging customers on how they use them through information gathering while respecting citizens' integrity and privacy.

The Next Generation Internet (NGI) initiative [11] has been envisioned by the EC to address these concerns with the ambition to ensure that the increased connectivity and the progressive adoption of advanced concepts and technologies, spanning across several domains, will ground the Internet of the future. Thus, more value will be delivered to the people as individuals and to the society overall.

The Goal of NGI is to develop a human-centric Internet that respects fundamental values of privacy, participation and diversity. Smart Networks and Services (SNS) has been conceived as the infrastructure pillar for the NGI vision to become a reality. This will take place by developing the set of concepts, technologies and solutions that are needed within the core principles and values of NGI, under the idea of human-centric technologies (e.g., secure, trustworthy, open, inclusive, etc.).

Although 5G networks offer undeniable improvements over legacy networks, **European research activities in the communication networking sector need to continue at an increased pace to further evolve these networks**.

In addition, the evolving geopolitical environment has highlighted the need to develop cybersecure infrastructures and to secure European sovereignty in critical technologies and systems [1]. Consequently, the SNS Partnership has been designed to address a strong European position on critical infrastructure supply chains (e.g. connectivity, cloud, data economy components and devices).

Several key challenges need to be addressed in a structured way to maximize the results. The following Subsections discuss in detail **why a new European Partnership is needed in the area of Smart Networks and Services**. Figure 1 presents the foreseen challenges and the expected impact of the SNS Partnership. How the SNS Partnership is planning to address these challenges is discussed in detail in Section 1.2.

Figure 1 Challenging areas for the SNS Partnership and expected impact

1.1.2 Full industrial digitization and support of vertical industries

Each successive generation of communication infrastructure goes beyond a simple increase in speed or performance, bringing unique new service capabilities. Especially the step from LTE to 5G is showing a paradigm shift by supporting vertical sectors. The full digitization of the industry, the necessity to integrate technological and business enablers, and mainly the need to address European and global challenges **across the full value chain** have created the basis for new research and innovation targets. Connectivity business models will need to adapt rapidly to this trend, offering new services over digital channels in several vertical domains stimulating strategic alliances with vertical sectors to build and offer powerful and persuasive B2B and B2C propositions. As explained in Section 1.1.4 the full digitization of the industry (a.k.a. vertical sectors) will bring significant financial benefits and ensure the competitive edge of EU industry.

Smart Networks and Services intends to empower several vertical domains such as smart buildings, smart manufacturing, smart transportation, healthcare, connected and automated mobility, media & entertainment, smart agriculture, public safety, smart cities, etc. Improving the operation of these sectors will assist in providing solutions for several SDGs as defined by the UN and further discussed in Section 1.1.3.

The **full digitization of the industry is years ahead**. In standardization, many verticals have not been thoroughly examined to identify key requirements under business viable scenarios. Moreover, current specifications cannot fully support all requirements, especially the more demanding ones. Therefore**, the evolution of network technologies requires strong collaboration with the vertical industries**. The telecommunication and IoT sectors need to cooperate to a) identify the variety of business models; b) identify specialized devices for e.g., industry automation, c) define appropriate and real-life requirements and d) validate that future networks can meet them. Also, this cooperation is needed to define the network to applications interfaces in a secure and trusted way [12]. Deploying and managing a large set of distributed devices with constrained capabilities is a complex task. Moreover, updating and maintaining devices deployed in the field is critical to keep the functionality and the security of the IoT systems. To achieve the full functionality expected of an IoT system, the partnership addresses relevant research, notably in advanced network reorganization and dynamic function assignment. It also addressed the provision of new device management techniques that are adapted to the evolving distributed architectures for IoT systems based on an open device management ecosystem.

Micro-electronic components and devices for IoT and vertical sector applications are essential elements of future secure and trusted networks and to support the digital autonomy of Europe. With respect to the increasing demand and expectation of secure and trusted networks, especially for critical infrastructures, the Partnership is committed to support the emergence of European providers for such devices as an additional source to latest technologies to complement the European value chain and mitigate the existing gaps. Micro-electronic components and devices for IoT and vertical sector applications are essential elements of future secure and trusted networks and to support the digital autonomy of Europe. With respect to the increasing demand and expectation of secure and trusted networks, especially for critical infrastructures, the Partnership is committed to support the emergence of European providers for such devices as an additional source to latest technologies to complement the European value chain and mitigate the existing gaps.

Problem Statement: Full industrial digitization is needed to empower all sectors of society and economy. This target is not yet fully achieved with 5G networks. A close collaboration among the communications and the vertical/IoT-industries is required to integrate business and technological enablers and support vertical domain applications. At the same time, independently of the addressed vertical sectors, the digital transformation is needed to open new business opportunities related to the provision of end-to-end cybersecurity and privacy services. Thus, in the next decade it will be decisive for Europe to develop lead markets to ensure its competitiveness at a global scale and keep the technology leadership.

The SNS Partnership will provide the nervous system of the future Human Centric Internet (B2C) and enabling the digital transformation of vertical industries (B2B).

1.1.3 Societal and political aspects

This section focuses on several social aspects, such as "A Europe fit for the Digital Age", the Green Deal, UN SDGs, digital autonomy and sovereignty, cybersecurity, competition as well the creation of high-skill jobs.

Green Deal and SNS Partnership objectives

The European Green Deal provides a roadmap for making the European economy sustainable by turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all [4]. While the main ambition is to ensure that Europe will be the first climate-neutral continent by 2050, the set of target objectives aims on developing and ensuring a *"new growth strategy to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use".*

For attaining the sustainability goals of the Green Deal in many different sectors, the EC has anticipated the need to invest on digital technologies such as **Artificial Intelligence, 5G, Internet of Things, cloud and edge computing**. Such technologies offer new opportunities for effective distance monitoring of air and water pollution, or for monitoring and optimising how energy and natural resources are used. At the same time, the Green Deal underlines also the need to investigate and invest in ICT technologies that are better sustainable (greener / more energy and climate friendly) by design.

In this respect, the SNS Partnership is committed to support the Green Deal goals (Annex 1) by acting on **reduction of energy consumption and carbon footprint** in two ways:

- Reducing the energy and carbon footprint of SNS platforms – see predictions in [13]
    - The subsector Green House Gas (GHG) percentage reduction between 2020 – 2030, outlined below are considered as a minimum target. The SNS partnership is committed to support such goals:
        - Mobile network operators 45 %
        - Fixed network operators 62 %
        - Data centre operators 53 %
    - Moreover, an important challenge is to elaborate how to increase the energy efficiency, compared to 1990 levels, in each sector, including the ICT sector, from a level of 20 % in 2020 to a level equal or higher than 32,5 % in 2030, [14].
- Reducing energy and carbon footprint, while increasing the energy efficiency within the vertical domains using SNS platforms. Studies that provide more insights on these footprints are described in [14], [15] and [16]. Again, the SNS Partnership is committed to develop solutions that will assist in this goal.

Sustainable Development Goals (SDGs)

The United Nations 2030 SDGs [17] are a key driver for future developments to address societal challenges globally. The SDGs and the environmental sustainability challenges call for new and evolved Smart Networks and Services capabilities, high-level requirements and demands in capacities that must be understood in a human-centric and societal context.

Smart cities and municipalities, smart mobility, smart eHealth and smart building solutions are examples of use case areas that can help mitigating societal challenges around an ageing population and increasing urbanization. Smart manufacturing and communication services can enable more distributed and decentralized production of physical goods. Together with smart mobility solutions new possibilities will emerge that can positively influence and lower the urbanization trend as well as result in reduced transportation and pollution.

There are challenges and opportunities within aquaculture, agriculture and waste handling for several verticals. These can be addressed by supporting further advancements across various areas of IoT. New sensor technologies and new connectivity means, new methods and techniques for life-cycle assessment can be enabled and supported to reduce the use of natural minerals and resources, reducing toxic waste and improve their handling, as well as reducing climate gas emissions.

Existing reports (e.g., [18]) explain how mobile networks are contributing to the economic growth and are addressing social challenges.

ITU has summarized the contributions of the ICT sector to work on the UN SDGs [19] as well as the investment in digital technology [20]. These ITU guidelines will be used to design the future SNS platforms for the efficient support of key UN SDGs as explained in Annex 2.

The Partnership is committed to support the most relevant SDG goals through a well-defined methodology (c.f., Annex 2). The Partnership is not aiming at addressing all SDGs but focus on the most relevant (e.g., SDG 2 (for smart agriculture), SDG 3 (for autonomous driving and increased healthcare), SDG 8 (e-commerce and cyber-trust); SDG 9 (universal and affordable access to the Internet); SDG 11 (solutions for smart cities); SDG 13 (ICT support for greener lifestyle and reduction of energy consumption in the ICT sector). Other SDG's (e.g., reduced inequalities, quality education, life below water and on land etc.) are indirectly supported through the enhanced application potential provided by the target SNS platform.

Target for digital autonomy, European technology sovereignty and securing EU infrastructures

The strategic digital autonomy of the European Union is a major concern with the rising of multiple threats and dependencies crossing both technical and socio-economic aspects [2]. For example, in 2017 the Wannacry attack demonstrated the vulnerability of today's infrastructures [21]. Our daily lives and economies will continue to be increasingly dependent on digital infrastructures and services. SNS will have to mitigate the continuously evolving threat landscape by:

- showing resilience, deterrence and cybersecurity protection capabilities,
- protecting democratic, ethic, human-centric approaches and
- ensuring the digital transformation without uncontrolled dependencies.

The strategic role of Smart Network and Services is obviously becoming crucial considering the convergence with operational technologies and the consequent dependencies of critical services. Operators of essential services such as energy, water, gas, transport, health, public safety, etc., need to rely on trustable networks and services.

As a result of the digital transformation, citizens and the digital economy, including vertical markets, will continue to develop a critical dependency upon evolved networks and their cybersecurity capabilities. Such capabilities go far beyond classical components (hardware and software) or product supply-chains, since digital infrastructure today relies on a combination of complex systems, services and enablers. This essentially translates into an unprecedented attack surface.

It has to be ensured that the Smart Networks and Services development will only depend on technologies which are compliant with EU specific policies (to protect citizens' data, i.e. GDPR [22], AI models based on biased data, Green Deal and energy efficiency, etc.). Thus, they should be independent from third parties, which may not share Europe's fundamental values and interests.

To counter threats intrinsically related to the technology, EC recommendations on Cybersecurity of 5G networks [23] will be considered. In particular the cybersecurity toolbox proposed by the Commission [1] targets reinforced security mechanisms and a diversified supply side. Considering that providers may be constrained by foreign agencies leading to disruptions in SNS access, Europe should be able to sustain its own critical components delivery and foster internal developments. Thus, it is needed to create an inventory of critical components, from hardware (SoC, chipsets, etc.) to software (Operating Systems,

virtualization, orchestration, etc.) and the required infrastructure (cables, Data Centres, etc.) and prioritize the needs and the actions. A strategic EU digital autonomy forecast may be considered as beneficial from an industry perspective. It should strengthen the value of the ICT industry to the highest standards, promoting competitiveness at a worldwide level. Digital autonomy and European technology sovereignty have as a main objective to achieve a framework of alternative European offers to support freedom of decision making by keeping free trade in a global competitive economy.

In that context, the Partnership is committed to research solutions to reinforce cybersecurity across complex connected systems taking and end to end perspective (device, connectivity, service platforms), to support the emergence of EU actors across this value chain and to support the cybersecurity toolbox objective of a diversified supply chain.

Social inclusiveness and creation of sustainable high-value jobs.

Smart Network and Services are key enablers for social inclusiveness. The evolution of vertical industries, the sustainable urbanization, the provision of smart and inclusive mobile systems, the enhancement of democratic governments and citizens participations are some of the key EC policies [24] that will rely heavily in the future in Smart Networks and Services.

Furthermore, this increased inclusiveness is expected to provide attractive and creative jobs, growth and prosperity for all European citizens. The development of SNS for the vertical sectors will also provide the demand for a significant number of high-skill jobs all over Europe during the next decade. The SNS partnership is committed to work with the academic sector in SNS projects and activities for skill development that will allow European actors to master the underpinning advanced technologies and to favour inclusion.

Problem statement: The 2030 vision, see e.g., [25] of the European industrial model is to successfully connect economic progress with major environmental and societal challenges. SNS can address these challenges but a full mobilization of the public and the private sector (e.g., telecommunications' manufacturers, operators, verticals) is needed to co-design and develop viable and effective solutions.

To deploy these solutions in several utilities and critical services it is crucial to ensure that the solutions will be fully secure and trustable. A key requirement to fulfil this goal is that digital autonomy and European technology sovereignty across the value chain will be achieved during the next decade.

This set of new services and applications, along with the full digitization of the vertical industries, will offer new opportunities for employment and growth.

The SNS Partnership will support the abovementioned challenges following dedicated roadmaps in the Strategic Research and Innovation Agenda (SRIA) to serve the ambitious European goals for a better society.

1.1.4 Business aspects - Europe's share on the global market

Smart Networks and Services provide energy-efficient, ubiquitous and high-performance network and computing infrastructures on which digital services can be developed and deployed, becoming the cornerstone of the Digital Economy and the Digital Single Market [26]. The benefits of the information-based economy depend on ubiquitous smart broadband connectivity. Beyond impact on vertical industries, it will have direct impact on European citizens and become comprehensive platforms for innovation. **A strong EU industrial leadership requires that end to end security and reliability of these infrastructures is also ensured, as mentioned in the previous section.**

Industries must take part and transform upon intelligent connectivity to unleash innovation and economic opportunities. According to [27], new business models, products, processes and services are emerging every day, accelerating growth towards a digital economy worth some US$ 23 trillion by 2025 and opening a new economic growth cycle.

Further, this digital economy has grown 2.5 times faster than global Gross Domestic Products (GDP) over the past 15 years [27].

The European ICT sector is operating a significant part of its research and development activities in Europe. These numbers do not consider the multiplication factor of advanced communications in the overall economy. As a matter of fact, ecosystems connected to digital platforms and marketplaces have the potential to disrupt entire industries and are having a significant impact in many other sectors of our society and economy. For example according to [28], the automation achievable by the IoT across a broad range of sectors is expected to lead to a potential economic impact in the range of $ 4 trillion to $ 11 trillion by 2025 (Figure 2). The number of connected IoT devices is expected to grow significantly to about 29 billion by 2022 [29].

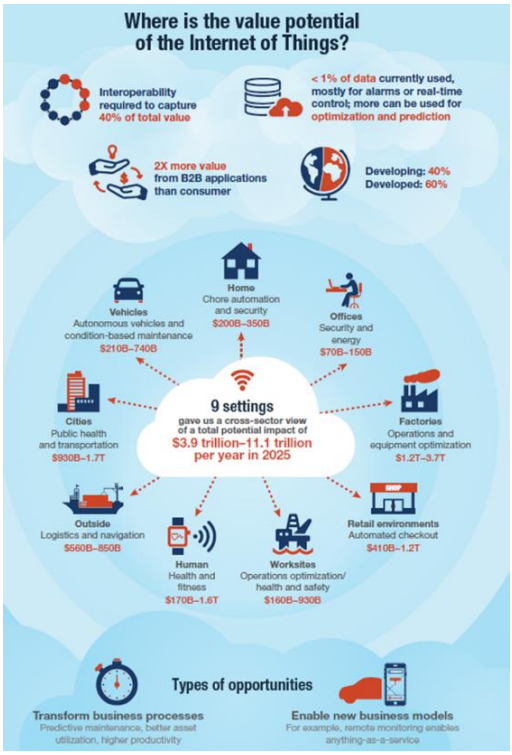


Figure 2 The value potential of IoT [28]

The Partnership will ensure that the knowledge and resources available in the EU are combined in a coordinated manner to build Europe's **future communication infrastructure ecosystem across all value chain segments.** The value chain for SNS is richer than that of 5G (c.f. Section 1.3.2). 5G is paving the way to new network and IT services, which will appear from now until 2030. These new services will enable the management, processing and routing of huge amounts of data, with different levels of criticality and/or complexity, owned by various players, collected from IoT devices or generated by communication systems over ubiquitous and multitenant infrastructures. The ultimate objective is to structure the value chain(s) in compliance with verticals players' requirements and the promotion of social, environmental and economic interests of EU citizens.

Smart Networks and Services, with its extended scope beyond telecommunications, will address a much larger market of the total European ICT employment. The addressable market and R&D expenditures are significantly higher than the figures before, as more and more industries rely on ICT and future networks for their digital transformation.

In Europe, the entire ICT domain contributes significantly to the economy with about 5 % of total GDP, which corresponds to a market size of 600 Billion €. This is also confirmed by findings of Eurostat [30]. In particular, the communication systems and networks sector [31]

(manufacturing, including communication equipment and telecommunications) is critical in this market with a strong contribution to the European economy:

- About 27.2 % (1.74 million employees) of ICT employment
- 37 % (234 Billion €) of ICT market size
- 47 % (15 Billion €) of R&D expenditure in Europe.

Specifically, for Europe, a fully functional Digital Single Market could contribute € 415 billion per year to the European GDP [32]. Moreover, considering that 1) digital technologies and processes are increasingly being adopted [33] and 2) the digitization of society is still in an early stage, (i.e., only 20 % of the companies in the EU 28 countries are highly digitized and there are still many opportunities to be exploited especially by SMEs [34]), the impact is expected to grow substantially.

According to an Accenture study [35], the economic opportunity from digitization in Europe is indeed over 4 Billion € in value per day. **For this to be realized, future networks must support platforms with much lower latency for access to mission-critical applications, enabled by edge computing and distributed allocation of data centres.** Openness is essential to support user driven innovation. Such a revised architecture would open opportunities for new entrants in the platform business also from Europe, which is currently significantly behind US and China. To open such new opportunities and to enable the infrastructure to support new businesses with vertical sectors, especially for mission-critical applications with high requirements on security, availability and reliability, well planned steps for **research**, **development and deployment of SNS are needed**.

The SNS partnership is committed to research and trial the needed architectures and technologies and to run pilot in various application domains in view of maximising economic impact.

Finally, European leadership in research and innovation is directly coupled to Europe's capabilities to be a lead market for advanced technologies. This is related to the fact that industrial R&I investments tend to relocate in the most advanced regions from a deployment perspective. To lead in SNS areas, Europe needs to deploy 5G at scale, as 5G may be seen as the SNS precursor. Today, 5G deployment is starting in Europe whilst 5G for verticals deployment is still a medium-term prospect. The 5G PPP has initiated early 5G testing of connected cars as a lead market using pan European corridors. SNS is committed to continue the support of such 5G lead use cases in line with the EU CCAM – Connected, Cooperative and Automated Mobility partnership. Strategic issues on selected activities under the CEF2 Programme will be discussed and prepared between the EU Commission, Member States and the private side under the umbrella of the SNS European Partnership (c.f. Annex 3).

Overall, the SNS partnership is committed to research and trial the needed architectures and technologies and to run pilots in various application domains in view of maximising economic impact.

Problem statement: The full industrial digitization and the support of emerging technologies will unleash innovation and economic opportunities. This is expected to have a significant impact on the European economy, and it will be a unique opportunity for European companies. To provide high-quality products and gain a significant share of the global market, the triggering of a well-thought collaboration among multiple stakeholders in several research and innovation activities is needed.

The SNS Partnership will mobilize those cross-sector pan-European forces to sustain and increase Europe's global market share through highly competitive products and services and to support innovation. The SNS Partnership will further support 5G deployment activities in selected geographical areas.

1.1.5 B5G systems design and support of emerging applications

Although the first Releases of 5G specification have been finalized and commercial products are available, **the evolution of these networks** is a continuous process that has a **significant impact on the provision of new services as well as on the telecommunications' market.**

The support of **emerging applications** (e.g., Internet of senses, holographic communications, full autonomous driving etc.) will require the improvement of the offered capabilities of B5G systems in terms of some **Key Performance Indicators (KPIs) by at least an order of magnitude**.

New innovations are closely related to social inclusion and personal wellbeing, as well as the digital transformation of industries and businesses. These changes will **require a flexible and programmable architecture to satisfy the large diversity of use cases and applications**. In addition, the next generation of networks beyond 5G will go from software-centric towards the concept of human-centric: considering human skills, activities and behaviours first, and using automated functions to support them. The benefits can include reduced risk, higher rates of compliance, enhanced management support and improved interaction with users. These new functionalities must come hand in hand with **advanced security and privacy schemes** to safeguard sensitive information for the users.

Additional modifications are also expected due to the requirements that will emerge through the **full digitization of the vertical industries.** Moreover, the operation of multiple logical networks (a.k.a. network slices) over the underlying network infrastructure supporting multiple vertical industries, will increase considerably the **complexity of the overall system**. **A new set of technological enablers has to be adopted by future communication systems**, such as advanced IoT solutions, Artificial Intelligence (AI), cloud & edge computing and cybersecurity. Meeting the performance KPIs, also requires a more extensive use of *high-performance distributed computing*. This way, data will be close enough to end devices to achieve almost zero latency (e.g., tactile Internet). Moreover, advancements in electronics and specialized hardware is also needed to reduce energy consumption and help meeting strict KPIs in terms of delay, throughput, etc. These enablers are the most promising solutions to tackle network complexity and help us meet the desired KPIs.

Furthermore, it is expected that new emerging applications based on tactile IoT, will be developed in the near future, see e.g., [36]. Examples of Emerging applications using tactile IoT, are described in [36]:

- Holographic media applications: Involve not only the local rendering of holograms but networking aspects, specifically the ability to transmit and stream holographic data from remote sites.
- Multi-Sense Networks: Include emerging applications that involve not only optical (video, holograms) and acoustic (audio) senses, but as well smell and taste senses.
- Time Engineered Applications: Use a communication system that can coordinate between different sources of information such that all the parties involved have synchronized views of the application.
- Critical Infrastructure support applications: Support of critical infrastructures that refer to those essential assets that are considered vital to the continued smooth functioning of the society as an integrated entity.

The SNS partnership is committed to undertake R&I in view of developing novel networking solutions and support new classes of applications currently not contemplated with existing network/IoT evolutions as foreseeing in the near future.

Problem statement: In order to support (1) emerging applications, (2) multiple logical networks, that will increase the network complexity, and (3) new business opportunities for vertical industries, communication networks must further evolve and adopt new technological enablers. Technologies like AI, distributed HPC, cloud and edge computing and cybersecurity, should be used in an integrated way that will bring technology-led

transformations across all European industries, including the telecommunication sector, creating new opportunities and benefits for key industrial sectors.

Performing pioneering research and innovation activities in these domains is one of the main objectives for the SNS Partnership.

1.1.6 SWOT analysis for Europe and proposed strategy for the SNS Partnership

As mentioned above, the SNS architecture will be increasingly driven by software, AI, cloud storage and platform-based services. Europe is strong in the design, manufacturing and integration of complex systems in many different industries including the telecommunications' sector. However, the paradigm shift to new network architectures provides many challenges, where Europe is not as well prepared as in other technological areas. For example, Europe is currently not so strong in cloud services, platform-based services and the manufacturing of components.

The SWOT analysis in Table 1, clearly shows that Europe is currently in a privileged position by having a number of strengths such as a) two out of the main four major telecommunication vendors and three world-wide satellite operators, b) a very strong vertical industry that is ready for the full digitization, c) highly skilled personnel, and d) a worldwide acceptance for considering high standards for privacy and security. At the same time, Europe is lagging in terms of cloud platforms, end devices and micro-electronics in the communications domain. Also, deployment of networks in Europe are taking place in much slower pace compared to other world regions. It is a big opportunity for Europe to mobilize its ICT sector and provide full digitization for the public and the private sector. Several weaknesses can hence be tackled through appropriate measures (e.g., targeted research and innovation calls, implementing large scale trials etc.). The current socio economic and geopolitical changes combined with new technological opportunities (IoT, edge computing, network softwarisation) open great opportunities for Europe to address these weaknesses through a combined public-private effort, mobilising a wide range of stakeholders and justified by the magnitude and impacts of issues at stake. The aim is to provide a European alternative offer providing solutions in this field.

Strengths	**Weaknesses**
• Investment grade regulation (EECC) • Two out of three of major telecommunication communication systems vendors • Wide manufacturing industry • Vertical industry ready for adoption • Privacy regulation (GDPR) now a worldwide benchmark • High awareness of network security issues • Strong research ecosystem in industry, R&D centres and universities • Highly skilled personal in ICT (incl. wireless, network, AI, IoT, etc.) and many vertical sectors • Growing footprint of 4G/5G coverage and penetration • In some EU countries strong start-up scene • Research Programmes for cooperation among different stakeholders • 3 world-wide satellite operators are based in Europe • High number of telecom operators per country ensures competition	• Regulation not clearly oriented to data economy compared to US and Asia (e.g., latest draft of the ePrivacy Directive makes it difficult for network operators to process personal data) • Fragmented European market and regulatory environment • Lack of strong European Cloud providers • Lack of highly reliable, secure, intelligent, flexible and open multi-service Internet • Lack of a platform industry in Europe • Weak European industry in the micro- and nanoelectronics industry (components) • No European mass market devices industry • Weak European IT industry • Lack of investment in newest technology • Slow and delayed deployment of newest technology compared to other regions • Less skilled personnel in computer science and software technology
Opportunities	**Threats**
• Smart connectivity and network services supporting all types of applications, enabling innovation in advance application services	• EU unable to keep pace with US and Asia economies which will be largely AI driven in the next decade (now largely data driven)

• Strong SNS driven enablement for digital transformation of industry/verticals and public sectors • Create a data driven economy for automation of industry by distributed computing • Unfolding of a data driven economy in the EU with EU data (over 500 Million population under coverage), reap full benefit of AI on EU data • Need to boost data driven public policies (e.g., Data for Smart Mobility and SDGs), consolidate Verticals digital transformation • Enhanced dependency on micro- and nanoelectronics industry to improve supply chains for communication and computing components • Arrival of new range of connected devices (IoT) opening device industrial opportunities for Europe • European values and ethical principles to improve security and user-controlled privacy as drivers of innovation, which is becoming attractive also for other regions • A strong European drive for advanced use of smart network and communication solutions for the mitigation of climate change and other societal challenges (e.g., aging population, urbanization, EMF etc.) • Emergence of new computing paradigms like fog, edge and core cloud processing under European data security law and secure communication networks providing end-to-end security for applications • Explosion of content generated by industry but end users that need to be forwarded • Enhance public safety through advanced communications and by building the link between IoT and emergency communications	• Benefits of EU data leveraged outside EU by non-European players. Verticals and SMEs may lose competitiveness • Single stakeholder platform industry from outside of Europe dominates markets and business models • The industrial value chains increasingly rely on digital infrastructure that is susceptible to be hacked or sabotaged. The EU's high reliance on imports and technology can expose it to supply chain disruptions penetrating its critical infrastructure [37] • Foreign companies (largely) controlling European data networks (because of equipment and/or operation) • High number of telecom operators across Europe creates a fragmented digital market [38]

Table 1 SWOT analysis of European ICT sector

The SNS partnership strategy targets reinforced EU strengths through leveraging of opportunities and in view of minimising the risks.

A core industrial target is to support the emergence of a European offer covering the key aspects of the SNS value chain and encompassing connected devices, connectivity infrastructure, and service delivery platform. It builds on EU strongholds in connectivity to stimulate EU capabilities in the related domains.

Four main activities are supporting these objectives:

1. Mobilize the European verticals' sector towards full digitization and stimulate cooperation within the ICT sector. This requires the elaboration of **a long-term SRIA** agreed by all actors driving subsequent projects. It covers the full life cycle from early R&I, proof of concepts, to pilots and full-scale trials as presented in Section 2.1 (c.f., Section 2.1.1 Streams C and D). This collaboration would be difficult to achieve at the desired scale outside such a Partnership.
2. Keep up the pace in the mid-term evolution and deployment of 5G networks under the CEF2 Programme while also research revolutionary and disruptive technologies for the long-term advancements of telecommunication networks and system (c.f., Section 2.1.1 Streams A and B). This is important for EU industries as EU projects in these areas are used for long time to agree future trends and reach consensus among global players as preparation for future global standards and economic exploitation.
3. Integrate new technologies and enablers into the telecommunication systems that will provide new capabilities and allow them to tackle the envisioned complexity, improve

the performance of control and management functions. As the SNS Partnership will perform its own specific research for these enablers (e.g., AI, HPC, cybersecurity etc.) links will be planned with related partnerships and associations (c.f., Section 2.1.2)

4. Support cross-national coherence and synergies with different national research and innovation activities to maximize synergies and leverage existing national developments, e.g. platforms and Digital Innovation Hubs (c.f., Section 2.1.4).

1.1.7 Building on the 5G PPP organization and achievements

The SNS Partnership proposal is building upon the successful operation of the 5G Infrastructure Public Private Partnership (5G PPP) Programme. This Programme has provided significant achievements [39] such as:

- **Measurable Programme Key Performance Indicators (KPIs)** (e.g., contributions by the private side and a leverage of 10, 12 times the EC investment for large industry and SMEs, a significant participation of SMEs (~20% of beneficiaries), an increase of new jobs/skills for all participating entities, a significant impact in the yearly turnover (10.1%) and yearly revenues (11.9%) for the participating SMEs, addressing all technical KPIs etc.).
- **Large number of technical achievements** (i.e., 15 key technical achievements of Phase 1 projects [40] and 60 highlighted technological results for Phase II projects [41].
- **Multiple technical contributions to standardization bodies** (i.e., 611 contributions until September 2019).
- **Widespread dissemination and promotion of European achievements** (e.g., organization of / participation in many global events and over 800 publications in journals and conferences(September 2019), 24 cross 5G PPP white papers [42]) and the
- **Provision of key roadmaps** (e.g., Trials Roadmap Version 4.0 [43]). The 5G PPP has created 5G technology leadership for the European industry through the hard work of 5G PPP projects, Working Groups, and Task Forces.
- **Preparing Europe for deployment:** moving from initial research activities to large scale trials and testbeds while getting closer to market applications. This has also created **wide awareness of 5G across EU Member States** in view of preparing for their spectrum licensing policies.
- **Involvement in multiple vertical industries** from concepts to large scale trials [44], [45] as captured in the verticals cartography [46].
- **The overall mobilization of the scientific community** (universities and research centres) in Europe as well as the business sector (large industries and SMEs) contributed to a great deal of European know-how that secured **a major share of 5G contracts worldwide**.

This 5G PPP Programme has been instrumental to support 5G development and deployments across Europe, to build EU industrial capabilities and to promote pan-European synergies and engagement of several SMEs.

Although several achievements have been accomplished, many challenges remain. The changing nature of the policy environment requires a fresh approach to critical SNS technologies and infrastructures to address industrial sovereignty, new societal issues and economic opportunities. It requires in particular a wider mobilisation of stakeholders and a better connection with the developments at Member States level to optimize efficiency of public investments.

A well-structured plan, as described in the following sections, will support Europe to fulfil the ambitious business and societal objectives it has set for the next decade.

1.2 Common vision, objectives and expected impacts

The SNS partnership ambition to address the problem statements as described in Section 1.1 is fully aligned with key **policy objectives** of the strategic planning for **Horizon Europe** [24]. The vision is based on the socio-economic evolution of SNS platforms which are becoming critical infrastructure for the economy, on the need to retain technological leadership in Europe and on the need to address societal concerns. The corresponding objectives include:

- ensuring EU competitive edge and sovereignty of the EU industry through a value chain approach covering EU technological capabilities in devices (IoT), networks and service platforms (edge computing);
- Supporting large scale digitisation of EU industry through SNS platforms covering the most demanding use cases;
- Supporting the emergence of new classes of applications, opening new economic opportunities;
- Addressing societal needs, notably as outlined in the Green Deal and SDG's;
- Supporting European access and inclusion to new high skilled jobs;
- Promoting Europe as a lead market for specific use cases (focus on automotive to leverage CEF2 activities).

1.2.1 General, specific and operational objectives

A key goal of the SNS Partnership is to define and implement the research, innovation and deployment roadmaps that will enable Europe to lead in the creation of the next generation of smart network technologies and services. These will be designed and implemented in such a way that European values like security and privacy are safeguarded and European technological sovereignty is further strengthened. The Partnership will also focus on the full digitization of European society including vertical industries and public administration. Thereby, the SNS Partnership targets to have a positive impact on the quality of life for European citizens and boost the European data economy.

This goal will be achieved by supporting the development and uptake of a wide range of technologies (AI, blockchain, IoT, etc.) and services (personalized access to information, services and media, everything-as-a-service, etc.) across all sectors of our society. The aim is to address important social, economic and environmental challenges with independence and technology sovereignty. Overall, the ambition is to create a more inclusive, open and participatory society centred on the citizens' needs, both as individuals and as organizations (private and public ones), minimize the digital divide and reduce inequalities.

To this purpose the SNS Partnership will:

- Create an appropriate environment for successful R&D&I activities to flourish and grow, reaching out to all key players in all Member States and Associated Countries.
- Mobilize the relevant stakeholders across the value chain.
- Stimulate operational collaborations with related initiatives.
- Define common operational roadmap across stakeholders based on SRIA cross interests, which will be available in June 2020.
- Design and verify an overall framework where novel smart network and services solutions will be combined with state-of-the-art AI mechanisms and advanced security schemes that will operate in high-performance distributed computing facilities, including tighter integration and operation of IoT devices and services.
- Support exploitation of R&I results, dissemination and downstream deployment.
- Based on the SRIA, develop a strategy, in collaboration with the EU and stakeholders of related enabling technologies, to address current European industrial and market shortcomings (c.f. Table 1) and to create new opportunities for European ICT and verticals industries.

- Provide and enforce a governance model, which supports the goals of openness, transparency and representativeness, while ensuring efficient management with minimized overhead.
- Support an efficient coordination and information flow between R&D&I projects by respecting the interests of all the partners regarding confidentiality and access rights.
- Ensure programme effectiveness, agility and adaptation according to research needs and an appropriate impact assessment, including societal and human factors.
- Incorporate EC policy requirements, reflecting public interest during the implementation of the Partnership.

The following key objectives are proposed to address the problem statements presented in Section 1.1. To meet these objectives, the activities described in Section 2.1 are based on planning assumptions analysed in Section 2.2. The implementation of the objectives and activities agreed in the SRIA will be reviewed and adapted with the stakeholders during the lifetime of the partnership.

1.2.1.1 Objective 1 – Full industry digitization and support of vertical industries

General Objective:

1. To provide and validate (in trials and pilots) the enablers and solutions for full digitization of the European vertical industries in order to improve the business operation.

Specific Objective (by 2030):

1. Identify those vertical sectors and understand their specific needs that will benefit most from the full digitization.
2. Mobilize the multi-disciplinary stakeholders to create efficient and high-quality solutions.
3. Ensure the adoption and deployment of these solutions.

Operational Objectives:

1. Identify at least 10 vertical sectors, that can benefit from Smart Networks and Services, starting from vertical sectors that have shown promising results in Horizon 2020. An indicative first list includes: Industry 4.0, agriculture, automotive, transport and logistics, smart cities, public safety, energy, eHealth, media and entertainment and smart (air)ports.
2. Create the appropriate collaboration environments among multiple stakeholders (i.e., telecommunication manufacturers, operators, vertical industries, academics etc.) to identify real life requirements and needs.
3. Establish MoUs with relevant international initiatives.
4. Develop and validate solutions that reduce OPEX for the selected vertical sectors.
5. Organize open calls for project proposals that will provide the design of PoCs, demos and large-scale trials and will cover the operational needs for at least 10 selected vertical sectors.
6. Analyse and understand the results produced by the large-scale trials and revisit verticals' requirements and needs.
7. Disseminate the results in a structured way to maximize the deployment and adoption of these solutions (e.g., via a close collaboration with DIHs in the Digital Europe Programme, CEF2 and relevant European Partnerships i.e., CCAM).
8. Support related standardisation and ad-hoc regulation

1.2.1.2 Objective 2 – Societal and political aspects

General Objective:

To foster the development and adoption of technologies and solutions that will help to address societal challenges that can directly or indirectly contribute to

1. Achieve EU Green Deal's targets and United Nations SDGs' goals.
2. Enable Europe to reach digital autonomy and technology sovereignty.
3. Ensure that digitization of our society will be done in a secure way to retain Europe's leading position in trust and privacy.
4. Create high-skill jobs and social inclusive technologies.

Specific Objectives (by 2030):

1. Identify those verticals that will have a significant positive impact to the Green Deal objectives.
2. Design and validate specific SNS solutions that will achieve the desired levels of energy reduction for these verticals.
3. Design and validate ICT building blocks that can be used to achieve one or more United Nations' SDGs.
4. Ensure that Europe will be self-sustained in key technological sectors, including the value chain considered for SNS [1].
5. Provide advanced end to end cyber security solutions considering among others, the support of highly critical services and infrastructures and the privacy of the end users.
6. Link SNS technological directions to social inclusiveness and the creation of high-skill jobs via the digitization of vertical industries and the support of emerging applications.

Operational Objectives:

1. Reduction of the subsector GHG percentage between 2020 – 2030, should according to [13] be:
   - Mobile network operators: 45 %
   - Fixed network operators 62 %
   - Data centre operators 53 %
2. Reduction of energy footprint of SNS platforms by increasing the energy efficiency, compared to 1990 levels, in each sector, including the ICT sector, from a level of 20 % in 2020, to a level equal or higher than 32,5 % in 2030, if operators manage to deploy the new solutions by the end the SNS Partnership.
3. Reduction of GHG emissions, compared to 1990 levels [14], from a level of 20 % in 2020 to a level equal or higher than 40 % in 2030, if verticals adopt the SNS solutions.
4. Follow ITU's methodology [20] to identify ICT building blocks that will be used to meet goals set by at least 5 different UN's SDGs.
5. Provide solutions that have the potential to stimulate viable technological alternatives for at least 4 sectors (e.g., micro-electronics, specialized devices, data economy and cloud) where EU is currently dependent on other regions. This will also include stimulation of the presence of EU actors in open source activities.
6. Provide solutions that reduce electromagnetic field (EMF) exposure to citizen.
7. Provide solution that will access availability to real time Cyber Threat Intelligence information (attacks/threats and vulnerabilities).
8. Develop risk analysis tools and services enabling 100 % of awareness and level-based appropriate protection counter-measure deployment.
9. Build a framework that will build trust in ICT infrastructure through systematic exposure of cybersecurity levels 100 % compliant with the European-legal basis (certification, Security Service Level attributes, GDPR/EU strategy for Data, etc.).
10. Address highly critical applications and essential services requirements leading to sovereign solutions able to provide 100 % availability of services for verticals.
11. Improve attack detection and response mean time of Cybersecurity incidents including zero % unprotected data leakage.
12. Provide solutions for disaster relief.

13. Create applications and services that promote social inclusiveness.

1.2.1.3 Objective 3 – Business aspects – Europe's share on the global market

General Objective:

1. To ensure European leadership in the ICT sector and mobilize cross-disciplinary private sector forces to build solutions that will improve the operation of European vertical industries.

Specific Objectives (by 2030):

1. Produce high-quality results (scientific, IPRs, standards contributions, trials, etc.) that will have a global impact.
2. Mobilize the private sector to invest in key technologies and become engaged in multiple additional activities.
3. Create an environment which allows the easy setup of multi-disciplinary and cross-sectoral consortia (i.e., verticals, stakeholders from the telecom sector, academia, etc.).
4. Strengthen the participation of SMEs in R&I activities.
5. Strengthen verticals deployment perspectives in Europe.

Operational Objectives:

1. Reach more than 15 % in declared 5G and B5G patent families (granted and non-granted) by European based HQ companies.
2. Reach a patent grant rate of more than 60 % for European based HQ companies.
3. Provide contributions to more than 1000 contributions in SDOs.
4. Provide more than 1000 publications in international journals and conferences.
5. Organize more than 25 workshops and more than 100 webinars.
6. Target the organization of large-scale trials where synergies among multi-disciplinary stakeholders can be achieved.
7. Ensure commitments from the partner (i.e., respective Association) to collectively mobilize additional resources to further support the objectives of the SNS Partnership and develop synergies with relevant national, regional and EU programmes and investments.
8. Organize additional activities that will have multiplier effects (c.f. Section 2.2).
9. Secure commitment from the private sector on financial and/or in-kind contributions.
10. Ensure that SMEs reach an overall share of 20 % of funding in R&I projects.
11. Increase the turnover for each participating SME in R&I project.
12. Define and regularly update the Strategic Deployment Agenda (SDA) for CEF2 (c.f., Annex 3).
13. Establish clear links with the CCAM Partnership and exchange technical information that will address topics related to connected and automated mobility potentially by open calls.

1.2.1.4 Objective 4 – B5G Systems design and support of emerging applications

General Objective:

1. To research, develop and validate the next generation of telecommunications networks and support emerging services, while enabling networks to efficiently support any service to be provisioned under all relevant environments.

Specific Objectives (by 2030):

1. Integrate key technological enablers in future networks (i.e., IoT, AI, distributed HPC, cloud and edge computing and cybersecurity).
2. Based on the SRIA, develop a coherent long-term research framework and roadmap to identify priorities and main challenges to be addressed to build future networks' critical building blocks.

3. Evaluate and validate novel solutions and mechanism in appropriate large-scale trials.
4. Bring key developed solutions to relevant standardization fora.

Operational Objectives:

1. Identify the requirements from the emerging services and their impact on future networks
2. Design and validate network enhancements to support emerging services.
3. Identify network complexity issues that require the use and integration of key technological enablers.
4. Provide architectural solutions to accommodate those enablers and to address these issues (AI, HPC, IoT etc.).
5. Develop and implement common agendas, where appropriate, with key initiatives, notably KDT, Cybersecurity and CCAM.
6. Validate their performance through PoCs, pilots and large-scale trials.
7. Provide requirements and receive feedback and guidance from partnerships and associations focusing specifically on these enablers through workshops and Impact Assessment and Facilitation Actions (IAFAs – c.f. Section 2.1.1).
8. Reduce service creation time from 90 minutes to 9 minutes.
9. Contribute significant advancements on network architectures and capabilities such as:
    - Significant improvement of the network KPIs (c.f. Annex 4).
    - Minimization of the necessary radiated RF power close to physical limits.
    - Provision of more efficient network management solutions without human interaction.
    - Further improvement of energy efficiency compared to 5G 3GPP Releases 16 and 17.

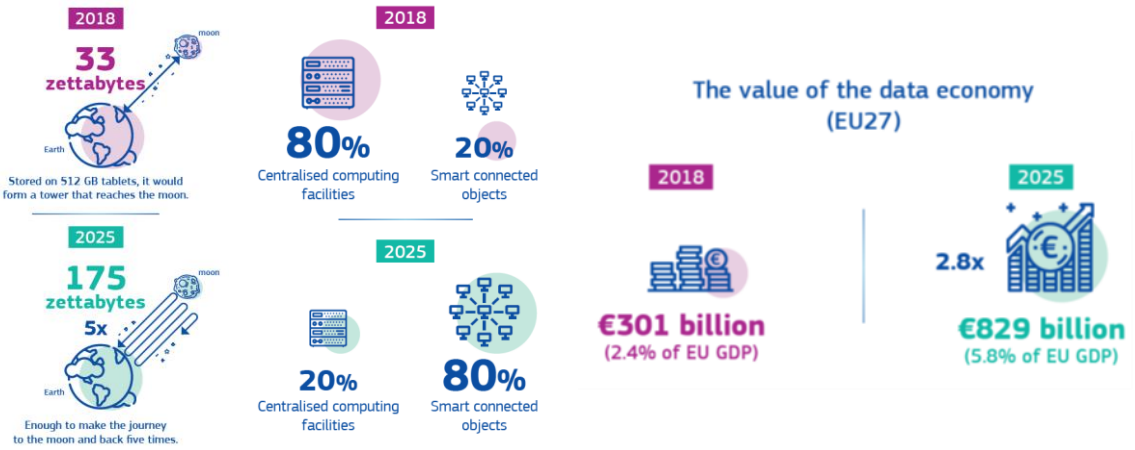
The overall monitoring framework for the Partnership will be aligned with the requirements of European Partnerships under Horizon Europe [47], [48]. Potential technical KPIs are currently under discussion mainly in the scientific community with respect to the envisaged usage of future systems, cost implications, business cases and technical feasibility. For the time being no KPIs are agreed for the evolution of current communication systems. Annex 4, [49] and [50] show an example, which presents a suggestion for network KPIs for the short-, medium- and long-term evolution of 5G. Such KPIs are under investigation and need to fit to requirements of industry and will be regularly updated based on state-of-the art findings. The SNS Partnership will establish a Specification Group to discuss and agree KPIs of future systems and will push them towards international organizations like ITU-R, NGMN and GSMA, 5GAA, 5GACIA, etc. Also, it will provide a clear roadmap based on the SRIA setting concrete milestones on when these achievements will be met.

ITU-R WP5D started in February 2020 a “Technology Trend Report”, which should lead to an update of the “IMT Visions” Recommendation for systems beyond 5G including globally accepted technical KPIs. WP5D intends to start the work on the IMT Vision Recommendation in June 2021 which should be finalized and approved prior to WRC 2023. This timing fits very well to the SNS Partnership to actively contribute to build global consensus on this topic.

1.2.2 Common vision and ambition

1.2.2.1 Full industry digitization and support of vertical industries

The European Commission has released its **Digital Strategy** package addressing a new **Data Strategy**, a **Whitepaper on Artificial Intelligence** and the overall democratization of digital technologies ([51], [52], [53]). Data will have an impressive growth untapping new opportunities when processed by Artificial Intelligence systems while data processing will suffer a paradigm shift reversing the 80/20 proportion between cloud and distributed edge devices in the next coming years (Figure 3).



a) Worldwide Web Data b) Data Processing c) Data Economy

Figure 3 Elements of the Digital Strategy, [51] to [53]

Industries need to transform their processes and business models based on Intelligent Connectivity to unleash innovation and economic opportunities. New business models, products, processes and services are emerging every day, accelerating growth towards a digital economy worth some US$ 23 trillion by 2025 and opening a new economic growth cycle. Further, this digital economy has grown 2.5 times faster than the global Gross Domestic Products (GDP) over the past 15 years [27]. Moreover, ecosystems and vertical industries connected to digital platforms and marketplaces have the potential to disrupt entire industries and are having a significant impact in many other sectors of our society and economy. For example, the automation achievable by IoT across a broad range of sectors is expected to lead to a potential economic impact in the range of $ 4 trillion to $ 11 trillion by 2025 [28]. The number of connected IoT devices is expected to grow significantly to about 29 billion by 2022 (Figure 4, [29]).

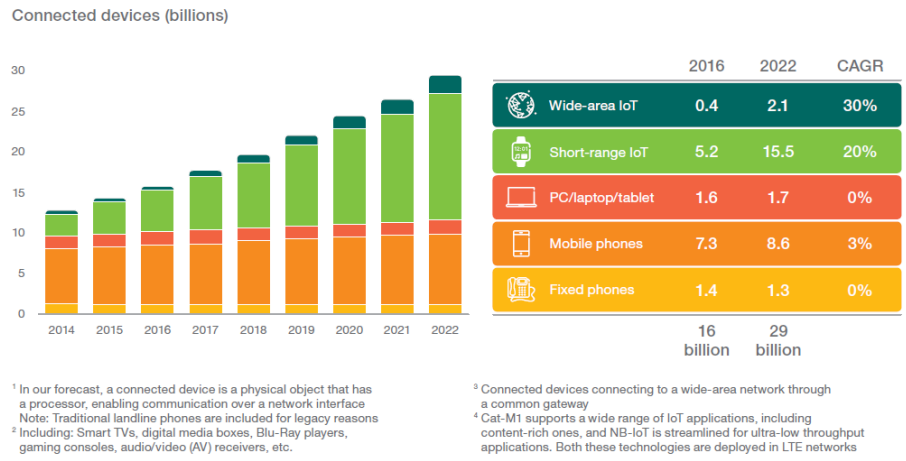


Figure 4 Connected IoT devices [29]

Europe wants to take the lead on Digital Economy leveraging the huge potential of industrial data for B2B and B2C applications and its world class regulatory environment on data protection based on the **Digital Strategy** package ([51], [52], [53]). The European Data Strategy will address issues, such as data availability, imbalances of market powers to access data, data quality and interoperability, data governance and cloud infrastructures, poor data skills and literacy, a cybersecurity framework to be refocused on edge rather than cloud, to create a trusted EU data single market and will be based on the following horizontal pillars:

1) **A Cross sectorial governance framework to access and use data**, 2) **Investments in data infrastructures and capabilities** and 3) **Competences – Empowering Individuals,**

investing in skills and SMEs. Along with the aforementioned horizontal measures the EU Data Strategy is envisaging common data spaces in strategic vertical sectors and the public domain. In this context, the European Commission intends to fund the **establishment of EU-wide common, interoperable data spaces** in strategic sectors, which are: 1) industrial (manufacturing) data space, 2) Green Deal data space, 3) mobility data space, 4) health data space, 5) financial data space, 6) energy data space, 7) agriculture data space, 8) data spaces for public administration, and 9) skills data space.

The SNS Partnership **will support the EU Digital Strategy** by providing Europe with an independent service delivery platform for cloud and edge devices. The digital transformation will be supported by end-to-end cybersecurity and privacy services. Overall, the SNS Partnership will prepare for the nervous system of the future Human Centric Internet and other complementary networks. Furthermore, the SNS Partnership is planning to support at least 10 vertical industries that can benefit from full digitization. Such solutions need to integrate business data and technological enablers to support the future vertical domain applications requirements.

1.2.2.2 Societal and political aspects

The challenges are further analysed below.

Green Deal and SNS Partnership objectives

On 11 October 2019, the European Commission published the European Green Deal [4] presenting a list of actions to be taken [54] aimed at driving Europe to reach net-zero global warming emissions by 2050. The goal of the European Green Deal is to improve the well-being of people by making Europe climate-neutral and protecting Europe's natural habitat for the benefit of people, planet and economy.

Joint efforts across Partnership extensive value chains on "climate-proofing, resilience building, prevention and preparedness" are fully recognized as crucial. The collective efforts, risk management and mitigation will affect all the stakeholders, public and private sectors across the EU, including investors, insurers, businesses, cities and citizens. Topics like connectivity, edge computing, IoT devices, energy efficient end-to-end platforms, massive photonics, AI, e2e security, privacy solutions will need to be mobilized and deployed to support the climate neutral' Europe objectives. The following overview is linking the SNS Partnership focus areas and Green Deal set goals. The Green Deal areas consist of 1) Climate neutral Europe, 2) Sustainable industry and Circular economy, 3) Buildings renovation and retrofitting, 4) Eliminating pollution, 5) Ecosystems and biodiversity, 6) Farm to fork strategy, and 7) Sustainable mobility. A more detailed description is provided in Annex 1.

The European Green Deal targets for EU are:

- reach climate neutrality by 2050,
- protect human life, animals and plants by cutting pollution,
- help become world leaders in clean products and technologies and
- help ensure a just and inclusive transition.

Some of the reasons for motivating the initiation of the European Green Deal are [55]:

- 93 % of Europeans see a climate change as a serious problem.
- 93 % of Europeans have taken at least one action to tackle climate change.
- 79 % agree that acting on climate change will lead to innovation.

Some of the European Green Deal priorities are analysed in Figure 5 and reflected upon within the scope of the SNS Partnership expected impact.

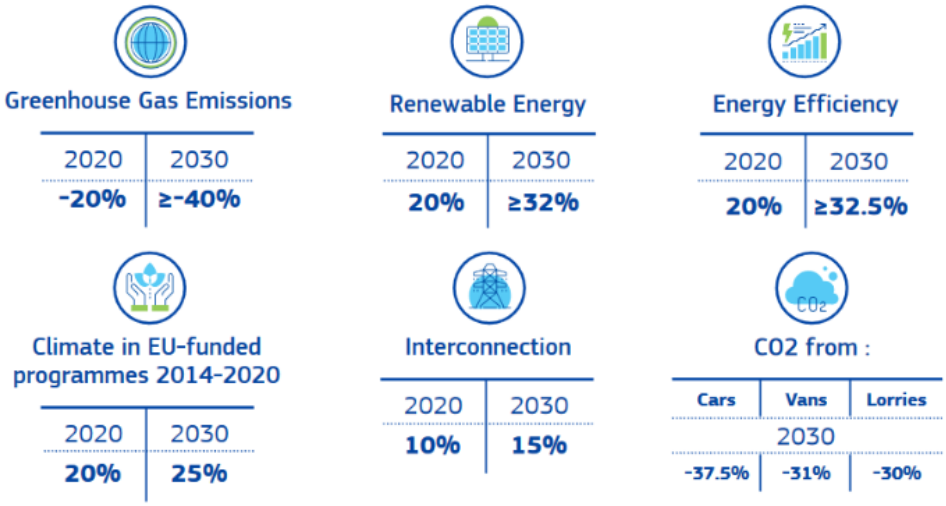


Figure 5 EU-Energy and Climate Targets 2018/2019 / Source: European Commission 2019 [14]

The SNS Partnership will launch activities to investigate and validate the Europe's Green Deal objectives in each of these technology and domain areas. It is recognized that the transition to climate neutrality necessitates smart infrastructures, supported by cross-border, regional cooperation to ensure resources optimization and affordability of the transition towards the objectives of reaching carbon neutrality (Figure 5). The SNS Partnership's SRIA will include focus areas and synchronization points with the Green Deal timeline while anticipating and reacting towards the upcoming Climate Pact and other upcoming directives.

Annex 1 describes in detail the road to a successful enablement of the Green Deal. Below a brief summary shows the challenges that need to be overcome. Moreover, Annex 1 describes a detailed and per-year description of the energy and carbon footprint reduction:

- Reducing the energy and carbon footprint of SNS platforms according to the prediction described in [13] and the GSMA SBTi Initiative in [56] and [57] and Section 1.2.1.2.
- Reducing energy and carbon footprint, while increasing the energy efficiency within the vertical domains using SNS platforms can be achieved following the prediction shown in Figure 5. A study that provides more insights on these footprints is described in [15] and [16].

Carbon emissions are projected to decline due to decreasing coal demand [15]. In order to achieve a 1.5^{o} C temperature rise limitation by 2050 (see IPCC [16]), more far-reaching decarbonization initiatives are needed across all sectors, including the vertical domains. In [58], it is shown that the estimated carbon reduction in ten different vertical domains, can be enabled by the use of mechanisms, such as machine-to-machine (M2M) connections and the functionality of smart devices. These estimated carbon reduction savings can go up to 70 %, see [58], when using machine-to-machine (M2M) technologies.

Solutions, within the SNS Partnership, will be investigated and validated to realize the reduction of the GHG emission in vertical domains, compared to 1990 levels, from a level of 20 % in 2020 to a level equal or higher than 40 % in 2030, see [14]. The per year GHG percentage reduction can follow the projections shown in [59]. Another possible way to follow, is to assume that the per year GHG percentage reduction during 2020 – 2030 follows a linear curve. Upon the start of the Partnership, a detailed study will be made to identify those vertical industries that look most promising to achieve significant results in energy and carbon footprint reduction when using SNS solutions.

Sustainable Development Goals (SDGs)

As described in Section 1.1.3, the United Nations 2030 Sustainable Development Goals (SDGs) [17] are a key driver for future developments to address societal challenges globally. The SDGs and the environmental sustainability challenges call for new and evolved Smart Networks and Services capabilities, high-level requirements and demands in capacities that must be carefully understood in a human-centric and societal context.

Existing reports (e.g., [17]) explain how mobile networks are contributing to the economic growth and are addressing societal challenges. The United Nations Broadband Commission for Sustainable Development has set deployment targets for 2025 [27] to underline the importance of smart communication systems and networks. The UN SDGs require the availability of ubiquitous and affordable communication networks to support the digitization of society and economy in developing and developed countries. ITU has summarized the contributions of the ICT sector to work on the UN SDGs (Figure 6) [19] as well as the investment in digital technology [20].

Figure 6 ITU-R view in Sustainable Development goals [17], [19]

The European Commission is committed to the abovementioned SDGs [60]. The SNS Partnership in the context of Horizon Europe contributes to this European vision as "**Smart Networks and Services empowers society and protects citizens**". The Partnership is committed to support the most relevant SDG goals through a well-defined methodology (c.f., Annex 2). The Partnership is not aiming at addressing all SDGs but focus on the most relevant ones as already explained in Section 1.1.3.

Target for digital autonomy and European sovereignty

As described in Section 1.1.3, **the strategic digital autonomy of the European Union is a major concern with the rising of multiple threats and dependencies crossing both technical and socio-economic aspects [1] and [2].**

The Communication of 29 January 2020 on a cybersecurity toolbox acknowledges the proposal to launch of a "6G initiative" as a public private partnership to develop EU sovereignty in the smart networks domain [1]. This Partnership proposal covers the private side view of such an initiative.

The cybersecurity toolbox involves several tools to secure 5G and beyond critical infrastructures. These include the development of adequate end to end security standards, and the emergence of a diversified supply chain for critical elements of the value chain.

New opportunities emerging at device level, through a wealth of connected devices and at computing level through the emergence of edge computing must be exploited at EU level to reconstruct EU capabilities in these sectors. In addition, EU strongholds in networks need to

be reinforced and secured. In addition, EU capabilities in enabling technologies at the component level need to be enhanced.

In addition to the mentioned challenges, opportunities have been identified [25], such as:

“New and fast-growing world markets as an opportunity for Europe’s businesses, including SMEs, to increase sales of their products and services through globalization. By building on its excellence in scientific research, position as the world's largest exporter of manufactured goods and services, and one of the biggest global markets, Europe could reinforce its position as a leader in world-class innovative and sustainable products and services”.

By taking a value chain approach towards critical technologies and systems, **the SNS Partnership will address the concerns raised in the Cybersecurity communication and develop a framework for alternative secure technological solutions**.

Moreover, the 5G Action Plan for Europe (5GAP) calls for actions to ensure that the EU can use advanced 5G connectivity as a strategic advantage to lead in digital transformation, especially in vertical industries, and in support of key societal objectives. One of these strategic sectors, with strong public interest, is Connected and Automated Mobility (CAM). Recognising the transformative potential of 5G in the field of mobility, and driven by the ambition to make Europe a world leader in CAM products and services, the Commission in 2016 has set ambitious Gigabit connectivity objectives [61], starting with a coordinated launch of 5G in all EU Member States by 2020 and a comprehensive deployment by 2025 to ensure full urban coverage as well as uninterrupted 5G coverage along main transport paths (roads and railways). The Commission emphasized its commitment to work with Member States and stakeholders to develop a **network of pan-European 5G corridors** for large-scale testing and early deployment of advanced connectivity supporting CAM (c.f., Annex 3). The SNS Partnership is fully committed to support these activities both as the means to achieve digital autonomy and European technical sovereignty in this key vertical sector, but also as an opportunity for European leadership in this business market.

Social inclusiveness & creation sustainable high-value jobs

According to [25], Europe is the home to the most advanced welfare systems in the world and to a wealth of best practice and social innovations, but it needs to confront and adapt to unprecedented societal challenges. Both the EU and Member States are facing rapid changes taking place in our societies and the world of work. The key challenge is that the world population is aging and in 2030 Europe will be the region with the oldest population in the world. While investment in robotics, automation and other new technologies offers the opportunity to re-shore manufacturing in Europe, a lack of skilled individuals and talents will create a bottleneck in this process. In particular, data professionals are expected to almost double and as well that the digital literacy increases by 20 % in 2025 (Figure 7).

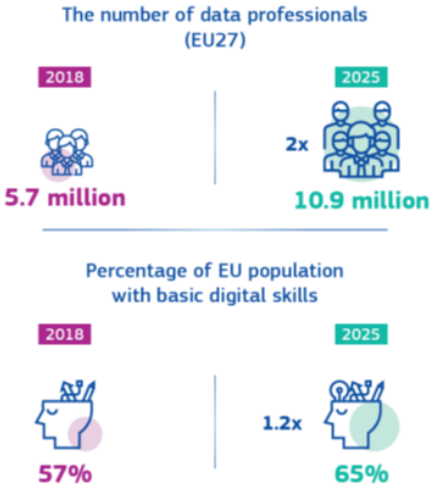


Figure 7 Digital Skills, [51] to [53]

According to the pillar “Competences - Empowering Individuals, investing in skills and SMEs” of the European strategy for data [52], citizens will be empowered with more control over the data they generate. In particular, strong measures will be put in place in order to close the gap of 1 million digital experts needed to support EU industry digital transformation to keep pace with the global development in the digital domain.

The SNS Partnership will support the EU Digital Strategy providing world class research and innovation activities and ensure an increase of employment and economic growth by enabling skill development activities and providing exploitation results.

Further societal aspects are summarized in Annex 1, Annex 2 and Annex 5.

1.2.2.3 Business aspects – Europe’s share on the global market

International organizations such as the UN, the ITU, the OECD, and the World Bank confirm that the ICT sector is a key driver of sustainable development. Broadband access leads to Gross Domestic Product (GDP), productivity and employment growth [62], [63]. In terms of growth, a recent World Bank study [62] indicates that a 10 % increase of broadband connections led to a 1.19 % increase in GDP per capita in developing countries and a 1.35 % increase in developed countries. This section is devoted to present the **common vision and ambition of the SNS Partnership in what concerns business aspects, so that Europe can achieve a large share of the global telecommunications market.**

The total investment in European telecom networks was 48.6 Billion € in 2018, with ETNO companies deploying 70.5 % of the **total network investment** in Europe (34.4 Billion €, fixed and mobile). ETNO companies have the highest proportion of revenues dedicated to investment among global peers in Japan, US and South-Korea. However, investment per capita in Europe remains lower than those of such global peers, with Europe investing around 89 € per person, as opposed to global peers’ average at 177 € per person. European markets remain fragmented, with 47 main mobile network operators (MNOs) in Europe, as opposed to 7 in the USA, and 3 in South-Korea and Japan respectively. Europeans use and spend less in connectivity services as compared to their global peers. Telecom service revenues is stuck at around 165 Billion € for the past 5 years as are mobile and fixed Average Revenue Per User (ARPU) at 14.9 € and 21.5 € in 2019 respectively. This means European telecom markets must become stronger before they can deliver a significant leap in network investment. **The SNS Partnership** targets to increase the market for the operators by enabling them to expand their business to serve the full digitization of vertical industries. **This will require the mobilization of a significant number of multi-disciplinary stakeholders that will create innovative PoCs, further develop them and validate them into large scale trials. The SNS Partnership has also the objective to mobilize the necessary resources to achieve such synergies. These resources consist of in-kind contributions to operational costs at project level and additional activities from the private partners (the Association, which is representing its members) to the Partnership. The SNS Partnership targets to mobilize a leverage factor of the public funding to support its strategic objectives.**

European headquartered telecommunication manufacturers have a significant part in the global market both in terms of LTE as well as 5G contracts. Although they are currently in a satisfactory position, the telecommunications’ sector is rather competitive, and the European manufacturers need to keep on evolving. The full digitization of the vertical industries and the support of emerging technologies require that they will be prepared for the future. **The SNS Partnership offers the needed ecosystem** of telecommunication manufacturers and e.g., verticals, operators, SMEs, universities and research centres **to design the future network solutions and validate them in real life** scenarios. **Organized global dissemination activities** of results of this scale will help to maintain and further **increase their place at a global level**.

According to [31], the value added (VA) by the ICT sector to the European economy was 632 Billion € in 2015. The breakdown of the VA in 2015 is as follows: 398 Billion € by the ICT services sector excluding telecommunications (63 %) and 234 Billion € (37 %) for ICT

telecommunications. The latter comprises 185 Billion € for telecommunications (connectivity), 37 Billion € for manufacturing excluding communication equipment, and 13 Billion € for communication equipment. The growth in the services domain (Figure 8) shows the increasing cooperation with vertical sectors. **The SNS Partnership will address an increasing part of the services market beyond telecommunications, specifically considering the additional focus on IoT and the cloud.**

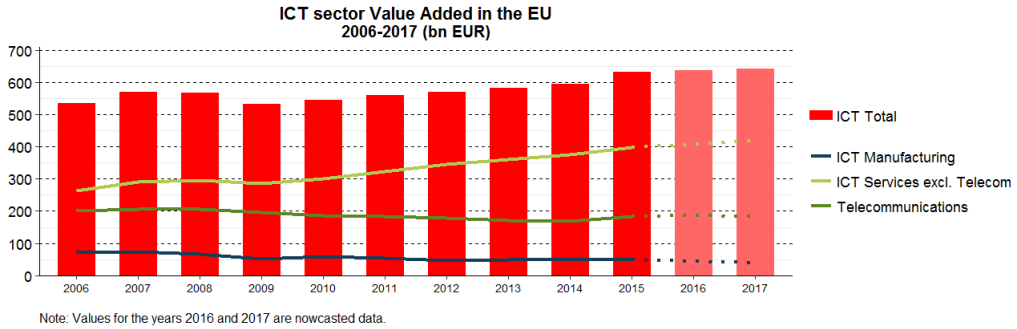


Figure 8 Value added in the ICT sector, 2006 – 2017 [31]

Although Europe has fallen behind in terms of smartphones' market, the support of the vertical industries creates new opportunities for IoT devices. **The value chain approach adopted by the SNS Partnership and the inclusion or collaboration among multiple stakeholders** (e.g., end devices, micro-electronics, etc.) is expected to act as t**he catalyst for the creation of European solutions**. As recently indicated in [64], "**M2M connections** will grow 2.4-fold, from 6.1 billion in 2018 to 14.7 billion by 2023 (Figure 4 in [64]). There will be 1.8 M2M connections for each member of the global population by 2023". This suggests that an important opportunity could be ahead for European companies.

The cloud computing domain will also be a significant component of future networks. European enterprises are in the process of increasingly applying cloud solutions. Within the next three years, the European public cloud market is expected to grow by 22 % [65]. A critical aspect here is that the cloud market in Europe is largely dominated by US companies [65], [66] as well as the associated platform market [37]. Likewise, Europe has only 3 % of the share of the worldwide data economy, versus 70 % of the US [37]. This low share comes also with a poor guarantee of data security and privacy (e.g. Cambridge Analytica case) [67]. This has raised several concerns in relation with the increasing adoption of networks, cloud and platform applications for critical infrastructures. The EU Commission is responding to this situation with the newly adopted cloud strategy [68]. Consequently, **high security requirements need to be supported by Smart Networks and Services including data centres in Europe according to the European data security law**. It is also important to note that nowadays there exist substantial differences in terms of the adoption rate of cloud technologies between Eastern and Western Europe. Therefore, **the SNS Partnership will help close this gap by facilitating an enhanced and more homogeneous access to cloud services across Europe**.

A large share of the economic growth will come from the SMEs. In the business services sector, where most of the ICT work is performed nowadays, SMEs account for 82 % of total employment and 76 % of value added [69] SMEs in the ICT sector should therefore be very important beneficiaries of the economic growth. **The SNS Partnership has dedicated operational objectives for the engagement of SMEs.** European SMEs operating in non-ICT domains will also benefit from the digitization of the society to operate in an environment that will help them strengthen and increase their global market share.

R&D intensity of business enterprises

Research and development are essential preconditions to enable the huge market success and growth in the ICT services domain. The ICT sector is one of the most R&D intense sectors in European industry. According to [31], the Business Enterprise R&D Expenditure (BERD) in the ICT sector in 2015 was 32 Billion €, the highest value in the period 2006 – 2015. The

breakdown of the expenditures of the different sectors is as follows: 17 Billion € by the ICT services sector excluding telecommunications (53 %), and 15 Billion € for ICT telecommunications (47 %). The expenditures of the service domain are growing, and expenditures of manufacturing are nearly stable in Europe due to technology changes and the impact of globalization. In relative terms, the research expenditures for infrastructure systems and communication equipment (47 % of expenditures for 37 % of value added) is much higher than in the services domain (53 % of expenditures for 63 % of value added). Investments in infrastructure research is much more capital intensive with longer time scales in time to market than for application research and development, which results in bigger risks in the infrastructure domain.

There is a huge difference in R&D intensity of the ICT sector compared to other regions. By using a definition which allows comparison on global level, BERD corresponds to 5.2 % of the value added in 2015 compared to a similar value in China of 5.5 %. But there is huge gap between Europe and the US with 12 % and Japan with 9 % [31]. Therefore, **there is a strong need for collaborative research under Horizon Europe in the domain of communication systems and networks to enable the industry in Europe to maintain and improve its position considering the fierce global competition and standardization for the forthcoming paradigm shift towards cloud-based and platform driven Smart Networks and Services. The SNS Partnership will help in maintaining a high R&I intensity rate in Europe and mobilize additional resources needed to deploy innovative solutions.**

1.2.2.4 B5G systems design and support of emerging applications

The high-level SRIA targets the Area of Intervention “Next Generation Internet” in the Cluster “Digital, Industry and Space” of the proposed Specific Programme of Horizon Europe by the EU Commission [48]. Details of the Specific Programme are still under discussion between the EU Commission, the EU Parliament and EU Member States. However, [48] provides a good indication of the intended priorities. **The common vision and ambition of the proposed SNS Partnership concerning research, development and validation of B5G system blocks perfectly fits under the “Next Generation Internet” Area of Intervention.** Figure 9 shows the basic scope of the proposed Partnership in relation to the Networld2020 Strategic Research and Innovation Agenda [49] and [70], which is currently revised, and the proposed Specific Programme [48]. Figure 9 illustrates the wide range of issues to address across a variety of stakeholders.

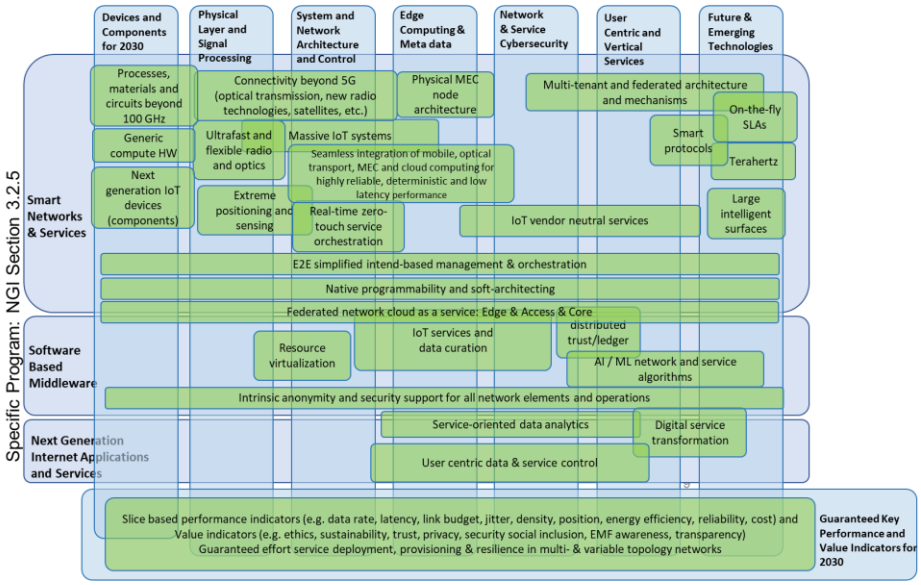


Figure 9 Basic scope of the proposed Smart Networks and Services Partnership

The major areas foreseen in the Smart Networks and Services European Partnership are also listed in Annex 4, from the perspective of the NGI vision and the need for digital transformation in Europe, the high-level objectives of the Partnership (technology, ecosystem and societal

objectives) and the input from the Networld2020 European Technology Platform and the 5G-IA are considered.

The role of key enablers for the SNS Partnership

The common vision of the **SNS Partnership envisages the integration of selected elements from new technologies such as Artificial Intelligence, Machine Learning (ML) and Data Analytics, High Performance Distributed Computing, as well as Cybersecurity and Trust**.

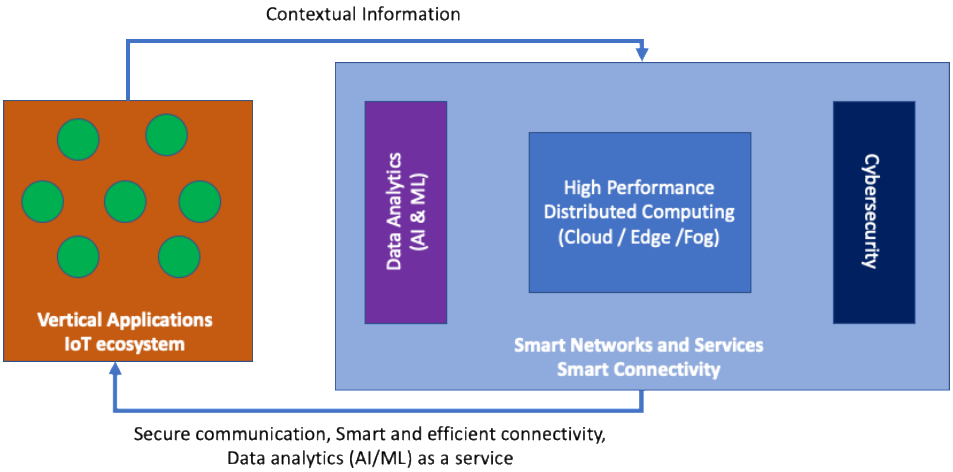


Figure 10 Integration of new technologies into the Smart Networks and Services vision

Figure 10 illustrates the interplay and integration of such new technologies whereas the rationale and main elements identified by the Partnership are described. Some of these enabling technologies are:

- Artificial Intelligence (AI) and Data Analytics: AI is perceived as a potential technology solution to cope with the increasing complexity of Smart Networks and Services system design and associated management, due to the extreme range of requirements for user experience, efficiency, and performance. Future **Smart Networks and Services will require robust intelligent algorithms to adapt network protocols and perform network and resource management tasks for different services in different scenarios** [71]. AI will also help telecom operators to optimize network deployment in real time according to user requirements. Accordingly, **Smart Networks and Services are needed to connect in an efficient and timely manner the data to the AI algorithms.**
- High Performance Distributed Computing (HPC): The computing paradigm has radically changed [72]: in past decades, it was common to assemble the highest performing processors inside the same infrastructure equipment. However, the today's model is to design a data centre scale system with the entire network in mind. Thus, the trends that are most affecting HPC today are highly influenced by the need to have all aspects of the distributed computing infrastructure working in unison. Two of the most relevant aspects are the need for (i) a fast (and potentially massive) access to storage from anywhere in the network without disturbing the processing engines; and (ii) efficient strategies for network-wide off-loading, since nowadays CPUs are reaching their performance limits and, thus, the rest of the network must be better utilized to enable additional performance gains. **Smart Networks and Services emerges as a key enabler for the transformation of the HPC domain.** Regarding the impact of HPC to Smart Networks, significant advances in components and techniques for wireless transmission are expected from continued research on quantum processing and technologies in such a way that emerging **quantum technologies are expected to provide true breakthrough advances in, e.g., computing speeds within the next**

decade and, by doing so, pave the way for more secure communications through potentially unbreakable cryptography.

- Cybersecurity and Trust [1]: Starting from the NIS directive followed by strategic positions [73], GDPR or continuing efforts on the Cyber Act [22] and the EC recommendations on Cybersecurity of 5G networks [74] the EU has recognized the fundamental role of cybersecurity in the digital world. This leads to at least two major priorities focused on (i) the **contribution of Smart Networks and Services to secure the digital world**, which includes the provision of data and information protection (e.g., location, data on the move) in all dimensions to protect citizens, enterprises and governments against malicious or outlaw usages with diverse security levels, as well as the detection of attacks and mitigation of their risks through the various components of digital services; and (ii) **the cybersecurity threats related to the Smart Networks and Services themselves**, namely, mitigating security threats related the various sensitive (new) components coming with 5G and beyond 5G technologies (e.g., identity and access management in mobility, virtualization, softwarization, over-the-air updates, AI technologies, etc.) as well as the monitoring and sustaining security levels for complex Smart Networks and Services.

Currently, many governments, globally, identify that world-class communications networks are, or will become, an intrinsic component of their critical national infrastructure and essential to ensuring that citizens can take full advantage of increasingly pervasive digital services across the plethora of existing and emerging applications, use cases and verticals, see e.g., [36]. In particular, this can accelerate data-driven innovation, industrial automation, AI deployment and ensuing social and economic opportunities across economies, and increasingly between economies, for example the European Union's developing Digital Single Market, or if considering how an autonomous system might operate across borders. Examples of such **emerging applications**, presented in [36] are:

- Holographic media applications: Involve not only the local rendering of holograms but networking aspects, specifically the ability to transmit and stream holographic data from remote sites.
- Multi-Sense Networks: Include emerging applications that involve not only optical (video, holograms) and acoustic (audio) senses, but as well smell and taste senses.
- Time Engineered Applications: Use a communication system that can coordinate between different sources of information such that all the parties involved have synchronized view of the application.
- Critical Infrastructure support applications: Support of critical infrastructures that refer to those essential assets that are considered vital to the continued smooth functioning of the society as an integrated entity.

The SNS Partnership will investigate and validate solutions to support emerging applications, via improved networking technologies and integrating several enablers as already discussed. This approach will bring technology-led transformations across all European industries creating new opportunities and benefits for key industrial sectors.

Role of Open Source and O-RAN

The classical role of standards (such as those from 3GPP or ETSI) in the 5G ecosystem and **the SNS Partnership will continue to have a pivotal role, especially in the RAN segment as,** with their focus on interface definition and functionality, they guarantee global scale, interoperability, and enable long-term outlook and backwards compatibility. However, already today, the infrastructure part of a 5G network and its overall architecture is designed and built around open platforms and open APIs concepts and products, especially in the core and its management. These open platforms are mainly consolidated around broad accepted technical specifications and are implemented under open source initiatives. There are open source

communities covering all network parts RAN, Edge/Fog, core, network management and OSS such as O-RAN, LF-Edge, ONF, OSM NFV, ONAP, etc.

The modus operandi of an open source community is different than the standardization bodies in terms of agility, timescale, releases, prototyping and tests. The outcome is not just a document and proof-of-concepts but running code answering certain needs. They start from the technical specifications and refine the functionalities and models when necessary as implementation progresses and new needs are required and validated within the community for giving feedback to specification later. This has a positive impact since it endows the network with the required flexibility, lowers the adoption barrier and enables speed of innovation and collaboration among the different stakeholders, that would be impossible to achieve working in silos. On the other hand, an iterative approach is necessary to avoid implementation divergences and lack of interoperability.

Within this context, it is expected that in the 5G evolution towards Smart Networks and Services, the interplay between standards and open source environments will become stronger, building consensus among different stakeholders involved. The key link between these worlds will be open interface definitions, such as those being developed within O-RAN. It should be noted that the definition of “open interfaces” is not limited to these new alliance initiatives. On the contrary, the existing classical telecommunication standards organizations are responsible for many of these key open specifications.

For the Smart Networks and Services Partnership this means that the range of relevant standardization bodies will increase from the existing classical telecoms SDOs, which will continue to have a pivotal role, to new organizations focusing more on enhancements for deployment and operations. The key objective of the Partnership should be to guide these open interface activities to areas which bring a wider eco-system and innovation advantage. This will require active engagement to both incorporate the ideas, concepts, and developments elaborated within these groups, but also to contribute using the appropriate inputs stemming from the projects’ results.

1.2.3 Collaboration Opportunities

The private side of the proposed Smart Network and Services Partnership is already in discussion for future cooperation with several R&I initiatives, including candidate European Partnerships on the collaboration on joint agendas such as:

- **Key Digital Technologies** on opportunities for components and devices to understand technology advances in microelectronics technologies and to provide requirements on future communication systems to the microelectronics sector;
- **Cybersecurity**.

There is a second tier of collaborations for collecting requirements on future communication systems and networks to other partnerships and communities as well as gaining information from other communities to be considered for the SNS platform. Examples are:

- **Transforming Europe's rail system** on advanced mobility and logistics solutions by means of ICT;
- **CCAM** to develop mobility solutions based on future communication systems;
- **AI, Data and Robotics** on the use of AI in future communication networks and further develop AI algorithms for communication networks purposes;
- **High Performance Computing** on the interconnection of supercomputers an using HPC data centres in future communication networks;
- **Photonics Europe**;
- New European Media (NEM) which address media content and immersive technologies.

Further details are available in Section 2.1.

These collaborations tend to address the full industrial digitization and the support of verticals. They also provide links with key technologies that will be used as enablers in the future SNS systems. These collaborations will assist significantly the research and development of B5G systems, ensuring the European competitiveness and the support of all targeted societal aspects.

In addition to the R&I partnerships, there are other programs and organizations funded by the European Commission and where strong links will exist and where coordination links will be formed. The Connecting Europe Facility (CEF2) is one of the most important one as it will address deployment of 5G networks especially at cross border major transport routes including Connected and Automated Mobility (CAM) which is one of the most promising areas [75], [76].

Horizon Europe and CEF2 are different programmes in the next Multiannual Financial Framework from 2021 to 2027. It is intended that the proposed SNS Partnership will be coordinating and organizing activities under Horizon Europe and being involved in strategic discussions on the identification of 5G deployment activities and the coordination with national programmes under CEF2 between the EU Commission, EU Member States and the private side. In relation to CEF2 the SNS Partnership will drive the process of the Strategic Deployment Agenda (SDA) development, as it is currently done in the context of the 5G PPP Automotive WG.

In 5G PPP Phase 3 in Horizon 2020 first trial projects on corridors [77] are already supporting the EU objectives to provide major cross border transport routes with 5G by 2025 [61]. The CEF2 programme is targeting a big step forward in that direction based on an agreed EU strategy [78] towards comprehensive commercial deployment along cross-border corridors. Details are summarized in Annex 3.

As 5G for CAM is one of the most important verticals that emerged under the 5G PPP, the coordination and pre-structuring of the CEF2 programme in this field is an evident task for the SNS Partnership. The 5G PPP Partnership Board has tasked the 5G PPP Automotive WG to develop a first version of the SDA [76], to set out the main elements that can be considered for the CEF2 Work Programme. It covers 5G CAM services requirements, a range of cooperation models and regulatory considerations. 5GAA [79] and GSMA [80] are participating in this activity.

Activities towards CEF2 under the SNS Partnership are related to strategic discussions between the EU Commission, EU Member States and the private side to regularly update the SDA and to identify and align 5G deployment projects through coordination activities among the European Commission, the Member States and the private sector. The implementation of CEF2 projects will be implemented by an existing Agency (c.f. Section 2.3). This domain is expected to be a clear success for Europe as the technological push of R&I activities and the market pull via deployment activities will reinforce each other and will create the necessary conditions to achieve European technological sovereignty in this field.

1.2.4 Estimated R&I investment

The research, development and standardization of new communication systems, networks and services requires in the time frame of about 10 years for the development of a new system a private investment of the European ICT sector (vendors, operators, vertical sectors, SMEs, academia) in the order of several tens of Billion €. This is easily shown based on publicized R&D figures of major companies in annual reports as well as the EU Commission Digital Agenda Scoreboard [31], which reports around 3 Billion € annual spending for telecommunications (connectivity) alone. With the very conservative assumption of an annual spending of 3 Billion € the expected overall private R&D investment in Europe until 2029 will be at least 30 Billion €. Although the private sector is bound to pursue on its own the technological evolution and investments in new solutions, the new landscape formed by the arrival of 5G presents some significant differences. The need for full digitization requires exploration of new possibilities in a significant number of vertical industries that one company alone cannot pursue. Moreover, it has been observed in the past that the private sector is usually forming small consortia. These efforts have rather limited global impact but are

extremely good to investigate specific solutions. With the extended scope of the SNS Partnership the related annual R&D investment in Europe will be much higher.

In order to fulfil the objectives of the proposed Partnership it is estimated that an overall investment of 2 Billion € is needed (under the assumption of 1 Billion € public investment [2] and including contributions and collective commitments from the private partner). Resource needs and commitments will be further elaborated in the context of developing the SRIA. It is proposed that the public investment in the Smart Networks and Services Partnership will cover an early but strategically critical part of the overall investment, which enables consensus building at the early research phase for the preparation of future standards, the development of key IPRs and the development of a clear roadmap to align research and innovation activities in Europe.

1.2.5 Triggering transformational changes in the R&I ecosystem

As discussed in Section 1.2 the SNS Partnership is targeting to achieve a number of objectives, by supporting the development and uptake of a wide range of European solutions and services (e.g., personalized access to information, services and media, everything-as-a-service, etc.) across all sectors of our society. The aim is to address important social, economic and environmental challenges by improving European technology sovereignty. Overall, the ambition is to create a more inclusive, open and participatory society centred on the citizens' needs, both as individuals and as organizations (from private to public ones), minimising the digital divide and reducing inequalities.

To this purpose the Partnership will:

- Achieve digital sovereignty by adopting a value chain approach for the design and validation of solutions to stimulate collaboration among relevant partnerships and associations.
- Implement and review a long-term SRIA in a synergetic manner with relevant partnerships and associations.
- Create the Strategic Deployment Agenda for CEF 2 and coordinate with Member states to assist in the deployment of CCAM.
- Enable digital transformation of and innovation in verticals and public sectors by improved effectiveness in trials and experimentation.
- Strengthen the adoption of Smart Networks and Services in vertical sectors.
- Develop innovative business models and efficient business layer enablers especially in vertical application domains, IoT, clouds and platforms, although also addressing the horizontal layer across networking administrative domains.
- Stimulate stakeholder investment for R&D activities, system development and deployment in Europe.
- Contribute to global standardization with consensus results from the SNS Partnership.
- Contribute to the regulatory process with technical expertise on spectrum issues and other relevant regulatory issues.
- Accelerate the support of SDGs by cooperating with relevant bodies and stakeholders.
- Assist in reaching Green Deal goals related to the ICT sector.
- Design technologies to foster digital inclusion allowing basic Internet access at minimum cost.
- Assist in developing skilled personnel on new technologies, software platforms, IoT, clouds and relation to the components and devices (for vertical sectors) industries.
- Encourage SMEs' participation with a focus on start-ups and scale-ups in relation to venture capital.
- Address acceptance and user-experience of new technology and services by society and consumers.

[2] The private contributions under the umbrella of the SNS Partnership will be adapted depending on the final EU funding.

- Provide analysis on international developments and international cooperation opportunities.

As mentioned before, the telecommunication sector is a rather competitive one and multiple activities take place at a global level. In different parts of the world significant differences can be identified in terms of deployment and take up rate of 5G networks, budget allocation for R&D activities, market regulation actions, etc. Until the advent of 5G, the telecommunication sector was characterized by a fierce financial competition. Europe faces all those weakness and threats mentioned in Section 1.1.6. What is needed to address them are a) a common pan-European strategy, b) well organized coordinated activities at a European level and c) enough funding to create the critical mass for transformational changes to start taking place. Although, Europe cannot directly compete with other regions in all aspects (e.g., funding for research, rapid deployments due to the regulatory framework etc.,) it has clear advantages (e.g., strong vertical sector, top telecommunication manufacturers, strong network operators, etc.,) that if leveraged appropriate they can provide significant results.

Moreover, it is worth noting that these days, apart from the financial/technological competition, we are witnessing that 5G networks are part of a geopolitical rivalry. This has brought Europe in a difficult position as to some extend it is dependent on technologies and solutions provided by third countries. The evolution of 5G networks and the full industrial digitization is the needed opportunity for Europe to perform a technological leap and at the same address its weaknesses. Moreover, this rivalry may lead to fragmented technological and deployment solutions in different parts of the world. This situation has been experienced in past generations of mobile networks and the outcome was clearly problematic. To tackle these issues targeted international collaboration activities are needed.

5G-IA has been very active building up international cooperation for 5G networks. This is obviously of the outmost importance for keeping Europe in the frontline of key players at a global level. More specifically, in the context of 5G PPP, 5G-IA has signed MoUs with ENCQOR (Canada), 5G Americas (USA), TeleBrasil 5G Brasil, TSDSI India, IMT2020 (China), 5G Forum (Korea) and 5GMF (Japan). 5G-IA has been actively involved in the organization of the 5G Global events. In the scope of the SNS Partnership, existing MoUs will be renewed and new ones will be signed to keep these global links active. This is rather important to disseminate European achievements and solutions and build consensus at a global level.

1.2.6 Exit strategy

As explained in Section 2.1, the proposed Partnership consists of 4 different streams each of which is composed of several Phases. The Partnership is organized in different phases from precompetitive research towards trials and closer to the market activities in later phases. In parallel to these phases the private side is increasingly moving from concepts towards product development and economic exploitation at the end of the Partnership, where no public funding will be allocated anymore. These activities will be very close to the market and will be financed, beyond the Partnership, by the individual actors of the private side.

In line with the classical time to develop a new generation of connectivity platforms (about 10 years), the Partnership is proposed for a duration that spans the lifetime of Horizon Europe. It should hence be designed with a target date to completion of 2029.

At this stage, the exit strategy principles are still under discussion in the Commission. Hence, only generic principles can be outlined in this section. It is noted that the exit strategy is motivated by the need to commit to achieving the specific objectives of the proposed Partnership during a pre-defined duration (not more than the lifetime of the framework programme). The SRIA of the SNS Partnership will describe a clear and comprehensive roadmap to deliver concrete results in the expected time frame.

After the end of funding under Horizon Europe and the completion of the projects from the last calls, the SNS Partnership will in principle come to end with its proposed mandate. Entering follow-up discussions will be subject to the overall process and conditions to be established under FP10, considering the results of the evaluations and should address:

- Achievements of the running Partnership;
- Policy context of the Union;
- Existence of a roadmap for a follow up initiative;
- Member States opinions and strategic interests;
- International visibility of the Partnership;
- Stakeholders motivation: level of support for follow up at the top management level of key companies

1.3 Necessity for a European Partnership

The proposed SNS Partnership shifts a gear up compared to the 5G PPP. In order to achieve the ambitious objectives, it is necessary to ensure a common EU strategic approach with **strong presence and ownership of industry and Member States**. Also, a significant mobilization of stakeholders from multiple disciplines is needed to achieve the full digitization of the vertical industries. This can be best guaranteed through the Partnership compared to implementation by individual projects through calls for proposals.

Due to its holistic approach the **SNS Partnership will mobilize additional in-kind contributions for building the ecosystem** and bring to the market systems, solutions and products, based on research results (Section 1.2.4) which is not possible with traditional Horizon Europe Calls for Proposals. The SNS Partnership is linking policy objectives and Missions to technical requirements through guided roadmap-based research (i.e., the SRIA). At political level, discussions between the EU Commission and Member States are needed for setting an appropriate legal framework for data security and integrity in the single Digital Market supported by the necessary technical expertise in the Partnership. Strategic discussions between the EU Commission, Member States and the private side will also shape trial activities (access to frequency spectrum and infrastructures) and the identification of CEF2 5G deployment activities (access to major transport routes mainly in cross border regions and frequency spectrum) in relation to national programmes. The Partnership will build on the achievements and best practices from the 5G PPP that was launched in 2014 and positively evaluated in 2017.

Moreover, the developed SNS infrastructure will be the catalyst for the European data economy as well as other critical areas such as AI, HPC, Cybersecurity and KDT. The global political environment is changing towards increased protectionism in other regions, which may impact the access of European industry to newest technology in existing supply chains. Therefore, industrial strategic choices support important political objectives for improving Europe’s digital autonomy. They also enable network security and data integrity solutions that are based on European values and data security law (GDPR), which will be a key asset for improving the everyday life of citizens but also for exporting solutions at global level.

With respect to Section 1.3 the proposed activities in the SNS Partnership are of strategic importance especially for building global consensus on future systems at precompetitive stage, generating European IPRs and impacting global standards. A European Partnership provides the legal framework for cooperation between different stakeholders and even competitors.

The nature and magnitude of the implementation of the Partnership activities and, especially large-scale experimentation and deployment activities (Section 2.1) require action at EU level that capitalizes on Member States initiatives for 5G R&I and validation facilities. These synergies are important as none of the Member States can reach alone the critical mass needed to influence global developments (e.g., international standardization, spectrum allocations, etc.). In that sense, the Partnership will ensure that the knowledge and resources available in the EU will be combined in a coordinated manner to build Europe's future communication infrastructure ecosystem across all value chain segments.

Activities of the Partnership with a single European voice in international events and fora will be supported by international cooperation with counterparts in other regions (such as the US, China, Japan, South Korea and Brazil among others) to prepare global consensus starting at an early stage of the development.

New SNS concepts and enablers will become a critical enabling technology and an infrastructure and networking services platform across literarily all economic and public sectors, including business layer and business model enablers. **Only a strong coordinated community effort can enable the needed research, development and innovation across verticals and stakeholder groups. This vision cannot be supported by the private or public sectors alone but only through combined forces.** The topic must be formulated and served in a **cross-disciplinary and cross-European way**. As it has been proven by previous Programmes such activities are able to improve the everyday life of European citizens but also provide the means to strengthen European industries and thus, Europe's economy.

1.3.1 Collaboration of stakeholders within the Partnership

The SNS Partnership is open and transparent. It is bringing together relevant stakeholders (i.e., beneficiaries in selected projects based on open Calls for Proposals) from industry, SMEs and the research community in the domains of:

- communication systems, network infrastructure and services,
- IoT equipment and applications,
- Cloud services providers,
- related technology initiatives on micro- and nanoelectronics for components and devices for IoT and vertical sectors (cooperation with the ECSEL Joint Undertaking and/or the proposed Key Digital Technologies Partnership), which should be revitalized in Europe,
- vertical industries and users.

These stakeholders will define the needed SRIA and cooperate in collaborative research and innovation projects following overall common objectives to develop solutions and systems for SNS in all selected vertical domains by further evolving 5G systems and beyond. The Partnership will enable inter-beneficiaries and inter-project cooperation to address the challenge of developing the new smart communications' system. It will also tackle associated policy-oriented topics to provide an appropriate environment for future system deployment and economic exploitation. All beneficiaries in Partnership projects will have access to the generated results by Partnership projects. Common working groups in identified areas will be established. In addition, the Partnership will facilitate cooperation and information exchange with different industry associations and European Technology Platforms in workshops and events. Only a European Partnership allows this kind of cooperation based on a stable and existing legal framework as set by the Horizon Europe Regulation and Model Grant Agreement as well as Consortia Agreements per project and the cross-projects Collaboration Agreement. This ensures the necessary access rights to results among beneficiaries.

The Partnership enables the development of a common research strategy and corresponding roadmaps (e.g., a Strategic Research and Innovation Agenda and Strategic Deployment Agenda) that are agreed by all relevant stakeholders, even among competitors. Collaborative research projects within the Partnership provide an efficient way for cooperation on these technical areas of common interest and objectives, which can be exploited in future international standardization and pave the way for testing and deployment activities.

Figure 11 shows that cooperation between different stakeholders towards consensus building is most efficient in the early research phase, when new concepts and solutions are not mature and relevant IPR portfolios are small. In this phase, consensus-based solutions obtained in collaborative research projects will be coordinated top-down by the Partnership, which will significantly facilitate efforts on global standardization, spectrum allocations and other regulatory issues. It is a major objective of the Partnership to contribute to global standardization by providing appropriate research results via established channels available from project participants who are also members of respective international standardization bodies. Therefore, the proposed Partnership shows a huge potential for the development of solutions, which will be accepted by the global market, and for economic exploitation to the benefit of Europe.

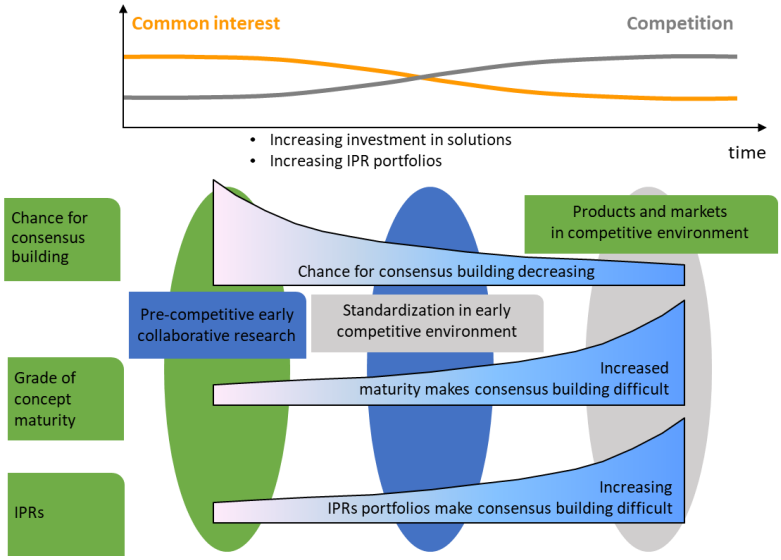


Figure 11 Collaboration of stakeholders in a competitive environment

1.3.2 Impact of the Partnership in the value-chain

The Partnership will ensure that the knowledge and resources available in the EU are combined in a coordinated manner to build Europe's future communication infrastructure ecosystem across all value chain segments. The value chain for SNS is richer than that of 5G. 5G is paving the way to new network and IT services, which will appear from now until 2030. These new services will enable the management, processing and routing of huge amounts of data, with different levels of criticality and/or complexity, owned by various players, collected from IoT devices or generated by communication systems over ubiquitous and multitenant infrastructures. The ultimate objective is to structure the value chain(s) in compliance with verticals players' requirements and the promotion of social, environmental and economic interests of EU citizens.

Figure 12 depicts a high-level vision of the SNS value chain. The development of networks softwarization and edge-computing is expected to be a key evolution direction for 5G networks and beyond, which will lead to a convergence of network and (local) cloud infrastructures. Besides local data storage, edge cloud infrastructures will provide computing capabilities to host applications, supplied by the infrastructure owner or third parties, close to the users in order to enable highly reactive services. AI-based applications are particularly expected to take advantage of being localized close to their users to provide innovative services to end users. In addition, the generalization of IoT, especially critical IoT, within various industrial and public sectors, will call for the development of an industry of specialized IoT microelectronics components and devices with specific design constraints (e.g. ruggedized, highly secured). These directions are expected to play an important role in shaping the future society and represent opportunities of new growth areas for the European industry.

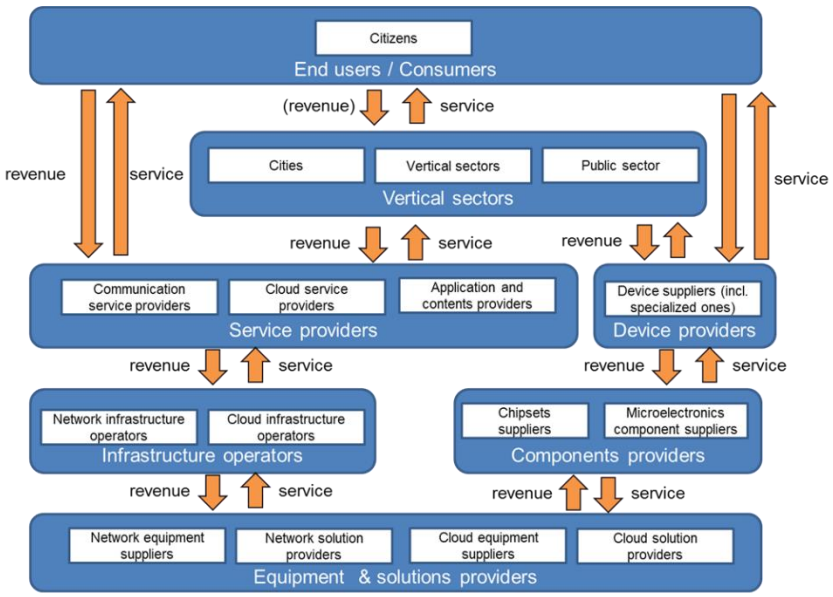


Figure 12 Value chain for Smart Networks and Services

Whilst Europe is less prominent on cloud and device technologies than other regions, a tighter coupling of these domains with European strongholds like networking infrastructure and security expertise offers the European industry a lever for renewed competitiveness. In addition, Europe has two more important characteristics on which a European value chain can leverage:

a) the ability to create trust in data management due to a strong track record on establishing protective ruling to preserve individual privacy and protect data from unwanted access and,
b) the idea that the "value" should not only be considered by its direct economic impact alone, but societal and environmental impacts should also be considered.

Regarding the societal impacts, Smart Networks and Services are of strategic importance as they facilitate jobs and economic growth in all sectors of society and the economy. Moreover, the Partnership will integrate and coordinate efforts at EU level, which will provide an effective foundation for further EU-wide innovation and growth in the digital industry and its related applications. This will have significant positive social impacts in many areas, and the digital transformation of industries such as health, automated cars, media, space, energy, transport, education, etc.

Regarding the environmental impacts, the Partnership will allow for the development of a capability to connect people, sensors, services and systems, which will create enormous efficiency gains in all areas of society. With this approach, the Partnership supports objectives of the Green deal and goals of UN's SDGs, such as energy efficiency, carbon footprint reduction, and better use of resources.

1.4 Partner composition and target groups

1.4.1 Building up the Partnership

The private side of the Smart Network and Services Partnership will mainly build upon the existing 5G Infrastructure Association (5G-IA). In addition, this constituency is extended by representatives of other sectors and cooperation with other initiatives. Examples are IoT (AIOTI), Artificial Intelligence (proposed AI, Data and Robotics Partnership), cloud (Cispe.Cloud, NESSI ETP) and components and devices (ECSEL and proposed KDT Partnership) and from vertical sectors (e.g. proposed High Performance Computing, Photonics Europe and CCAM) to support the value-chain approach for future systems and networks. The 5G PPP strongly relies on the member organizations from the Networld2020 European Technology Platform (ETP) to support the SRIA design and is open to any other participant

willing to participate in 5G PPP projects, especially those considered as critical to develop, commercialize and use 5G network infrastructures and services. On the public side, a stronger involvement of Member States is expected, reflecting the increased strategic nature of the proposed Partnership.

The Networld2020 ETP [81] and the 5G-IA [82] have been created by stakeholders involved in the development and deployment of terrestrial and satellite telecommunications infrastructures and services. The community behind this proposal is based on the huge membership in both organizations, including industry, network operators and manufacturers from the ICT and vertical domains, SMEs, Research Centres and Universities. The Networld2020 ETP counts 1026 members across Europe as of March 2020. 55 organizations are members of the 5G-IA, including 53 full members and 2 associate members. In addition, 5G-IA also has partner organizations i.e. industry associations and ETPs, as well as international cooperation partners. Figure 13 and Figure 14 show the current composition of the membership in both organizations.

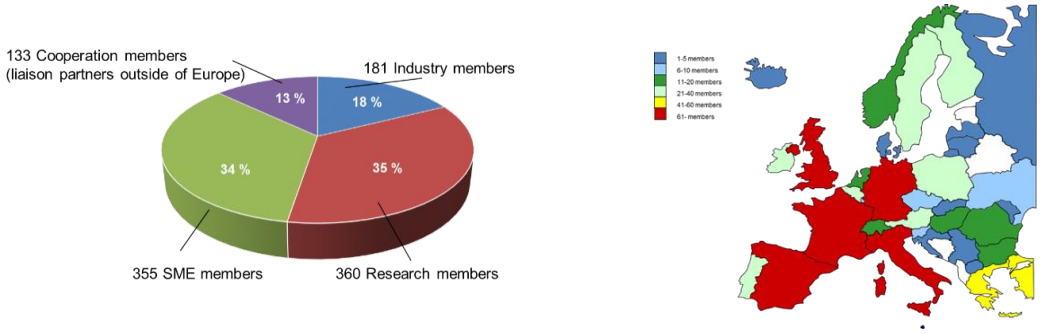


Figure 13 Networl2020 membership structure [81]

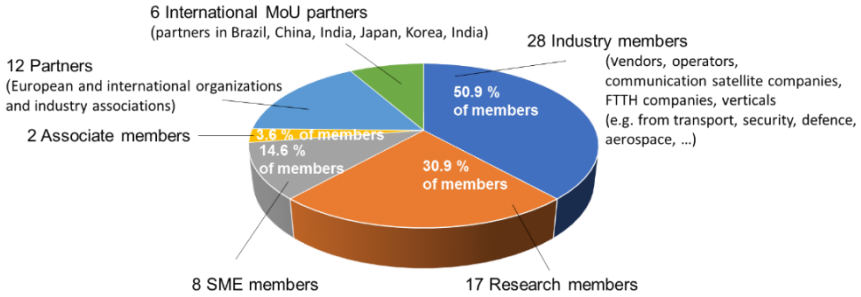


Figure 14 5G-IA membership structure [82]

The SNS Partnership will expand its reach and extend its scope with respect to the objectives in Section 1.2. This means that stakeholders currently not directly involved in the 5G PPP or in Networld2020 will become active participants in the SNS Partnership. This new stakeholder group will be two-fold and come from complementary technological domains such as IoT (AIOTI), cloud, Artificial Intelligence (AI), components and devices, and from vertical sectors that are not yet much involved at this stage in 5G PPP.

The first group of stakeholders will come from those initiatives that are also signatories to this proposal and as such were actively involved in its drafting. The main fora from the European communities are in the IoT domain, the Alliance for Internet of Things Innovation (AIOTI) [83] (members: 41 industry companies, 53 SMEs, 42 academia members, 19 Associations and 2 end-user organisations), in the cloud domain the NESSI ETP [84] and Cispe.cloud [85].

The second group of stakeholders is coming from the automotive domain CCAM, the AI domain, namely the proposed AI, Data and Robotics Partnership [86], [87]. The Components and Devices ecosystem already has its own partnership, the Electronic Components and Systems for European Leadership (ECSEL) Joint Undertaking [88] and is working on a new Partnership Key Digital Technologies under Horizon Europe. ECSEL is jointly managed on the private side by three associations (the European Technology Platform on Smart Systems

Integration EPoSS [89], the industry association promoting R&D&I in Electronic Components & Systems to strengthen European competitiveness AENEAS [90], and ARTEMIS Industry Association [91], the association for actors in Embedded Intelligent Systems within Europe) representing the actors from the areas of micro- and nanoelectronics, smart integrated systems and embedded/cyber-physical systems. It is likely that the stakeholders contributing to the device and components domain in the SNS Partnership will come from member organizations in AENEAS, ARTEMIS and EPoSS.

This leads to stakeholder engagement in format of concentric circles (Figure 15). Stakeholders forming the inner circle and especially their members may be interested in a membership in the private Association forming the new Partnership with the Commission. Whereas stakeholders in the outer circle are expected to establish MoUs and/or collaboration agreements with the SNS Partnership.

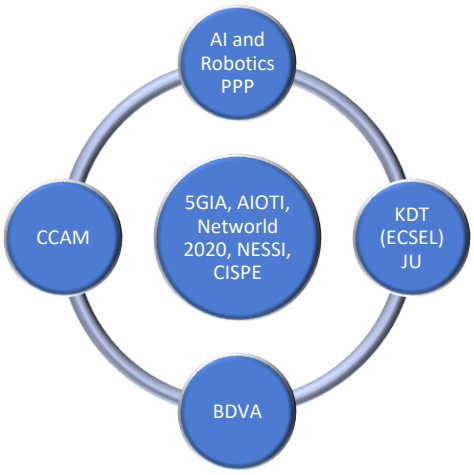


Figure 15 Different tiers of stakeholder involvement

All these stakeholders are essential to achieve the objectives in Section 1.2.1 by developing the technologies with the required performance and to achieve the expected impact on policy objectives (c.f. Section 1.1) as shown in Figure 16.

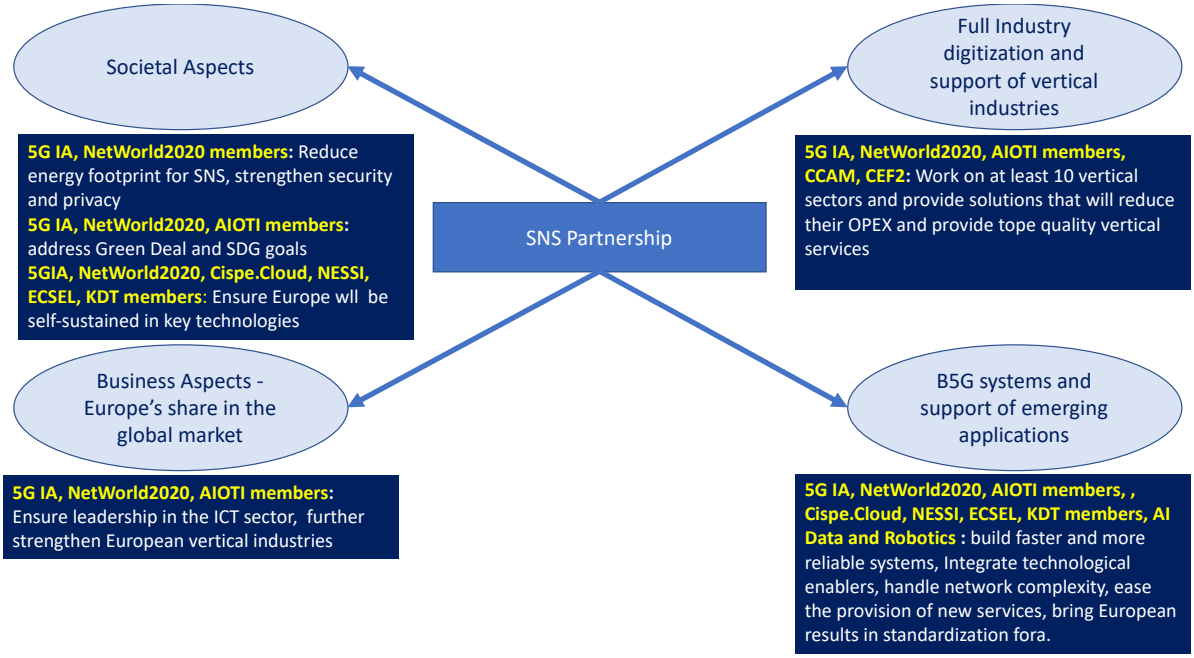


Figure 16 SNS Stakeholders and their link to the Partnership's objectives

1.4.2 Composition of Partners for the SNS Partnership

The SNS Partnership is supported on the public side by the EU Commission and EU Member States (c.f. Section 2.3) and on the private side (including industry, SMEs and academia) by the European ICT sector and vertical sector representatives with the capability to make the Smart Network and Services ecosystem happen. The already existing 5G-IA [82] will evolve and extend its constituency to represent the private side in the Partnership with its members and regional distribution in Annex 6. This proposal is supported by the enlarged European ICT sector with the organizations 5G-IA [82], Networld2020 [81], AIOTI [83], Cispe.Cloud [85] and NESSI [84] with its members and regional distribution according to Annex 7. All parties will be represented in the governance of the Partnership (c.f. Section 2.3). It is expected that public funding will only be committed by the EU Commission, and not by EU Member States. With respect to the strategic importance of communication networks for the European societies and economy and contributions to common policy objectives (Section 1.1) this inclusive approach is beneficial for identifying and steering research directions and trials under Horizon Europe as well as identifying 5G deployment activities under the CEF2 Programme. Especially, strategic discussions between the EU Commission, Member States and the private side will shape, in relation to and combination with national programmes:

- trial activities including access to frequency spectrum and infrastructures of new SNS systems and solutions and the
- identification of CEF2 5G deployment activities including access to major transport routes mainly in cross border regions and frequency spectrum

This should ensure the most efficient investment for all stakeholders and to achieve the ambitious objectives of the Partnership. The form of this involvement is further described in Section 2.3 “Governance”.

The current partner organisation (other than the Union) is described in Annex 6 (i.e., The 5G Infrastructure Association as the contracting partner from the private side in the SNS Partnership) and Annex 7 (i.e., the additional organisations supporting this proposal). The community on the private side is open and is continuously expanding, especially towards vertical stakeholders, thanks to the willingness of all actors involved to develop and deploy 5G-based solutions in many vertical sectors. With the advent of the SNS Partnership, the partners will also come from other domains such as IoT, cloud, Artificial Intelligence (AI), components and devices, and from vertical sectors that are not yet involved.

The industry partners have a significant global market share in their area of business. All these players have a long history in the last decades in collaborative research projects on European level on 3G/UMTS, LTE, IMT-Advanced, 5G and beyond including satellite, optical and broadband networks as well as in the cooperation with many other sectors in society and economy. This involvement has been instrumental in keeping European industry on the leading edge of telecommunications systems and services in a very competitive environment at global level.

Industry partners are actively involved in the development and standardization of all major communication network systems, standards, services and applications especially in vertical domains. It is intended to build on this success and the valuable experience gained in pre-competitive collaborative research.

The main role of SMEs is to provide contributions in terms of innovative and disruptive technologies, and to take advantage of their existing business activities in vertical stakeholders to develop 5G-based and beyond solutions and applications tailored to the needs of vertical sectors, that will take advantage of the features of 5G and beyond.

The research community’s contribution is essential to provide new paradigms, concepts and solutions for a medium- to long-term horizon.

It is expected that the development of Smart Networks and Services will continue more than ever to be based on an ecosystem of a close cooperation between industry, SMEs and the

research community to develop innovative, ubiquitous and affordable solutions and to ensure the acceptance and exploitation of these solutions in global standards and markets.

Industry will play a major role in the European Partnership with respect to the necessary long-term investment in global standardization and the integration of all technological contributions into complex interoperable and deeply integrated systems and solutions for various application domains. ICT network manufacturers, communication service providers and many vertical application sectors contribute significantly to the research and development of new global systems and standards and the development of new business models. The continuous dialogue between different stakeholder groups is essential to define appropriate new system capabilities with respect to requirements of many different application sectors, user experience and cost.

The private sector (industry and SMEs) in Europe that will be involved in the SNS Partnership will look at strengthening the communication sector in the development of Smart Networks and Services as well as to maintain the high European market share at global level, in cooperation with the research community. The ambition of those partners will be to make the SNS Partnership the major European initiative to boost research, development and innovation on future network infrastructures and services and in domains that can bring added value to future networks i.e. IoT, cloud, and AI. It also provides the platform for the development of a European data economy in cooperation with other initiatives to grow a European micro- and nanoelectronics (components) and devices industry in the IoT and vertical domains.

The SNS Partnership intends to continue defining, reaching and engaging all the relevant partners, including the newly involved partners. This has already been initiated within the 5G PPP, e.g. via the Networld2020 SME Working Group dedicated to engaging and promoting SMEs, the 5G-IA Verticals Task Force, that is coordinating the effort to engage with the most relevant vertical sectors, the 5G PPP Automotive Working Group, MoUs between the 5G-IA and European or international organizations in similar or complementary domains through participation in dedicated events, etc.

1.4.3 Target Groups and Stakeholder Communities

The identification and engagement of the relevant target groups and stakeholder communities has already been one of the main activities of 5G PPP. Figure 17 is showing the main stakeholder groups targeted, which have been checked with the constituencies of the 5G PPP via the project representatives.

The main targeted stakeholder communities were first identified at the beginning of Phase 2 of the 5G PPP and then updated in April 2020 at the core of Phase 3. Following the first stage identification, several actions were pursued to make sure that those communities were engaged in the most relevant manner, along with the progress of the initiative as a whole. For example, the business verticals stakeholders have turned from external players to which 5G promotion was the main action, into participants in the 5G PPP projects, at least in the main sectors targeted by the 5G PPP. Interaction with standardization organizations grew with the contributions to standard bodies from the projects.

5G related organizations were dealt with at European and international level mostly via MoUs and bilateral and multilateral events by the 5G-IA, leading for example to the organization of regular “Global 5G Events” co-organized by the 5G-IA and its related counterparts in other continents. SNS and the digital economy in general are critical domains for European technology sovereignty. Therefore, attention shall be paid to the international dimension with respect not only to sovereignty but also to security and privacy issues, European independence e.g. in components and devices, and other such critical areas.

The SNS Partnership will build on those stakeholder communities already engaged with the 5G PPP, but also with the other organizations involved in the other domains, already mentioned in the previous Subsection (most of them had been identified already in Figure 17 as part of the “5G-related organizations”). One of the main challenges will be to build the

effective bridges among the communities to build a renewed SNS community making room for all its components. The proven methodology from the 5G PPP will be re-used to such effect.

Beyond uniting several communities within common objectives and projects, additional stakeholders are also foreseen: civil society organisations, more verticals sectors will need to be involved, once a few first adopters will have demonstrated the interest of using 5G in their domain; there might also be new players involved in the evolution of 5G and in what is described nowadays as “beyond 5G” or “6G”. We cannot know at this stage all of them, which is why regular revisions of the targeted stakeholders need to be performed and that is part of the current process as well.

Another area where more stakeholders could play an important role in the SNS Partnership is an improved engagement with Member States and the national initiatives around the domains targeted by SNS. Beyond industrial and research communities, user groups and associations may become targets for results to ensure adoption of solutions. The request for an increased focus on societal impact may require additional activities beyond the activities in the 5G PPP.

In other words, the target stakeholders and the partners composition will be adapted throughout the lifetime of the Partnership to the evolution of the whole domain and the global technological, economic and societal context.

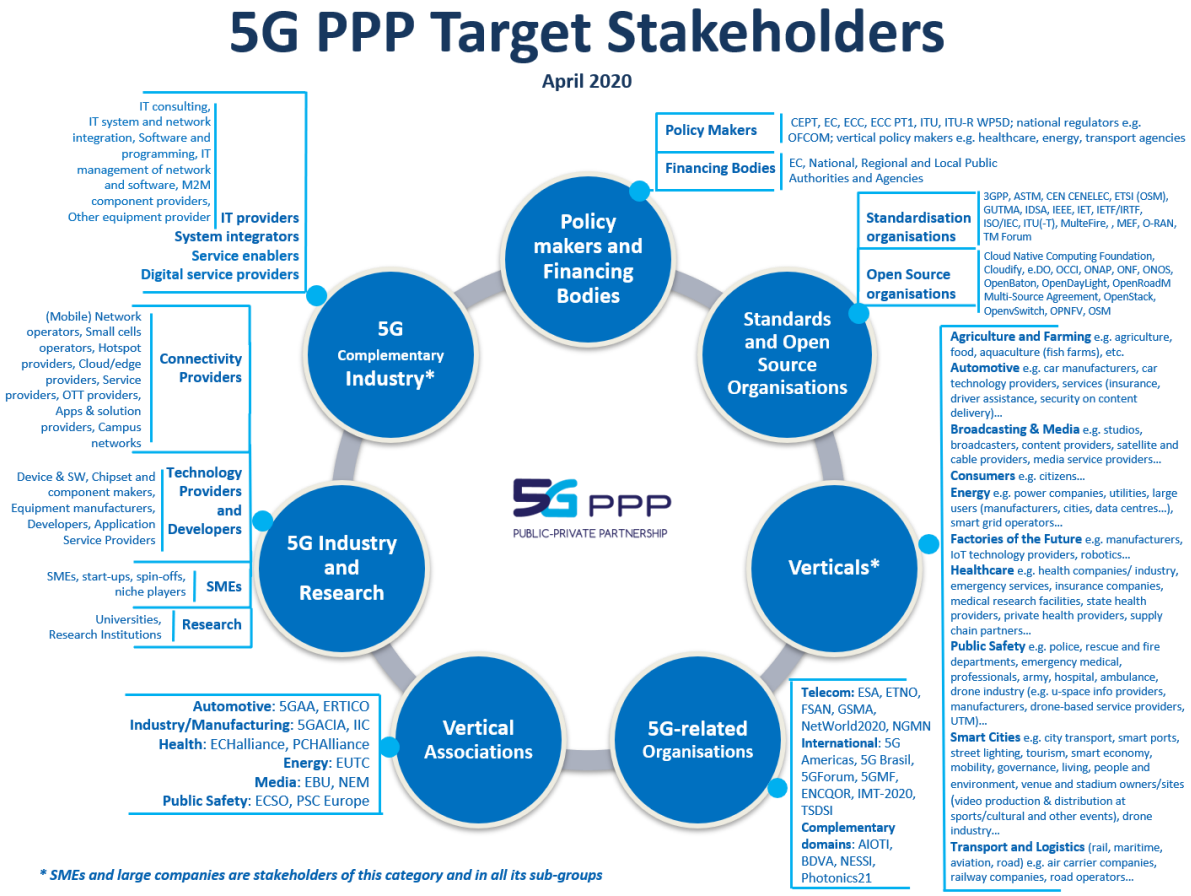


Figure 17 5G PPP Stakeholder Groups and Communities – Phase 3 of the 5G PPP

2 Planned Implementation

2.1 Activities

As explained in Section 1.3.2, **the scope of the SNS Partnership needs to consider the full value chain.** The scope of activities extends beyond "networks" to "networks and services" including SNS platform capabilities and services. In considering this end-to-end approach, several technologies and areas become relevant. Some of these areas make use of network technology and will be key for future “users” such as IoT. Some areas provide key technological components such as cloud computing, AI and cybersecurity and some areas have the potential to leverage the new smart networks technology to develop new industrial leadership for Europe such as big data and devices. However, including all these areas and technologies within the SNS activities would yield the Partnership too broad and disperse. Consequently, an approach to identify the common scope elements between network infrastructure and these end-to-end aspects has been carried out. The common portfolio has already been described in in Section 1.2.2.4. In the next section we describe how the identified work is organized in streams and phases. Next, the connection and coordination of this work with other activities in these areas is described. These complementary activities will be running in other Programmes and cross-national projects (Section 2.1.4) to ensure most effective alignment and impact.

2.1.1 Main activity streams and phases

The SRIA and the Partnership Work Programme for the SNS Programme, recognize as a starting point the aforementioned main subject areas and topics. Also, the SRIA takes into consideration a) the successful organization of Horizon 2020 and b) Horizon 2020’s results to be delivered just before the beginning of Horizon Europe. Thus, there will be both a smooth transition from the old to the new Programme, while at the same time new advanced research activities will also commence.

The various key SNS challenges and topics are mapped to one or more of four following main transversal streams in a way that fits the characteristics of the given stream:

- **Stream A:** *Smart communication components, systems and networks for beyond 5G systems.* Like the Phase 1 of 5G PPP, the focus will be oriented towards standardization activities, like 3GPP. This stream addresses the technology research and development for the Smart Network components and network infrastructure.
- **Stream B:** *Continuous research for radical technology advancement (in preparation for 6G and radical advancements of IoT, devices and software)*. Scheduled for a longer duration than Stream A, the key focus is for radical technology evolution. This stream is working for innovations and breakthroughs in networking as well as complementary technologies to achieve stronger value chains in both network services and network device components. This Stream will also address radical research and technology development in the areas adjacent to Smart Networks such as AI, IoT, security and high-performance distributed computing.
- **Stream C:** *SNS Enablers and Proof of Concepts (PoCs), including required experimental infrastructure (similar to Phase 2 of 5G PPP)*. This stream is taking input from the Streams A and B and is also used for a smooth transition from Horizon 2020 activities. The goal is to push service enablers closer to vertical applications by developing and experimenting though appropriate PoCs.
- **Stream D***: Large Scale SNS Trials and Pilots with Verticals, including the required infrastructure*. This Stream is like the Phase 3 of 5G PPP. It is positioned for co-creation, experimentation and advanced technological deployments with verticals to demonstrate both technological and business validation. For this Stream, again a smooth transition is envisioned from Horizon 2020 activities, to capitalize on existing results.

Figure 18 is summarising the major activities of the Partnership in an overall roadmap based on the SRIA during the lifetime of the Programme from 2021 until the end of the last activities

in the 2029/30 timeframe. There are two major and overarching roadmap tracks foreseen, namely the **"Smart Networks orientation"** track and the **"Verticals and Applications orientation"** track. This includes pre-standardization coordination and contributions to the next releases of the 5G specifications (Stream A), eventually evolving the full 5G specification to its maximum potential (i.e., Beyond 5G). It also includes experimental infrastructures (Stream C) and radical research activities (Stream B).

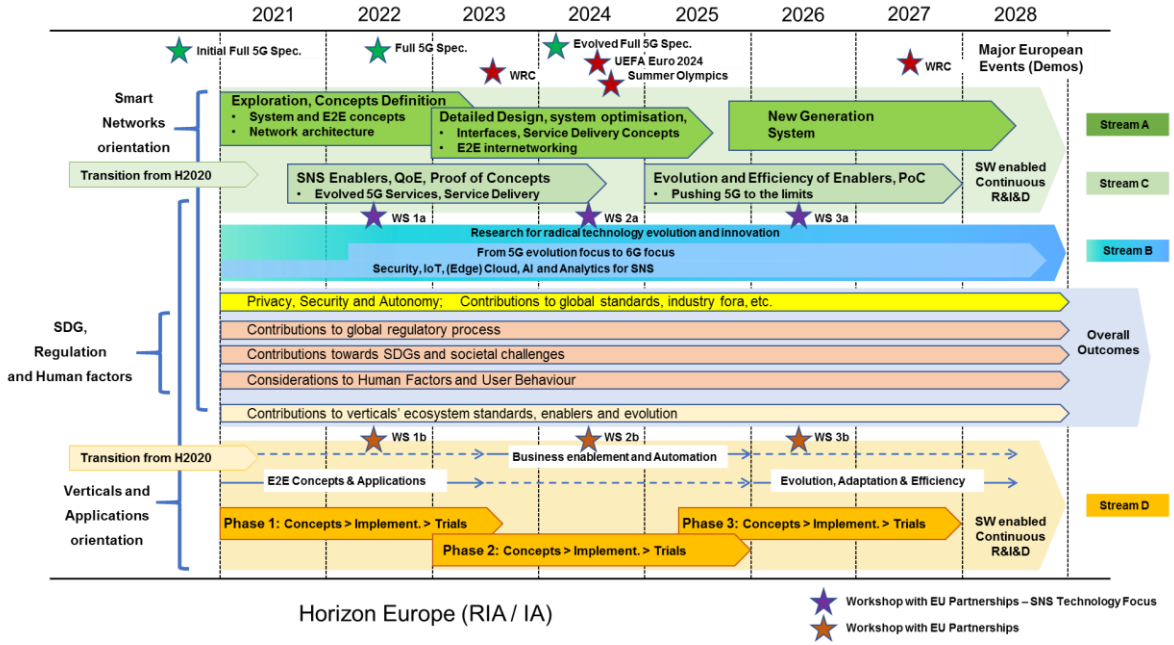


Figure 18 Main activity streams and phases

Considering major events, such as the WRC, this track will define the conditions for phase transition and help the "Verticals and Applications orientation" track to trigger new vertical oriented research, developments and innovation. The "Verticals and Applications orientation" track also capitalizes on the results of the experimental infrastructures (Stream C) and radical research activities (Stream B). Such phase transition should define the new advanced anticipated technology evolutions and conditions within areas such as dynamic radio resource management, virtualization, network embedded functions, edge cloud and fog computing, internetworking, routing and transport protocols, devices and satellite systems.

While there are several topics, elements, or properties of coordination and ways of work that will be common across all the main phases there are also elements or factors that will get more attention in a particular phase. This is for instance illustrated in the "Verticals and Applications orientation" – Stream D, where in the first phase it is important to continue the development of sound and robust end-to-end service concepts including holistic views of applications. High on the agenda, in the second phase, is the strengthening and expansion of business enablers and the amelioration of automation and cognitive management of resources and services across the value networks. These will be done according to the needs of the platforms and of specific verticals. For Phase 3, it is anticipated that advanced system adaptation and evolution support mechanisms will further strengthen the ability to adapt and change the solutions and systems effectively and efficiently according to changing conditions for the vertical sectors.

Figure 19 captures further characteristics and relationships between the two overarching streams and at the same item identify which technological areas, described in detail in Annex 4, are mainly addressed. As mentioned above, the "**Smart Networks orientation**" encompasses Stream A and Stream C and is driven by technology research and development according to foreseen technological opportunities and scientific advancements. The main research topics, or areas, are identified along with the high-level research agenda captured in Annex 4 and further developed by the SRIA for the SNS Partnership. The "**Verticals and Applications orientation**" which is mainly facilitated by Stream D is driven by applications addressing the full range of verticals and public sectors, end-customer value propositions,

business model enablement and solutions to mitigate societal and environmental challenges. As noted above, Streams A, C and D are all receiving contributions from Stream B. The research topics in Stream D will focus on exploring the application of technology, platforms and solutions, including socio-technical enablement, socio-economic factors, human factors, **regulation** and institutions. These points are described in detail in Annex 4, item 6 that covers "Human and socio-economic factors, regulation and institutions". The two streams complement each other, and effective feedback and information exchange mechanisms are anticipated as illustrated in Figure 19. This is important across the wide range of topics considered, exploiting and enabling digital transformation and innovation across the wider value chain, aiming at putting European industry and sectors into leading- and cutting-edge positions.

Figure 19 also shows that a large-scale trial infrastructure is essential to support large-scale trials and pilots, which are developed in SNS projects. Indeed, organizations require thorough testing facilities to develop products and solutions that are ready for deployment and commercialization. This is critical for SMEs, that do not have the resources to invest in such infrastructures on their own. It is therefore of utmost importance to plan in the SNS Partnership to set up test and trials infrastructures that would be open to SMEs (and possibly to other types of organizations), that would allow trials that are close to real business/commercial environments. Such infrastructures could be set up in SNS projects by e.g. telecommunications operators, organizations dedicated to providing test beds, and vertical players for trials in their domains. They should be open to SMEs for testing, ideally for free or for a small fee. The Partnership should also consider funding projects dedicated to setting up such facilities and being open for SME tests. Still another option would be to organize "call for trials" that would be issued by specific projects in charge of setting up and maintaining those facilities, offering awards or grants to SMEs.

These activities will also explore and exploit, infrastructures available at Member State level to optimize efficiency.

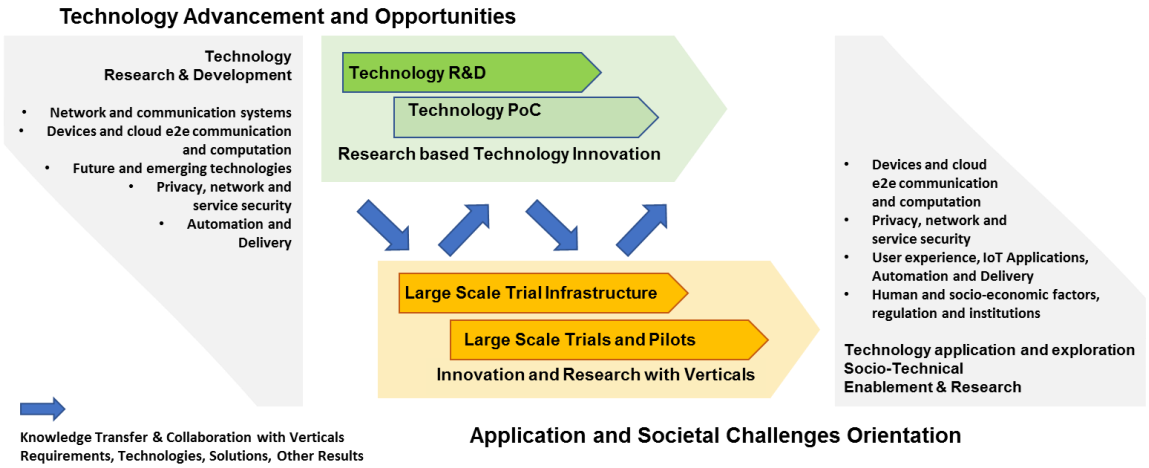


Figure 19 Characteristics of Technology advancement vs Application orientation

The main activity streams will be flexible and adaptable to potential radical evolutions in technology and services uptake and ecosystem changes as well as taking on-board feedback from trials by verticals and their deployments and innovations. **This includes taking on-board experiences and learnings from the Phase 3 of the Horizon 2020 5G PPP and the anticipated phases of the Horizon Europe Partnership and other relevant bodies**. This is considered by the value chain approach discussed in Section 1.3.2.

Moreover, to **ensure and strengthen the collaboration and interaction with a broad range of adjacent Partnerships, bodies and EU activities, a series of workshops with other partnerships are foreseen.** These workshops will take place prior and during the planning of Work Programmes to ensure transfer of valuable technical information among Partnerships (e.g., faced, obstacles, key achievement, breakthroughs etc.) This will as well enable the SNS

Partnership to address and contribute to solving societal challenges. These workshops will also be aligned with the efforts needed to update the SRIA. The workshops are highlighted in Figure 18 and are expected to take place in a biennial basis (i.e., they follow the three main phases of the Programme).

Building from the Collaboration Agreement of 5G PPP, the SNS Partnership will strengthen its mechanisms for cross-project collaboration. It will facilitate and ensure that its high-level objectives will be met. While focusing on its own core RIA and IA actions and activities, the Partnership will include additional mechanisms to facilitate research-driven impact assessment and creation, cross-project collaboration, interaction with external and adjacent entities, as well as a self-assessment, which all together can ensure agility and impact at the industrial level as well as at the level of societal challenges (Figure 20).

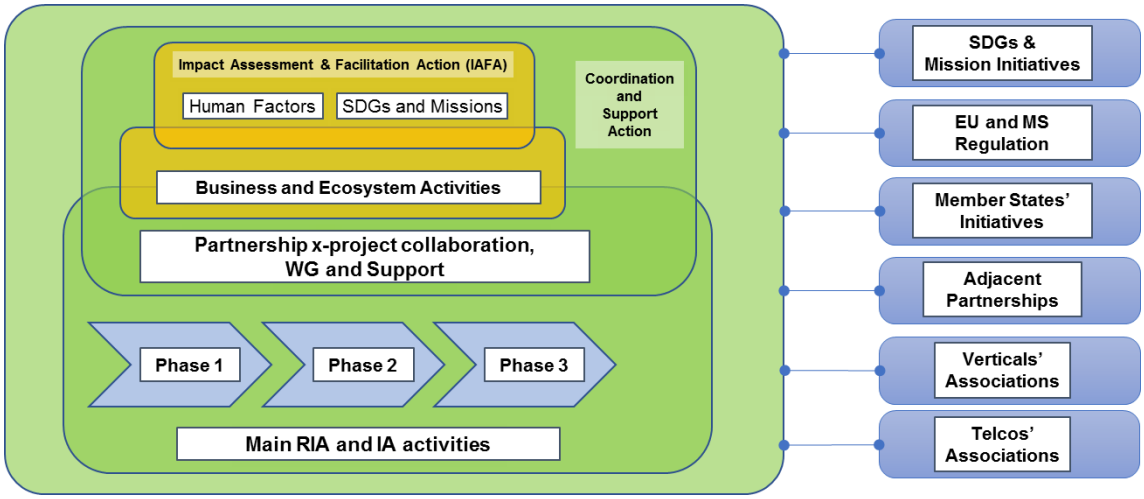


Figure 20 Partnership main types of activities and interaction with adjacent activities and bodies.

As discussed in the previous sections, societal and environmental sustainability challenges and the high-level demands and requirements will be addressed through continuous research and development efforts. The variety of research and development topics that have been identified will be covered by the initial and future SRIAs. The proposed roadmap takes these points into consideration. At the same time, it addresses how Smart Networks and Services technology research and development must be performed in a sustainable economic and industrial context. The research, trials, deployment, adaptation and uptake of the solutions will require deep knowledge into a) vertical industries and sectors, b) socio-technical and innovation system mechanisms and processes, including standardization, as well as c) innovations in business models and ecosystem platform development and evolution.

To ensure and facilitate for these anticipated effects, the Partnership proposes to strengthen these areas into specific activities and to establish "Impact Assessment and Facilitation Actions" (IAFA) that are research-based activities and that ensure relevance and impact as well as effective processes and activities to achieve these goals[3]. These activities will then bring in competence from industry analysis, ecosystems and innovation (e.g., platform ecosystems) and business models, regulatory and institution research and impact assessment competencies. To complement these factors and topics, research-based activities are also foreseen to address human factors, user behaviour and technology uptake and domestication. While typically, the CSAs focus on Programme internal coordination support, **the Impact Assessment IAFA activities** will focus on interaction with adjacent Partnerships, initiatives and relevant Associations to ensure relevance and synergies in both directions. This includes the Partnership workshop approach described above and illustrated in Figure 18. The

[3] These activities proposed by the SNS Partnerships could be implemented inside specific Coordination and Support Actions (CSA).

mechanism enabled by these activities and the bodies to interact with are further elaborated in the Sections 2.1.2 and 2.1.4.

The abovementioned activities, together with the Business Validation and Ecosystem activities, will enable a strong industry-focus to ensure industrial relevance and to follow up on the ambitions identified above on multi-actor coordination and collaboration arenas, interaction with public sectors and stakeholders, as well as standardization coordination and open source software coordination and facilitation. This way, the SNS Partnership defines the right balance and timing among the major areas and topics as well as their coverage and considerations within the main activity streams. The SNS Partnership ensures the best way to address these areas and topics and provide an effective technological progress and a high impact on the objectives of the Work Programme. The phasing and profile of each of the streams will be further considered and decided through the work with the SRIA and the specific planning of and input to the specific Work Programmes.

2.1.2 Complementarity of Joint Activities and related Mechanisms

This section details the key targeted interactions and related mechanisms, between the SNS Partnership and the other relevant initiatives of Horizon Europe, including other relevant European Partnerships and EU actions / initiatives beyond Horizon Europe.

The Smart Networks and Services Partnership will target strong synergies with other EU Partnerships to be implemented in Horizon Europe and with the specific actions to be implemented in the Digital Europe Programme as detailed below (c.f. Section 2.1.5).

As discussed in Sections 1.1 and 1.2, Smart Networks and Services are core enablers for a variety of forward-looking scenarios and applications in need of agile, robust and ubiquitous connectivity, upon which the development of our society relies. The Horizon Europe vision is indeed centred around the capability to strengthen science and technology, so as to foster industrial competitiveness, and implement the UN Sustainable Development Goals in the EU [92], as detailed in Section 1.2. The current draft list of EC Horizon Europe targeted Partnerships is captured in Figure 21. The SNS Partnership included in the Digital, Industry and Space Cluster is targeting specific interactions with several Partnerships.

The SNS Partnership will target very tight interactions within the Digital, Industry and Space Cluster with the High-Performance Computing (HPC), Key Digital Technologies (KDT), AI, Data and Robotics and Photonics Europe Partnerships. In addition, the SNS Partnership will also target specific information sharing and potential specific dedicated actions with some of the Partnerships with Verticals ecosystem focus (e.g., Towards zero-emission road transport, CCAM, Integrated Air Traffic Management, Accelerating Farming System Transition, etc.). The SNS Partnership is planning to have similar ties with some of the Partnerships with Societal Challenge focus (e.g., Carbon Neutral and Circular Industry, etc.). Specific Memoranda of Understanding (MoUs) will be developed with different Partnerships and include (among others) the organization of joint activities (e.g. joint workshops).

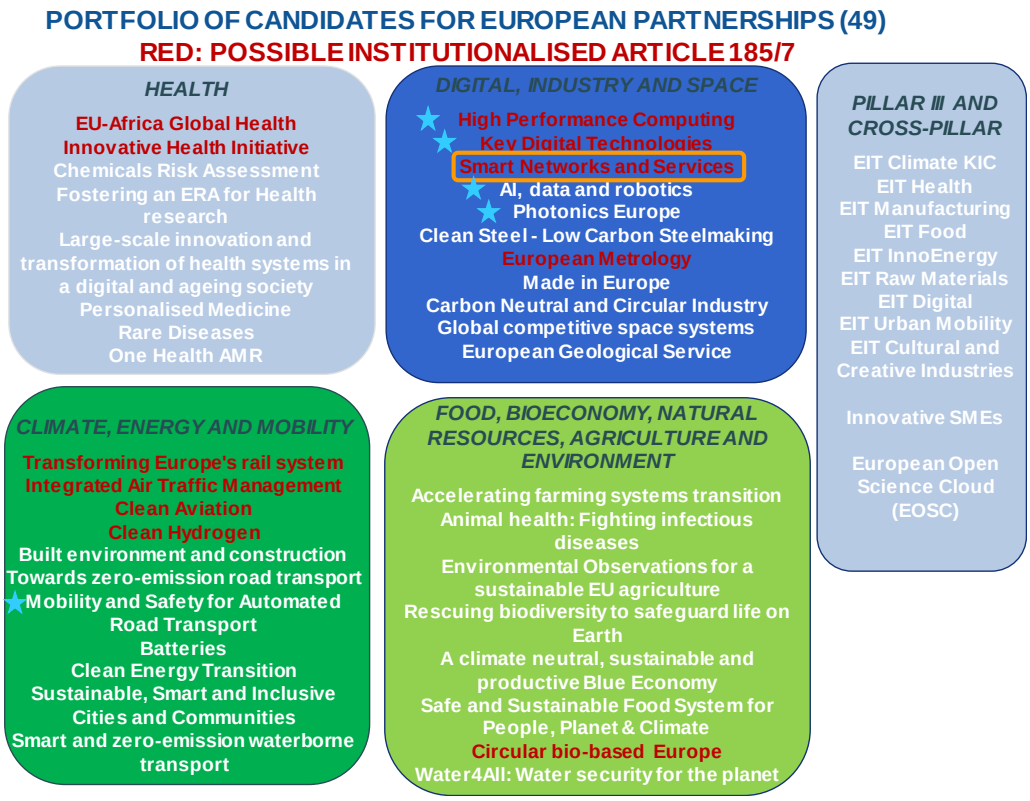


Figure 21 Horizon Europe (HEU) Targeted Partnerships (Draft) and potential related Partnerships (Mobility and Safety for Automated Road Transport Partnerships will be re-named in CCAM – Connected, Cooperative and Automated Mobility)

In addition to Horizon Europe, the EC has created a new Digital Europe Programme to shape and support the digital transformation of Europe's societies and economies that will have five focus areas: **Supercomputing/High Performance Computing**, **Artificial Intelligence**, **Cybersecurity and Trust**, **Advanced Digital Skills**, and "**Ensuring the wide use of digital technologies across the economy and society**".

Although an exhaustive analysis of how smart connectivity is deeply interleaved with these five Digital Europe Programme focus areas goes beyond the scope of this document, a brief overview of the SNS Partnership relevance to the Horizon Europe and Digital Europe Programme focus areas is provided in the following.

Note that for the planned collaborations with the following selected Partnerships and technological areas, specific interactions, including workshops, thematic meetings etc., will be organized and dedicated joint white papers will be developed to address priorities of common interests.

2.1.2.1 Supercomputing and High-Performance Computing (HPC)

HPC Research and Innovation actions will be implemented in both Horizon Europe and Digital Europe Programme in the context of the EuroHPC Partnership.

Europe is emphasizing on the race for exa-scale high power computing, pursued through the EuroHPC Joint Undertaking (JU). Cross-European data-intensive applications, exploiting the foreseen computing infrastructure, will entail the existence of fast, secure and reliable networks. In this sense, the interconnecting networks have the potential to become an integral part of the critical and strategic HPC infrastructure, provided that synergic efforts and investments are realized. Thus, Smart Networks and Services emerge as a key enabler for the transformation in the HPC/ domain.

From the SNS perspective, a cooperation with EuroHPC is envisaged to provide the high-performant and secure networks for the required interconnection to enable HPC applications.

2.1.2.2 Artificial Intelligence (AI)

AI research and innovation actions will be implemented in both Horizon Europe in the context of the AI, Data & Robotic Partnership and the Digital Europe Programme.

AI has recently gained a lot of momentum as a technology with applications in a myriad of areas, which include healthcare, infrastructure inspection and maintenance, transport, and agile production to name a few. More recently, AI is also being perceived as a potential technology solution to cope with the increasing complexity of SNS system design and associated management. Besides the applicability of AI in the SNS domain, AI itself capitalizes on digital technologies and access to data centres for Big Data applications and evaluation.

Therefore, there is a mutual interest between AI initiative and Smart Networks and Services to apply appropriate AI algorithms in Smart Networks and Services as well as to provide high-performant and secure networks for AI applications in other areas.

2.1.2.3 Cybersecurity and trust

The Generic Cybersecurity research and innovation actions will be implemented in the next Programs with a novel governance based on the forthcoming European Cybersecurity Competence Centre (ECC).

Smart Networks and Services have become extremely sensitive with respect to network security, privacy and data integrity. This leads to at least the two major priorities data and information protection and becoming a key segment of numerous economic sectors through the digital transformation.

Future communication networks must provide diverse security levels up to critical requirements, as initially declared in the Cybersecurity Act. Starting from basic level, objectives of the Act will be developed by the European Union Agency for Cybersecurity (ENISA) including advisory inputs from European Cybersecurity Organization (e.g. ECSO), which gathers representatives from both public (National Security Agencies, Regions) and private (industrial, academics) sectors.

Cybersecurity threats related to the Smart Networks and Services need to be considered. Therefore, the cooperation with cybersecurity initiatives is essential for Smart Networks and Services to achieve the necessary security level. As such Smart Networks and Services constitutes a major application domain for cybersecurity solutions which in turn support many other vertical use cases. Fulfilling the requirements of European Certificate demanded by the Cybersecurity Act and ongoing actions specified in the 5G specific Toolbox will allow awareness of the security level of the Smart Networks and Services.

ECSO attended by more than 260 industrial members (more than 2500 entities represented in total) develops vertical sector's requirements and objectives for products or services. ECSO also elaborates its SRIDA supporting future actions in the context of both Horizon Europe and Digital Europe Programmes. Cross participation of the communities and institutional relations allow to converge on a common understanding of priorities dedicated to the SNS sector.

2.1.2.4 Key Digital Technologies and Photonics

Key Digital Technologies and Photonics research and innovation actions will be implemented in Horizon Europe in the context of both the KDT and Photonics Europe Partnerships. Components (micro-electronic components) and devices mainly for IoT and vertical sector applications are essential elements of future secure and trusted networks and to support the digital autonomy of Europe. The SWOT analysis in Section 1.1.6 has shown that industry in Europe needs to rely today on its supply chain for micro-electronics components especially for communication and computing on vendors from outside of Europe. With respect to increasing demand and expectation of secure and trusted networks especially for critical infrastructures

there should also be an alternative European offer available for such devices as an additional source to latest technologies to complement the European value chain and to mitigate gaps identified in the SWOT analysis.

2.1.2.5 Approach for components

European semiconductor players are stronger in IoT and secured solutions, while mass-market oriented market are dominated by US or Asian players. For European industry to capture new business opportunities associated with our connected world, it is crucial to support European technological leadership in connectivity supporting digitization based on IoT and Systems of Systems technologies.

Increasingly, software applications will run as services on distributed systems of systems involving networks with a diversity of resource restrictions.

It is important to create the conditions to enable the ecosystem required to develop an innovative connectivity system leveraging both heterogeneous integration schemes (servers, edge device, etc.) and derivative semiconductor processes already available in Europe.

Smart services, enabled by smart devices will be used in a variety of application fields, being more user-friendly, interacting with each other as well as with the outside world and being reliable, robust and secure, miniaturized, networked, predictive, able to learn and often autonomous. They will be integrated with existing equipment and infrastructure – often by retrofit.

Enabling factors will be: Interoperability with existing systems, self- and re-configurability, scalability, ease of deployment, sustainability, and reliability, will be customized to the application scenario.

Related to technological game changers in 5G network infrastructure, Europe strengths are RF SOI and BICMOS technologies for cost-effective GaAs replacement, FD-SOI for integrated mixed signal System on Chip (SoC). Possible international collaborations could be leveraged.

The 5G technologies and beyond will utilize the sub-6 GHz band and the spectrum above 24 GHz heading to millimetre-wave technology moving towards 300 GHz and Terahertz frequencies for 6G technologies.

The design of electronic components and systems to provide the 5G and beyond connectivity have to take into account the new semiconductor processes for high-speed, high-efficiency compound semiconductor devices considering the significant increases in the density of wireless base stations, wireless backhaul at millimetre wave frequencies, increased transport data rates on wired networks, millimetre wave radios in 5G equipment and multi-frequency/multi-protocol IoT intelligent nodes to support higher data rates, more devices on the network, steerable beams resulting from massive MIMO antennas, low power consumption and high energy efficiency.

It is expected that the mobile and intelligent IoT devices will have access to edge computing capabilities and intelligent connectivity using multi-frequency/multi-protocol communications technologies. Cellular IoT devices covering higher frequencies will need to integrate microwave and analogue front-end technology and millimetre wave monolithic integrated circuits (MMIC).

The development of 5G technologies and beyond requires semiconductor technologies that are used for RF devices, base stations, pico-cells, power amplifiers to cover the full range of frequencies required. The new Horizon Europe SNS and KDT Partnerships must address the development of III-V semiconductors-based GaAs, GaN, InGaAs, SiC semiconductor technologies to implement new components, devices and systems to have the edge in efficiency and power usage needed for base stations.

The new devices for 5G technologies and beyond need to combine RF, low operating power, thermally and energy-efficient, small form factor and heterogeneous integration of different functions. These new requirements push for creating new components based on multi-chip

modules and Silicon in Package (SiP) and various technologies that combine the capabilities of silicon CMOS with III-V semiconductors.

The focus for new 5G and beyond connectivity IoT devices is on providing new components including hybrid electronic circuits able to operate with better stability, less noise, providing increase functionality, complexity, and performance. The new functionalities include stronger security mechanisms and algorithms integrated into the devices and components and designed for easy implementation of end-to-end security at the application level.

Activities need to be aligned with the KDT Partnership to develop 150 mm and beyond wafers for III-V semiconductors on Silicon to provide the components for 5G and beyond wireless cellular networks and devices for providing optimum use of available bandwidth for millimetre-wave and higher frequencies.

The proposed SNS Partnership will support component research, development and design through tight links with other initiatives to provide the know-how and later the design and production of communication and computing components.

These activities will help to facilitate the re-launch of the micro-electronics industry in the ICT domain in Europe by means of cooperation with the ECSEL JU and/or the proposed Key Digital Technologies Partnership by promoting the development of European added value embedded solutions for innovative and secure applications. Smart Networks and Services will develop the communication know-how and IPRs and will provide algorithms to the micro-electronics industry, which will be dealing with the design and production. With this approach ongoing activities in the ECSEL JU and/or the proposed Key Digital Technologies Partnership can be leveraged. From the Smart Networks and Services perspective that could be a fabless approach. Joint activities among different Partnerships under Horizon Europe will involve the appropriate expertise from different communities.

2.1.2.6 Approach for devices

Devices and especially end devices for IoT and vertical applications including critical infrastructures are an essential part of future networks. In addition to components they also must fulfil a high security level. – The focus will not be on high volume consumer electronics such as smart phones. Therefore, Smart Networks and Services will enable and validate specialized devices for IoT and sensor systems especially for vertical sectors by leveraging system on chip activities and specifying the way they communicate in the network/systems as well as controlling them and integrating them in their operational systems in vertical (and as well cross-vertical) application domains by means of cooperation with the ECSEL JU and/or the proposed Key Digital Technologies Partnership and leveraging AIOTI activities. System on chip activities can be leveraged for such industrial device activities. The close cooperation between vertical sectors and the ICT industry in Europe will support the development of entire communication and networking solutions in Europe. These activities offer opportunities for start-ups to design communication modem chips and other components devised for many vertical applications.

2.1.3 Advanced digital skills

Growth, jobs, innovation, growth, and European competitiveness requires a strong digital economy. The pervasive digital transformation that is expected to be achieved thanks to Smart Networks and Services will have an unprecedented impact on the labour market and the type of skills needed in the economy and society. Moreover, it will also impact on increasing EU's international competitiveness together with developing and reinforcing Europe's strategic digital capacities [2].

In particular, the new business opportunities related to Smart Networks and Services have the potential to change the structure of employment, leading to the automation of "routine" tasks and to the creation of new and different types of jobs. On top of that, digitisation can change the way we learn by fostering online communities, by enabling personalized learning

experiences, by supporting the development of soft skills such as problem solving, collaboration and creativity, and by making learning fun.

Universities and research centres will be directly involved in SNS bodies, the Association and especially in SNS projects. This helps to develop necessary skills on new technologies by direct involvement in research and innovation actions. In addition, research results are disseminated through universities, and public workshops and webinars will be offered, which will be organized under the leadership of the Steering and Technology Board (c.f. Section 2.3.3), The SNS Partnership will support skill development activities by involving students and other people for training activities in new technologies and skill development to ensure that well-educated experts are available for the growing ICT job market for the newly upcoming business models.

2.1.4 Cross-national coherence and synergies

The SNS Partnership will define the key research and innovation priorities to be addressed in the Partnership's Open Calls, based on the Partnership's SRIA and the SDA. The text of the Partnership Open Calls will be published in the Partnership Work Plan. The Partnership will leverage on the successful approach of the Pre-Structuring Model (PSM) developed in the context of the Horizon 2020 5G PPP by the 5G-IA's members. The goal of the PSM is to ensure that the consecutive set of projects (portfolio) work together in a complementary manner within and in consecutive phases of the programme. The PSM is focused on projects portfolio and related projects. The PSM is presenting features and recommendations to enable a smooth integration of new projects in an existing coordinated programme. It is also targeting system recommendations to develop future efficient cross-projects cooperation, ensuring a comprehensive coverage of research and innovation topics, with minimized gaps or redundancies. The PSM for a dedicated Call is presented during specific Information Days (organized in Brussels and in different EU Member States) and is enriched through community feedbacks and specific public Consultations.

The definition of the Partnership Work Plan will also consider the different national research and innovation activities to possibly maximize synergies and leverage existing national developments, e.g. platforms and hubs. As current examples, the SNS Partnership will rapidly liaise with the different 6G initiatives and programmes started in specific EU Member States as well as relevant smart network and digitization R&I initiatives and programmes. Specific interactions, including workshops, thematic meetings etc. will be organized with the stakeholders involved in the national programmes in order to develop synergies and maximize impact at EU level. The Partnership will leverage the experience gained in the context of the Horizon 2020 5G PPP and the related EC Study EU 5G Observatory (E5GO) and an equivalent Observatory will be started from the early stage of the proposed Partnership, taking benefit from the E5GO experience and targeting a possible joint co-definition (EC, private side and Member States) of the Observatory objectives and roadmap (including targeted outcomes, timing and inputs from the different stakeholders). The Partnership will also leverage the experience gained in the context of the 5G PPP with the specific Platforms Cartography summarizing the key information on research and innovation Platforms available in the different Member States and supported by both national and EC funding.

Finally, the SNS Partnership will also enable very strong synergies between Member States actions in connection to the CEF2 Programme, as detailed in Annex 3.

2.1.5 SNS Programme synergies: The complete picture

The challenges targeted by the SNS Partnership require a close collaboration with other partnerships, associations, and the EU Member States to benefit from synergies. Figure 22 illustrates that the SNS Partnership will collaborate with other related candidate European Partnerships through several scheduled Workshops during its lifetime. The Impact Assessment and Facilitation Actions (IAFA) activities will also assist in the collection, dissemination and coordination of information across stakeholders. The same activities will also be used to exchange information with all related associations targeting mainly topics

related to strategic decisions, business case evaluation and socio-economic issues. Finally, the SNS Programme will have close coordination activities with the Member States to achieve the best coordination with the CEF2 activities. As mentioned in the previous Subsection, an Observatory may also be used to coordinate activities and roadmaps (including targeted outcomes, timing and inputs from the different stakeholders).

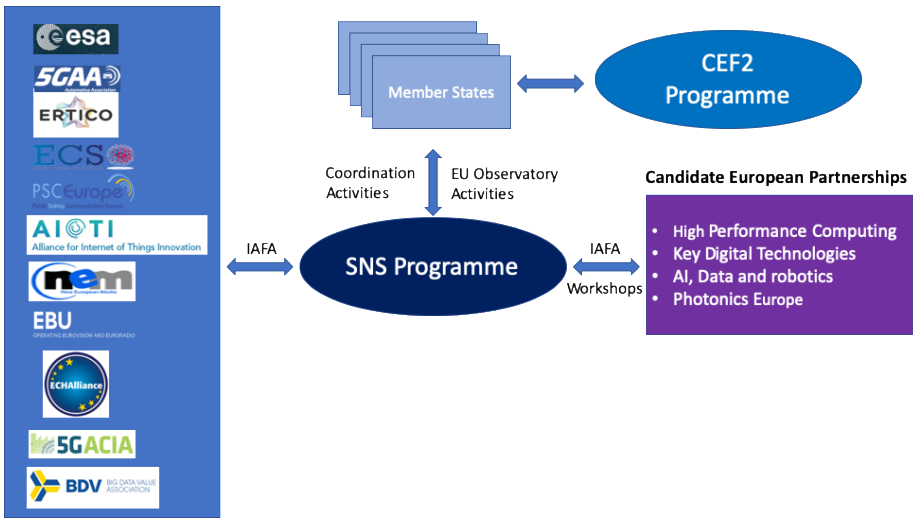


Figure 22 Characteristics of Technology advancement vs Application orientation

2.2 Resources

In this section the budget estimate and contributions from the private side are described.

The **overall cost** in the core industry to develop a new communication system including research and development, standardization and product development and testing in the time frame 2021 to 2029 (assumed lifetime of the Partnership) is expected with at least be 30 Billion € (c.f. Section 1.2.4). **It is estimated that to achieve the objectives of the SNS Partnership proposal** between 2021 to 2027, around 2 Billion € (public and private investment included under the planning assumption of 1 Billion € public investment [4]) will be required. It is expected that the Partnership will catalyse a leveraging factor for additional private investment for research and innovation activities in industry, including in-kind contributions for additional activities. These additional activities in the wider SNS context will take place outside the Partnership and in the competitive domain. Partnership activities will be limited to the pre-competitive domain.

Resources contributed by the private side will be:

- In-kind contributions to the projects funded by the Union contributions (based on non-reimbursed eligible costs);
- In-kind contribution for additional activities foreseen in the SRIA not covered by Union funding;
- Investments in operational activities that is spend beyond the work that is foreseen in the SRIA.

The absolute value of the commitments of the private side as well as in-kind contributions in the SNS Partnership context will be agreed based on the final SRIA, which is currently produced by the Networld2020 ETP.

An initial indicative list of **additional activities** includes (provided that such activities can be reported in a trusted way with respect to confidential information and company secrets):

- Spin off Research and development in scope of Smart Networks and Services
- Contributions to standardization

[4] The private investment under the umbrella of the SNS Partnership will be adapted depending on the public investment.

- Contributions to the regulatory process, e.g. preparation of forthcoming WRCs via the European process in CEPT/ECC and ITU-R, regulatory impacts in key diving policies and notably societal domains including Green Deal, EMF, key SDG's, cybersecurity
- EIB (European Investment Bank) loans
- Contributions to all 5G-IA WGs and NetWorld2020 WGs, which are not funded by projects
- Potential support the Programme Office in case of an Institutionalized Partnership
- Activities to develop the ecosystem including verticals
- Dissemination activities of results globally to achieve consensus on supported technologies as preparation of future standards
- Trials, demos and pilots, e.g. for vertical applications, which are extended beyond publicly funded projects
- Pre commercial trials
- International cooperation

In addition to the in-kind contributions and additional activities, the private side provides further contributions

- to Partnership activities such as dissemination activities and direct Partnership contributions to global standardization;
- to manage the Association and to support Association activities such as workshops, presentations and publications, activities and provides resources, which are linked to market, regulatory, societal or policy uptake;
- to contribute to activities of the Networld2020 European Technology Platform especially for the regular update of the SRIA.

The private side is financing and organising the Association by a membership fee, the amount of which depends on the type of member category such as industry, SME, academia and Associations. The staff members of the Association such as the Executive Director / Secretary General and Head Office are financed by the membership fees.

The Association is organising and supporting Working Groups under the umbrella of the Association especially on strategic and policy-related topics, which are only funded by the private side.

The individual organizations of the private side will actively participate in the proposal preparation and the actual research work in selected projects under the Partnership umbrella.

Further, the private side will actively support cross-project activities: governing bodies in the SNS Initiative (e.g., Steering Board, Technology Board) and Working Groups.

In the CEF2 part, the private side is developing regular updates to the Strategic Deployment Agenda for the preparation of respective cross border projects in cooperation with the EU Commission and Member States.

As a major result of the Partnership, the private side will prepare future deployments of newly developed technologies and solutions by contributing to the global standardization and the regulatory process to ensure economic exploitation and impact. These are mainly performed outside of the core Partnership activities, typically as part of the leverage factor and in-kind contributions to additional activities.

For an Institutionalized European Partnership, the management of the programme is organized by an Office, where the cost is shared between the EU Commission and the private side. With respect to today's knowledge, the Office cost are expected in the order of 2 Million €/year at the beginning. This cost should be shared equally between the EU Commission and the private side, which results in 1 Million €/year at the beginning. With an assumed annual inflation rate of 2 % the total Office cost for an assumed lifetime of the office of 9 years from January 1, 2021 to the end of the last projects around end of 2029 correspond to 9.75 Million € for the private side.

The private side will mobilize the private contribution to the Office.

The monitoring arrangements will follow the rules set out in respective legal basis [47], [48] to monitor the contributions of the private side. It is proposed that the SNS Partnership will setup, in collaboration with the EC, those mechanisms to collect the information from the private side without risking exposing confidential information or company secrets.

Each year the SNS Partnership will deliver detailed information in the form of an Annual Journal and a Progress Management Report that will contain information about the technological and the financial progress of the Programme. The results will be evaluated every two years so that corrective actions are undertaken by the governing body in case where there is a deviation from the agreed plan.

According to Section 2.1, each programme phase comprises research and technology development activities and trials. Towards the end of the programme, the focus will move towards large-scale trials. Therefore, towards the end of the programme the necessary budget will be higher than in the first exploratory phase. The following assumptions apply for a relative budget estimate during the lifetime of the programme:

- The total funding from the Horizon Europe budgets 2021 to 2027 corresponds to 100 % (red line aggregated budget in % in Figure 23).
- The relative effort in year 1 will increase from 100 % to 150 % in year 9 (orange bars in Figure 23). The effort is linearly increasing from year to year.
- An annual inflation rate of 2 % is assumed.
- The annual relative funding budget (blue bars in Figure 23) is estimated based on the growing effort including the inflation rate.

The budget for the different Calls for Proposals will be adjusted to the Call objectives within the overall proposed budget frame of public funding.

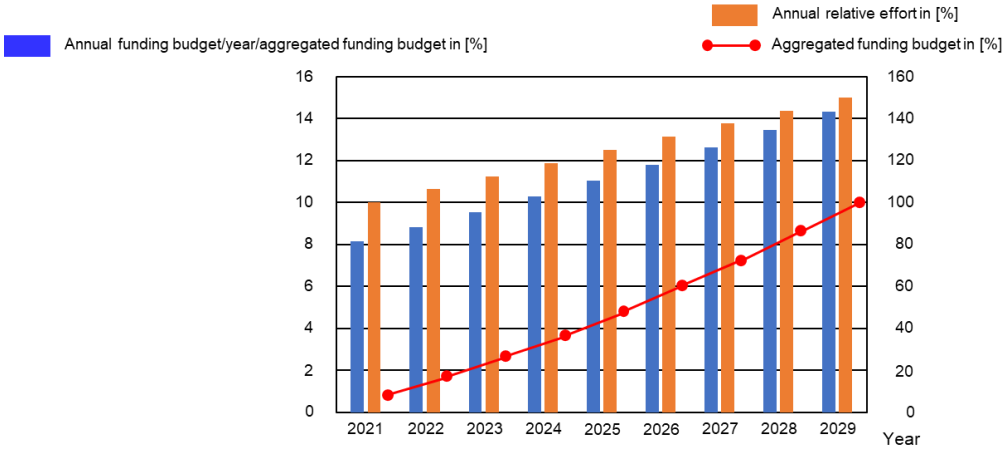


Figure 23 Estimated relative annual funding budget in [%], relative effort in [%] and aggregated funding budget in [%]

2.3 Governance

This Section is describing the overall organization of the Partnership and the decision-making procedures.

2.3.1 Smart Networks and Services within the next Multi-Annual Financial Framework

The actors behind the SNS Partnership proposal prefer a Co-Programmed European Partnership with respect to the privately organized ICT sector in Europe and the expected reasonable complexity of this instrument concerning administrative overhead, flexibility and decision-making procedures.

However, the private side is also considering an Institutionalized European Partnership (e.g. Joint Undertaking). An Institutionalized European Partnership provides a higher level of

integration of all stakeholders with respect to the strategic importance of the sector but appears to be a more complicated set-up compared to a Co-Programmed European Partnership.

The final decision depends on the outcome of the ongoing discussions in the public sector about the implementation of Horizon Europe and an in-depth Impact Assessment of the potential instruments. A final decision on the implementation is expected by mid of 2020.

In the following Subsection a generic governance structure is described.

It is intended that the Partnership will address two programmes in the next Multiannual Financial Framework namely, a) Horizon Europe for research and technology development activities and b) Connecting Europe Facility 2 (CEF2) 5G for deployment activities. Newly developed technologies as well as deployed systems may be applied for applications under the Digital Europe programme (DEP). Figure 24, shows the value chain of Horizon Europe and the Connecting Europe Facility 2 (as well as Digital Europe Programme), which are the basis for the Smart Networks and Services Partnership.

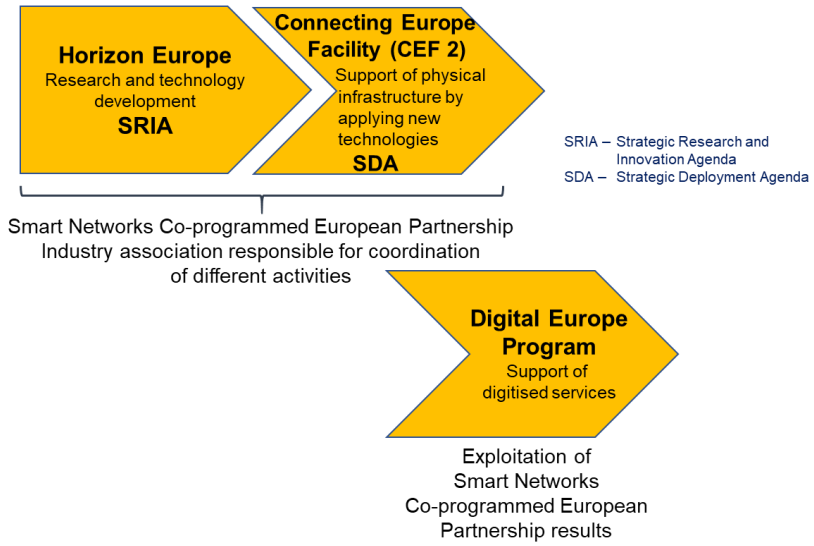


Figure 24 Value chain of Horizon Europe and the Connecting Europe Facility 2 (as well as Digital Europe Programme)

Further technology developments are performed in Horizon Europe under the Area of Intervention NGI (Next Generation Internet). The proposed research efforts are described by a Strategic Research and Innovation Agenda (c.f. Annex 4). Deployment activities closer to the market are handled under CEF2, where a Strategic Deployment Agenda (SDA) is needed. In the proposed SNS Partnership, the Industry Association, hereinafter referred as the Association, is intended to be responsible for the coordination of these activities as far as the private side is concerned. with different financing instruments from the different programmes Horizon Europe and CEF2. The EU Member States will be involved especially in the CEF2 Programme for deployments (e.g., in major transport corridors as well as also for research activities) and especially for strategic discussions on the Strategic Deployment Agenda in relation to national initiatives.

2.3.2 General considerations on governance structure and decision-making procedures

The key principles for the governance of the SNS Partnership are transparency, openness, representativeness and efficiency. The Association, as the representative of the private side will be the counterpart of the European Commission, who is the representative of the public side. The internal relation among Partnership's projects and participants in the SNS Initiative will be described in a Collaboration Agreement.

The **Steering Board** and the **Technology Board**, as it will be defined in the Collaboration Agreement, are responsible for the cooperation across the SNS Partnership projects and working groups. Their goal is to steer the Partnership towards achieving its SRIA/Roadmap,

ensure alignment and complementarities with other relevant initiatives, and to ensure that the overall objectives are achieved through appropriate R&I activities, including Calls for Proposals.

Flexibility of implementation will be important to ensure that the Partnership can adapt to changing policy or market needs or scientific advances. This will be ensured by regularly reviewing/updating the overall roadmap in a continuous interactive process, monitored by the Steering Board and the Association. Also, there should be flexibility in the lifetime of Collaborative Projects to respond and amend their work plans depending on the evolution of the overall roadmap.

The Association will be responsible for the link with the SNS Initiative. The Association will organize an evaluation of the project portfolio selected after the Grants have been awarded in order to evaluate to which extent these projects contribute to the SRIA and what aspects of the SRIA need further commitment. The following indicative elements will be considered:

1. The coherence with the Partnership overall roadmap, SRIA ambitions and KPIs.
2. The relevance of the exploitation plan.

The supporting partners are fully in agreement with the concept of reserving part of the budget of the different projects to invite individual solution providers to join this work as it progresses, hence also contributing to further openness of the overall process. There are many examples of large-scale systems where many elements of the important functionality are provided by SMEs which have inherent skills and adaptability for the special needs of specific scenarios. It will be ensured that these opportunities are maintained and properly integrated.

2.3.3 Generic description of the organizational structure for a European Partnership

An efficient and workable governance model is the target. There are three layers in the governance that will have to be considered (Figure 25):

- The **European Commission** is representing the public side.
- In addition, **the Public Members Board** (or **States Representatives Group**) is associated to the Partnership representing Member States with the main objectives:
  - information exchange with Member States on Partnership activities and
  - discuss the coordination of common activities especially for trials in Horizon Europe and deployment actions in CEF2,
  - discuss the coordination of Member States research and innovation activities, large-scale experimentation and deployment to leverage national and EU level activities,
  - discuss access to frequency spectrum and road infrastructures for CEF2 projects.

  The Member States Board will be leveraged towards strategic upfront planning from an advisory perspective. It will raise its opinions on the Work Programme, budget allocation to Calls for Proposals and the selected project portfolio after proposal evaluation.
- The **Association** is representing the private side in the Partnership including all relevant sectors. The Association will have the main task to enter into the Contract of the Partnership and to implement that contract in partnership with the EU Commission.
- These three parties are cooperating via the **Partnership Board/Governing Body**, which is the formal body for coordination, decision-making and information exchange between the three parties. The Governing Body consists of representatives from the **EU Commission**, the **Public Members Board** (Member States) in a consultancy role and the **Private Members Board**. Decision-making is based on consensus as much as possible or on voting procedures. The voting rights should be allocated according to the provided funding and resources by the public and the private side for:
  - Horizon Europe activities:

- ½ for the public side
- ½ for the private side
- The Member States contribute their opinions on all relevant topics, which need to be considered by the Governing Board.

- CEF2 activities:
  - Strategic discussions on the Strategic Deployment Agenda between EU Commission, Member States and the private side.
  - Potential alignment with 5G national deployment programs.
  - The management of CEF2 projects will be done by a separate agency outside the SNS Partnership.

For Horizon Europe no co-funding is expected by Member States, while for CEF2 activities the three sides are contributing funding budgets and resources.

It is intended to use an existing separate Agency for the management of CEF2 activities.

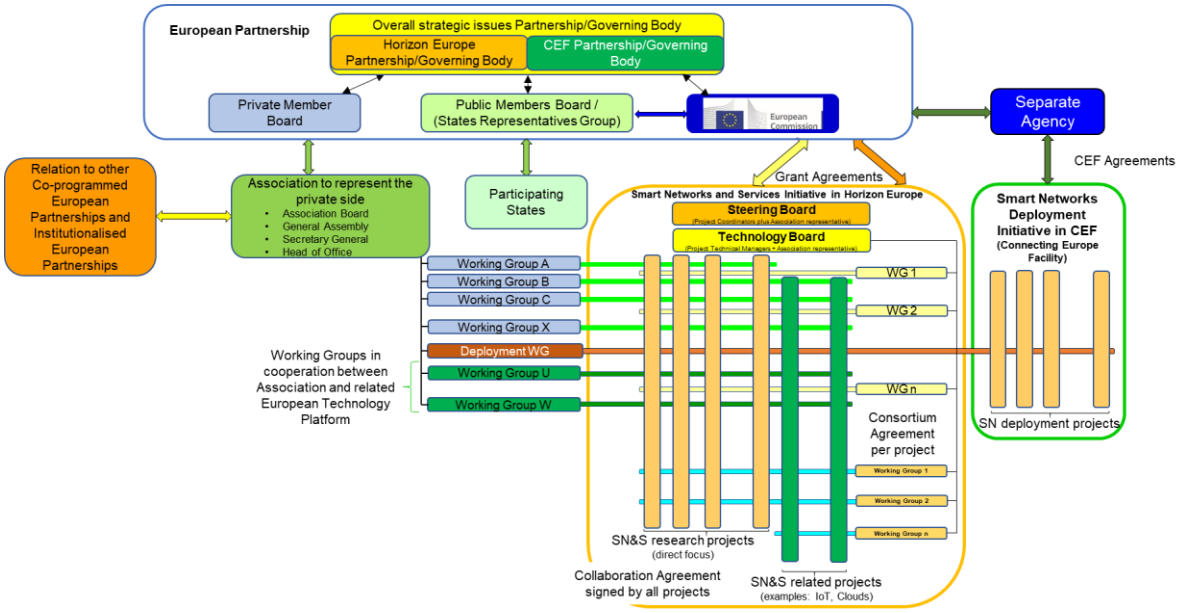


Figure 25 Overall generic structure of the European Partnership in relation to the EU Commission and Member States

The SNS Initiative structure and projects

The cooperation across projects will be realized through an SNS Collaboration Agreement between the partners involved in the projects selected in order to describe the internal relations between Partnership projects and partners.

Each project in the SNS Initiative has a Grant Agreement with the EU Commission. In addition, each project will establish a Consortium Agreement signed by all project beneficiaries to describe the project internal handling of ownership and access rights, confidentiality and management of the projects. Based on the Grant Agreement, for projects that are cooperating in partnerships enter into the so-called Complementary Grant Agreements. The beneficiaries in these projects should work towards common objectives and have mutual access rights to information and results. Details are described in the Collaboration Agreement across all projects signed by all beneficiaries involved in complementary projects.

The overall coordination between these projects is organized by the Steering Board (Project Coordinators of projects) and the Technology Board (Technical Managers of projects). Research projects organize technology oriented Working Groups under the Technology Board.

The Association will establish policy oriented Working Groups in cooperation with research projects, where appropriate. Additional Working Groups may be organized in cooperation with the related European Technology Platform to involve the wider community.

In parallel to the projects, and in the context of the Horizon Europe Programme, activities will be established between the EU Commission and the Association for deployment purposes under the CEF2 Programme. A respective Deployment Working Group is proposed for the coordination of these activities. CEF2 projects will have CEF2 Agreements with the EU Commission like research projects will be using Grant Agreements.

The mutual cooperation with other related sectors and initiatives to support a European micro- and nanoelectronics sector in the communication domain (e.g. ECSEL Joint Undertaking and/or the proposed Key Digital Technologies Partnership) and the computing domain (e.g. the AI PPP, the cloud community) as well as the support of a European devices sector especially for the IoT and vertical domains will be facilitated by the Association. The SNS Partnership will provide information of necessary performance KPIs to collaboration partners and is looking for technical information, which will be researched by collaboration partners and which will be intended to be adapted and used in the scope of the SNS Partnership.

These activities will achieve the envisaged major outcomes of the Partnership as described in Section 1.2. Annex 8 discusses the Partnership criteria while Annex 9 and Annex 10 present the principles of Association Statutes and its modus of operandi respectively.

2.3.4 Role of the EU Commission in the preparation process

The EU Commission DG Connect and the private side are in close contact to prepare a the SNS Partnership under Horizon Europe since the publication of the Horizon Europe proposal in June 2018. In these discussions the following policy objectives of the EU Commission were addressed as guiding principles:

- A Europe fit for the digital age
- Green Deal
- Cybersecurity and technology sovereignty
- Competitiveness and sovereignty.

Also, the extended scope of the SNS Partnership to areas such as IoT, clouds, AI and opportunities for components and devices has been extensively discussed.

The EU Commission has discussed with EU Member States since about mid of 2019. During this process, DG Connect and DG Research provided constructive comments to the proposal document. DG Connect proposed Smart Networks and Services as an Institutionalized European Partnership to the Commission internal procedure and the discussion with EU Member States (c.f. Figure 21). The final form will be decided by the EU Commission Regulatory Scrutiny Board mid of 2020. The overall financial envelope of public funding is subject to an agreement between the EU Commission, EU Member States and the EU Parliament based on the next Multiannual Financial Framework for the period 2021 to 2027.

2.4 Openness and transparency

2.4.1 Optimising openness combined with efficiency for establishing the Partnership

The Partnership proposal is developed by the support of 5G-IA, the Networld2020 European Technology Platform and AIOTI (Section 1.4).

The 5G Infrastructure Association (5G-IA) is the Association, which is representing the private side in 5G PPP and will be further developed towards Horizon Europe to support the proposed new Partnership. It is an international non-for-profit association under Belgian law, which has demonstrated its working procedures in the successful management of 5G PPP. Its membership and regional distributed is available in Annex 6.

The statutes of the Association in the SNS Partnership will be based on the established 5G-IA's statutes. 5G-IA's name and purpose will be adapted to serve the goals and principles of the new Partnership. The management bodies of the Association should remain of manageable size in terms of number of members to ensure that the goal of a full innovation trajectory will be achieved with the necessary focus to guarantee impact. There will be full

Members with full voting rights and Associated Members without voting rights. Any legally established organization, which is registered in an EU Member State, Associated and Candidate Country can apply for membership. The membership will be extended to representatives from the IoT, AI, cloud and components and devices communities via an open process.

Members with voting right will have full access to information, the right to nominate candidates for the Association Board and other bodies and will have the right to attend, to speak at the relevant meetings of the Association and to vote in the General Assembly and other Association bodies and working groups.

Associated Members without voting rights will have full access to information and will have the right to attend and to speak at the relevant meetings of the Association. Legal entities may change status and become Member instead of Associated Member.

This approach ensures that decision making in the Association is based on the principles of transparency and openness for a wide membership and that all necessary expertise in the scope of the SNS Partnership will be represented in the Association in order to ensure good representativeness of the relevant sectors.

The Association will nominate representatives in the governance structure of the Partnership to represent the private side through an open and transparent process.

2.4.2 Access to information on the Partnership programme

The Partnership will use standard Horizon Europe rules for Calls for Proposals, proposal Evaluation and Selection. Calls will be published well ahead of submission deadlines based of the Partnership Work Plan, which will be publicly available on the EU Commission and the Partnership websites. This ensures that each interested party can participate in consortia for proposal development and submission.

The Partnership will organize Proposer's Days to make the community aware of the call subjects and the programmatic approach. Based on the work plan per Call for Proposals the Association will develop and publish a pre-structuring model as a recommendation to the community how to potentially map call topics to research areas to support a good coverage of the call objectives and to minimize overlap of selected projects for the efficient use of funding resources.

The Partnership will provide a public brokerage platform for offering and search of expertise and partners on the Partnership website to enable new actors to get involved in proposal consortia and to avoid potential barriers. During project proposal preparation phase stakeholders are interested to join ongoing consortia, which are under preparation, and proposal consortia are looking for missing specific expertise to complement their consortium. The brokerage platform is a matchmaking marketplace as an offer to the community for consortia building. This tool offers the opportunity to publish anonymized information on offered expertise (for joining consortia) and desired expertise (for complementing consortia). In the case of mutual interest, a contact will be established between stakeholders and consortia. This platform is successfully applied in 5G PPP and this service will again be offered in the SNS Partnership.

Specific activities will be organized via a dedicated SME working group as part of the overall governance model to mobilize the participation of SMEs in project proposals. This approach demonstrated its successful contribution to 5G PPP to enable an SME participation in the order of 20 % in terms of received funding.

There will be no link between the participation in project proposals and research projects and the membership / membership fee of the Association, which is representing the private side in the Partnership. This ensures that there are no barriers for interested parties to be involved in Partnership activities. Any actor in the community is free to build consortia and to submit project proposals under the SNS Partnership.

2.4.3 Means to ensure openness of participation in Partnership activities

According to Section 2.1, the Partnership will be organized in different phases from exploratory concept definition, to detailed design specification and proof of concepts and large-scale trials. The different phases and types of activities will involve different expertise and stakeholders. Therefore, the constituency of beneficiaries will change from programme phase to phase and trials. Like in 5G PPP the participation of several hundred organizations is expected in Partnership projects and activities during its lifetime. Appropriate indicators will be set up to monitor this.

Activities will be launched to enable technology transfer from project results to start-ups by means of incubators for further exploitation in the future ecosystem of Smart Networks and Services. Especially, R&D centres in Europe will be helpful to support such activities via their own incubators.

Links are under establishment with BDVA/IA on the planned AI, Data and Robotics Partnership in Horizon Europe, AIOTI mainly for IoT devices topics, the NESSI European Technology Platform and Cispe.Cloud on cloud topics and the ECSEL Joint Undertaking in Horizon 2020 and the proposed successor Key Digital Technology Partnership in Horizon Europe on components and devices. These collaborations will enable actors from such related technology domains to be involved in respective Partnership activities and projects of the SNS Partnership projects.

2.4.4 Development of the Strategic Research and Innovation Agenda (SRIA)

The Networld2020 European Technology Platform with more than 1000 member-organizations is facilitating the open development process and roadmap of the SRIA in cooperation with 5G-IA. Networld2020 issued a call for interest in November 2019 to be at the core of the SRIA development process. Based on the call, an Expert Working Group was established in December 2019 from the enlarged European ICT community including vertical sectors with the mandate to prepare a draft SRIA, which was published for public consultation beginning of June 2020.

The process is based on stakeholder workshops that were broadly advertised with representatives from different related technology domains, which took already place in 2019 and a vision workshop in November 2019 to plan the SRIA and to identify future research topics. The SRIA was then be developed by the Expert Group from a programmatic perspective with respect to the objectives of the SNS Partnership as a consolidated view of the European ICT community.

Like during Horizon 2020 the draft SRIA was published for public consultation, where everyone can comment and can make proposals for improving the SRIA. This ensures that the final SRIA will be supported by a wide community beyond the Association and the Networld2020 ETP. It will be available end of June 2020. Therefore, the Partnership work programme is based on the feedback and interest of the wider community and will support future economic exploitation. The SRIA will regularly be updated in minimum every two years as input to the Partnership work programmes for the different Partnership phases.

The link to the draft SRIA is published on the Networld2020, the 5G-IA and the EU Commission's website as well as in newsletters of these three organizations to make the community aware for active contribution to the public consultation. In addition, the members of Networld2020 and 5G-IA are directly contacted. This ensures that the entire community even beyond Networld2020 and 5G-IA is made aware and able to raise its opinion.

In addition to these communities, involvement in these activities will also be sought from user and consumer groups. Potential user/consumer groups dealing with ICT, services and applications, digital technology and digital rights are

- The European Consumer Organization [93],
- The European Consumer Consultative Group (ECCG) [94]) and
- National consumer bodies [95].

Their views will be considered on

- Potential barriers for accepting new technology by society and consumers.
- Electromagnetic emissions are an area of concern.
- Network security and privacy issues, which must be addressed by future systems.

The involvement of such organizations will help to identify at an early stage potential barriers and concerns in order to develop mitigation strategies. Industry will use means of Corporate Social Responsibility for the introduction of new technologies. If there are ethical issues involved from the new research, public consultations will be organized.

The timing of the actual SRAI is as follows:

- July 4, 2019: Networld2020 Stakeholder Workshop on IoT and Cloud. Brussels.
- October 2, 2019: Networld2020 Stakeholder Workshop on components and devices. Dresden.
- November 27 and 28, 2019: Start of SRIA development: Networld2020 Visions Workshop. Lisbon.
- December 2019: Establishment of Expert Group. The involved organisations are shown in Annex 11.
- June 5 to 25, 2020: Public consultation (https://www.networld2020.eu/sria-public-consultation-smart-networks-in-the-context-of-ngi/) of the first draft SRIA available for public consultation (https://bscw.5g-ppp.eu/pub/bscw.cgi/d356802/Smart-Networks-in-the-context-of-NGI_SRIA-public-1.1.pdf). Feedback is provided by means of a web-based tool at https://www.networld2020.eu/networld2020-sria-2021-27-smart-networks-in-the-context-of-ngi-public-consultation/.
- June 25, 2020: Public consultation results available.
- June 30, 2020: Final SRIA version 2020 for submission to the EU Commission.

References

[1] European Commission: Secure 5G deployment in the EU - Implementing the EU toolbox. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, 29.1.2020 COM(2020) 50 final, https://ec.europa.eu/digital-single-market/en/news/secure-5g-deployment-eu-implementing-eu-toolbox-communication-commission

[2] Breton, T. – Commissioner designate for Internal Market by President of the EU Commission Ursula von der Leyen. Brussels, 7 November 2019, https://ec.europa.eu/commission/sites/beta-political/files/president-elect_von_der_leyens_mission_letter_to_thierry_breton.pdf.

[3] Breton, T.: Europe has everything it takes to lead the technology race. January 22, 2020, https://www.linkedin.com/pulse/europe-has-everything-takes-lead-technology-race-thierry-breton/.

[4] European Commission: The European Green Deal. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, 11.12.2019 COM(2019) 640 final, https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf.

[5] Leyen, U. v.d.: Political Guidelines of President elect Ursula von der Leyen: Political guidelines for the next Commission (2019-2024) – 'A Union that strives for more: My agenda for Europe'. December 2019, https://ec.europa.eu/commission/sites/beta-political/files/political-guidelines-next-commission_en.pdf.

[6] European Commission: DESI Dimensions. https://digital-agenda-data.eu/datasets/desi/indicators#desi-dimensions.

[7] European Commission: Social Dimensions, Social scoreboard. https://composite-indicators.jrc.ec.europa.eu/social-scoreboard/#socialdimensions.

[8] European Commission: Connectivity - Broadband market developments in the EU, Digital Economy and Society Index Report 2018, https://ec.europa.eu/digital-single-market/en/desi.

[9] Cisco: Cisco Visual Networking Index: Forecast and Trends, 2017-2022. 2019, https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-741490.pdf.

[10] Cisco: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2017-2022. 2019, https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-738429.pdf.

[11] Next Generation Internet: https://www.ngi.eu/.

[12] The Economist Intelligence Unit: Next Generation Connectivity. October 2018, http://www.osborneclarke.com/insights/next-generation-connectivity-jeremy-kingsley-the-economist-intelligence-unit/.

[13] GSMA: Setting Climate Targets. https://www.gsma.com/betterfuture/wp-content/uploads/2020/03/Setting_Climate_Targets_singles.pdf.

[14] European Commission: Fourth Report on the State of the Energy Union. 9 April 2019, https://ec.europa.eu/commission/publications/4th-state-energy-union_en.

[15] McKinsey: Global Energy Perspective 2019: Reference Case, Energy Insights. https://www.mckinsey.com/~/media/McKinsey/Industries/Oil%20and%20Gas/Our%20Insights/Global%20Energy%20Perspective%202019/McKinsey-Energy-Insights-Global-Energy-Perspective-2019_Reference-Case-Summary.ashx.

[16] IPCC Intergovernmental panel on climate change: Global Warming of 1.5º C., October 2018, https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf.

[17] United Nations: Sustainable Development Goals, August 12, 2015, http://www.un.org/sustainabledevelopment/sustainable-development-goals/.

[18] GSMA: The Mobile Economy 2018. 2018, https://www.gsma.com/mobileeconomy/wp-content/uploads/2018/05/The-Mobile-Economy-2018.pdf.

[19] ITU: ITU News, October 31, 2018, https://www.itu.int/en/itunews/Documents/2018/2018-04/2018_ITUNews04-en.pdf.

[20] ITU: SDG Digital Investment Framework - A Whole-of-Government Approach to Investing in Digital Technologies to Achieve the SDGs. ITU, 2019, https://www.itu.int/dms_pub/itu-d/opb/str/D-STR-DIGITAL.02-2019-PDF-E.pdf.

[21] DigitalEurope: PwC study - Accelerate to a trusted Digital Single Market. February 2018, https://www.digitaleurope.org/wp/wp-content/uploads/2018/02/PwC-pdf-version-final-2.pdf.

[22] European Commission: General Data Protection Regulation. Regulation (EU) 2016/679 of the European Parliament and of the Council, 27 April 2016, https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1532348683434&uri=CELEX:02016R0679-20160504.

[23] European Commission: Cybersecurity of 5G networks. Commission Recommendation, Strasbourg, 26.3.2019, https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=58154.

[24] European Commission: Orientations towards the first Strategic Plan for Horizon Europe, December 2019, pp. 70, https://ec.europa.eu/info/sites/info/files/research_and_innovation/strategy_on_research_and_innovation/documents/ec_rtd_orientations-he-strategic-plan_122019.pdf.

[25] European Commission: A vision for the European Industry until 2030". 2019, https://op.europa.eu/en/publication-detail/-/publication/339d0a1b-bcab-11e9-9d01-01aa75ed71a1.

[26] European Commission: Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society. September 2016, https://ec.europa.eu/digital-single-market/en/news/communication-connectivity-competitive-digital-single-market-towards-european-gigabit-society.

[27] United Nations Broadband Commission for Sustainable Development: The State of Broadband: Broadband catalysing sustainable development. September 2018, https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.19-2018-PDF-E.pdf.

[28] McKinsey & Company: The Internet of Things: Mapping the value beyond the hype. McKinsey Global Institute, June 2015, https://www.mckinsey.de/files/unlocking_the_potential_of_the_internet_of_things_full_report.pdf.

[29] Ericsson: Ericsson mobility report 2017. https://www.ericsson.com/assets/local/mobility-report/documents/2017/ericsson-mobility-report-june-2017.pdf.

[30] Eurostat: ICT sector - value added, employment and R&D. January 2018, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_sector_-_value_added,_employment_and_R%26D and Eurostat: National accounts and GDP. 2017: http://ec.europa.eu/eurostat/statistics-explained/index.php/National_accounts_and_GDP#Further_Eurostat_information.

[31] European Commission: Digital Agenda Scoreboard – The EU ICT Sector and its R&D Performance. 2018, http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=52246.

[32] European Commission: Digital Single Market. Making the most of the digital opportunities in Europe. 2017, https://ec.europa.eu/digital-single-market/en/policies/shaping-digital-single-market.

[33] European Commission: Europe's Digital Progress Report 2017. Commission Staff Working Document, SWD (2017) 160 final, https://ec.europa.eu/transparency/regdoc/rep/10102/2017/EN/SWD-2017-160-F1-EN-MAIN-PART-27.PDF.

[34] European Commission: Digital Transformation Scoreboard 2018, EU businesses go digital: Opportunities, outcomes and uptake. https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/Digital%20Transformation%20Scoreboard%202018_0.pdf.

[35] ETNO: Accenture Study “Lead or Lose – A Vision for Europe’s digital future”. https://etno.eu/digital2030/people-planet-prosperity.

[36] ITU-T, FG-NET-2030: Network 2030: A Blueprint of Technology, Applications and Market Drivers Towards the Year 2030 and Beyond, May 2019, https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/White_Paper.pdf.

[37] European Political Strategy Centre: EU Industrial Policy after Siemens-Alstom. Finding a new balance between openness and protection. 2019, https://ec.europa.eu/epsc/publications/other-publications/eu-industrial-policy-after-siemens-alstom_en.

[38] Delta Partners: The state of European Telcos: What left Europe behind in the race? May 2019, https://www.deltapartnersgroup.com/state-european-telcos-what-left-europe-behind-race.

[39] 5G Infrastructure Association: 5G PPP Progress Monitoring Report -2018, November 2019, https://5g-ppp.eu/wp-content/uploads/2020/01/5G-PPP_PMR2018-Sept2019_Final.pdf.

[40] 5G PPP: Phase 1 project achievements: https://5g-ppp.eu/phase-1-key-achievements/#1507204993929-bc016a9a-7b69.

[41] 5G PPP: Phase 2 project achievements: https://5g-ppp.eu/phase-2-key-achievements/.

[42] 5G PPP: White Papers. https://5g-ppp.eu/white-papers/.

[43] 5G PPP: 5G Pan-European Trials Roadmap – Version 4.0. https://5g-ppp.eu/wp-content/uploads/2018/11/5GInfraPPP_TrialsWG_Roadmap_Version4.0.pdf.

[44] 5G PPP: White paper 5G Infrastructure PPP Trials and pilots: https://5g-ppp.eu/wp-content/uploads/2019/09/5GInfraPPP_10TPs_Brochure_FINAL_low_singlepages.pdf.

[45] 5G PPP: White paper 5G network support of vertical industries in the 5G PPP ecosystem. February 2020, https://5g-ppp.eu/wp-content/uploads/2020/03/5PPP_VTF_brochure_v2.1.pdf.

[46] 5G PPP: Vertical sectors cartography. https://global5g.org/cartography.

[47] European Commission: Proposal for a Regulation of the European Parliament and of the Council establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination. Brussels, 7.6.2018, https://ec.europa.eu/commission/sites/beta-political/files/budget-may2018-horizon-europe-regulation_en.pdf and https://data.consilium.europa.eu/doc/document/ST-7942-2019-INIT/en/pdf.

[48] European Commission: Annexes to the Proposal for a Decision of the European Parliament and of the Council on establishing the specific programme implementing Horizon Europe – the Framework Programme for Research and Innovation. Brussels, 7.6.2018 COM(2018) 436 final ANNEXES 1 to 3, https://eur-lex.europa.eu/resource.html?uri=cellar:7cc790e8-6a33-11e8-9483-01aa75ed71a1.0002.03/DOC_2&format=PDF and https://data.consilium.europa.eu/doc/document/ST-7942-2019-INIT/en/pdf.

[49] Networld2020 European Technology Platform: Strategic Research and Innovation Agenda (SRIA) 2021 – 2027 (under preparation), based on the EU EMPOWER project.

[50] EMPOWER project: HORIZON 2020 ICT, Deliverable 2.2: First Technology roadmap for advanced wireless. https://www.advancedwireless.eu/wp-content/uploads/Deliverables/EMPOWER_deliverable_D2_2_final.pdf.

[51] European Commission: Shaping Europe's Digital Future. February 2020, https://ec.europa.eu/info/sites/info/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf.

[52] European Commission: A European strategy for data. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Brussels, 19.2.2020 COM(2020) 66 final, https://ec.europa.eu/info/sites/info/files/communication-european-strategy-data-19feb2020_en.pdf.

[53] European Commission: White Paper on Artificial Intelligence - A European approach to excellence and trust. Brussels, 19.2.2020 COM(2020) 65 final, https://ec.europa.eu/info/sites/info/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf.

[54] European Commission: Actions being taken by the EU. https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu_en.

[55] European Commission: What is the Green Deal. December 2019, file:///C:/Users/dems1cf8/AppData/Local/Microsoft/Windows/INetCache/IE/NLQHX0PI/What_is_the_European_Green_Deal_en.pdf.pdf.

[56] GSMA: Guidance for ICT Companies Setting Science Based Targets. https://www.gsma.com/betterfuture/wp-content/uploads/2020/02/GSMA_IP_SBT-report_WEB-SINGLE.pdf.

[57] GSMA: GSMA Climate Action Handbook. https://www.gsma.com/betterfuture/wp-content/uploads/2019/10/GSMA_Climate-Change-Handbook_2019_WEB-SINGLE.pdf.

[58] Global e-Sustainability Initiative: GeSI Mobile Carbon Impact: How mobile communications technology is enabling carbon emissions reduction. 29 November 2016, https://www.gsma.com/latinamerica/wp-content/uploads/2016/11/GeSI-Mobile-Carbon-Impact-study_Presentation-for-GSMA-Latam-webinar_20161129.pdf.

[59] Runge-Metzger, Artur: The European Green Deal: Towards a climate neutral EU by 2050. European Commission, February 2020, https://www.catchments.ie/climate-lecture-the-european-green-deal-towards-a-climate-neutral-eu-by-2050/.

[60] European Commission: The Sustainable Development Goals. https://ec.europa.eu/europeaid/policies/sustainable-development-goals_en.

[61] European Commission: 5G for Europe: An Action Plan. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels, 14.6.2016, COM(2016) 588 final. http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=17131.

[62] World Bank: Exploring the Relationship Between Broadband and Economic Growth. Michael Minges, World Development Report, 2016, http://documents.worldbank.org/curated/en/178701467988875888/pdf/102955-WP-Box394845B-PUBLIC-WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf.

[63] World Bank: Information and Communication for Development: Extending Reach and Increasing Impact – Economic impacts of broadband, 2009, http://siteresources.worldbank.org/EXTIC4D/Resources/IC4D_Broadband_35_50.pdf.

[64] Cisco: Cisco Annual Internet Report (2018–2023) White Paper. March 9, 2020, https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.html.

[65] Analytics Insight: Growth of Europe's Cloud Market is a Boon for US Enterprises. January 15, 2019, https://www.analyticsinsight.net/growth-of-europes-cloud-market-is-a-boon-for-us-enterprises/.

[66] CNBC: Europe's cloud market is giving a big boost to US giants like Amazon and Salesforce. January 11, 2019, https://www.cnbc.com/2019/01/09/cloud-computing-in-europe-salesforce-amazon-are-big-winners---.html.

[67] Wikipedia: Facebook–Cambridge Analytica data scandal. 2019, https://en.wikipedia.org/wiki/Facebook%E2%80%93Cambridge_Analytica_data_scandal.

[68] European Commission: The European Commission adopts a new Cloud Strategy. May 28, 2019, https://ec.europa.eu/info/news/european-commission-adopts-new-cloud-strategy-2019-may-28_en.

[69] European Union: Annual Report on European SMEs 2016/2017. Focus on self-employment SME Performance Review 2016/2017. November 2017, Eurostat; National Statistical Offices; and DIW Econ, https://www.eubusiness.com/topics/sme/sme-report-16-17.

[70] Networld2020: Smart Networks in the Context of NGI – Strategic Research and Innovation Agenda 2021-2027, 2018, accessible at https://www.networld2020.eu/wp-content/uploads/2018/11/networld2020-5gia-sria-version-2.0.pdf.

[71] Rongpeng Li, Zhifeng Zhao, Xuan Zhou, Guoru Ding, Yan Chen, Zhongyao Wang, and Honggang Zhang: Intelligent 5G: When Cellular Networks Meet Artificial Intelligence – Section on "Challenges". IEEE Wireless Communications, Vol. 24(5), October 2017; DOI: 10.1109/MWC.2017.1600304WC, https://ieeexplore.ieee.org/document/7886994?ALU=LU1043073.

[72] Kagan, M.: Networking Trends in High-Performance Computing. CIOReview, https://high-performance-computing.cioreview.com/cxoinsight/networking-trends-in-highperformance-computing--nid-12770-cid-84.html.

[73] European Commission: Resilience, Deterrence and Defence: Building strong cybersecurity for the EU. Joint communication to the European Parliament and the Council. Brussels, 13.9.2017, JOIN(2017) 450 final, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017JC0450&from=en.

[74] European Commission: Impact assessment accompanying the document Proposal for a Regulation of the European Parliament and of the Council on ENISA, the "EU Cybersecurity Agency", and repealing Regulation (EU) 526/2013, and on Information and Communication Technology cybersecurity certification ("Cybersecurity Act"), Brussels, 13.9.2017, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52017SC0500.

[75] 5G PPP Automotive Working Group. https://5g-ppp.eu/5g-ppp-work-groups/.

[76] 5G PPP Automotive Working Group: 5G Strategic Deployment Agenda for Connected and Automated Mobility in Europe. Initial proposal, 31 October 2019, https://5g-ppp.eu/wp-content/uploads/2019/10/20191031-Initial-Proposal-5G-SDA-for-CAM-in-Europe.pdf.

[77] 5G PPP: Phase 3 projects. https://5g-ppp.eu/5g-ppp-phase-3-projects/.

[78] European Commission: On the road to automated mobility: An EU strategy for mobility of the future. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels, Communication of 17.5.2018, COM(2018) 283 final, https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180283_en.pdf.

[79] 5GAA - 5G Automotive Association: http://5gaa.org/.

[80] GSMA: https://www.gsma.com/.

[81] Networld2020 European Technology Platform (ETP): https://www.networld2020.eu/.

[82] 5G Infrastructure Association (5G-IA): https://5g-ppp.eu/.

[83] AIOTI: https://aioti.eu/.

[84] NESSI ETP: The European Technology Platform dedicated to Software, Services and Data. http://www.nessi-europe.com/default.aspx?page=home.

[85] Cispe.Cloud: https://cispe.cloud/members/.

[86] BDVA: Big Data Value Association. http://www.bdva.eu/.

[87] euRobotics: https://www.eu-robotics.net/.

[88] ECSEL: ECSEL Joint Undertaking – Electronic Components and Systems for European Leadership. https://www.ecsel.eu/.

[89] EPoSS: https://www.smart-systems-integration.org/

[90] AENEAS: Industry association promoting RD&I in Electronic Components & Systems to strengthen European competitiveness. https://aeneas-office.org/.

[91] ARTEMIS: Industry Association on embedded intelligence. https://artemis-ia.eu/.

[92] European Parliament: Horizon Europe - Framework programme for research and innovation 2021–2027. Briefing, EU Legislation in Progress 2021-2027 MFF, October 2018, http://www.europarl.europa.eu/RegData/etudes/BRIE/2018/628254/EPRS_BRI%282018%2962 8254_EN.pdf.

[93] The European Consumer Organisation: http://www.beuc.eu/.

[94] The European Consumer Consultative Group (ECCG): https://ec.europa.eu/info/policies/consumers/consumer-protection/our-partners-consumer-issues/european-consumer-consultative-group-eccg_en.

[95] National consumer bodies : https://ec.europa.eu/info/policies/consumers/consumer-protection/our-partners-consumer-issues/national-consumer-bodies_en.

[96] European Commission: Clean energy: 11 December 2019, https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6723.

[97] European Commission: Sustainable industry. 11 December 2019, https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6724.

[98] European Commission: Building and renovating. 11 December 2019, https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6725.

[99] European Commission. Eliminating pollution. 11 December 2019, https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6729.

[100] European Commission: Biodiversity. 11 December 2019, https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6728.

[101] European Commission: From farm to fork. 11 December 2019 https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6727.

[102] European Commission: Sustainable mobility. https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6726.

[103] Euractiv: Europe ringfences 35% of research budget for clean tech. 2019, https://www.euractiv.com/section/energy-environment/news/europe-ringfences-35-of-research-budget-for-clean-tech/.

[104] Euractiv: EU research 'moonshots' focus on climate crisis. 2019, https://www.euractiv.com/section/energy-environment/news/eu-research-moonshots-focus-on-climate-crisis/.

[105] ITU Academy: Green ICT Technologies: how they can help mitigate the effects of Climate Change General aspects of Green ICT: https://www.itu.int/en/ITU-D/RegionalPresence/AsiaPacific/Documents/ICTCC_Session_7_Green%20ICT%20Technologies%20V4.pdf.

[106] GSMA: 2018 Mobile Industry Impact Report: Sustainable Development Goals. 2018, https://www.gsmaintelligence.com/research/?file=ecf0a523bfb1c9841147a335cac9f6a7&download.

[107] Juncker, J.-C.: State of the Union speech. 2017, http://europa.eu/rapid/attachment/SPEECH-17-3165/en/EN-FR-DE-Speech.pdf.

[108] European Commission: EU Budget for the Future. May 2018 https://ec.europa.eu/commission/sites/beta-political/files/communication-modern-budget-may_2018_en.pdf.

[109] European Commission: Draft Orientations towards an Implementation Roadmap - Connecting Europe Facility (CEF2) Digital. Non-paper, 5 December 2019, https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=63665.

[110] European Commission: Proposal for a Regulation of the European Parliament and of the Council establishing the Connecting Europe Facility and repealing Regulations (EU) No 1316/2013 and (EU) No 283/2014. Brussels, 6.6.2018, COM(2018) 438 final https://eur-lex.europa.eu/resource.html?uri=cellar:da5da09e-6a5a-11e8-9483-01aa75ed71a1.0003.03/DOC_1&format=PDF.

[111] Annex to the Proposal for a Regulation of the European Parliament and of the Council establishing the Connecting Europe Facility and repealing Regulations (EU) No 1316/2013 and (EU) No 283/2014. Brussels, 6.6.2018, https://eur-lex.europa.eu/resource.html?uri=cellar:da5da09e-6a5a-11e8-9483-01aa75ed71a1.0003.03/DOC_2&format=PDF.

[112] 5G PPP 5GCroCo project: https://5gcroco.eu/.

[113] 5G PPP 5G MOBIX project: https://www.5g-mobix.com/.

[114] 5G PPP 5G CARMEN project: https://www.5gcarmen.eu/.

[115] European Commission DG Connect: Study "Funding the Gigabit society: supporting the implementation of CEF2, SMART 2017/0018". Publication in October-November 2019 after a validation stakeholders' workshop in September 2019.

[116] 5G PPP Automotive Working Group: Business feasibility study for 5G V2X deployment. Version 2, February 2018, https://bscw.5g-ppp.eu/pub/bscw.cgi/d293672/5G%20PPP%20Automotive%20WG_White%20Paper_Feb2019.pdf.

[117] Wikipedia: List of 5G NR Networks. https://en.wikipedia.org/wiki/List_of_5G_NR_networks.

[118] RCR Wireless News: South Korea 5G service. https://www.rcrwireless.com/20190912/5g/how-south-korea-built-5g-and-what-its-learning.

[119] ATOS: Journey 2020: 2017, https://atos.net/content/mini-sites/journey-2020/?utm_source=ascent.atos.net/journey-2020/&utm_medium=301.

[120] OPENET: Digital Evolution: Cut BSS/ OSS Costs, Reduce Delivery Timescales. 2018, https://www.openet.com/doc-redirect/index_form2.php?docid=724.

[121] Neuralink: Ultra-high bandwidth brain-machine interfaces to connect humans and computers. 2018, https://www.neuralink.com/.

[122] ETSI: ETSI NFV "Zero touch network and Service Management" (ETSI ZSM ISG). December 2017, http://www.etsi.org/technologies-clusters/technologies/zero-touch-network-service-management.

[123] TMForum whitepaper: "OSS of the Future". 2017, https://www.tmforum.org/resources/whitepapers/oss-of-the-future/.

[124] Wikipedia: DevOps model. January 2019, https://en.wikipedia.org/wiki/DevOps.

[125] WHO (UN World Health Organization): https://www.who.int/.

[126] ICNIRP (International Commission on Non-Ionizing Radiation Protection): ICNIRP Guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields (up to 300 GHz). ICNIRP publication 1998, https://www.icnirp.org/.

[127] ICNIRP: ICNIRP Guidelines for limiting exposure to electromagnetic fields (100 kHz to 300 GHz). ICNIRP publication 2020, https://www.icnirp.org/.

[128] GSMA: AI & Automation: An Overview. June 25, 2019, https://www.gsma.com/futurenetworks/wiki/ai-automation-an-overview/.

[129] European Commission: A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee, the Committee of the Regions and the European Investment Bank, Brussels, 28.11.2018 COM(2018) 773 final, https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_en.pdf.

[130] Council of the European Union – ERAC: ERAC Plenary in Brussels on 6 December 2018 - Item 5.2 - Proposal by the Commission on the "Draft criteria Framework for European Partnerships under Horizon Europe". Working Paper, Brussels, 23 November 2018, WK 14470/2018 INIT, https://era.gv.at/object/document/4375.

Table of abbreviations

AI	Artificial Intelligence
AIOTI	Alliance for Internet of Things Innovation
AISBL	Association Internationale Sans But Lucratif (Non-for-Profit Association)
API	Application Programme Interface
AR	Augmented Reality
ARPU	Average Revenue per User
ASIC	Application-Specific Integrated Circuit
BDVA	Big Data Value Association
BERD	Business Enterprise R&D Expenditure
BEREC	Body of European Regulators for Electronic Communications
BICMOS	Bipolar CMOS (Complementary Metal-Oxide Semiconductor)
BNetzA	Bundesnetzagentur
BNT	Bio-Nano Things
B2B	Business-to-Business
B2B2X	Business-to-Business-to-X
B2C	Business to Consumer
B5G	Beyond 5G
CAM	Connected and Automated Mobility
CCAM	Cooperative connected automated mobility (formerly known as Mobility and Safety for Automated Road Transport Partnerships)
CEF	Connected Europe Facility
C-ITS	Cooperative Intelligent Transport Systems
CMOS	Complementary Metal-Oxide Semiconductor
CPE	Customer Premises Equipment
CPU	Central Processing Unit
CSA	Coordination and Support Action
DLT	Distributed Ledger Technology
DSP	Digital Signal Processor
DT	Digital Twin
EC	European Commission
ECSEL	Electronic Components and Systems for European Leadership JU
ECSO	European Cyber Security Organisation
EECC	European Electronic Communication Code
EIT	European Institute of Technology
EMF	Electro-Magnetic Field
ENISA	European Union Agency for Cybersecurity
EOSC	European Open Source Cloud
ERAC	European Research Area and Innovation Committee
ETP	European Technology Platform
ETSI	European Telecommunications Standards Institute
EU	European Union
e2e	End-to-End
E5GO	European 5G Observatory
FD-SOI	Fully Depleted Silicon-on-Insulator
FPGA	Field Programmable Gate array
GaAs	Gallium Arsenide
GaN	Gallium Nitrid
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GHG	Greenhouse Gas
GSM	Global System for Mobile Communications
HEU	Horizon Europe
HPC	High-Performance Computing
HW	Hardware
IA	Innovation Action
IAFA	Impact Assessment and Facilitation Actions
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ICT	Information and Communication Technology

IMT	International Mobile Telecommunications
InGaAs	Indium Gallium Arsenide
ION	Intelligent Operation Network
IoT	Internet of Things
IPR	Intellectual Property Right
IT	Information Technology
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union – Radio Sector
ITU-T	International Telecommunication Union – Telecommunications Sector
IVZW	Internationale Vereniging Zonder Winstoogmerk (Non-for-Profit Association)
JU	Joint Undertaking
KDT	Key Digital Technologies
KPI	Key Performance Indicator
LF-Edge	Linux Foundation
LTE	Long-Term Evolution
MAC	Medium Access Control
MEC	Mobile Edge Computing
MIMO	Multiple Input Multiple Output
ML	Machine Learning
MMIC	Millimetre wave Monolithic Integrated Circuits
mMTC	Massive Machine Type Communication
MNO	Mobile Network Operator
MoU	Memorandum of Understanding
M2M	Machine-to-Machine
NB	Narrow Band
NCC	Network and Computing Convergence
NESSI	The European Technology Platform dedicated to Software, Services and Data
NGI	Next Generation Internet
NGMN	Next Generation Mobile Networks
NIS	Network and Information Systems
NFV	Network Function Virtualization
OECD	Organization for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
ONAP	Open Network Automation Platform
ONF	Open Networking Foundation
OPEX	Operational Expenditures
O-RAN	Open RAN (Radio Access Network)
OSM	Open Source MANO (Management and Orchestration)
OSS	Operation Support System
PESTLE	Analysis tool for Political, Economic, Social, Technological, Legal Environmental issues
PoC	Proof of Concept
PPP	Public Private Partnership
PSM	Pre-Structuring Model
QoS	Quality of Service
RAN	Radio Access Networks
RAT	Radio Access Technology
R&D	Research and Development
R&D&I	Research, Development and Innovation
RF	Radio Frequency
RF SOI	Radio Frequency Silicon-on-Insulator
RIA	Research and Innovation Action
R&I	Research and Innovation
SAE	Society of Automotive Engineers
SBI	Service Based Interface
SCS	Sub-Carrier Spacing
SDA	Strategic Deployment Agenda
SDG	Sustainable Development Goal
SDN	Software Defined Network
SiC	Silicon Carbide

SiP	Silicon in Package
SLA	Service Level Agreement
SME	Small and Medium size Enterprise
SNS	Smart Networks and Services
SoC	System on Chip
SRIA	Strategic Research and Innovation Agenda
SRIDA	Strategic Research Innovation and Deployment Agenda
SW	Software
TRL	Technology Readiness Level
SWOT	Strengths Weaknesses Opportunities Threats
UMTS	Universal Mobile Telecommunication System
UN	United Nations
URLLC	Ultra Reliable Low Latency Communication
USB	Universal Serial Bus
UWB	Ultra-Wide-Band
VA	Value-Added
VR	Virtual Reality
V2X	Vehicular-to-X
WG	Working Group
WHO	World Health Organization
WP5D	ITU-R Working Party 5D
WRC	World Radiocommunications Conference
ZSM ISG	Zero Touch Network and Service Management Industry Specification Group
3G	Third Generation
3GPP	Third Generation Partnership Project
4G	Fourth Generation
5G	Fifth Generation
5GAA	5G Automotive Association
5GAP	5G Action Plan for Europe
5G-IA	5G Infrastructure Association
6G	Sixth Generation

Annex 1 Overview of the Green Deal

The European Green Deal is effectively a response to challenges related to climate change [4]. It is also focused on a *"new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use".* The multidimensional goals of the Green Deal resonate with the objectives of the SNS Partnership which aims at supporting its overall roadmap and SRIA. The collective efforts, risk management and mitigation will affect all the stakeholders, public and private sector across the EU, including investors, insurers, businesses, cities and citizens. Topics like connectivity, edge computing, IoT devices, energy efficient end-to-end platforms, massive photonics, AI, e2e security, privacy solutions will need to be mobilized and deployed to support the climate neutral' Europe objectives. The following is providing an overview of the Green Deal goals.

The Green Deal focuses on several technology and domain areas.

A1.1. Climate neutral Europe [96]

The EU aims to reach net-zero Greenhouse Gas emissions by 2050, an objective that will be endorsed in a 'Climate Law' presented in March 2020. In particular, the reductions in the GHG emissions compared to 1990 are:

- -20 % in 2020 – 2023: EU member states update their national energy and climate plans to reflect the new climate ambition.
- -50 – 55 % in 2030.
- No net emissions of greenhouse gases in 2050 [4].

The proposed objectives to realize these targets are:

- Interconnect energy systems while integrating and increasing share of renewable energy sources into the grid.
- Promote and integrate innovative technologies and modern infrastructure.
- Boost energy efficiency and eco-design of products.
- Decarbonize the gas sector and promote smart integration across sectors.
- Empower consumers and help Member States to tackle energy poverty.
- Increase cross-border and regional cooperation to better share clean energy sources.
- Promote EU energy standards and technologies at global level.
- Promote support for citizen dialogues and support of energy communities.

A1.2. Sustainable industry and Circular economy [97]

In March 2020, a new circular economy action plan has been launched as part of a broader EU industrial strategy that will include a sustainable product policy with "prescriptions on how we make things" in order to prioritize reducing and reusing materials before recycling them. Moreover, the minimum requirements will be set to prevent environmentally harmful products from being placed on the EU market. False green claims will be tackled. The first efforts are targeted to focus first on resource intense sectors such as: textiles, construction, electronics, plastics.

In order to achieve the EU's climate and environmental goals requires a new industrial policy based on the circular economy. Some mentioned figures are:

- From 1970 to 2017, the annual global extraction of materials tripled, and it continues to grow.
- More than 90 % of biodiversity loss and water stress come from resource extraction and processing.
- EU's industry accounts for 20 % of the EU's emissions.
- Only 12 % of the materials used by EU industry come from recycling.

Europe needs a digital sector that puts sustainability and green growth at its heart. In particular, digitization presents new opportunities for:

- monitoring of air and water pollution and
- monitoring and optimising how energy and natural resources are consumed.

A1.3. Buildings renovation and retrofitting [98]

The reason of focusing on this objective is since 40 % of European's energy consumption is by buildings. The main focus will be to renovate buildings, to help people cut their energy bills and energy use.

The proposed objectives to accomplish better energy performance of buildings are:

- Prices of different energy sources should incentivize energy-efficient buildings.
- Design of buildings should be in line with the circular economy.
- Increased digitization.
- More climate-proofing of buildings.
- Strict enforcement of rules on energy performance of buildings.

A1.4. Eliminating pollution [99]

Whether in air, soil or water, the objective is to reach a "pollution-free environment" by 2050. The following objectives are proposed to reduce pollution:

- Clean water:
  - Preserve biodiversity in our lakes, rivers and wetlands.
  - Reduce pollution from excess nutrients thanks to the Farm to Fork strategy.
  - Reduce particularly harmful pollution from micro-plastics and pharmaceuticals.
- Clean air:
  - Review air quality standards in line with the World Health Organization guidelines.
  - Protect citizens against dangerous chemicals with a new chemical strategy for sustainability for a toxic-free environment.
  - Combine better health protection with increased global competitiveness.
  - Reduce pollution from large industrial installations.
  - Provide support to local authorities to achieve cleaner air for our citizens
- Industry
  - Reduce pollution from large industrial installations.
  - Improve prevention of industrial accidents
- Chemicals
  - Protect citizens against dangerous chemicals with a new chemical strategy for sustainability for a toxic-free environment.
  - Combine better health protection with increased global competitiveness.
  - Reduce pollution from large industrial installations.
  - Provide support to local authorities to achieve cleaner air for our citizens.
  - Develop more sustainable alternatives.
- Improve rules on assessment of substances launched on the market.

A1.5. Ecosystems & biodiversity [100]

In March 2020 a new biodiversity strategy has been presented in the run-up to a UN biodiversity summit intended to take place in China in October 2020.

The EU targets to:

- Lead by example, through the European Green Deal.
- Use diplomacy, trade and development cooperation to advance climate action.
- Set standards for sustainable growth across global value chains.

The uptake of the planned eco-schemes and shift of the focus from compliance to performance towards improved environmental and climate performance, including managing and storing carbon in the soil, and improved nutrient management to improve water quality and reduce emissions is expected to increase the demand for the enabling technologies as well as foster innovation within the sustainable practices, such as precision agriculture, organic farming, agro-ecology, agro-forestry and stricter animal welfare standards and potentially sustainable seafood as a source of low-carbon food.

A1.6. Farm to fork strategy [101]

In spring 2020, the new farm to fork strategy will be launched that will aim for a "green and healthier agriculture" system. The target is to make sure that Europeans get:

- affordable and sustainable food,
- tackle climate change,
- protect the environment,
- preserve biodiversity and
- increase organic farming.

The European Commission will work with Member States and stakeholders to realize the following objectives:

- Ensure the transition is fair and just for everyone working in the European agricultural and maritime sector.
- Reduce significantly the dependency, risk and use of chemical pesticides, as well as of fertilizers, antibiotics.
- Develop innovative farming and fishing techniques that protect harvest from pests and diseases.
- Farm to fork will also help combat food fraud by preventing, detecting and fighting it through coordination with Member States and non-EU countries.
- Imported food products from third countries must comply with the EU's environmental standards.

A1.7. Sustainable mobility [102]

According to the European Green Deal, Europe must reduce emissions from transport further and faster. Transport accounts for a quarter of the European Union's Greenhouse Gas emissions and these continue to grow. Therefore, the Green Deal seeks a 90 % reduction in these emissions by 2050.

Some of the objectives of realising the Sustainable mobility Green Deal targets are:

- Go digital
  - Automated mobility and smart traffic management systems will make transport more efficient and cleaner.
  - Smart applications and 'Mobility as a Service' solutions will be developed.
  - Use different modes of transport
    - more freight should be transported by rail or water,
    - the Single European Sky should significantly reduce aviation emissions at zero cost to consumers and companies.
  - Boost supply of sustainable alternative transport fuels.
- By 2025, about 1 million public recharging and refuelling stations will be needed for the 13 million zero- and low-emission vehicles expected on European roads.
  - Reduce pollution
    - The Green Deal will address emissions, urban congestion, and improve public transport, which can be realized by:
    - stricter standards on pollution by cars,
    - to reduce pollution in EU ports,
    - to improve air quality near airports.

A1.8. R&D and innovation

It is considered that the Horizon Europe research and innovation program will also contribute to the Green Deal during the next seven years (2021 – 2027). In particular, it is planned that 35 % of the EU's research funding will be set aside for climate-friendly technologies under an agreement struck earlier this year [103]. Moreover, a series of EU research "moon shots" [104] will focus chiefly on environmental objectives.

- Climate neutral Europe,
- Sustainable industry and Circular economy,
- Buildings renovation and retrofitting,
- Eliminating pollution,
- Ecosystems & biodiversity,
- Farm to fork strategy,
- Sustainable mobility.

A1.9. The road to the successful enablement

Industrial transformation towards the Green Deal may be approached in two dimensions. The first is related to the objectives. *"Europe needs a digital sector that puts sustainability at its heart. The Commission will also consider measures to improve the energy efficiency and circular economy performance of the sector itself, from broadband networks to data centres and ICT devices".* In addition, the Commission will assess the need for more transparency on the environmental impact of electronic communication services, more stringent measures when deploying new networks and the benefits of supporting 'take-back' schemes to incentivize people to return their unwanted devices such as mobile phones, tablets and chargers.

This dimension includes activities that need to be taken in order to reduce the energy and carbon footprint of SNS platforms. Objectives of the SNS Partnership contribute both to decarbonize ICT itself and the industries served by ICT [105].

The second dimension addresses the solutions that the SNS Partnership can contribute towards Green Deal goals within focus areas that indicatively include: farm to fork, buildings retrofitting as well as monitoring, sustainable industry and circular economy, eliminating pollution, sustainable mobility and energy transformation etc. This dimension includes activities that need to be taken in order to reduce the energy, carbon footprint of vertical domains using SNS platforms.

Annex 2 Exemplary analysis and mapping of SDGs to ICT building blocks

The UN SDGs require the availability of ubiquitous and affordable communication networks to support the digitization of society and economy in developing and developed countries. ITU has summarized the contributions of the ICT sector to work on the UN SDGs [19] as well as the investment in digital technology [20].

Mobile networks have a central role to play in this. Existing reports (e.g., [106]) have presented, using a qualitative and quantitative analysis, the impact of the mobile industry in all 17 SDGs (Figure 26). Obviously, not all SDGs are met equally well for several reasons (e.g., maturity of services, lack of required networking technological solutions etc.). However, these normalized scores should be improved significantly in the future. Beyond 5G networks will lead such efforts as they will affect a number of vertical industries that cover multiple sectors of everyday life. Continuous research activities will create several technological breakthroughs. These are needed for the efficient support of the diverse requirements of the verticals and the expected massive connectivity of end-devices. All these efforts require multi-disciplinary and cross organizational collaboration activities (public and private sector, regulatory bodies etc.).

ITU has provided a methodology to identify which are the ICT building blocks for each SDG target group. For some of the SDG targets, this methodology is feasible since the related services of a vertical industry are quite mature. However, this is not the case for all SDGs, since some of these domains and processes are either in their infancy or they are currently evolving. Looking at the big picture though, one can easily identify what are the main technological areas that characterize each SDG.

Figure 26 SDG impact scores [106]

Figure 27 presents such an indicative listing where some SDGs (i.e., 6, 7, 11, 13, 15) require mainly ubiquitous availability, energy efficiency and massive IoT service management. These

SDGs are related for example to the deployment of vast numbers of IoT devices that collect information and improve the everyday life of citizens (e.g., water, quality, smart cities, improved management of power and energy etc.). Other SDGs (i.e., 3, 9) require a virtually "infinite network capacity", high throughput, ultra-low latency and high reliability. Examples of related services to these SDGs are those used in the autonomous vehicles' domain. Note here that although significant work has been performed in this area (i.e., V2X communication), fulfilling the capacity and delay requirements for full autonomous driving (i.e., SAE level 5) is still not supported by 5G networks as additional technological breakthroughs are needed.

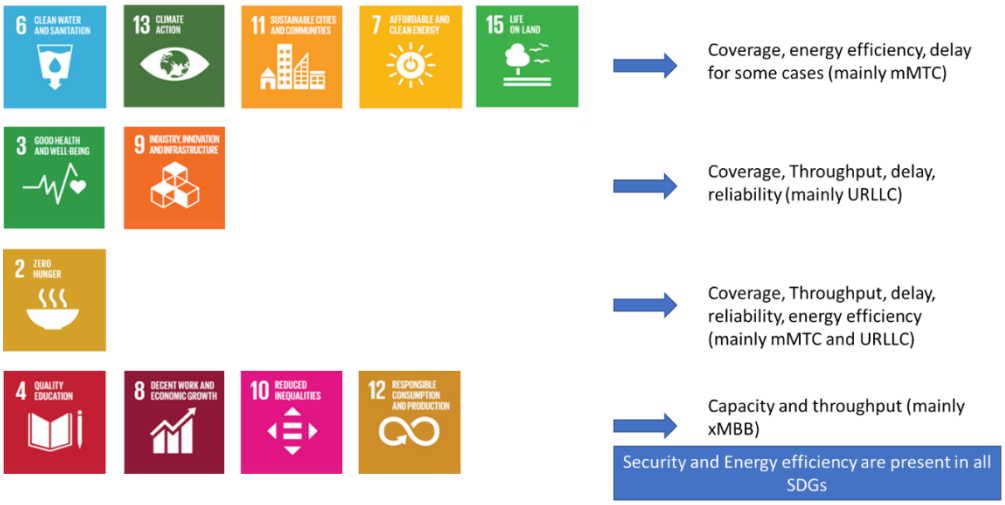


Figure 27 Indicative technological areas and their relation to SDGs

In relation to the SDG 2, an initial analysis indicates that it needs a combination of technological solutions discussed for the previous two SDG groups. For example, zero hunger can be addressed by increasing the food productivity (i.e., smart farming requiring a significant amount of IoT solutions) and efficient cultivation techniques (e.g., remote/autonomous driven tractors etc.). Finally, the last group of SDGs (i.e., 4, 8, 10 and 12) requires ubiquitous availability, infinite network capacity and mainly increased throughput to support advanced services (e.g., advanced collaboration using holograms, etc.). Note that security and privacy are present in all the technological areas.

To understand in detail how the SDGs can be met, and which ICT building blocks need to be developed and used, one needs to follow a more formal approach. In [20] a methodology is explained on how the SDG targets can be eventually mapped into the necessary building blocks. In Annexes A2.1 and A2.2 we briefly discuss this methodology and present two exemplary cases of such an analysis. A thorough analysis of all SDGs will take place during the first phase of the Smart Networks and Services Programme. This will allow the Programme to set solid and realistic goals until the end of the Programme.

Significant research efforts must be undertaken during the next decade for all these technological areas. Figure 28 is an example on how the technological areas needed by the SDGs are mapped into research activities for B5G systems. It also presents a list of enablers for these research areas.

The European Commission is committed to the abovementioned SDGs [60]. In his State of the Union speech in 2017 the President of the EU Commission, Jean-Claude Juncker, formulated the vision of "***a Europe that protects, a Europe that empowers, a Europe that defends***" [107], which guides to the proposed next Multiannual Financial Framework from 2021 to 2027 of the European Union and the proposed Horizon Europe programme [108]. Data security and citizen's integrity are key European objectives. This is one of the key enablers for Europe's strategic autonomy. The proposed Partnership in Horizon Europe contributes to this European vision as "***Smart Networks and Services empowers society and protects citizens***".

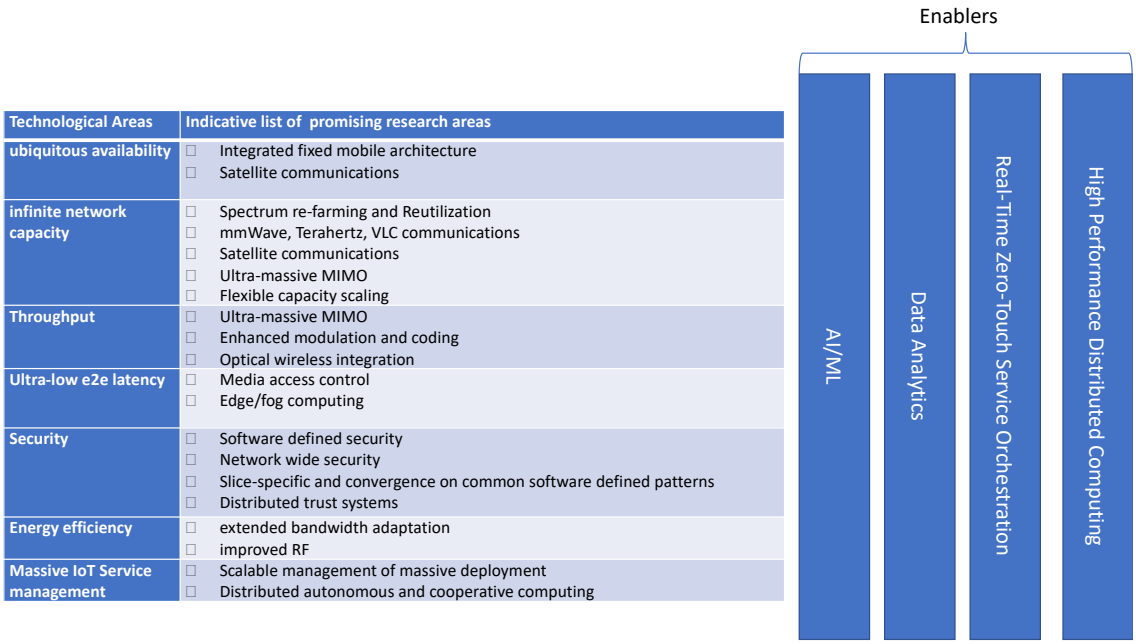


Figure 28 Indicative list of research areas and technical enablers

The analysis in the following two Sections is based on the ITU methodology presented in [20]. This methodology suggests starting from SDG targets (i.e., define high-level objectives to which governments systematically align their development goals), define use cases (i.e., define the steps necessary to achieve a business objective contributing to one or more SDG Targets.) and the workflows (i.e., generic business processes, such as 'client communication' or 'procurement', that support the delivery of a Use Case.) and finally end up at ICT building blocks (i.e., reusable software components that enable workflows and use cases across multiple sectors). The ICT building blocks are related to mid and long-term objectives as described in Annex 4.

In the next two Subsection we have applied this analysis to two SDGs. Note that a thorough analysis for the different SDGs is needed to end up with solid conclusions and tangible goals that will be met by the end of the Programme.

A2.1 Example 1: SDG 2 – Zero Hunger

From the description of SDG 2 the most relevant goals to the SNS Programme are the following:

- **Goal 2.3:** By 2030, double the agricultural productivity and incomes of small-scale food producers, especially women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
- **Goal 2.C:** Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility.

Indicative use cases are:

1. Improve productivity and decrease cost through innovative production processes (e.g., smart farming, remote machinery operation).
2. Provide access to specialized information for some cases in real time (e.g., health of crops using AR/VR systems).
3. Provide access to markets and information in a globalized environment.
4. Provide the means for end-to-end product traceability information.

The corresponding workflow examples are:

1. Easy connection and management of massive IoT devices.
2. Support the automation of the farming activities (autonomic and remotely operated farming machinery).
3. Collection and management of vast amounts of information of localized significance.
4. Access to AI based systems to receive specialized information.
5. Global coverage and always on connectivity in an affordable way.

Finally, the needed ICT building blocks to support the abovementioned workflow are:

1. Support of novel functional architecture (e.g., slicing, advanced ad-hoc mode of operation, support mMTC and URLLC networks, satellite communications etc.).
2. Self-reacting core-orchestrators.
3. Provide efficient and affordable means for coverage and capacity in telecommunication systems (NFV/SDN, advanced edge computing and meta-data, energy efficient mechanisms).
4. Software defined security, distributed trust systems.
5. Scalable management of massive deployment distributed autonomous and cooperative computing, nanothings networking.
6. Energy efficiency through improved RF components and systems.
7. Swarm computing.

A2.2 Example 2: SDG 3 – Good Health and well-being

From the description of SDG 2 the most relevant goals to the SNS Programme are the following:

- **Goal 3.6:** By 2020, halve the number of global deaths and injuries from road traffic accidents.
- **Goal 3.8:** Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all.

Indicative use cases are:

1. Provide improved road safety solution for vehicles and pedestrians.
2. Provide access to advanced health services (e.g., remote surgery).
3. Provide support for advanced warning system.

The corresponding workflow examples are:

1. Support V2X communication systems for gradually introduce new levels of autonomous driving.
2. Connection to real time and non-real time medical services and doctors even to remote places.
3. Access in a secure way to AI based systems to receive specialized medical information.

Finally, the needed ICT building blocks to support the abovementioned workflow are:

1. Support of novel functional architecture (e.g., slicing, support URLLC networks, integrated fixed-mobile architectures, satellite communications, intent-driven and AI management of network etc.).
2. Seamless fog/edge/cloud orchestration to support V2X Application servers.
3. Provide efficient and affordable means for coverage and capacity in telecommunication systems (spectrum, bandwidth adaptation, advanced edge computing, improved radio technology and signal processing, e.g., Terahertz, mmWave, VLC, capacity scaling).
4. Network wide security and trust on an end-to-end basis.
5. Native integration of AI solutions for both the network and the applications.

Annex 3 CEF2 activities

It is intended that the Smart networks and Services Partnership will also coordinate CEF2 activities towards such 5G deployments. The overall intended objectives and the approach are summarized in [109], which is still under discussion in the EU Commission.

A3.1 Deployment vision

There are excellent opportunities for the Smart Networks and Services Partnership to exploit synergies with other programmes in addition to Horizon Europe. In particular the CEF2 Digital programme [110], [111] foresees deployment actions in the area of 5G corridors for Connected and Automated Mobility (CAM). As 5G for CAM was one of the most important verticals that emerged under the 5G PPP, the coordination and pre-structuring of the CEF2 programme in this field is an evident task for the Smart Networks and Services Partnership.

The 5G PPP Partnership Board has tasked the 5G PPP Automotive WG [75] to develop a Strategic Deployment Agenda (SDA), where the first version is just published [76], to set out the main elements that can be considered for the CEF2 Work Programmes. It covers 5G CAM services requirements, a range of cooperation models and regulatory considerations. 5GAA [79] and GSMA [80] are participating in this activity.

Horizon Europe and CEF2 are different programmes in the next Multiannual Financial Framework from 2021 to 2027. It is intended that the proposed European Partnership is coordinating activities of both pillars, where activities under Horizon Europe are focused on research and forward-looking topics and activities under CEF2 are related to 5G deployments in cross border regions.

In 5G PPP Phase 3 first trials projects on corridors [77] are supporting the EU Commission objectives to provide major cross border transport routes with 5G by 2025 [61]. The CEF2 programme in Horizon Europe is targeting a big step forward in that direction based on an agreed EU strategy [78] towards comprehensive commercial deployment along cross-border corridors.

A3.2 Coordination of CEF2 5G deployment activities

The 5G Action Plan for Europe (5GAP) calls for actions to ensure that the EU can use advanced 5G connectivity as a strategic advantage to lead in digital transformation, especially in vertical industries, and in support of key societal objectives. One of these strategic sectors, with strong public interest, is Connected and Automated Mobility (CAM). Recognising the transformative potential of 5G in the field of mobility, and driven by the ambition to make Europe a world leader in CAM products and services, the Commission in 2016 has set ambitious Gigabit connectivity objectives [61], starting with a coordinated launch of 5G in all EU Member States by 2020 and a comprehensive deployment by 2025 to ensure full urban coverage as well as uninterrupted 5G coverage along main transport paths (roads and railways).

In the area of mobility, the Commission adopted its strategy for Connected and Automated Mobility in May 2018 underlining the societal benefits as well as economic opportunities for Europe in this field. The Commission emphasized its commitment to work with Member States and stakeholders to develop a **network of pan-European 5G corridors** for large-scale testing and early deployment of advanced connectivity supporting CAM. For such a pan-European network to emerge it is necessary to start at an early stage with 5G cross-border sections, first for experimentation through Horizon 2020 and then deployment through CEF2 Digital. Public intervention at EU level is therefore justified on these "**5G cross-border corridors**".

A milestone in this process has been the Letter of Intent signed in April 2017 at the occasion of the first Digital Day in Rome by 27 EU countries, plus Norway and Switzerland agreeing to cooperate in the field. To date a total of ten 5G cross-border corridors have been agreed among neighbouring states across Europe. Four of those are covered by the first set of Horizon 2020 trial projects [112], [113], [114].

The CEF2 proposal already indicates two lists of corridor segments, one covering first cross-border sections for large-scale experimentation and one with longer segments for deployment and early use of CAM and the full range of other 5G services, the latter mainly based on TEN-T. In addition, during the CEF2 negotiations, Member States have added potential corridors to this indicative list.

The overall aim is to ensure uninterrupted coverage of the full pan-EU network, using CEF2 at cross-border sections and complemented with private investment projects in commercially viable areas and national programmes in the remaining challenge areas.

Activities under CEF2 Digital on CEF2 Corridors are expected to have a significant share of the 3 Billion € budget of CEF2 Digital. Deployment activities unlocked by the programme of such scale will have a structuring effect on markets in this area and involve a broad range of stakeholders from various sectors as well as public authorities. In order to ensure the take-up of the programme as such and to build a consistent project pipeline, the coordination work under this Partnership is needed.

A3.3 High-level Strategic Deployment Agenda

The overall aim is to ensure uninterrupted coverage of the full pan-EU network, using CEF2 mainly to drive investments in cross-border sections in complementarity with private investment projects in the commercially viable areas. National programmes could be mobilized to support investments in the remaining challenge areas.

Service requirements

A key step in the strategy setting will be to get a common understanding on the evolving role of 5G connectivity infrastructure along with transport paths in the provision of CAM services over time, alongside a broad range of digital services in vehicles. While these services cannot be predicted today with great certainty, it is however important to ensure that the planned 5G infrastructure will be sufficiently “future-proof” to address a broad range of “high level automation services” that will emerge in the next decade. Such information will be essential to optimize the deployment of 5G connectivity infrastructure with a European-wide perspective, provide for a step change to mobile services available today, and protect the long-term financial viability of the investments. The SDA includes the identification of the main broad categories of services in a forward looking way, and lead to a common understanding on their impact on 5G connectivity needs.

Connectivity performance levels and minimum Quality of Service

Another important requirement for the planning of the future 5G infrastructure along transport paths is the need to ensure specific network performance levels (including bandwidth and coverage needs) and Quality of Service. This will largely determine the kind of 5G infrastructure that needs to be deployed. The analysis should not only address the various needs for CAM service implementation (various driving automation levels, platooning, etc) but also for other relevant services that could be delivered (e.g. “infotainment” on board, public safety, and mobile office in the longer term).

The main requirements for CAM are a sufficiently dense network allowing for highly reliable uninterrupted service, sufficient performance as regards capacity, speed, latency and number of connections, as well as advanced service features such as network slicing to guarantee the quality in a multi-service environment (in relation to non-CAM services like infotainment provided over the same infrastructure).

Technical characteristics of 5G networks for CAM

This step in the SDA development should focus on the generic technical elements that should be part of a shared reference model to describe the cellular infrastructure for CAM along 5G corridors. It should extend beyond the 5G base station and also include spectrum aspects (e.g. suitable bands), backhauling requirements, and possibly some additional technical elements,

as appropriate, such as equipment to support Mobile Edge Computing (MEC) functionalities, network slicing capabilities, interfaces to road sign equipment or any other relevant infrastructure elements other than 5G-specific equipment such as specific software components.

Deployment scenarios

Corridors identified by the EU Commission and Member States

The principle of the 5G infrastructure initiative envisaged is to seize market opportunities and societal benefits of CAM services and of other (commercial) services. The logic of investment should therefore follow a private sector's 5G investment roadmap, while also meeting public interest objectives. The coordination with public-sector driven infrastructure projects is highly relevant, especially regarding the reuse of road infrastructure and common planning of civil engineering. The CEF2 Digital proposal contains two sets of cross-border corridors [76], which are part of major transport paths across Europe. They are of strategic importance from the public perspective, inter alia to make sure that CAM services develop at pan-European level. This should also be of interest to the private sector.

Predicted investment plans and market failure areas

As already stated, the investments necessary to meet EU 5G deployment objectives will mainly have to come from the private sector. According to first estimates, the investment required (combining private/public) to cover pan-EU corridors with 5G would be in the order of at least 10 Billion €, whereas the investment required for a deployment including rail and larger national roads would amount to the order of 100 Billion €. Dedicated 5G coverage obligations in spectrum auctions, e.g. as already envisaged in Germany by BNetzA, are promising to play a significant role in guiding MNO investments and will have an impact on the deployment strategies of mobile network operators, including on the definition of priority areas such as major transport paths and cross-border corridors. However, it is desirable that commercially viable services also contribute to the stimulation of investments for 5G coverage along major transport routes. In this respect, emerging ecosystems around vehicles offer broad business opportunities for market players. These include enabling CAM services, but also a wide range of digital services to passengers in cars, when passengers in cars will become less active as drivers. These go beyond transport-related services and include for example mobile office and entertainment.

Nevertheless, the specific features of 5G corridors for CAM, as compared to "normal" 5G network deployment addressing consumer and business markets may entail higher risk levels and longer payback periods, which could hinder and delay the deployment. We can already anticipate in particular:

- Need for an uninterrupted 5G connectivity coverage along transport paths to ensure CAM business continuity (i.e. independently from the nature of the crossed areas such as rural, mountains, cross-border etc.) and related prospects of return on investment.
- Different categories of actors involved on both sides of 5G CAM markets, with their respective and distinct economic models and related business plans (e.g., road operators, telecom operators, specialized CAM service providers, car manufacturers/OEM, fleet/freight companies etc.).
- Effectiveness of CAM solutions only from a certain penetration rate of 5G CAM-equipped vehicles.

The above factors could delay the potentially huge market opportunities and societal benefits of 5G-based CAM. Against this background, coordination at EU level, coupled with targeted financial support for deployment based on CEF2 Digital seems indispensable.

Clear indications of market failure to reach the full set of deployment targets combined with the strong public interest for CAM services as well as the need for a European dimension amply justify the consideration for public funding of 5G cross-border segments.

Such public funding should therefore be used to create a positive momentum in the market by catalysing and coordinating the investments from stakeholders.

The SDA will present a common understanding on the various market situations and how public funding could complement private investments, coherent with EU competition law principles. As far as the use of CEF2 Digital funding is concerned, the coherence with competition law principles will probably require demonstrating how the infrastructure "step change" will be achieved by the investment, as compared to existing or planned cellular networks along similar corridors. The step change can relate to network coverage and performance, but also service features such as network upgrades allowing for advanced network slices for CAM.

Even though funding through the proposed CEF2 Digital programme as part of the EU budget will not directly be subject to State Aid, its design needs to be coherent with competition law principles: it will normally entail that some form of access is granted to users by any economic actor receiving CEF2 funding for its connectivity infrastructure. In this context, public funding of passive infrastructure will be the easiest case. The SDA should therefore elaborate on the choices regarding which active infrastructure option is relevant to be fundable in the future CEF2 Work Programmes. DG CONNECT has launched a study which will identify costs and provide estimates for relevant 5G corridor scenarios in this context of the future CEF2 programme and define a methodology for assessing the conditions pursuant to which a CEF2 Digital funding could intervene, in particular in cases where parts of a 5G corridor would not be economically viable for deployment [115]. As an initial step the 5G PPP Automotive Working Group "Business Feasibility Study for 5G V2X Deployment" White Paper [116] elaborates on different sharing options in the highway scenario from a business feasibility perspective. More in depth studies could include a discussion on best scenarios for the progressive build-up of the infrastructure addressing geographical priorities and type of deployment topologies that can be envisaged over the successive time periods between now and 2025, and even beyond. This should consider the identification of areas and corresponding business cases where there is a lack of financial viability and hence where public funding would be most appropriate.

Cooperation models

The SDA can provide guidance on what cooperation models could be envisaged. This could include provision of passive infrastructure, active infrastructure made available at wholesale level, complete 5G networks on infrastructure sharing basis, or other type of 5G infrastructure. There will probably be at least three categories of situations: cases where private investments are sustainable, cases where only one shared infrastructure can be financed by the private sector and cases where there is no profitable business model without the support of public funding (market failure).

The cooperation model chosen may also be influenced by the fact that a consortium member would need to provide some forms of access to interested users, and EU funding could be conditioned to some forms of access requirements. To the extent that a consortium might involve more than one horizontal competitor (e.g. network sharing by MNO participants), antitrust issues and safeguards might also need to be considered in setting out the model.

As far as public support is concerned, activities under CEF2 Digital on CEF2 Corridors are expected to have a significant budget (planned for at least 1 Billion €). Deployment activities unlocked by the programme of such scale will have a structuring effect on markets for connectivity and involve a broad range of stakeholders from various sectors as well as public authorities.

When the particular use of CEF2 funding is being considered, the project should make clear upfront how the infrastructure will be used after the project is finished. Details on cooperation arrangements could be specified between participants in a consortium agreement. The project needs to demonstrate how the infrastructure will contribute to the public policy objectives in the context of CAM. While recognising that the 5G infrastructure is "multi-service" including a broad range of commercial services, it should not only serve the commercial purposes of the

owner of the infrastructure. Concrete commitments for the provision of CAM services or for enabling services for players inside or outside of the consortium will be necessary.

The preparation of the SDA is an opportunity to review the above cooperation challenges from a multi-stakeholder's perspective.

It is essential to involve the appropriate set of stakeholders in the elaboration of the proposed SDA. In addition to the two obvious sectors which are at the core of CAM deployment, the automotive industry and the telecom/IT sector, it is expected that road infrastructure operators and suppliers will also be key partners in the approach. It would also be appropriate to involve other relevant communities, in due time, such as technology/service innovators, local public authorities, infrastructure investors (distinct from network operators), road safety authorities, public transport operators, manufacturers of road signage installations road police authorities. It will be the responsibility of the participants to ensure an open and balanced representation of all concerned parties.

Service continuity between network operators is a special case of cooperation that will require innovative business approaches to be applicable on a large-scale basis and enable service continuity across borders and across types of road infrastructures.

Regulatory aspects

There is a clear contrast between the significant societal benefits expected from CAM and the strategic risks incurred by early investors in 5G corridors: regulatory-enabled cooperation models may play an important role to address this externality, and more generally to incentivize investments.

The possible regulatory approaches to help bridging the gap between investments and full benefits should preferably be considered "upfront" in the SDA framework. In this context, it is anticipated that the CEF2 programme will offer concrete opportunities to test, in a "green-field" scenario environment, new regulatory approaches supported by the modernized telecom rules.

As most CAM services are "mission-critical" they are expected to represent a prominent example of 5G specialized services implemented with so-called "network slices". A common understanding of the main features of such network slices accepted by stakeholders and regulators as compliant with the net neutrality rules and modernized BEREC guidelines could help to provide legal certainty for specialized services in the CAM context, as well as for other 5G specialized services. Approaches that prove appropriate in this context could be taken up in other network or service environments. They could also feed into guidelines of national and European regulators. On a wider basis, models for specialized services approved at EU level would contribute to legal certainty in this field.

The recently adopted European Electronic Communication Code ('the Code') contains several new regulatory innovations, such as co-investment arrangements, infrastructure sharing, wholesale-only network provision, open access approaches. It also includes provisions to serve transnational demand (i.e. cross-border) with harmonized wholesale access products, spectrum issues and open numbering resources with extra-territoriality features for connected vehicles. Some of these rules could be relevant beyond fixed broadband networks and be used in 5G scenarios where they could incentivize investment in 5G corridors.

The SDA can be instrumental to specify the needs regarding 5G spectrum bands as well as the regulatory conditions, e.g. types of bands and spectrum sharing conditions. The SDA could also identify the various requirements of market actors regarding test licenses and access to spectrum for longer-term services.

Another important aspect is the C-ITS legal framework and associated delegated acts. Whereas 5G systems for CAM go beyond the scope of C-ITS, progress in 5G corridors can be an important element for the review or revision of such legislation.

Annex 4 High-level Research Agenda

The high-level Research Agenda is based on the state-of-the-art and gap analysis to identify necessary research topics.

A4.1. State of the art and gap analysis

A4.1.1. State of the art

5G technology is already a success, with the first commercial new radio deployment on April 17, 2019. Ericsson, Nokia, Huawei and ZTE have already delivered new radio base stations and networks to the different operators that provide new radio commercial service. On the terminal side, three commercial 5G modem chipsets are already available: Qualcomm X50, Huawei Balong 5000 and Samsung Exynos 5100. None of these chipsets implements the full release 15 specification, implying some service and performance restrictions. As one example, the X50 modem can only work in NSA (Non-Standalone) deployments and does not support multi-band carrier aggregation. The chipsets have already been incorporated by around 15 smartphone models, but availability of CPE and USB dongles is still very scarce.

There are currently 19 countries [117] with new radio service, all of them with Non-Standalone deployments and around 90 MHz of assigned spectrum. Most countries are currently operating in the n78 band (3.5 GHz), and coverage is available in several cities in the order of 10 to 50. The widest coverage is currently provided in South Korea [118], currently covering over 90 % of South Korea's population. New radio commercial availability has been announced for 2020 by most other countries in the world. Even though we already have 19 countries with new radio commercial service, deployment of edge computing is absolutely marginal, and slicing is still not commercially available. These shortcomings severely limit the network capability to offer very low delay and being the service factory that 5G is aiming to become.

The current new radio deployments are already allowing for throughputs around 500 Mbps in mobile terminals. Current latency figures depend on the measuring endpoint upstream, and it can be established in the range of 10 ms to 20 ms, while delay jitter is in the range of 1 ms to 20 ms. Spectrum efficiency is in the order of 6 bps/Hz for a single terminal, and the aggregated value for the base station, depending on the nT/mR MIMO configuration.

All the new radio services currently in operation are based on Release 15 of 3GPP, and the corresponding technical and scientific solutions to implement it. Relevant 5G characteristics are still limited in Release 15, such as multicast service and network-controlled device to device. Moreover, not all the capabilities of Release 15 are implemented by commercial equipment.

Potential technical KPIs are currently under discussion mainly in the scientific community with respect to the envisaged usage of future systems, cost implications, business cases and technical feasibility. For the time being no KPIs are agreed for the evolution of current communication systems. Table A1, [49] and [50] show an example, which presents a suggestion for network KPIs for the short-, medium- and long-term evolution of 5G. Such KPIs are under investigation and need to fit to requirements of industry and will be regularly updated based on state-of-the art findings. The SNS Partnership will establish a Specification Group to discuss and agree KPIs of future systems and will push them towards international organizations like ITU-R, NGMN and GSMA, 5GAA, 5GACIA, etc. Also, it will provide a clear roadmap setting concrete milestones on when these achievements will be met.

Target KPI	5G NR	5G NR SEVO	5G NR MEVO	5G NR LEVO
Spectrum	< 52.6 GHz	< 250 GHz	< 500 GHz	< 1000 GHz
Bandwidth	< 0.5 GHz	< 2.5 GHz	< 5 GHz	< 10 GHz
Peak Data Rate	DL: > 20 Gbps UL: > 10 Gbps	DL: > 100 Gbps UL: > 50 Gbps	DL: > 200 Gbps UL: > 100 Gbps	DL: > 400 Gbps UL: > 200 Gbps
User Data Rate	DL: > 100 Mbps UL: > 50 Mbps	DL: > 500 Mbps UL: > 250 Mbps	DL: > 1 Gbps UL: > 0.5 Gbps	DL:> 2 Gbps UL: > 1 Gbps
Peak Spectral Efficiency	DL: > 30 bps/Hz UL: > 15 bps/Hz	DL: > 40 bps/Hz UL: > 20 bps/Hz	DL: > 50 bps/Hz UL: > 25 bps/Hz	DL: > 60 bps/Hz UL: > 30 bps/Hz
Density	> 1 device/sqm	> 1.3 device/sqm	> 1.7 device/sqm	> 2 device/sqm
Area Traffic Capacity	> 10 Mbps/sqm	> 50 Mbps/sqm	> 100 Mbps/sqm	> 200 Mbps/sqm
Reliability	URLLC: > 1 - 10-5	> 1 - 10-6	> 1 - 10-8	> 1 - 10-9
U-Plane Latency	URLLC: < 1 ms	< 0.5 ms	< 0.2 ms	< 0.1 ms
C-Plane Latency	< 20 ms	< 10 ms	< 4 ms	< 2 ms
Net. Energy Efficiency	Qualitative	> 30 % gain	> 70 % gain	> 100% gain
Term. Energy Efficiency	Qualitative	> 30 % gain	> 70 % gain	> 100% gain
Mobility	< 500 Km/h	< 500 Km/h	< 500 Km/h	< 1000 Km/h
Positioning accuracy	NA (< 1 m)	< 30 cm	< 10 cm	< 1 cm

Table A1 Examples of technical KPIs for the Smart Networks and Services [49] and [50]

A4.1.2. Mid-term research objectives

As we have seen in Subsection A4.1.1, the 5G ambitious objectives have still not been reached, and relevant research challenges should be addressed to achieve them for the coming Release 16. Moreover, the 5G technology will not stand still and will continue to evolve and be upgraded through new technological developments to be incorporated in Releases 17 and 18. Industrial research work is mainly focused on finding solutions towards 3GPP Releases 16 and 17 of 5G, and also looking ahead towards 5G evolution. Complementary developments are also ongoing in the WiFi domain, with the development of Wi-Fi7 (or 802.11be). On the wired connectivity side, the passive optical infrastructures are widely deployed and available more and more closely to the customers. Research is ongoing on optical access technologies up to 100 Gbps, usable also for cellular networks radio sites fronthaul or backhaul, and on smart optical aggregation and transport networks offering more and more differentiated quality for on-demand services. Relevant research topics are being addressed by industry in the different network and services areas.

Within control research we can identify the following relevant objectives being currently pursued:

- Self-reacting core orchestrators, with capacity for event detection, reconfiguration decision, deployment and operation.
- Improved Service Based Interface (SBI): Evolution of the SBI underlying the Core Service Based Architecture.
- User/Control plane separation, with capacity to handle multiple user data flows arising from MEC options.
- Slices for multitenant and Federation: Achieving seamless multitenancy of the RAN and customer federation of slices from multiple operators.
- SLA implementation and control: Improved redesign of QoS architecture to guarantee and monitor customers' SLAs.

Within radio research we can identify the following relevant objectives being currently pursued:

- Massive MIMO and active antennas, with special emphasis on:
  - Improvements on spatial reutilization, integrated RF processing, and better footprint.
  - Flexible subcarrier and slot resource assignment: Improved numerology, dynamic SCS/slot configuration, faster duplexing to reduce latency, among others.
- Extended functional splits: Adaptation to different physical configurations, integrated crosshaul/midhaul networks, multiple physical layers or multi-RAT integration.
- Energy reduction: Covering topics such as extended bandwidth adaptation, narrow beams, or improved RF components and systems.
- New deployment options, such as
  - Non-terrestrial networks based on high altitude and satellite platforms,
  - Network-controlled sidelink and device to device (V2X).

Within service research, there is relevant work on the following directions:

- Software-centric services: Evolution from system-based services to software-based services.
- Seamless fog/edge/cloud orchestration: Porting virtual machines and applications vertically, and horizontally through the network topology (e.g. game backend following a bus of users).
- New lightweight, but sufficiently robust, authentication mechanism and improved cybersecurity system capabilities.

We can see that current industry-led research is addressing the most important current industry needs focusing on Release 16 of 3GPP and addressing some topics beyond Release 16, towards Release 17 (5G evolution), and looking into some possible areas towards Release 18. This is certainly very relevant research work, but it is clearly not enough.

In order to maintain the European leadership in Smart Networks and Services, in the coming era of further advance and convergence with computing, it is necessary that Europe addresses also long-term and disruptive research topics. Other world regions are heavily investing in new directions, in order to deliver the next generation of Smart Networks and Services, supporting a new wave of digitization in business, society and administration, across all vertical sectors.

These disruptive research topics will bring the base for the future fundamental ICT services, systems, devices, concepts and paradigms. We should therefore incorporate into Horizon Europe research action lines pointing towards these disruptive directions, while supporting also the required industrial research for 5G evolution.

A4.1.3. Gap analysis and long-term research

The mid-term research objectives just presented in the previous Subsection are very relevant and are pursued by the industry to deliver the next product line for 5G Release 16 and

advancing into Release 17. However, we have identified relevant gaps, in disruptive directions towards the future Smart Networks and Services.

As already stated, Europe needs to pursue more ambitious and long-term research objectives not to be left behind by other world regions in such a strategic area as digital infrastructures. We have identified several fundamental research lines not currently addressed that will lead to disruptive technical results. The envisaged fundamental research lines are the following:

- Digital Service Transformation:
  - Swarm computing, enabling the coordination of clouds, networks, IoT and data to enable multitudes of entities and devices to combine to form dynamic and intelligent collectives [119]. The limited computing capacity of individual objects is complemented and supplemented by their connection to other objects in relevant communities.
  - B2B2X (Business-to-Business-to-X) systems that are: a) context-aware, b) immersive, c) omnipresent, d) intelligent and e) autonomous. This should be based on automated open platforms that are fully virtualized and use microservices to provide service assurance adapted to business needs [120].
- Software-Centric to Human-Centric Services:
  - User interfaces recognising voice, including mood, plus gestures and attitude, capable to react based on them as it is done in a human-human communication.
  - E-skin devices interfacing with multiple sensors applications as part of the service. Sensors will have the ability to compute data and perform cryptography in our bodies, or the ability to transmit and receive digital data and talk directly to machines in their digital language.
  - Ultra-high bandwidth brain-machine interfaces to improve the human-computer interaction [121].
- Network-Unaware Vertical Services:
  - Intent-driven plus and AI managing both network and services, enabling the system to redistribute workload, perform intelligent placement, implement traffic load balancing versus link utilities, and handle dynamic flows in large-scale networks. The combination of an intent-driven approach and AI techniques for managing both networks and services will bring enormous gains in services, in service effectiveness and in functionality.
- Extreme Automation and Real-Time Zero-Touch Service Orchestration:
  - Big-data driven policy management based on AI driven orchestration incorporating the network capabilities of auto-provisioning and self-redundancy for improved reliability and resource utilization. ETSI NFV has started a specific group on ”Zero Touch Network and Service Management” (ETSI ZSM ISG) that plans to focus on some of the aforementioned challenges in relation to network and service management, in order to allow all the operational processes to be executed automatically [122].
  - Greater policy-driven autonomic support will be required for network automatic self-healing and self-organization [123] with no human intervention.
- Service injection loop:
  - Automatize interoperability, service-store, services metamodel, etc.
- Nano-Things Networking:
  - Application specific channels, ultra-low power, massive nano-node integration, HW-SW co-design, etc.
- Bio-Nano-Things Networking:
  - Synthetic-biology and nanotechnology convergence, chemical interfaces, implantable BNT, molecular communication channels, etc.

- Quantum Networking:
  - Quantum key distribution, quantum digital signatures, quantum multiparty protocols, etc.
- AI enabled Network and Services:
  - AI-based network design, automated operations, smart OPEX, intelligent cybersecurity, resilient and ubiquitous multitenant, multi-technology networking etc.
- Impact of IoT on Network and Services:
  - Support for massive scale IoT, contention MAC, certificate authentication, lightweight stacks, scalable solutions and need for edge computing, etc.
- Convergence of Protocols and SDN/NFV:
  - Cross-layer protocols, inter-orchestrator protocols, policy-based protocols.
- Application Level Networking:
  - Content networks, game networks, drone networks, fleet networks, etc.
- Applications (Components) in the Network:
  - Service discovery, glass-to-glass ecosystem, privacy and data management, novel programming models, etc.
- Applications Making Specific Demands to the Network:
  - Evolution of socket interface: Local service and network function instantiation, latency and QoS services, regulation-based APIs, etc.

The technical orientation and the SRIA in Annex A4.2 are derived from these advanced research objectives.

A4.2. High-level Research Agenda

The high-level research agenda targets the Area of Intervention “Next Generation Internet” in the Cluster “Digital, Industry and Space” of the proposed Specific Programme of Horizon Europe by the EU Commission [48], Subsection 1.2.2.4. Details of the Specific Programme are still under discussion between the EU Commission, the EU Parliament and EU Member States. However, [48] provides a good indication of the intended activities. The proposed Smart Networks and Services Partnership fits well under this Area of Intervention. Figure 29 shows the basic scope of the proposed Partnership in relation to the Networld2020 Strategic Research and Innovation Agenda [70] and the proposed Specific Programme [48].

The three horizontal layers show three specific program areas, i.e., *Smart Networks and Services*, *Software based Middleware* and *Next Generation Internet Applications and Service*.

The bottom horizontal layer supports the vision of a *Guaranteed Performance and Value Indicators for 2030*. The vertical columns represent the technology areas used in each and across specific program area.

Moreover, technologies and research activities that may cut across one or several technology areas and sometimes the horizontal layers are shown as well.

For example, the *Device and Components 2030* technology area includes the *Processes, Materials and Circuits beyond 100GHz*, *Generic Compute HW* and the *Next generation IoT devices and components technologies and research activities*, applied in the *Smart Networks and Services* specific program.

Some technologies and research activities apply to more than one specific program and technology areas. For example, the *IoT services and Data Curation* technology, belonging to the *System and Network Architecture and Control*, *Edge Computing and Meta data* and *Network and Service Cybersecurity* technology areas, is applied in the *Smart Networks and Services* and as well in the *Software Based middleware* specific programs.

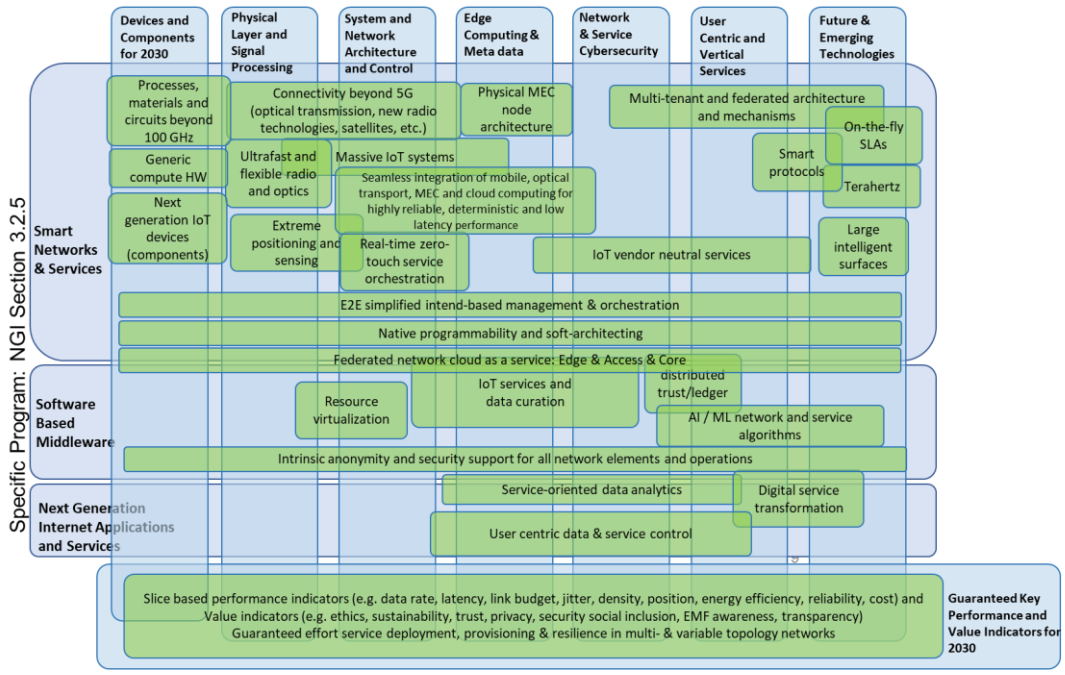


Figure 29 Basic scope of the proposed Smart Networks and Services Partnership

Advances in fundamental research will enable and open new capabilities and functions for network science and technology:

- Within physical sciences, significant advances are envisioned in switches, processors, memories, mass storage, and transmission (both wired and wireless) fundamental technologies. These advances will come from continued research for the applications of two-dimensional crystal materials such as Graphene, nanotechnology, advanced optics, biochemical components, optical devices, antenna and radio technologies for all wireless technologies, including cellular, microwave and satellite and quantum technologies. Integration of optics and electronics will enable a raft of innovation, providing solutions with unprecedented compactness, energy efficiency, and cost-performance ratio.
- Within System and Software Sciences, significant advances are expected on, self-organization and automation, reliability, security and privacy, based on continued research of new developments on network softwarization and virtualization, slicing, protocol theory, cryptography, Distributed Ledger Technology, Big Data, real-time and off-line structured and unstructured data analytics and game theory.

Artificial Intelligence and Machine Learning are promising ground-breaking technologies not only for cognitive operations, but also for the automation of any general network operation task. Blockchains will provide radically new forms of secure cooperation based on distributed ledgers. The emerging quantum technologies are expected to provide true breakthrough advances in communication speeds within the next decade. All of these being examples of technological advancements, which will drive and enable the future digitalization.

With massive virtualization of infrastructure, functions, and services, new fully automated deployment and validation paradigms will be developed that shall go beyond the DevOps (Development and IT Operations – process improvement for software development and administration) model, which describes "a set of practices intended to reduce the time between committing a change to a system and the change being placed into normal production, while ensuring high quality" [124]. These paradigms will also consider the implications of the newly developed software on the infrastructure architecture, and other software entities or services sharing the infrastructure. This shall ensure that both the software and the infrastructure complement each other to cater for the e2e service functional/operational objectives in a performant and reliable manner.

The distributed ledger technology is also quite promising in interconnecting and governing various federated networks. Such a technology proves to be extremely useful in allowing

different federations to agree on their policies, exchange information reliably and keep all important network events transparently visible within a shared ledger.

A new network control architecture will be needed as the impact of computing inside and around the network increases. Operators will need to deploy, maintain and control a massive distributed computing infrastructure, that must be operated in complete coordination with the networking resources. The network will then be composed of physical and virtualized resources for transmission, switching, storage and processing for which the control system will have to enable and manage a virtualized view to satisfy the customer needs according to the specific SLAs and regulatory mandates.

Massive machine type communication and IoT will be supported in new and more effective ways with the introduction of 5G. Further research and development of IoT communication, platforms and applications is needed and will open new opportunities for verticals that increasingly will derive a diverse and rich set of requirements. Further enhancement of vertical specific ecosystem and business enablers and innovation support will help to unleash the potentials of the new smart network capabilities and service enablers.

Furthermore, disruptive research and innovation, beyond Horizon 2020 on fundamental technologies and their applications will also be required to meet the digital needs of the future and to retain Europe's ability to shape the continuing digitization of our world.

The following domains will have a key impact on efficient and reliable operations of future communication systems and networks to provide Smart Networks and Services and it is recommended to cooperate closely between the different domains (Figure 30):

- Trustworthy Smart Communication and IoT technologies
- Software technologies
- Artificial Intelligence and Machine Learning
- Cybersecurity and DLT (Digital Ledger Technology)

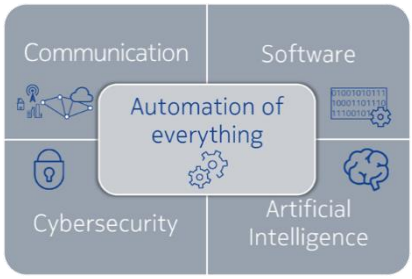


Figure 30 Digital automation of everything – Key-enabling technologies for Smart Networks and Services

These areas are key enabling technologies, which are complementing each other and are fundamental for the digitalization in all public and private sectors. Therefore, conducting research and cooperation on these technologies will be a strong lever with a broad impact on the whole economy and society. It will provide the technological advancements as needed for secure, efficient, and adaptable Smart Networks with AI-based services that drive the automation of everything and assist people in their professional and private life. Research will also support developing the skill sets required to use and apply the new digital technologies across all sectors.

With respect to the experience in the last 20 years, a challenging issue is that there is a strong need for looking beyond technology-focused research only, as communications became the nervous system of our modern society. Research and innovation topics that should be addressed are related to human factors, business, ecosystem and economic impacts, system deployment, regulations, formal/informal rules and government institutions, technology evolution, and innovation. The adoption of 5G in vertical markets will foster the emergence of new business models and processes in various vertical segments and further requirements for networking services not yet addressed by the first generation of 5G must be catered for.

From the perspective of the NGI vision and the need for digital transformation in Europe, the high-level objectives (technology, ecosystem and societal objectives) and the input from the Networld2020 European Technology Platform [70]and the 5G-IA the following major areas are foreseen in the Smart Networks and Services European Partnership. This should enable both the expansion and evolution of 5G as well as beyond 5G solutions:

1. **Network and communication systems**
    a. Identification of Key Performance Indicators Towards 2030
        i. Societal and business drivers for future networks and services using PESTLE model:
            1. Political and Economic considerations
            2. Social and Technological considerations
            3. Legal/Regulatory and Environmental considerations
            4. Green Deal considerations
        ii. UN Sustainable Development Goals (SDGs) and future networks and services:
            Linking UN SDGs into tangible indicators
        iii. Technical/Functional Key Performance Indicators (KPIs):
            Data Rate, Latency, Link Budget, Jitter, Density, Position, Energy Efficiency, Reliability, Capacity, Mobility, Cost, Position Accuracy, Imaging resolution, EMF values [5], Security metrics, Open Interfaces, Vertical specific metadata, Resource Efficiency, Guaranteed Effort Service deployment, provisioning and resilience in multi- and variable topology networks.
        iv. Technical/Functional Vertical KPIs:
            Industry 4.0, Automotive, Energy, Health, Media, etc.
        v. Non-technical/Non-Functional Key Value Indicators:
            Ethics, Sustainability, Trust, Privacy, Security, Social Inclusion, EMF awareness, Transparency, Societal Value.
    b. **System architecture and control:**
        i. General Vision and Concept (user-centrism, any resource, programmable system with some unknowns), Virtualized Network Control for Increased Flexibility, User-Plane Evolution, Deep Edge, Terminal and IoT Device Integration, Rich User Services and Resource Management, Evolution of NFV/SDN and AI-based System Evolution, Central office of the future. Network and IT convergence.
        ii. With the success of 5G, we expect much more diversity in the device types (from powerful smartphones to cars, factories and numerous smart and intelligent IoT devices). These devices will be able to become active elements of the network architecture due to their advanced, intelligent capabilities. Therefore, rich device-to-device interaction will be an important evolution at the edge of the network.
        iii. Multitenant systems: support for complex E2E services in smart networks; extreme federation across networking and computing; system and service guaranteed deployment, provisioning and resilience in multi- and variable topology networks.
    c. **Radio technology and signal processing:** Spectrum re-farming and reutilization; Millimetre waves and networking; Optical wireless communications, especially VLC; Satellite communications; Terahertz communications including new materials (graphene); Ultra-massive MIMO including intelligent reflecting surface; Waveform, non-orthogonal multiple access and full-duplex; Enhanced modulation and coding; Integrated positioning and sensing including radar; Random access for massive connections; Wireless edge caching for further increased spectrum and energy

[5] Technical solutions to allow deployment of future connectivity systems in areas with challenging EMF limits despite the operation in new additional spectrum bands and network densification. The system design is targeting to reduce the necessary RF power emissions as much as possible with respect to aggregated EMF limits and in the interests of citizens. Such activities are limited to technical means.

The evaluation of the impact of RF power emissions on human beings and the definition of EMF limits is the responsibility of international organisations such as UN World Health Organisation (WHO) [125], ICNIRP [126] and [127], GSMA [80] and public authorities in countries.

efficiency; Artificial intelligence in radio technology where traditional signal processing is not completely effective, e.g. in channel modelling and estimation, or spectrum awareness.

d. **Optical networks:** Flexible capacity scaling (spectrum, space, modulation) leveraging advances in component technology (fibre, transceivers, amplifiers, switches); New switching paradigms and multi-layer architectures; Elastic Photonic networks; Deterministic networking with controlled latency; Optical wireless integration; Future PON systems; Optical network slicing and automation; Security and resilience for mission critical services; Ultra-high energy efficiency and carbon footprint; Optical integration 2.0; Optical Fibre Infrastructure management and spectrum brokering.

e. **Satellite communication technologies:** Enabled services; Ground segment; Space segment; New constellations; Multi-layer architectures; Virtualized communication architectures; Predictive routing; Dynamic spectrum management; Integration into heterogeneous networks (including radio technology, radio access, signal processing and security); Flexible HTS payloads (radio resource management); Antenna technologies (active antennas, meta-surfaces, MIMO scheme); Q/V/W- and optical links; Role of artificial intelligence (e.g., distributed-AI, federated learning, etc).

f. **Multi-modal device and gateway communication in support of IoT:** Devices and network elements supporting a richer set of communication features and multi-service connectivity; Devices with advanced AI hardware architectures in support of new features at radio, network and application layers; These features will be used to support either *Operation-focused AI, such as AI-based network planning, optimization and operation* or *Service-focused AI, such as customer experience AI*, see e.g. [128].

g. Devices with IoT gateway capabilities in support of different IoT connectivity modes, both at local and public network level. In particular, for each supported vertical industrial domain and as well cross vertical industry domains:
    I. requirements will be derived on which software and hardware capabilities and characteristics these multi-modal IoT devices and network elements should support, when integrated and used into the 5G and beyond 5G network infrastructures.
    II. integration and evaluation activities of these multi-modal IoT devices and network elements in the 5G and beyond 5G network infrastructures will be planned and executed.

h. The **IoT devices using three different frequency bands** must include components and antennas for sub-1 GHz, (700 MHz), 1 - 6 GHz (3.5 - 3.8 GHz), and millimetre-wave (above 24 GHz) and integrate multiple protocols in addition to cellular ones, as considered by 3GPP. Also, the IoT devices require a range of different requirements: high data capacity, highest levels of reliability (connectivity), fast reaction times (low latency), sensing/actuating, processing and storage capabilities.

2. **Devices and cloud e2e communication and computation**

a. **Fog and edge computing and meta-data:** Beyond mobile edge computing; Future directions for Fog Computing; Massive IoT services; Data analytics and data monetization; Integration of multi-modal IoT devices and network elements and convergence of cloud, Edge and Fog in integrated architectures, enabling new business models.

b. **Next Generation End-to-End Protocols** enabling and supporting new applications / services for heterogeneous and advanced devices and edge / or fog computing paradigms, including multi-modal IoT devices and network elements, platforms and applications.

c. **New paradigms in end-to-end cloud communication and computing,** including multi-modal IoT devices and network elements and providing support of flexible mesh topologies and dynamic SLAs.

3. **Future and emerging technologies**
   a. Communication and computing resources including nano- and bio-nano-things and networks; Algorithms and data; Applications.
   b. Quantum Computing and Communications. Quantum information networks, and hardware security towards post-quantum secure systems.
   c. Extreme THz communications.
   d. Intrinsic Anonymity and security support for all network elements and operations.
   e. Neuromorphic hardware for low-power and low-latency event-based AI on the edge.

4. **Privacy, network and service security**
   a. **Privacy and confidentiality:** Computing, storage and communication services and privacy policies and mechanisms, enabling new privacy driven application and services. Data centric security issues for data sharing and data privacy. AI security and privacy.
   b. **Network and service security:** Security transformation; Network-wide Security; Slice-Specific and Convergence on common Software Defined patterns; Distributed systems; Artificial Intelligence applications; Dealing with technology, architecture and business transformation; Data centric issues; Security assessment/monitoring; physical layer security at the radio level. Survivability under major attacks.
   c. **Security at IoT platform and application level:** End-to-end security from IoT devices via IoT infrastructure/platforms to applications, considering also Cyber Physical infrastructure and objects; Secure attestation of device integrity; Distribution of root of trust; Trusted Platform Modules and security functions across the architecture; Smart monitoring, attacks/anomaly detection and response function with embedded AI (Software Defined distributed approach, neuromorphic hardware); Trusted execution environment; DLT (Digital Ledger Technology) applications, including distributed mutual authentication; Lightweight cryptography. Sustainable security (for long-lived low-cost devices).

5. **User experience, IoT Applications, Automation and Delivery**
   a. **Human centric and vertical services:** Digital service transformation; from software-centric to human-centric services; Services everywhere, infrastructure no limits; Network-unaware vertical services; Extreme automation and real-time zero-touch service orchestration; Service injection loop.
   b. **User and customer interaction and quality of experience** to ensure a good user and customer experience along with the new and heterogeneous and advanced devices and edge / or fog computing paradigms.
   c. **New smart network and services management paradigms and automation** driven by advances in AI, policy-based mechanisms and model driven architectures.
   d. **Advancing service delivery platforms, orchestration and models** along with flexibility and agility needed to accommodate new layered and multi-actor / multi-domain service structures, evolving ecosystems, and business models.
   e. **Service design thinking and collaboration with verticals by** applying state-of-the-art methods) to ensure improved customer engagement and impacts by new technology.

f. Design, exploration and evolution of **charging principles, business models, dynamic contracts and SLAs**. This includes evolution and exploration of distributed ledger technics and solutions.

6. **Human and socio-economic factors, regulation and institutions**
   a. **Human and domestication** factors affecting technology uptake, how humans domesticate technology, and technology affecting humans as consumer, employees, clients, etc., protection of human values and rights.
   b. **Societal opportunities, impacts and challenges** addressing how technologies and network services can enable solutions for and impact specific social challenges, considering topics such as trust, privacy, education, work-life, health, natural resources, environment, and climate.
   c. **Industry and ecosystem evolution** addressing how technological capabilities shape, interact with and is fitted into new industry and ecosystems (business models, structures, competition, innovation), and governing mechanisms, including, openness, affordability, modularity and standardization.
   d. **Regulation and institution** study how Smart Networks and Services may evolve as a technological innovation system, in interaction with formal and informal societal and industrial governing mechanisms and institutions, which attend to and regulate the emerging information infrastructure.

7. **Opportunities for Devices and Components**
   a. **Sub-10 GHz RF:** Extended carrier aggregation; MIMO, massive MIMO and cell-free MIMO, very programmable radio transceivers, transceivers with strong digital content (digital phase-locked loops, digital transmitters), highly integrated frontends, full-duplex, joint radar and communications, passive sensing.
   b. **Millimetre-wave and Terahertz:** Beamforming, efficient generation of power, mm-wave CMOS design, MIMO and MU approaches, high-efficiency front-ends, wideband data converters, analogue processing, frequency synthesis with high spectral purity, chip-package-antenna co-design, combination of silicon technologies with III-V technologies, joint radar and communications.
   c. **Ultra-low power Wireless:** NB-IoT, Cat M (category M), Cat NB (category NB) will evolve; UWB enabler for low power spatial awareness; Battery-less transceivers, energy harvesters.
   d. **Antenna and Packages**
      Metamaterials and meta-surfaces: Smart environment; Electromagnetic processing; 3D printed meta-surfaces; Nano-scale technologies.
   e. **High-speed transceivers, wireline and optical:** Radio-over-fibre communication, sub-systems and components for B5G and 6G networks; Terabaud capable opto-electronic transceivers; Optically assisted analogue-to-digital and digital-to-analogue conversion; Ultra low-cost and low-power coherent “lite” transceivers; Integrated low linewidth laser sources; Integrated optical phase locked loops; Novel equalization approaches relying on co-developed opto-electronics; Optically assisted wireless subsystems; Surface Wave Transmission Line Communication System.
   f. **Baseband Modems:** ASIC, DSP, FPGA evolutions; Impact of CMOS scaling; Mask cost beyond 7 nm; Accelerators; Software-defined radios; Hardware commonalities of radio and radar.
   g. **Application Processors**
   h. **Processors for Cloud-AI and Edge-AI:**
      i. Cloud-AI: Processors capable of handling very complex learning algorithms for convergence; Low latency, efficient accelerators for small batches.

ii. Edge-AI: Extreme quantization, In-Memory Compute; Lifelong learning abilities; Unsupervised learning; Processor/sensor integration.

i. Memories:

Compute-in-Memory: Concept and classification; Dependency of targeted applications on type computation-in-memory architecture/ circuit design/ NVM; Potential and challenges in materials/technology, circuit/architecture, tools/compilers.

j. Hardware for Security:

i. Survivability under Major Attacks: new HW mechanisms with graceful degradation under attacks, automated recovery of security, guarantee of critical services.
ii. HW Security towards Post-Quantum Secure Systems: insure security against future quantum-based attacks.
iii. Sustainable Security: security in long lifetime systems, security for 20+ years with minimal maintenance cost.
iv. AI Security and Privacy: AI HW with security and privacy support; decentralized/federated AI training systems with strong privacy guarantees for the decentralized data.

k. Hardware for IoT Devices, supporting a diversity of requirements:

i. **Requirements applied for each supported vertical industry domain and as well cross vertical industry domains** when integrated and used into the 5G and beyond 5G network infrastructures.
ii. **At least three different frequency bands** for sub-1 GHz, (700 MHz), 1 - 6 GHz (3.4 - 3.8 GHz), and millimetre-wave (above 24 GHz) and integrate multiple protocols in addition to cellular ones.
iii. **Functional and non-functional** requirements, such as high data capacity, highest levels of reliability (connectivity), fast reaction times (low latency), sensing/actuating, processing and storage capabilities; low power consumption.

Annex 5 Ecosystem and societal orientation

- **To ensure the creation of smart ecosystems as the foundation of the Digital Europe vision.** Connected smart ecosystems, cities and communities require a multiservice and highly performant network infrastructure that can support massive IoT-based scenarios, mobile broadband, and ultra-low latency services and applications. The Partnership will be instrumental in ensuring to boost the development and deployment of the smart networks as the backbone infrastructure Europe needs to ensure better services for all citizens.
- **To ensure European industry leadership and competitiveness**, by fostering close and effective collaboration among stakeholders and ensuring agility of the European Partnership. To be competitive and successful in the global market, European players have no option than come together fostering synergies and orchestrated developments. The Partnership programme with attempt to unleash positive self-reinforcing effects of collaborative innovation by mobilising forces and resources that will strengthen competitiveness of European industry from bigger big to small and medium players.
- **To pave the way for new business models and market opportunities across verticals.** The adoption of next generation connectivity will affect industries in different ways and at different rates. Connectivity will change the organization and structure of any business and radically modify also public services and solutions. New market opportunities are expected to arise especially for SMEs and Start-ups that can be more agile and thereby respond more quickly to market opportunities created by new solutions. At times of new business models, SMEs can play a key role. They often have more flexibility than larger players and depend less on incumbent product lines being ready for changes as early as the market starts adopting new solutions. The ambition is that European SMEs will be the first in line at a global level, which is key to boost our economy and create new job opportunities across Europe.
- **To contribute tackling inclusion and other crucial societal challenges** such as integration, participation, urbanization, transport, etc. Ubiquitous and affordable connectivity across countries and Europe will have a positive impact on our society contributing to minimize the digital divide and improve inclusion, while providing better access to several services across various sectors such as education, health, transport, government, etc. Means will be sought for allowing basic Internet access at minimum cost in order to foster geographical and social inclusion.
- **To foster the development of sustainable technologies and solutions in respect of climate changes and environment** through energy efficient and climate respectful networks allowing "greener" solutions to be built across all verticals. This directly aligns with the European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy [129]. In addition, the Partnership will encourage high efficiency of natural resources usage by the ICT sector in order to sustain Earth resources, for instance by promoting ease of recycling by design.
- **To investigate new collaboration models and policies** for better targeted/effective investments in communication infrastructures and creation of inclusive ecosystems capable of mitigating the social challenges, unleashing innovation and investment potentials, while facilitating knowledge sharing. This will allow scenarios that can mitigate the social challenges, unleashing innovation and investment potentials, engaging relevant stakeholders such as technology users, investors, innovators and policy makers.
- **To contribute to the research and innovation agenda for future generation ecosystem platforms,** investigating scenarios for evolution and roadmaps towards future ecosystem platforms, including the role of standardization and cross actor coordination. This is key also to ensure coordinated efforts across different categories of stakeholders, as well as contributions and alignment with commonly adopted standards.

Annex 6 Membership and regional distribution of 5G-IA (5G Infrastructure Association)

The participation in the Networld2020 European Technology Platform is on voluntary basis. Figure 31 and Table A2 show the membership and its regional distribution.

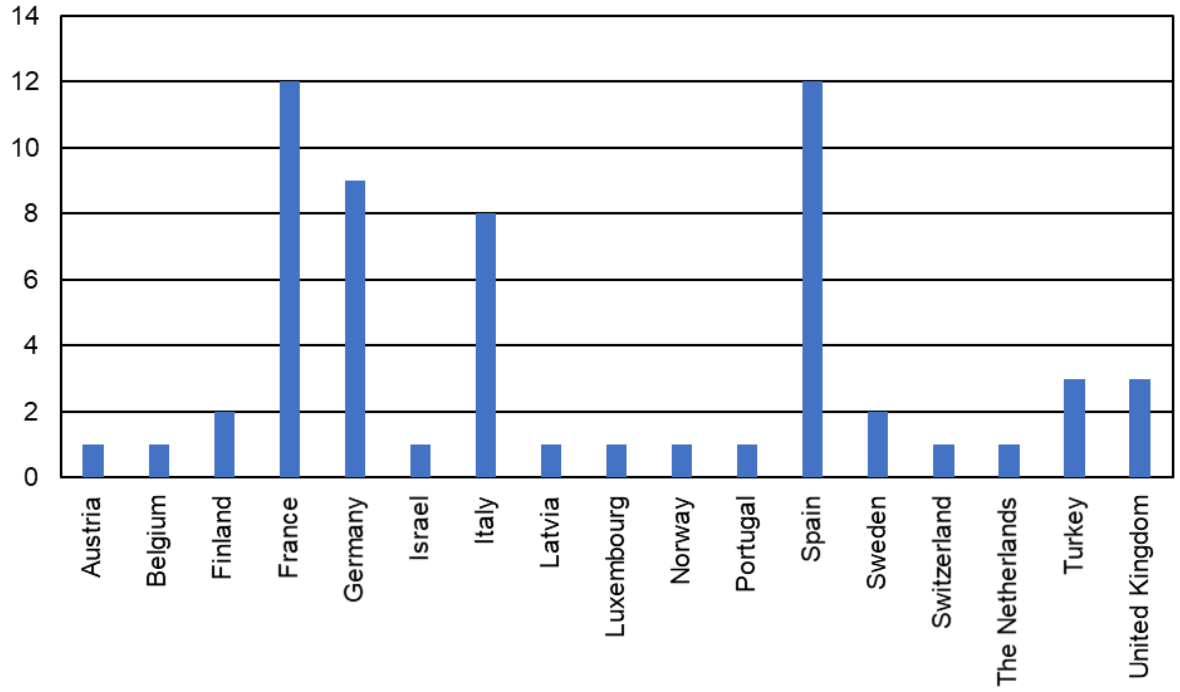


Figure 31 Regional membership distribution of 5G-IA

Table A2 5G-IA membership list Spring 2020

No.	Organisation	Country	Stakeholder Group
1	Adva Optical Networking SE	Germany	Industry
2	Airbus Defence and Space	France	Industry
3	Atos	France	Industry
4	Deutsche Messe AG	Germany	Industry
5	DOCOMO Communications Laboratories Europe GmbH	Germany	Industry
6	Ericsson	Sweden	Industry
7	Eutelsat	France	Industry
8	Fastweb SpA	Italy	Industry
9	Huawei Technologies Duesseldorf GmbH	Germany	Industry
10	Indra Sistemas S.A.	Spain	Industry
11	Intel Deutschland GmbH	Germany	Industry
12	Leonardo S.p.A.	Italy	Industy
13	Mitsubishi Electric R&D Centre Europe	France and U.K.	Industry
14	NEC Laboratories Europe GmbH	Germany	Industry
15	Netaş Telecommunication A.S.	Turkey	Industry
16	Nokia Solutions and Networks	Finland	Industry
17	Orange Labs	France	Industry
18	Open Fiber	Italy	Industry
19	Samsung Electronics Research Institute Ltd. (SRUK)	U.K.	Industry
20	SES	Luxembourg	Industry
21	Telecom Italia	Italy	Industry
22	Telefónica I+D	Spain	Industry
23	Telenor ASA	Norway	Industry

24	Telespazio	Italy	Industry
25	Thales Alenia Space	France	Industry
26	Thales SIX GTS France	France	Industry
27	Turkcell İletişim Hizmetleri A.Ş.	Turkey	Industry
28	Turk Telekomünikasyon A.Ş.	Turkey	Industry
29	ZTE Wistron Telecom AB	Sweden	Industry
30	AIT Austrian Institute of Technology	Austria	Research
31	CEA-LETI	France	Research
32	Centre Tecnologic de Telecomunicacions de Catalunya (CTTC)	Spain	Research
33	Consorzio Nazionale Interuniversitario per le Telecomunicazioni (CNIT)	Italy	Research
34	DLR (German Aerospace Center) – Institute of Communications and Navigation	Germany	Research
35	Fraunhofer Gesellschaft zur Foerderung der angewandten Forschung e. V.	Germany	Research
36	Fundació Privada i2CAT, Internet i Innovació Digital a Catalunya	Spain	Research
37	Fundacion IMDEA Networks	Spain	Research
38	IMEC vzw	Belgium	Research
39	Institut Mines-Télécom	France	Research
40	Instituto de Telecomunicações	Portugal	Research
41	TNO	The Netherlands	Research
42	Universidad de Málaga	Spain	Research
43	University of Bologna – DEI	Italy	Research
44	University of Sussex	U.K.	Research
45	Universitat Politècnica de Catalunya	Spain	Research
46	Vicomtech	Spain	Research
47	VTT Technical Research Centre of Finland Ltd	Finland	Research
48	CityPassenger	France	SME
49	Integrasys SA	Spain	SME
50	INTERINNOV -	France	SME
51	Martel GmbH	Switzerland	SME
52	Nextworks s.r.l.	Italy	SME
53	Oledcomm	France	SME
54	Quobis	Spain	SME
55	Satelio IoT Services	Spain	SME
56	Seven Solutions S.L.	Spain	SME
57	Electronic Communications Office of Latvia	Latvia	Associate Member
58	SIGOS	Germany	Associate Member
59	Starhome LTD	Israel	Associate Member

Annex 7 Membership list of Networld2020, AIOTI, Cispe.Cloud and NESSI and regional distribution

Networld2020 Membership

The participation in the Networld2020 European Technology Platform is on voluntary basis. Figure 32 and Table A3 show the membership and its regional distribution.

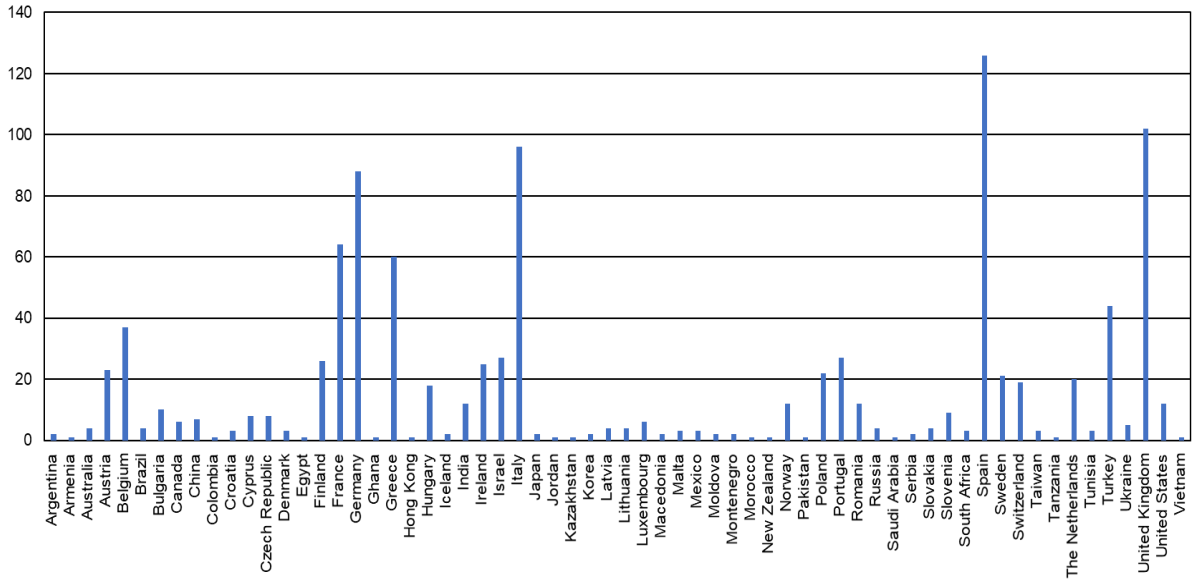


Figure 32 Regional membership distribution of Networld2020

Table A3 Networld2020 membership list Spring 2020

No.	Organisation	Country	Stakeholder Group
1	2K Bilişim	Turkey	Industry
2	3logic MK srl	Italy	SME
3	4GCelleX	Israel	SME
4	5GW News	USA	COOP
5	Aalborg University	Denmark	Research Domain
6	Aalto University	Finland	Research Domain
7	Abeeway	France	SME
8	Abo Akademi University	Finland	Research Domain
9	Accelleran	Belgium	SME
10	A-CING	Spain	Industry
11	ACORDE Technologies S.A.	Spain	SME
12	Acreo Swedish ICT AB	Sweden	Research Domain
13	ACTA Ltd	Greece	SME
14	ADVA AG Optical Networking	Germany	Industry
15	ADVANTIC SISTEMAS Y SERVICIOS S.L.	Spain	SME
16	Aetheric Engineering Ltd	U.K.	Industry
17	AFUSOFT Kommunikationstechnik GmbH	Germany	Industry
18	Agence Wallonne des Telecommunications	Belgium	COOP
19	AGH University of Science and Technology, Department of Telecommunications	Poland	Research Domain
20	Ago Telecom S.L.	Spain	Industry
21	AICO EDV-Beratung GmbH	Austria	SME
22	AIJU - Asociación de la Industria del Juguete	Spain	Research Domain
23	Airbus Defence and Space (former ASTRIUM)	France	Industry
24	AITIA International, Inc.	Hungary	SME
25	Albatronics	Israel	SME

26	Alcatel-Lucent	Germany	Industry
27	ALETI	Argentina	COOP
28	Almouroltec, Lda	Portugal	SME
29	Alpineon d.o.o.	Slovenia	SME
30	ALTRANPORTUGAL, S.A.	Portugal	Industry
31	AMBEENT WiRELESS	Turkey	SME
32	Amber Flux Pvt Ltd	India	COOP
33	AMETIC	Spain	COOP
34	Amledo & Co	Sweden	SME
35	Amphinicy Technologies	Croatia	SME
36	AMVG	Turkey	SME
37	Ansur Technologies	Norway	SME
38	Antares S.c.ar.l.	Italy	SME
39	ANTY Foundation	Belgium	COOP
40	Antycip Simulation	UK.	SME
41	AnySolution S.L.	Spain	SME
42	APFUTURA	Spain	SME
43	apocope	France	SME
44	AppArt	Greece	SME
45	Applied RESearch to Technologies s.r.l. (ARES2T)	Italy	SME
46	APTECH	Turkey	Industry
47	Aradiom	Turkey	SME
48	Aragon Technological Institute (ITA)	Spain	Research Domain
49	Aratos Technologies	Greece	SME
50	Arcelik A.S.	Turkey	Industry
51	Arctos Labs Scandinavia AB	Sweden	SME
52	ARDIC APPLIED RESEARCH DEVELOPMENT INNOVATION CENTER	Turkey	SME
53	Ariadna Servicios Informáticos S.L.	Spain	SME
54	ArtHaus DOO Skopje	Macedonia	SME
55	Artklikk Ltd.	Hungary	SME
56	Ascora GmbH	Germany	SME
57	ASELSAN	Turkey	Industry
58	Asmaitha Wireless Technology Pvt Ltd	India	COOP
59	ASN Plus s.r.o.	Czech Republic	SME
60	Asociacion de Investigacion y Cooperacion Industrial de Andalucia (AICIA)	Spain	Research Domain
61	aspien GmbH	Germany	SME
62	Associazione PIIU	Italy	Research Domain
63	ASSOKNOWLEDGE CONFINDUSTRIA SIT (2)	Italy	COOP
64	ASTER S. Cons. P.A.	Italy	Research Domain
65	Astera Ltd.	Russia	COOP
66	Astius Technology	U.K.	SME
67	AT&T	USA	COOP
68	AT4 wireless, S.A. (former CETECOM)	Spain	Research Domain
69	ATC	Greece	SME
70	Ateknea Solutions Europe	Spain	SME
71	Athens Information Technology (AIT)	Greece	Research Domain
72	Athens University of Economics and Business	Greece	Research Domain
73	Athlone Institute of technology	Ireland	Research Domain
74	Athonet	Italy	SME
75	ATiT	Belgium	SME
76	Atlantic Wireless Telecommunications	Ireland	SME
77	Atlantis Consulting S.A.	Greece	SME
78	Atlascom Ltd.	Bulgaria	SME
79	ATOS Origin	Spain	Industry
80	atSistemas	Spain	Industry
81	Austrian Institute of Technology - AIT	Austria	Research Domain
82	Avanti Communications plc	U.K.	SME
83	Avea	Turkey	Industry
84	Aviat Networks	USA	COOP

85	AVL List GmbH	Austria	Industry
86	AWE Communications GmbH	Germany	SME
87	Aykan Teknoloji S.T.A.S.	Turkey	SME
88	Azcom Technology	Italy	SME
89	BALKANPLAN Ltd.	Bulgaria	SME
90	Bar Ilan University	Israel	Research Domain
91	BATI-BINOM	Turkey	COOP
92	b-com	France	SME
93	Beacon Tech Ltd. Yoram Bar-Zeev	Israel	SME
94	Beia Consult International	Romania	SME
95	Beijing Jiaotong University	China	COOP
96	Beijing University of Post and telecomminications (BUPT)	China	COOP
97	Ben-Gurion University of the Negev	Israel	Research Domain
98	Bettair Cities	Spain	SME
99	Bianor Services EOOD	Bulgaria	SME
100	BITNET CCSS	Romania	Industry
101	BitWise D Eadie	U.K	SME
102	Blekinge Institute of Technology	Sweden	Research Domain
103	Blu Wireless Technology Ltd	U.K.	SME
104	Bluegiga Technologies Oy	Finland	SME
105	Bluetab	Spain	SME
106	BOSCH	Germany	Industry
107	British Telecommunications plc (BT)	U.K.	Industry
108	Broadcom	Israel	Industry
109	Brunel University	U.K.	Research Domain
110	Budapest University of Technology and Economics (BME)	Hungary	Research Domain
111	BUMA Ltd.	Israel	SME
112	Business Integration and Business Intelligence	Montenegro	SME
113	Business Management Networking Solutions	Saudi Arabia	COOP
114	C Tech Bilisim	Turkey	SME
115	C.R.E.A.M. Europe PPP Alliance	Germany	COOP
116	CARD4B SYSTEMS S.A.	Portugal	SME
117	Catholic University College Limburg	Belgium	Research Domain
118	CEA-LETI - Commissariat a l'Energie Atomique	France	Research Domain
119	CEFRIEL - ICT Institute - Politecnico di Milano	Italy	Research Domain
120	CEIT	Spain	Research Domain
121	Cellnex Telecom	Spain	Industry
122	cellocator	Israel	Industry
123	Cellusys	Ireland	SME
124	CELTIC Office	Germany	Research Domain
125	Center for Advanced Studies in Telecommunication (CAST), CIIT	Pakistan	COOP
126	Centre for New Technologies Research	Slovenia	Research Domain
127	Centre for telecommunications, Faculty of Electrical Engineering, University of Montenegro	Montenegro	Research Domain
128	Centro Ricerche FIAT	Italy	Industry
129	Centron System Solutions	Ireland	Research Domain
130	Centrum Wiskunde & Informatica	Netherlands	Research Domain
131	Ceragon	Canada	COOP
132	CERT - Telecommunications Research and Studies Center	Tunisia	COOP
133	CERTH	Greece	Research Domain
134	CETEMMSA	Spain	Research Domain
135	CETIC	Belgium	Research Domain
136	CeTIC-Technological Centre for Innovation in Communications	Spain	Research Domain
137	CETUC	Brazil	COOP
138	CEVA-DSP Ltd	Israel	SME
139	Chalmers University of Technology	Sweden	Research Domain
140	China Communications Standards Association	China	COOP
141	CHINACOMM ENGINEERING LIMITED	China	COOP

142	CIMSOLUTIONS	The Netherlands	Industry
143	Cisco Systems	Belgium	Industry
144	City University London, Mobile Networks Research Group	U.K.	Research Domain
145	Citypassenger	France	SME
146	Cluster TIC Galicia	Spain	COOP
147	Clyde Space	U.K.	Industry
148	CNES	France	Research Domain
149	CNIT - Consorzio Nazionale Interuniversitario per le Telecomunicazioni	Italy	Research Domain
150	CNR-ISTI	Italy	Research Domain
151	Cognitive Systems Corporation	Canada	COOP
152	COm DEV Europe	U.K.	Industry
153	Comarch S.A	Poland	Industry
154	COMBALSAT ltd.	Bulgaria	SME
155	Computer and Automation Research Institute of the Hungarian Academy of Sciences	Hungary	Research Domain
156	COMSIS	France	SME
157	Consejo Superior de Investigaciones Cientificas	Spain	Research Domain
158	Consultancy & Management Services	Belgium	SME
159	Consultora de Telecomunicaciones Optiva Media SL	Spain	SME
160	Content Group Austria	Austria	SME
161	Core Network Dynamics	Germany	SME
162	Coriant	Germany	Industry
163	Cork Institute of Technology	Ireland	Research Domain
164	CORNET	Israel	COOP
165	Corning	France	Industry
166	Corporate Fiber Technologies AB	Sweden	SME
167	COSMOTE Mobile Telecommunications S.A.	Greece	Industry
168	Council for Scientific and Industrial Research	South Africa	COOP
169	Coventry University	UK	Research Domain
170	CREALAB SRL	Italy	SME
171	CREATE-NET	Italy	Research Domain
172	Creativ-IT	Spain	SME
173	Creativity Software	U.K.	SME
174	CSEM	Switzerland	Research Domain
175	CTAG	Spain	Research Domain
176	CTTC - Telecommunications Technological Center of Catalonia	Spain	Research Domain
177	Cumucore Oy	Finland	SME
178	CyberEthics Lab.	Italy	SME
179	CyberLens Ltd	U.K.	SME
180	Cyprus International University	Turkey	Research Domain
181	Cyprus University of Technology	Cyprus	Research Domain
182	CyRIC (Cyprus Research and Innovation Center Ltd.)	Cyprus	SME
183	Cyta	Cyprus	Industry
184	Czech Technical University	Czech Republic	Research Domain
185	DAI Labor	Germany	Research Domain
186	DANTE	U.K.	COOP
187	D'Appolonia S.p.A.	Italy	Industry
188	Dar es salaam Institute of Technology (DIT)	Tanzania	COOP
189	Das Photonics	Spain	SME
190	Dataport Information Technology Services	Turkey	SME
191	DATATRONICS	Spain	Industry
192	DeFuTech	Germany	SME
193	Delektre Oy	Finland	SME
194	Delft University of Technology	Netherlands	Research Domain
195	Dell Technologies	Ireland	Industry
196	Dennis Gabor Applied University	Hungary	Research Domain
197	Deutsche Telekom AG	Germany	Industry
198	Diamond	Switzerland	Industry
199	Diamond Age GmbH	Austria	SME

200	Digital Dispatch	Finland	SME
201	Digital Turkey Platform	Turkey	Industry
202	Digital TV Group	UK	COOP
203	DigitalTwin Technology GmbH	Germany	SME
204	DIMECC Ltd.	Finland	Industry
205	Dimes Association	Finland	Industry
206	DLR (German Aerospace Centre)	Germany	Research Domain
207	DoCoMo Communications Laboratories Europe GmbH	Germany	Industry
208	Domos AS	Norway	SME
209	Douglas Connect GmbH	Switzerland	SME
210	Dublin City Council	Ireland	Research Domain
211	Dublin City University - School of Computing	Ireland	Research Domain
212	Durham University	U.K.	Research Domain
213	e2E Services Limited	U.K.	Research Domain
214	EANTC AG	Germany	SME
215	Easy Global Market	France	SME
216	EBNER electronic GmbH	Austria	SME
217	eBOS Technologies Ltd	Cyprus	SME
218	EchoStar Mobile Limited	Ireland	Industry
219	Ecole Nationale Supérieure des Télécommunications (ENST)	France	Research Domain
220	eCom Scotland Ltd	U.K.	SME
221	Edosoft Factory, S.L.	Spain	SME
222	EFP Consulting Ltd	Israel	SME
223	egatel	Spain	Industry
224	Ege Sistem Bilisim Hiz. San. ve Tic. Ltd. Sti. (egesys)	Turkey	SME
225	Ege University Science and Technology centre (EBILTEM)	Turkey	Research Domain
226	Eindhoven University of Technology	The Netherlands	Research Domain
227	Eletronics & Telecommunication Research Institute - ETRI	Korea	COOP
228	Elisa Corporation	Finland	Industry
229	ELSIS	Lithuania	SME
230	EMF (European Multimedia Forum)	U.K.	COOP
231	Emisfera Societa Cooperativa	Italy	SME
232	EMnify GmbH	Germany	Industry
233	EMS SATCOM UK Ltd	U.K.	Industry
234	Energy Sistem Soyntec SA	Spain	SME
235	Engineering Ingegneria Informatica S.p.A.	Italy	Industry
236	Enterprise Solutions Geoteam s.r.l.	Italy	Industry
237	EPIDOTE CONSULTING	Belgium	SME
238	Epitomical Limited	U.K.	SME
239	Ergonomics and Safety Research Institute (ESRI)	U.K.	Research Domain
240	Ericsson		Industry
241	ERNET India	India	COOP
242	Esempla Systems SRL	Moldova	SME
243	ESOA	Belgium	Industry
244	ESPACI	Spain	SME
245	ETA2U	Romania	SME
246	ETH Züruch Lab. for Electromagnetic Waves and Microwave Electronics	Switzerland	Research Domain
247	ETIK	Hungary	COOP
248	ETRA I+D	Spain	Industry
249	ETSI	France	COOP
250	EURECOM	France	Research Domain
251	Eurescom GmbH	Germany	Industry
252	Eureva	France	SME
253	EuroAftica-ICT initiative		COOP
254	EUROB CREATIVE	Spain	SME
255	Euroma	U.K.	SME
256	Eurona Telecom	Spain	COOP
257	European Digital SME Alliance	Belgium	COOP

258	EUROPEAN DYNAMICS S.A.	Greece	SME
259	European Hydrogen Association	Belgium	Industry
260	European Media Laboratory GmbH	Germany	SME
261	Euroreporter	Italy	SME
262	Eutelsat	France	Industry
263	Everis	Spain	Industry
264	EVESTA FOUNDATION	Bulgaria	COOP
265	evolaris next level privatstiftung	Austria	Research Domain
266	Evolution-net	France	SME
267	Exagate	Turkey	SME
268	Excellis Business Consulting	U.K.	SME
269	Exelixisnet	Greece	SME
270	EXENTE	Spain	SME
271	EXODUS S.A.	Greece	Industry
272	Eyeled GmbH	Germany	SME
273	Feron Technologies P.C.	Greece	SME
274	FGFactory	Ukraine	SME
275	FHM Bielefeld	Germany	Research Domain
276	FidanProje	Turkey	Industry
277	FIDO Intelligence	Poland	SME
278	Filtronic Broadband Ltd	U.K.	SME
279	Finmeccanica S.p.A.	Italy	Industry
280	FirstPoint Mobile Guard	Israel	SME
281	FIVECOMM - 5G COMMUNICATIONS FOR FUTURE INDUSTRY VERTICALS, S.L.	Spain	SME
282	Florella Ltd	Hungary	SME
283	Fogus Innovations & Services	Greece	SME
284	Fondazione Ugo Bordoni	Italy	Research Domain
285	Foreca Consulting Ltd	Finland	SME
286	FORTHnet	Greece	Industry
287	Foundation for Research and Technology Hellas	Greece	Research Domain
288	Fraunhofer ESK	Germany	Research Domain
289	Fraunhofer FIT	Germany	Research Domain
290	Fraunhofer FOKUS	Germany	Research Domain
291	Fraunhofer Heinrich Hertz Institut	Germany	Research Domain
292	Fraunhofer IIS	Germany	Research Domain
293	Fraunhofer Institute for Computer Graphics	Germany	Research Domain
294	FTI Communication Systems Ltd	U.K.	SME
295	Fujitsu Laboratories of Europe	U.K.	Industry
296	Fundación Gradiant	Spain	Research Domain
297	Fundación Universidad Empresa Gellega (FEUGA)	Spain	COOP
298	Fundación Universitaria Iberoamericana - FUNIBER	Spain	COOP
299	Fundarc Communcation (xgnlab)	India	COOP
300	Future Intelligence	Greece	SME
301	Future Internet Latinoamerica	Colombia	COOP
302	GARD	Israel	SME
303	Gdansk University of Technology - WiComm	Poland	Research Domain
304	GENERUM OY	Finland	SME
305	Ghent University	Belgium	Research Domain
306	Gilat Ltd	Israel	Industry
307	Global Communication & Services GmbH	Austria	Industry
308	Global VSAT Forum	U.K.	COOP
309	Globberry	Ukraine	SME
310	Globema Sp. z o.o.	Poland	SME
311	Gluk Advice BV	Netherlands	SME
312	GMV Aerospace&Defence	Spain	Industry
313	GomSpace	Denmark	Industry
314	Grado Zero Espace Srl	Italy	SME
315	Gradus Bilisim Teknolojileri Ltd Sti	Turkey	SME
316	Grant Thornton Advisory	Czech Republic	SME
317	Graz University of Technology	Austria	Research Domain

318	GTD GmbH	Germany	SME
319	gutura GmbH	Germany	SME
320	GWT-Tud	Germany	SME
321	H.I.T Holon Institute of Technology	ISRAEL	Research Domain
322	H3G Italy	Italy	Industry
323	Hamburg University of Technology	Germany	Research Domain
324	Happiest Minds Technologies Pvt Ltd	India	COOP
325	Harokopio University of Athens	Greece	Research Domain
326	HAVELSAN INC.	Turkey	Industry
327	Hedz Hungary,Ltd.	Hungary	SME
328	Hendrik Berndt Consulting	Germany	SME
329	HEPTA7291	USA	COOP
330	Heriot-Watt University	U.K.	Research Domain
331	Hetrogenous Communication Technologies Pvt. Ltd.	India	COOP
332	Hewlett Packard Enterprise	France	Industry
333	Hezelburcht	Netherlands	Industry
334	hi2	Spain	SME
335	HI-IBERIA	Spain	SME
336	Hiro-microdatacenters	Netherlands	SME
337	Hisbim IT Co.	Turkey	SME
338	HISPASAT	Spain	Industry
339	HLT-Platform, Hungarian Academy of Sciences, Research Institute for Linguistics	Hungary	Research Domain
340	Hochschule Luzern - iHomeLab	Switzerland	Research Domain
341	Hong Kong Applied Science and Technology Research Institute Company Limited (ASTRI)	Hong Kong	COOP
342	Hringidan / Vortex Inc	Iceland	SME
343	Huawei Technologies Duesseldorf GmbH	Germany	Industry
344	Hughes Network Systems Europe	U.K.	Industry
345	Hutchison Europe Telecommunications S.a.r.l.	Belgium	Industry
346	HW Communications	U.K.	SME
347	Hyperborea SRL	Italy	SME
348	I.C.A. (Informática y Comunicaciones Avanzadas)	Spain	SME
349	i2CAT Foundation	Spain	Research Domain
350	IBM	Israel	Industry
351	ICS LTD	Ghana	COOP
352	Ictech	Portugal	SME
353	IDATE	France	SME
354	IDESIO s.r.l.	Italy	SME
355	IDS Ingegneria dei Sistemi Spa	Italy	SME
356	IHP GmbH	Germany	Research Domain
357	IIMC International Information Management Corporation Ltd	Ireland	SME
358	IKERLAN-IK4	Spain	Research Domain
359	Il Village	Italy	SME
360	Ilmenau University of Technology	Germany	Research Domain
361	ILS Technologies	France	SME
362	IMA (Israel Mobile Association)	Israel	Industry
363	IMAGES & RESEAUX	France	COOP
364	IMDEA Networks	Spain	Research Domain
365	IMEC	Belgium	Research Domain
366	IMNR Bukarest	Romania	Research Domain
367	IMS	France	Research Domain
368	IMST	Germany	Industry
369	Incelligent	Greece	SME
370	INCITES CONSULTING SARL	Luxembourg	SME
371	Indra	Spain	Industry
372	Industrial Technology Research Institute ITRI	Taiwan	COOP
373	INESC Porto	Portugal	Research Domain
374	Infineon Technologies Austria AG	Austria	Industry
375	Infocom S.R.L.	Italy	SME
376	InfoGraph Ltd.	Greece	SME

377	INFOLYSIS P.C.	Greece	SME
378	Information Society Development Institute	Moldova	Research Domain
379	Infosys Limited	India	COOP
380	Ingenieria y Soluciones Informaticas	Spain	SME
381	INLECOM GROUP BVBA	Belgium	SME
382	Inmarsat	U.K.	Industry
383	inno group	Germany	SME
384	Innomine Group	Hungary	SME
385	InnoRoute GmbH	Germany	SME
386	Innova Technology	Turkey	Industry
387	InnovaPuglia S.p.A. (former Tecnopolis)	Italy	Research Domain
388	INNOVAS	France	SME
389	Innovati Networks S.L.	Spain	SME
390	Innovators S.A.	Greece	SME
391	iNOK	Portugal	SME
392	INOV	Portugal	Research Domain
393	INRIA Institut National de Recherche en Informatique et en Automatique	France	Research Domain
394	INSET Research & Advisory GmbH	Austria	Research Domain
395	Instalaciones Inabensa, S.A.	Spain	Industry
396	Institut für Rundfunktechnik GmbH	Germany	Industry
397	Institut Jozef Stefan	Slovenia	Research Domain
398	Institut Mines-Télécom	France	Research Domain
399	Institute e-Austria Timisoara / West University of Timisoara	Romania	Research Domain
400	Institute for Information Industry (III)	Taiwan	COOP
401	Institute Mikromakro Foundation	Poland	Research Domain
402	Institute of Accelerating Systems and Applications (IASA)	Greece	Research Domain
403	Institute of Communication and Computer Systems - ICCS/NTUA	Greece	Research Domain
404	Instituto de Informatica e Telematica	Italy	Research Domain
405	Instituto de Telecomunicações	Portugal	Research Domain
406	INTECS SpA	Italy	Industry
407	INTEGRASYS	Spain	SME
408	Intel	Germany	Industry
409	Intelekti Ltd.	Bulgaria	SME
410	Intelsat SA	Luxembourg	Industry
411	InterDigital UK	U.K.	Industry
412	INTERFUSION SERVICES LTD	Cyprus	SME
413	INTERINNOV	France	SME
414	International IT University	Kazakhstan	COOP
415	International Telecommunication Union - ITU	Switzerland	COOP
416	INTERNET INSTITUTE, communications solutions and consulting, Ltd.	Slovenia	SME
417	INTRACOM S.A.	Greece	Industry
418	Intron ltd	Ukraine	SME
419	INXITION	Italy	SME
420	IoThings	Czech Republic	Research Domain
421	ip.access Ltd	U.K.	SME
422	IPCom GmbH & Co. KG	Germany	SME
423	IPLUSF	Belgium	SME
424	IQUADRAT INFORMATICA	Spain	SME
425	IRIS Technology Solutions S.L.	Spain	SME
426	ISARS - National Observatory of Athens	Greece	Research Domain
427	ISDEFE	Spain	Industry
428	ISED SpA	Italy	SME
429	ISERD - Israel Europe R&D Directorate	Israel	COOP
430	Iskra	Slovenia	Industry
431	ISKRATEL Telecommunication Systems, Ltd.	Slovenia	Industry
432	ISMB - Istituto Superiore Mario Boella	Italy	Research Domain
433	IST - Technical University of Lisbon	Portugal	Research Domain
434	ISTOK-SOYUZ		COOP

435	IS-WIRELESS	POLAND	SME
436	IT ware Kft.	Hungary	SME
437	ITACA R&D Institute	Spain	Research Domain
438	ITALTEL	Italy	Industry
439	ITI - Instituto Tecnológico de Informática	Spain	Research Domain
440	ItoM	Netherlands	SME
441	ITS Information Technology Services S.p.A.	Italy	Industry
442	ITTI Sp. Z o.o.	Poland	SME
443	IVP Capital, LLC	USA	COOP
444	Janmedia Interactive Sp. z o.o.	Poland	SME
445	JAST Sarl	Switzerland	Industry
446	JCP-Consult SAS	France	SME
447	Jerusalem College of Technology	Israel	Research Domain
448	Jisc	U.K.	Research Domain
449	Joanneum Research	Austria	Research Domain
450	Johannes Kepler University Linz	Austria	Research Domain
451	Julius-Maximilians-University Wuerzburg Institute Informatics VII: Robotics and Telematics	Germany	Research Domain
452	Juniper Networks GmbH	Germany	Industry
453	K.-D. Kohrt	Germany	SME
454	K.S.C.	Netherlands	Industry
455	K.U.Leuven	Belgium	Research Domain
456	K.U.Leuven - ICRI-IBBT	Belgium	Research Domain
457	Kahdeksas Kanava Oy	Finland	SME
458	Karlstad University	Sweden	Research Domain
459	Keysight technologies	Belgium	Industry
460	King's College London	U.K.	Research Domain
461	Kingston University	U.K.	Research Domain
462	Kiwok Nordic AB	Sweden	SME
463	kleos r&d	France	SME
464	Klubverband-ITA Ltd.	Bulgaria	SME
465	Koc University	Turkey	Research Domain
466	KOHS	Austria	SME
467	Kontor46	Italy	SME
468	KULIS, Kocaeli University Laboratory of Image and Signal processing	Turkey	Research Domain
469	Kyushu Institute of Technology	Japan	COOP
470	La Salle - URL (University Ramon Llull)	Spain	Research Domain
471	LAAS-CNRS	France	Research Domain
472	LABRIS NETWORKS	Turkey	SME
473	Landatel Comunicaciones S.L.	Spain	Industry
474	Lappeenranta University of Technology	Finland	Research Domain
475	Larkhill Consultancy Limited	U.K.	SME
476	LASSENA	Canada	COOP
477	Lattanzio e Associati	Italy	SME
478	LEITAT Technological Center	Spain	Research Domain
479	Lenovo (Beijing) Ltd	China	COOP
480	Level7 S.r.l.u.	Italy	SME
481	LG Electronics France	France	Industry
482	LGI Consulting	France	SME
483	Link Consulting SA	Portugal	SME
484	Linköping University - Mobile Telecommunications	Sweden	Research Domain
485	LioniX International	Netherlands	SME
486	LiquidEdge Ltd	Ireland	SME
487	LiveU Inc.	Israel	SME
488	Load Interactive lda	Portugal	SME
489	Lomonosov Moscow State University	Russia	Research Domain
490	LS telcom	U.K.	Industry
491	LUDMATEC	Germany	SME
492	Luleå University of Technology	Sweden	Research Domain
493	Luxembourg Institute of Science and Technology (LIST)	Luxemburg	Research Domain

494	Luxinnovation GIE	Luxembourg	COOP
495	M.B.I.	Italy	SME
496	M/A-COM Technology Solutions, Ltd	Ireland	Industry
497	Made In Mind	U.K.	SME
498	Magister Solutions Ltd	Finland	SME
499	Magyar Telekom	Hungary	Industry
500	Malta Communications Authority	Malta	COOP
501	MÁNTICA Solutions S.L.	Spain	SME
502	Martel GmbH	Switzerland	SME
503	Maseng AS	Norway	SME
504	Mavigex s.r.l.	Italy	SME
505	McNicholas	U.K.	Industry
506	MediaTek Wireless Limited	U.K.	Industry
507	Meteorological and Environmental Earth Observation (MEEO)	Italy	SME
508	Metodos y Tecnologia	Spain	Industry
509	milestone management gmbh	Austria	SME
510	Ministry of Agriculture/Agricultural University of Athens	Greece	Research Domain
511	Ministry of Culture, Media and Information Society	Serbia	COOP
512	Ministry of Transport, Information Technology and Communications	Bulgaria	COOP
513	Mirantis Poland Sp. z o.o.	Poland	Industry
514	MiSONE	Turkey	SME
515	Mitsubishi	France	Industry
516	MOBICS SA	Greece	SME
517	Mobile VCE		COOP
518	Mobile World Capital Barcelona	Spain	COOP
519	Mobintec Ltd	U.K.	SME
520	Modio Computing PC	Greece	SME
521	moltosenso s.r.l.	Italy	SME
522	Montimage	France	SME
523	MOST Foundation	Poland	COOP
524	MostlyTek LTD	Israel	SME
525	Motorola	USA	COOP
526	Mott MacDonald Ltd	U.K.	Industry
527	Movation AS	Norway	SME
528	Mr. NeC	Netherlands	SME
529	MSWEB Cooperativa Valenciana	Spain	SME
530	Multicell	France	SME
531	Multifractal Semiconductors	South Africa	COOP
532	Multis Multum Foundation	Poland	Research Domain
533	Multitel	Belgium	Research Domain
534	Munich University of Technology	Germany	Research Domain
535	Naevatec	Spain	SME
536	National Aviation University	Ukraine	COOP
537	National Center for Scientific Research "Demokritos" - NCSR	Greece	Research Domain
538	National College Ireland	Ireland	Research Domain
539	National Institute for R&D in Informatics - ICI Bucharest	Romania	Research Domain
540	National Institute of Telecommunications	Poland	Research Domain
541	National Kapodistrian University of Athens (NKUA) - Wireless Systems Group	Greece	Research Domain
542	National Taiwan University	Taiwan	COOP
543	National Technical University of Athens	Greece	Research Domain
544	National technical university of Ukraine, International lab on Microelectromechanics Technologies	Ukraine	Research Domain
545	National University of Ireland Maynooth	Ireland	Research Domain
546	NEC Laboratories Europe GmbH	Germany	Industry
547	Nemergent Solutions SL	Spain	SME
548	NEMKO AS	Norway	Research Domain
549	Neogames	Sweden	SME
550	Neos	Italy	SME

551	Neoscopio	Portugal	SME
552	Net Surfing S.r.l.	Italy	SME
553	Net Technologies	Finland	SME
554	Net7	Italy	SME
555	Netas Telecommunication A.S.	Turkey	Industry
556	Netfort Technologies	Ireland	SME
557	NetHawk	Finland	Industry
558	NETvisor Ltd.	Hungary	SME
559	New Venture	Belgium	SME
560	Next European Industry	Belgium	SME
561	Nextworks s.r.l.	Italy	SME
562	NGMN - Next Generation Mobile Networks	Germany	COOP
563	NICT - National Institute of Information and Communications Technology	Japan	COOP
564	Nile University	Egypt	COOP
565	Nine Tiles	U.K.	SME
566	Nisantasi University	Turkey	Research Domain
567	Nites a.s.	Czech Republic	SME
568	NOKIA	Germany	Industry
569	Norcontel (Ireland) Ltd	Ireland	SME
570	Notitia Ltd	Croatia	SME
571	Nouveaucomm Networks Research Centre Private Limited	India	COOP
572	NOVATEX SOLUTIONS LTD	Cyprus	SME
573	Nuromedia	Germany	SME
574	NXP Semiconductors	Netherlands	Industry
575	O2	U.K.	Industry
576	OFFIS	Germany	Research Domain
577	OHB-System	Germany	Industry
578	Oledcomm	France	SME
579	one2many	Netherlands	SME
580	one2tribe sp. z o.o.	Poland	SME
581	ONERA	France	Research Domain
582	Open Cells Project	France	SME
583	OpenRevs	Australia	COOP
584	Opentix S.L.	Spain	SME
585	Optare Solutions	Spain	SME
586	Optima VoIP & SATCONXION	Spain	Industry
587	OPTRONICS Technologies SA	Greece	SME
588	ORANGE	France	Industry
589	Orbis Systems Oy	Finland	Industry
590	ORGA Systems enabling services GmbH	Germany	SME
591	ORION INNOVATIONS PRIVATE COMPANY	Greece	SME
592	OTE S.A	Greece	Industry
593	Ozyegin University	Turkey	Research Domain
594	PA Consulting Group	U.K.	Industry
595	PARAGON Europe	Malta	SME
596	PARAGON LTD	Greece	SME
597	Parhelion Global Communications Advisors	Netherlands	SME
598	Paris-Lodron-University Salzburg	Austria	Research Domain
599	Particula Group d.o.o.	Croatia	SME
600	Pedro Nunes Institute (Laboratory of Automatic and Systems)	Portugal	Research Domain
601	Peregrine Semiconductor UK Ltd	U.K.	Industry
602	Pharrowtech	Belgium	SME
603	PIPE Networks	Australia	COOP
604	Piran Partners LLP	U.K.	SME
605	Plasma Antennas Ltd	U.K.	SME
606	Pluribus One S.r.l.	Italy	SME
607	Polatis Ltd	U.K.	SME
608	Polimek Elektronik	Turkey	Industry
609	Politecnico di Bari	Italy	Research Domain

610	Politecnico di Milano	Italy	Research Domain
611	Politecnico di Torino	Italy	Research Domain
612	Politehnica University of Bucharest	Romania	Research Domain
613	Polska Telefonia Cyfrowa sp. z o.o.	Poland	Industry
614	Portugal Telecom Inovacao SA	Portugal	Industry
615	Postron Engineering S.r.l.	Italy	SME
616	Power Operations Limited	U.K.	SME
617	Pozitron	Turkey	SME
618	Poznan University of Economics, Department of Information Technology	Poland	Research Domain
619	Poznan University of Technology	Poland	Research Domain
620	Poznan, Supercomputing and Networking Center	Poland	Research Domain
621	PragmaDev	France	SME
622	PRESTO		COOP
623	Primetel Ltd	Cyprus	SME
624	PRISMA Telecom Testing	Italy	SME
625	Proximus	Belgium	Industry
626	Qamcom Research & Technology AB	Sweden	SME
627	Qorvo	USA	COOP
628	QUALCOMM CDMA Technologies GmbH	Germany	Industry
629	Queen Mary, University of London	UK	Research Domain
630	QUOBIS NETWORKS	Spain	SME
631	Quotient Associates Ltd	U.K.	Industry
632	R2M Solution s.r.l.	Italy	SME
633	RADIOLABS - Consorzio Università Industria Laboratori di Radiocomunicazioni	Italy	Research Domain
634	RAND Europe	U.K.	Research Domain
635	Ranplan Wireless Network Design Ltd	U.K.	SME
636	Real Wireless	U.K.	SME
637	Redes de Telecomunicación Galegas Retegal, S.A.	Spain	COOP
638	Redmill Marketing Associates	U.K.	SME
639	RedZinc	Ireland	Industry
640	Régens IT Plc.	Hungary	SME
641	RegPoint (former MedDay AB) Sophia Salenius	Sweden	Industry
642	Research Academic Computer Technology Institute	Greece	Research Domain
643	Research for Science, Art and Technology (RFSAT) Ltd.	U.K.	SME
644	Research In Motion UK Limited	U.K.	Industry
645	Research Institute for Artificial Intelligence "Mihai Draganescu"	Romania	Research Domain
646	Researchcenter of the Flemish Government	Belgium	COOP
647	RF DSP Inc.	USA	COOP
648	Ridgeback sas	Italy	SME
649	Riga Technical University	Latvia	Research Domain
650	Rikshospitalet Medical Center	Norway	Research Domain
651	Rinicom	U.K	SME
652	RMIT University	Australia	COOP
653	Rohde & Schwarz	Germany	Industry
654	Roke	U.K.	Industry
655	Rotel	Poland	Industry
656	Royal Institute of Technology	Sweden	Research Domain
657	RS-techMarketing	Israel	SME
658	RTC North Ltd	U.K.	SME
659	RunEL NGMT	Israel	SME
660	RWTH Aachen University, Department of Wireless Networks	Germany	Research Domain
661	S.C. Active Soft S.R.L.	Romania	Research Domain
662	S.C. IPA SA	Romania	Research Domain
663	SABANCI UNIVERSITY	Turkey	Research Domain
664	SADIEL S.A.	Spain	Industry
665	SAE - Automation,s.r.o.	Slovak Republic	SME
666	Sagax Communications	Hungary	SME
667	SAGEMCOM	France	Industry

668	Sai Technology pvt limited	India	COOP
669	Saliwell Ltd.	Israel	SME
670	Salzburg Research Forschungsgesellschaft mbH	Austria	Research Domain
671	SAMPAS	Turkey	Industry
672	Samsung Electronics Research Institute (UK) Ltd. (SERI)	U.K.	Industry
673	SAP AG	Germany	Industry
674	Sapienza Sl	Spain	SME
675	Satellite Application Catapult	U.K.	Research Domain
676	Schweizerische Eidgenossenschaft - Bundesamt für Berufsbildung und Technologie BBT	Switzerland	COOP
677	SciSys Ltd	U.K.	Industry
678	Scytl	Spain	Research Domain
679	Seavus	Sweden	SME
680	SECARTYS	Spain	COOP
681	Secure-IC	France	Industry
682	SemiBlocks	Netherlands	SME
683	SENER Ingeniería y Sistemas, S.A.	Spain	Industry
684	Seprotronic GmbH	Germany	SME
685	Sequans communications	France	SME
686	SES	Luxembourg	Industry
687	SETCCE	Slovenia	SME
688	Seven Solutions S.L.	Spain	SME
689	Siae Microelettronica S.p.A.	Italy	Industry
690	Siberian Telecommunications University	Russia	Research Domain
691	SICS - Swedish Institute of Computer Science AB	Sweden	Research Domain
692	Siemens	Austria	Industry
693	Sierra Wireless	France	Industry
694	Sigma Orionis	France	SME
695	Siklu Communication	Israel	SME
696	Simula Research Laboratory	Norway	Research Domain
697	SINTEF ICT	Norway	Research Domain
698	Sirab Technologies Inc.	USA	COOP
699	Sirecom	Italy	Industry
700	Sirius Satellite Radio	USA	COOP
701	Sistemas Avanzados de Tecnologia S.A. (SATEC)	Spain	Industry
702	SiTI	Italy	Research Domain
703	SK Consulting e.U.	Austria	SME
704	Skaitmeninio Sertifikavimo Centras	Lithuania	SME
705	Slovak University of Technology	Slovak Republic	Research Domain
706	Softeco Sismat SpA	Italy	SME
707	Software Radio Systems Limited	Ireland	SME
708	Source Photonics	USA	COOP
709	South-East European Research Centre (SEERC)	Greece	Research Domain
710	Southwest Jiaotong University (SWJTU)	China	COOP
711	sOwlers	Spain	SME
712	Space Engineering S.p.A.	Italy	SME
713	SPACE HELLAS S.A.	Greece	SME
714	Spectrum Insight Ltd	U.K.	SME
715	SPIIRAS, Russian Academy of Sciences	Russia	Research Domain
716	SPINNER GmbH	Germany	Industry
717	SQS,S.A	Spain	SME
718	Starhome GmbH	Israel	SME
719	State Engineering University of Armenia	Armenia	Research Domain
720	Stefan cel Mare University of Suceava	Romania	Research Domain
721	Steininger Consulting	Austria	SME
722	Stockholm University, Department of Computer and System Sciences	Sweden	Research Domain
723	Strategies Telecoms & Multimedia	France	Research Domain
724	Strosek Design GmbH & CO.KG	Germany	SME
725	Suedwestrundfunk	Germany	Industry
726	SUITE5 DATA INTELLIGENCE SOLUTIONS	Ireland	SME

727	Sunrise Communications AG	Switzerland	Industry
728	SUNTECH LTD.	Poland	SME
729	SUPAERO	France	Research Domain
730	Supélec	France	Research Domain
731	Super Radio AS	Norway	SME
732	SWAPCOM	France	SME
733	Swisscom AG	Switzerland	Industry
734	SwissIQ GmbH	Switzerland	SME
735	SwissMedia - Swiss IT & Multimedia Association	Switzerland	SME
736	Symantec Limited	Ireland	Industry
737	Synchromedia Lab, University of Quebec's Ecole de technologie superieure	Canada	COOP
738	Synelixis Ltd.	Greece	SME
739	Synergetics	Belgium	SME
740	SYNYO GmbH	Austria	SME
741	SystAG Systemhaus GmbH	Germany	SME
742	TAGES	France	SME
743	Tampere University	Finland	Research Domain
744	Tamum Consulting	France	SME
745	TARGET SISTEMI srl	Italy	SME
746	Targeting Innovation Ltd	U.K.	SME
747	TATA Consultancy Services	India	COOP
748	TCL	France	COOP
749	T-CONNECT SRL	Italy	SME
750	TEAMCAST TECHNOLOGY	France	SME
751	Technical University of Cluj-Napoca	Romania	Research Domain
752	Technical University of Denmark - DTU Fotonik	Denmark	Research Domain
753	Technicolor (THOMSON)	France	Industry
754	Technion	Israel	Research Domain
755	Technische Universität Berlin	Germany	Research Domain
756	Technische Universitat Darmstadt	Germany	Research Domain
757	Technological Education Institute of Messolonghi /Depart. of Telecommunication Systems and Networks	Greece	Research Domain
758	Technological Education Institute of Piraeus	Greece	Research Domain
759	Technological Educational Institute of Crete	Greece	Research Domain
760	Technological Educational Institute of Epirus	Greece	Research Domain
761	Technological Educational Institute of Western Macedonia	Greece	Research Domain
762	Technologický platforma kybernetická bezpečnost	Czech Republic	Research Domain
763	Technology Centre ASCR	Czech Republic	COOP
764	Tecnalia Research & Innovation	Spain	Research Domain
765	Tecnologico de Monterrey	Mexico	COOP
766	Tecnologico Fundacion Deusto	Spain	Research Domain
767	TEIEP MicTel Lab	Greece	Research Domain
768	Tekes, Finnish Funding Agency for Technology and Innovation	Finland	COOP
769	Tekever	Portugal	SME
770	Telcaria Ideas SL	Spain	SME
771	Telebid Ltd.	Bulgaria	SME
772	Telecom Italia	Italy	Industry
773	Télécom SudParis	France	Research Domain
774	Telecompare S.A.	Greece	SME
775	Telefonica	Spain	Industry
776	Telekom Austria AG	Austria	Industry
777	Telekom Slovenije	Slovenia	Industry
778	Telemetry Associates Limited	U.K.	SME
779	Telenity	Turkey	SME
780	Telenor ASA	Norway	Industry
781	Telespazio	Italy	Industry
782	TELETEL SA	Greece	SME
783	Telscom AG	Switzerland	SME
784	Tempos21	Spain	Industry

785	TeSA	France	Research Domain
786	Tessares	Belgium	Industry
787	Thales Alenia Space	France	Industry
788	Thales Communications & Security	France	Industry
789	The Federation of Finnish Technology Industries	Finland	COOP
790	The Internet of Thing Council	Belgium	COOP
791	The National Microelectronics Applications Centre Ltd	Ireland	SME
792	The Quality Group it vision GmbH	Germany	SME
793	The Technology Platform for Communication Tools and IoT (CTIT)	Czech Republic	Research Domain
794	The University of British Columbia	Canada	COOP
795	The University of Hull	U.K.	Research Domain
796	Thema TV	France	SME
797	Think Light	Sweden	SME
798	Three	U.K.	Industry
799	TiA Telecom	South Africa	COOP
800	TIGA TECHNOLOGIES SARL	France	SME
801	Time Critical Networks	Sweden	SME
802	time.lex	Belgium	SME
803	TISSAT	Spain	SME
804	T-mobile	USA	COOP
805	TNO Information and Communication Technology	The Netherlands	Research Domain
806	Torque Wind Turbine	Netherlands	SME
807	Toshiba Research Europe Ltd	U.K.	Industry
808	Toulouse University - IRIT	France	Research Domain
809	Tout Le Contenu SÃ RL	Switzerland	SME
810	Transport and Telecomm Institute	Latvia	Research Domain
811	Treelogic	Spain	SME
812	Trento RISE	Italy	COOP
813	TriaGnoSys GmbH	Germany	Industry
814	TRON ELEKTRONIK SISTEMLER AS	Turkey	SME
815	Trust-IT Services Ltd	U.K.	SME
816	TST	Spain	SME
817	TTG Int.LTD	Turkey	SME
818	TTI	Spain	SME
819	TU Chemnitz, Chair for Communication Networks	Germany	Research Domain
820	TU Dresden	Germany	Research Domain
821	TUBITAK	Turkey	COOP
822	Tunisia TV	Tunisia	COOP
823	Turk Telecom	Turkey	Industry
824	Turkcell Technology	Turkey	Industry
825	Turku University of Applied Sciences	Finland	Research Domain
826	TXT e-Solutions SPA	Italy	Industry
827	UAB Telesoftas	Lithuania	SME
828	UBITECH	Greece	SME
829	Ubiwhere	Portugal	SME
830	UDLAP - Universidad de las Americas Puebla	Mexico	COOP
831	Umicore AG & Co. KG	Germany	Industry
832	UNICAMP - Universidade Estadual de Campinas	Brazil	COOP
833	Unicampus	Italy	Research Domain
834	UNINOVA Ricardo Goncalves	Portugal	Research Domain
835	UNION Engenharia de Telematica Ltda	Brazil	COOP
836	UNIVERSAL K Ltd.	Bulgaria	SME
837	Universidad Camilo Jose Cela	Spain	Research Domain
838	Universidad Carlos III de Madrid	Spain	Research Domain
839	Universidad de Alcala	Spain	Research Domain
840	Universidad de Granada	Spain	Research Domain
841	Universidad de Malaga	Spain	Research Domain
842	Universidad de Murcia	Spain	Research Domain
843	Universidad de Oviedo	Spain	Research Domain
844	Universidad de Valladolid	Spain	Research Domain

845	Universidad de Vigo	Spain	Research Domain
846	Universidad de Zaragoza	Spain	Research Domain
847	Universidad Nacional General Sarmiento	Argentina	COOP
848	Universidad Politécnica de Madrid - UPM	Spain	Research Domain
849	Universidad Politécnica de Valencia	Spain	Research Domain
850	Universidad Publica de Navarra (UPNA)	Spain	Research Domain
851	Universidad Rey Juan Carlo	Spain	Research Domain
852	Universidade da Beira Interior	Portugal	Research Domain
853	Universidade Federal do Amazonas - UFAM	Brazil	COOP
854	Universita' Politecnica delle Marche	Italy	Research Domain
855	Universitat Autonoma de Barcelona	Spain	Research Domain
856	Universität Bremen (TZI)	Germany	Research Domain
857	Universität Göttingen	Germany	Research Domain
858	Universitat Politecnica de Catalunya - UPC	Spain	Research Domain
859	Universitat Pompeu Fabra	Spain	Research Domain
860	Universität Potsdam	Germany	Research Domain
861	Universität Zürich	Switzerland	Research Domain
862	Université Catholique de Louvain	Belgium	Research Domain
863	Université Pierre et Marie Curie - Paris 6 (UPMC)	France	Research Domain
864	University "Mediterranea" of Reggio Calabria	Italy	Research Domain
865	University Castilla La Mancha - Albacete Research Institute of Informatics	Spain	Research Domain
866	University College Dublin	Ireland	Research Domain
867	University College Ghent	Belgium	Research Domain
868	University College London	U.K.	Research Domain
869	University Cyril and Methodius Skopje	Macedonia	Research Domain
870	University Jaume I of Castellon	Spain	Research Domain
871	University of Aberdeen	U.K.	Research Domain
872	University of Aegean	Greece	Research Domain
873	University of Agder	Norway	Research Domain
874	University of Applied Sciences Offenburg	Germany	Research Domain
875	University of Applied Sciences Osnabrueck	Germany	Research Domain
876	University of Athens	Greece	Research Domain
877	University of Aveiro	Portugal	Research Domain
878	University of Belgrade	Serbia	Research Domain
879	University of Bern	Switzerland	Research Domain
880	University of Bologna	Italy	Research Domain
881	University of Bradford	U.K.	Research Domain
882	University of Bristol	U.K.	Research Domain
883	University of Cadi Ayyad	Morocco	COOP
884	University of Cagliari	Italy	Research Domain
885	University of Calabria	Italy	Research Domain
886	University of Camerino	Italy	Research Domain
887	UNIVERSITY OF CANTABRIA	Spain	Research Domain
888	University of Carthage, Sup'Com	Tunisia	COOP
889	University of Coimbra Department of Informatics Engineering	Portugal	Research Domain
890	University of Cordoba	Spain	Research Domain
891	University of Cyprus	Cyprus	Research Domain
892	University of Dortmund, Communication Networks Institute	Germany	Research Domain
893	University of Dublin, Trinity College	Ireland	Research Domain
894	University of East London	U.K.	Research Domain
895	University of Edinburgh	U.K.	Research Domain
896	University of Firenze	Italy	Research Domain
897	University of Geneva	Switzerland	Research Domain
898	University of Genova	Italy	Research Domain
899	University of Greenwich	U.K.	Research Domain
900	University of Groningen	The Netherlands	Research Domain
901	University of Guadalajara	Mexico	COOP
902	University of Hertfordshire	U.K.	Research Domain
903	University of Iceland	Iceland	Research Domain

904	University of Kaiserslautern	Germany	Research Domain
905	University of Kassel	Germany	Research Domain
906	University of Kent	U.K.	Research Domain
907	University of La Laguna	Spain	Research Domain
908	University of Lancaster	U.K.	Research Domain
909	University of Leeds	U.K.	Research Domain
910	University of Liverpool	U.K.	Research Domain
911	University of Ljubljana Faculty of Electrical Engineering	Slovenia	Research Domain
912	University of Luxembourg	Luxemburg	Research Domain
913	University of Macedonia, CONTA (Computer Networks & Telematic Applications) Lab	Greece	Research Domain
914	University of Malta	Malta	Research Domain
915	University of Media Stuttgart	Germany	Research Domain
916	University of Milano-Bicocca	Italy	Research Domain
917	University of Minho	Portugal	Research Domain
918	University of Miskolc Innovation Management Cooperation Research Center	Hungary	Research Domain
919	University of Modena and Reggio Emilia	Italy	Research Domain
920	University of New South Wales	Australia	COOP
921	University of Nicosia	Cyprus	Research Domain
922	University of North Dakota	USA	COOP
923	University of Oslo	Norway	Research Domain
924	University of Oulu	Finland	Research Domain
925	University of Oxford	U.K.	Research Domain
926	University of Padova	Italy	Research Domain
927	University of Parma	Italy	Research Domain
928	University of Patras	Greece	Research Domain
929	University of Pavia	Italy	Research Domain
930	University of Peloponnese	Greece	Research Domain
931	University of Perugia	Italy	Research Domain
932	University of Piraeus	Greece	Research Domain
933	University of Pisa	Italy	Research Domain
934	University of Porto	Portugal	Research Domain
935	University of Portsmouth Centre for Healthcare Modelling and Informatics	U.K.	Research Domain
936	University of ROMA TRE	Italy	Research Domain
937	University of Rome - "La Sapienza"	Italy	Research Domain
938	University of Rome - Tor Vergata	Italy	Research Domain
939	University of Rostock	Germany	Research Domain
940	University of Salzburg ICT&S Center	Austria	Research Domain
941	University of Sannio, Engineering Department	Italy	Research Domain
942	University of Siena	Italy	Research Domain
943	University of Strathclyde	U.K.	Research Domain
944	University of Sunderland	U.K.	Research Domain
945	University of Surrey	U.K.	Research Domain
946	University of Sussex	U.K.	Research Domain
947	University of Szeged, Department of Software Engineering	Hungary	Research Domain
948	University of the Basque Country	Spain	Research Domain
949	University of the West of Scotland	U.K.	Research Domain
950	University of Thessaloniki	Greece	Research Domain
951	University of Torino Department of Computer Science	Italy	Research Domain
952	University of Toronto	Canada	COOP
953	University of Tuebingen	Germany	Research Domain
954	University of Twente	The Netherlands	Research Domain
955	University of Udine	Italy	Research Domain
956	University of Valencia	Spain	Research Domain
957	University of Valladolid	Spain	Research Domain
958	University of Versailles - ASR / PRISM	France	Research Domain
959	University of Veszprém, Georgikon Faculty of Agronomy, Department of Statistics	Hungary	Research Domain
960	University of Western Macedonia	Greece	Research Domain

961	University of York	U.K.	Research Domain
962	University Paderborn	Germany	Research Domain
963	Uppsala University	Sweden	Research Domain
964	Urban Hawk Ltd	U.K.	SME
965	Urmet TLC S.p.A.	Italy	Industry
966	Utrecht School of the Arts	The Netherlands	Research Domain
967	V.A.S. Telekom	Turkey	SME
968	Val Space Consortium	Spain	COOP
969	Value Grid	Germany	SME
970	VATP	Latvia	SME
971	Velankani Electronics Pt. Ltd.	India	COOP
972	Ventspils University College	Latvia	Research Domain
973	Verhaert	Belgium	SME
974	VERTICAL M2M	France	SME
975	Viavi Solutions Deutschland GmbH	Germany	Industry
976	VICOMTECH	Spain	Research Domain
977	Vicomtech-IK4	Spain	Research Domain
978	Viettel Group	Vietnam	COOP
979	Vilnius University (Institute of Mathematics and Informatics)	Lithuania	Research Domain
980	VirtuOR	France	SME
981	VISIONA INGENIERÍA DE PROYECTO	Spain	SME
982	Visvesvaraya Technological University	India	COOP
983	Vitrociset	Belgium	Industry
984	VOCS	Belgium	SME
985	Vodafone	U.K.	Industry
986	Vrije Universiteit Brussel	Belgium	Research Domain
987	VT iDirect Solutions Limited	Ireland	Industry
988	VTT	Finland	Research Domain
989	VVKSO (Flemish Secretariat for Catholic Education)	Belgium	COOP
990	Výskumný ústav spojov, n. o.	Slovak Republic	Research Domain
991	W3C (World Wide Web Consortium)	France	COOP
992	Warsaw University of Technology, Institute of Telecommunications	Poland	Research Domain
993	Waterford Institute of Technology - TSSG	Ireland	Research Domain
994	WAVECOMM S.r.l.	Italy	SME
995	Wellness Telecom S.L	Spain	SME
996	WEST Aquila Srl	Italy	SME
997	WIBU-SYSTEMS AG	Germany	SME
998	Widian Ltd	Finland	SME
999	WINGS ICT Solutions	Greece	SME
1000	WIRELESS GALICIA S.L	Spain	Industry
1001	Wireless Innovation	Greece	SME
1002	Wireless Research Centre	New Zealand	COOP
1003	Wireless World Research Forum		COOP
1004	Wiser	Italy	Industry
1005	WIT-Software Lda	Portugal	SME
1006	Wiz consultancy	Spain	SME
1007	WIZI	Portugal	SME
1008	WOM - While on the Move	Finland	SME
1009	Worldadcom - Universaldynamic Technologies, SA	Portugal	SME
1010	Wroclaw University of Technology	Poland	Research Domain
1011	WSP | Parsons Brinckerhoff	U.K.	Industry
1012	Xenia Network Solutions	Italy	SME
1013	Yarmouk University	Jordan	COOP
1014	YASAD-Turkish Software Industry Association	Turkey	COOP
1015	Yasar University	Turkey	Research Domain
1016	Ydreams	Portugal	SME
1017	Yleisradio Oy	Finland	COOP
1018	Yonga Technology Microelectronics R&D	Turkey	SME
1019	Yonsei University	Korea, South	COOP

1020	YOUMOVE LDA	Portugal	SME
1021	Zeetta Networks Limited	U.K.	SME
1022	Zhejiang University	P.R.China	COOP
1023	Zilinska Univerzita	Slovak Republic	Research Domain
1024	ZTE	Germany	Industry
1025	Züricher Hochschule für Angewandte Wissenschaften - ZHAW	Switzerland	Research Domain
1026	ZVEI - German Electrical and Electronic Manufactureres' Association	Germany	COOP

AIOTI Membership

The participation in the AIOTI Association is on voluntary basis. Figure 33 and Table A4 show the membership and its regional distribution.

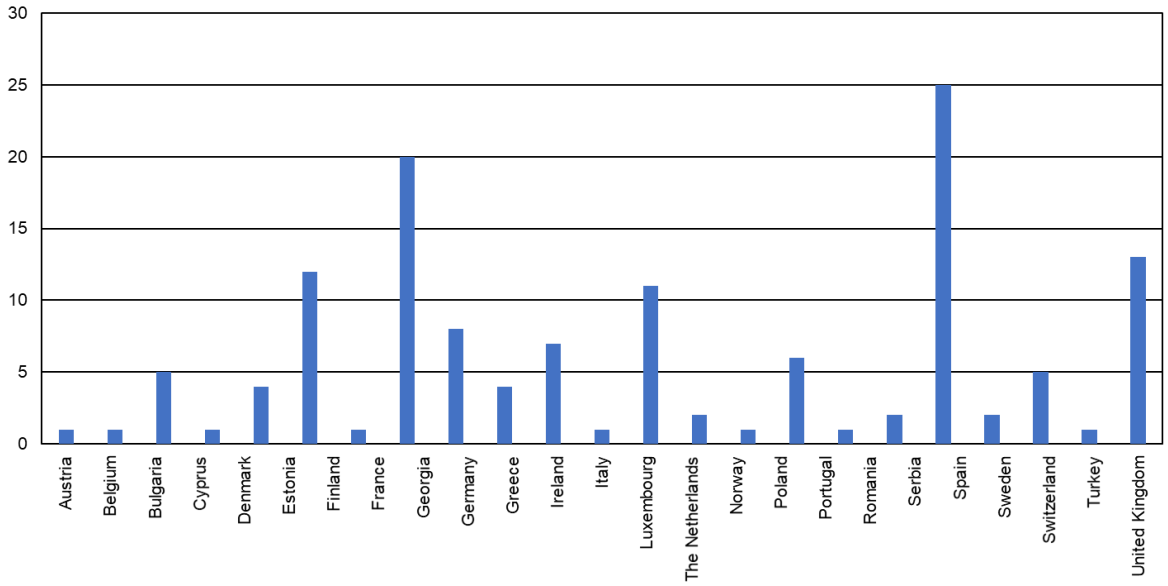


Figure 33 Regional membership distribution of AIOTI

Table A4 AIOTI membership list Spring 2020

No	Members Full Name	Country	Category
1	AIT Austrian Institute of Technology GmbH	Austria	University and/or research institute with a non-profit objective
2	AVL List GmbH	Austria	Company other than an SME
3	Virtual Vehicle Research GmbH	Austria	University and/or research institute with a non-profit objective
4	CECE - Committee for European Construction Equipment AISBL	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
5	CECIMO Comite Europeen de Cooperation des Industries de la Machine Outils AISBL	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
6	CEMA Comite europeen des groupements de constructeurs du machinisme agricole AISBL	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
7	Cisco Systems Belgium BVBA	Belgium	Company other than an SME
8	CNH Industrial Belgium NV	Belgium	Company other than an SME
9	COPA-COGECA Committee of the Professional Organisations of the European Union and General Confederation of Agricultural Cooperatives in the European Union	Belgium	Organisation that represents end-users, as referred to in Article 3.5.c (iv)
10	ECTP European Construction, built environment and energy efficient buildings Technology Platform AISBL	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
11	ENTSOE European Network of Transmission System Operators for Electricity AISBL	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
12	ERTICO - ITS Europe European Road Transport Telematics Implementation Coordination Organisation SCRL	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
13	Eurofins Digital Testing Belgium NV	Belgium	SME (as defined in the A.o.A.)
14	European DIGITAL SME Alliance AISBL	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
15	GS1 AISBL	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
16	IBM Belgium BVBA	Belgium	Company other than an SME

17	INTEROP-VLAB European Virtual Laboratory for Enterprise Interoperability AISBL	Belgium	University and/or research institute with a non-profit objective
18	LightingEurope AISBL	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
19	Qualcomm Europe Inc	Belgium	Company other than an SME
20	Schuttelaar & Partners NV	Belgium	SME (as defined in the A.o.A.)
21	SettleMint NV	Belgium	SME (as defined in the A.o.A.)
22	TE Connectivity BVBA	Belgium	Company other than an SME
23	Toy Industries of Europe	Belgium	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
24	Nearcom EooD	Bulgaria	SME (as defined in the A.o.A.)
25	CY.R.I.C Cyprus Research and Innovation Center	Cyprus	SME (as defined in the A.o.A.)
26	Aarhus University	Denmark	University and/or research institute with a non-profit objective
27	Alexandra Instituttet AS	Denmark	University and/or research institute with a non-profit objective
28	FORCE Technology RTO Research and Technology Organisation	Denmark	Company other than an SME
29	Grundfos Holding AS	Denmark	Company other than an SME
30	Soracom DK ApS	Denmark	SME (as defined in the A.o.A.)
31	AES Technologies OU	Estonia	SME (as defined in the A.o.A.)
32	Aaltoo-korkeakoulusaatio sr	Finland	University and/or research institute with a non-profit objective
33	Konecranes Oyj	Finland	Company other than an SME
34	University of Oulu	Finland	University and/or research institute with a non-profit objective
35	Wirepas Oy	Finland	SME (as defined in the A.o.A.)
36	AFNIC Association Française pour le Nommage Internet en Coopération ASBL	France	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
37	CITC-EuraRFID ASBL	France	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
38	Commissariat à l'énergie atomique et aux énergies alternatives EPIC, organismes divers d'administration centrale (ODAC)	France	University and/or research institute with a non-profit objective
39	CommLedge SASU	France	SME (as defined in the A.o.A.)
40	ERCIM GEIE - Groupement européen d'intérêt économique	France	SME (as defined in the A.o.A.)
41	ETSI ASBL	France	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
42	Institut Mines-Telecom EPSCP	France	University and/or research institute with a non-profit objective
43	ISEN Institut Superieur de l'Electronique et du Numerique ASBL	France	University and/or research institute with a non-profit objective
44	New Health Community SASU	France	SME (as defined in the A.o.A.)
45	Orange SA	France	Company other than an SME
46	Schneider Electric Industries SAS	France	Company other than an SME
47	Trialog SA	France	SME (as defined in the A.o.A.)
48	Apnisi	Georgia	SME (as defined in the A.o.A.)
49	7layers GmbH	Germany	Company other than an SME
50	agrathaer Gmbh	Germany	SME (as defined in the A.o.A.)
51	digital worx GmbH	Germany	SME (as defined in the A.o.A.)
52	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung eV	Germany	University and/or research institute with a non-profit objective
53	Fujitsu Technology Solutions GmbH	Germany	Company other than an SME
54	Huawei Technologies Dusseldorf GmbH	Germany	Company other than an SME
55	Infineon Technologies AG	Germany	Company other than an SME
56	John Deere GmbH & Co KG	Germany	Company other than an SME
57	NEC Laboratories Europe GmbH	Germany	Company other than an SME
58	Nokia Solutions and Networks GmbH & Co. KG	Germany	Company other than an SME
59	Offis eV	Germany	University and/or research institute with a non-profit objective
60	Panasonic R&D Center Germany GmbH	Germany	Company other than an SME
61	Siemens AG	Germany	Company other than an SME
62	struktur AG	Germany	SME (as defined in the A.o.A.)

63	Technischen Universitaet Chemnitz	Germany	University and/or research institute with a non-profit objective
64	Texas Instruments Deutschland GmbH	Germany	Company other than an SME
65	THINKT Digital GmbH	Germany	SME (as defined in the A.o.A.)
66	VDI/VDE Innovation und Technik GmbH	Germany	Company other than an SME
67	VDMA Verband Deutscher Maschinen- und Anlagenbau eV	Germany	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
68	ZVEI Zentralverband Elektrotechnik- und Elektronikindustrie eV	Germany	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
69	AIT Research and Education Laboratory in Information Technologies	Greece	University and/or research institute with a non-profit objective
70	Future Intelligence Ltd	Greece	SME (as defined in the A.o.A.)
71	Institute of Communication and Computer Systems non- profit academic research body	Greece	University and/or research institute with a non-profit objective
72	Intracom Telecom Solutions SA	Greece	Company other than an SME
73	Neuropublic SA	Greece	SME (as defined in the A.o.A.)
74	Satways Ltd	Greece	SME (as defined in the A.o.A.)
75	Synelixis Solutions Ltd	Greece	SME (as defined in the A.o.A.)
76	Uni Systems SA	Greece	Company other than an SME
77	Cainthus Ireland Ltd	Ireland	SME (as defined in the A.o.A.)
78	Insight Centre for Data Analytics non- profit academic research body	Ireland	University and/or research institute with a non-profit objective
79	The Convex Lens Ltd	Ireland	SME (as defined in the A.o.A.)
80	University of Limerick	Ireland	University and/or research institute with a non-profit objective
81	Bonfiglioli Riduttori Spa	Italy	Company other than an SME
82	Euroconsumers (Altroconsumo Edizioni srl)	Italy	Organisation that represents end-users, as referred to in Article 3.5.c (iv)
83	Fondazione LINKS Leading Innovation & Knowledge for Society	Italy	University and/or research institute with a non-profit objective
84	Nextworks SRL	Italy	SME (as defined in the A.o.A.)
85	Politecnico di Milano politecnico estatale	Italy	University and/or research institute with a non-profit objective
86	Telit Communications spa	Italy	SME (as defined in the A.o.A.)
87	Video Systems SRL	Italy	SME (as defined in the A.o.A.)
88	FBConsulting Sarl	Luxembourg	SME (as defined in the A.o.A.)
89	Arthur's Legal BV	Netherlands	SME (as defined in the A.o.A.)
90	iLabs Technologies BV	Netherlands	SME (as defined in the A.o.A.)
91	InnoAdds VOF	Netherlands	SME (as defined in the A.o.A.)
92	Martin Pot Interiors EL	Netherlands	SME (as defined in the A.o.A.)
93	NEN Netherlands Standardization Institute Non-Profit Organisation	Netherlands	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
94	Philips Electronics Nederland BV Research	Netherlands	Company other than an SME
95	RIPE NCC Reseaux IP Europeens Network Coordination Centre NPO	Netherlands	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
96	Signify Netherlands BV	Netherlands	Company other than an SME
97	Technische Universiteit Delft	Netherlands	University and/or research institute with a non-profit objective
98	Techwave Consulting B.V.	Netherlands	SME (as defined in the A.o.A.)
99	TNO Netherlands organisation for applied scientific research NPO Organisation for Applied Scientific Research KvK No. 27376655	Netherlands	University and/or research institute with a non-profit objective
100	Hafenstrom as	Norway	SME (as defined in the A.o.A.)
101	SINTEF AS	Norway	University and/or research institute with a non-profit objective
102	Institute of Bioorganic Chemistry of the Polish Academy of Sciences, Poznan Supercomputing and Networking Center PRO	Poland	University and/or research institute with a non-profit objective
103	Enercoutim - Associação Empresarial de Energia Solar de Alcoutim	Portugal	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
104	INOV INESC INOVAÇÃO NPO associação privada sem fins lucrativos	Portugal	University and/or research institute with a non-profit objective
105	Ubiwhere Lda	Portugal	SME (as defined in the A.o.A.)
106	Uninova Instituto de Desenvolvimento de Novas Tecnologias	Portugal	University and/or research institute with a non-profit objective

107	UNPARALLEL Innovation Lda	Portugal	SME (as defined in the A.o.A.)
108	WeTek SA	Portugal	SME (as defined in the A.o.A.)
109	SIVECO Romania SA	Romania	SME (as defined in the A.o.A.)
110	BioSense Institute	Serbia	University and/or research institute with a non-profit objective
111	DunavNET doo	Serbia	SME (as defined in the A.o.A.)
112	AnySolution	Spain	SME (as defined in the A.o.A.)
113	BluSpecs SL	Spain	SME (as defined in the A.o.A.)
114	Cellnex Telecom SA	Spain	Company other than an SME
115	Edosoft Factory SL	Spain	SME (as defined in the A.o.A.)
116	Eurecat Technology Centre OPI Organismo Público de Investigación	Spain	University and/or research institute with a non-profit objective
117	Everis Spain SL	Spain	Company other than an SME
118	FEUGA Galician Enterprise-University Foundation	Spain	Association with a statutory purpose that includes the Membership Criterion set out under Article 3.5.c (iii)
119	Fundación Centro de Tecnologías De Interacción Visual Y Comunicaciones Vicomtech	Spain	University and/or research institute with a non-profit objective
120	Fundacion Centro Tecnoloxico de Telecomunicacions de Galicia	Spain	University and/or research institute with a non-profit objective
121	Fundacion Tecnalia Research & Innovation	Spain	University and/or research institute with a non-profit objective
122	Fundacion Tekniker	Spain	University and/or research institute with a non-profit objective
123	GMV Aerospace and Defence SAU	Spain	Company other than an SME
124	IDEKO	Spain	SME (as defined in the A.o.A.)
125	IKERLAN	Spain	University and/or research institute with a non-profit objective
126	Indra Sistemas SA	Spain	Company other than an SME
127	IRTA Institute of Agriculture and Food Research and Technology is a research institute owned by the Government of Catalonia adscribed to the Department of Agriculture. It is regulated by Law 04/2009, passed by the Catalan Parliament on 15 April 2009, and it is ruled by private regulations	Spain	University and/or research institute with a non-profit objective
128	ITI Instituto Tecnologico de Informatica Asoc.	Spain	University and/or research institute with a non-profit objective
129	Kirale Technologies SL	Spain	SME (as defined in the A.o.A.)
130	Mondragon Goi Eskola Politeknikoa Jose Maria Arizmendiarrieta SCoop	Spain	University and/or research institute with a non-profit objective
131	MySphera SL	Spain	SME (as defined in the A.o.A.)
132	Pulverizadores Fede SL	Spain	SME (as defined in the A.o.A.)
133	TRAGSA Empresa de Transformacion Agraria SA	Spain	Company other than an SME
134	Universidad de Murcia	Spain	University and/or research institute with a non-profit objective
135	Universidad Politecnica de Madrid	Spain	University and/or research institute with a non-profit objective
136	Universitat de Valencia	Spain	University and/or research institute with a non-profit objective
137	IKEA of Sweden AB	Sweden	Company other than an SME
138	RISE IVF AB	Sweden	University and/or research institute with a non-profit objective
139	Insolar Technologies GmbH	Switzerland	SME (as defined in the A.o.A.)
140	Mandat International Foundation / Stiftung	Switzerland	University and/or research institute with a non-profit objective
141	Martel GmbH	Switzerland	SME (as defined in the A.o.A.)
142	SGS SA	Switzerland	SME (as defined in the A.o.A.)
143	STMicroelectronics International NV	Switzerland	Company other than an SME
144	Işıksoy Tekstil A.Ş.	Turkey	Company other than an SME
145	Bournemouth University	U.K.	University and/or research institute with a non-profit objective
146	BT Group plc	U.K.	Company other than an SME
147	Climate Associates Ltd	U.K.	SME (as defined in the A.o.A.)
148	Digital Catapult plc	U.K.	University and/or research institute with a non-profit objective
149	Hitachi Europe Ltd	U.K.	Company other than an SME
150	Hitachi Vantara (Pentaho Ltd)	U.K.	company other than an SME
151	INLECOM Systems LTD	U.K.	SME (as defined in the A.o.A.)

152	Intel Corporation (UK) Ltd	U.K.	Company other than an SME
153	Knowledge Transfer Network Ltd	U.K.	SME (as defined in the A.o.A.)
154	Thingstream Ltd	U.K.	SME (as defined in the A.o.A.)
155	Vodafone Global Enterprise Ltd	U.K.	Company other than an SME
156	Xelba.io Ltd	U.K.	SME (as defined in the A.o.A.)
157	Zebra Technologies Europe Limited	U.K.	Company other than an SME

Cispe.Cloud Membership

The participation in the Cispe.Cloud Association is on voluntary basis. Figure 34 and Table A5 show the membership and its regional distribution.

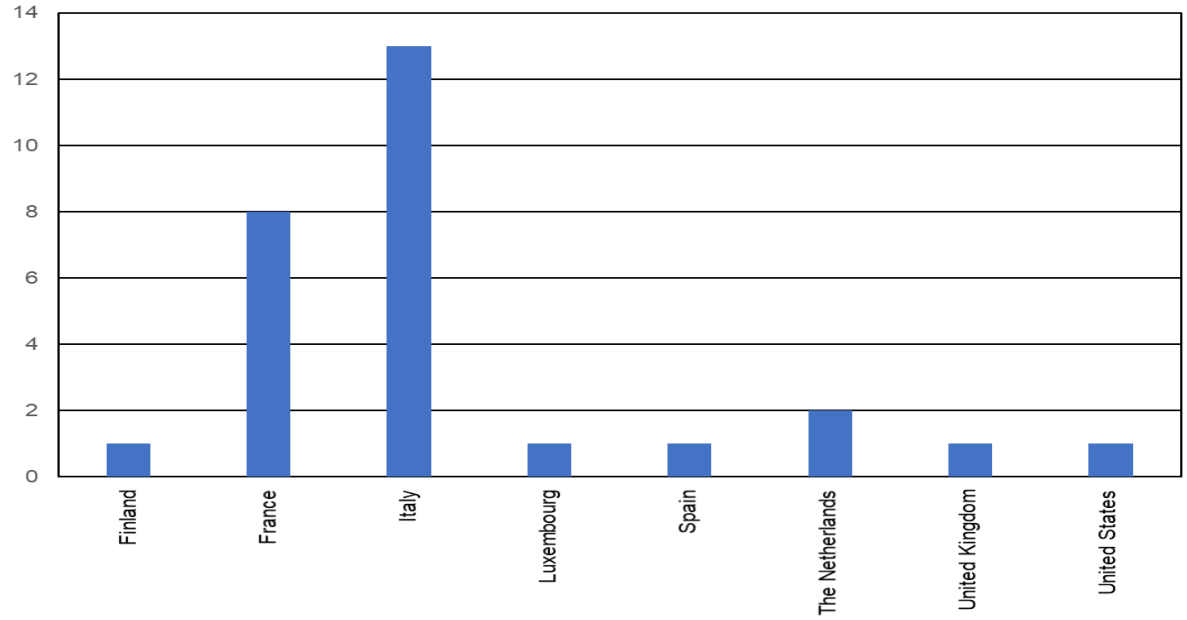


Figure 34 Regional membership distribution of Cispe.Cloud

Table A5 Cispe.Cloud membership list Spring 2020

No.	Company	Country
1	Aruba S.P.A.	Italy
2	Amazon Web Services EMEA SARL	Luxembourg
3	Ikoula SAS	France
4	OVH SAS	France
5	ALTUSHOST BV	Netherlands
6	Caelis SASU	France
7	CoreTech SPRL	Italy
8	Egenera	US
9	eLogic s.r.l	Italy
10	FlameNetworks S.r.l.	Italy
11	Gigas Hosting S.A.	Spain
12	ilger.com	Italy
13	Infoclip Group	France
14	IOMCloud Limited	UK - Isle of Man
15	IRIDEOS S.p.A.	Italy
16	ITnet S.r.l	Italy
17	Jaguar Network	France
18	Leaseweb Global B.V. (LSW)	Netherlands
19	Lomaco SAS	France
20	Netalia s.r.l.	Italy
21	Outscale SAS	France
22	Reevo SRL	Italy
23	Register S.p.A	Italy
24	Scaleway	France
25	Seeweb s.r.l.	Italy
26	Server Plan SRL Unipersonal	Italy
27	Systema Srl	Italy
28	Upcloud Ltd.	Finland

NESSI European Technology Platform Membership

The participation in the NESSI European Technology Platform is on voluntary basis. Figure 35 and Table A6 show the membership of the core members and its regional distribution.

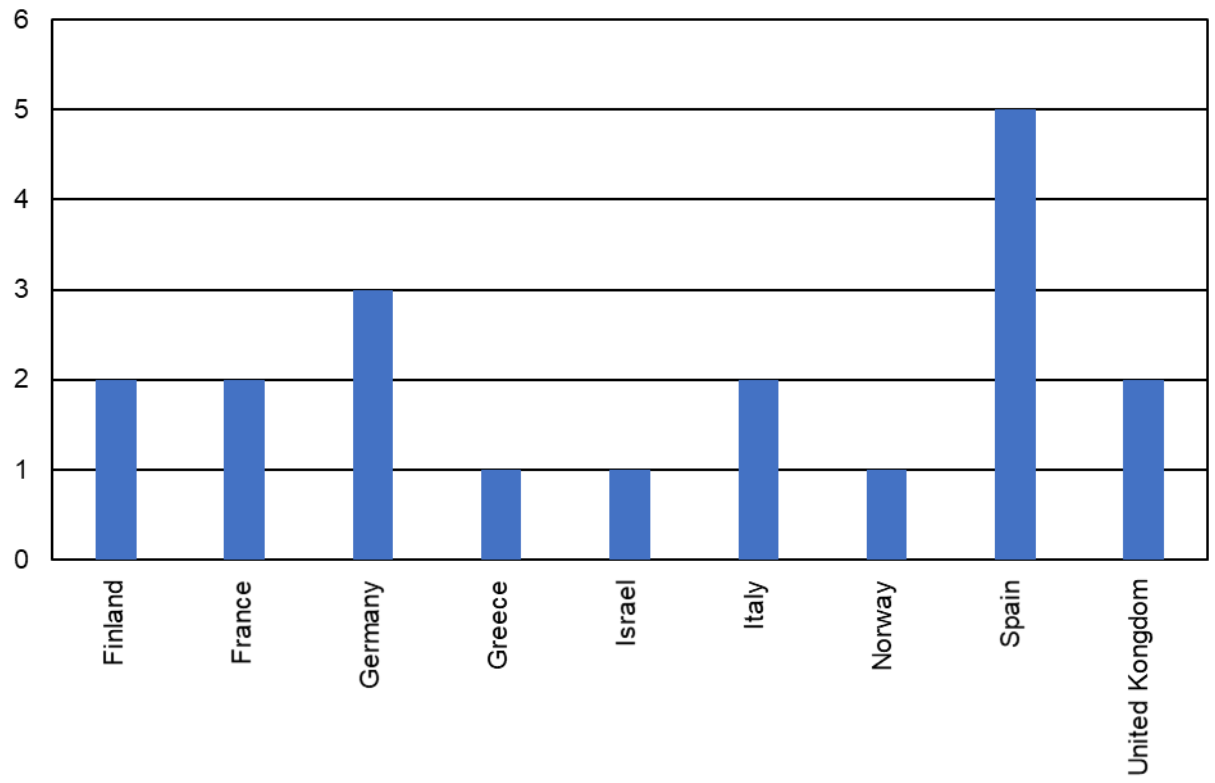


Figure 35 Regional core membership distribution of NESSI

Table A6 NESSI core membership list Spring 2020

No	Members Full Name	Country	Category
1	Answare	SME	Spain
2	ATC	SME	Greece
3	Atos	Large Industry	Spain
4	CINI	Research	Italy
5	Engineering	Large Industry	Italy
6	IBM	Large Industry	Israel
7	ICE	SME	U.K.
8	INDRA	Large Industry	Spain
9	IT Innovation	Research	U.K.
10	ITI	Research	Spain
11	Nokia	Large Industry	Finland
12	Orange	Large Industry	France
13	Paluno	Research	Germany
14	Siemens	Large Industry	Germany
15	Sintef	Research	Norway
16	Software AG	Large Industry	Germany
17	Thales	Large Industry	France
18	UPM	Research	Spain
19	VTT	Research	Finland

Annex 8 Partnership criteria

Partnership proposals are evaluated against a set of criteria as described by an ERAC Working Paper according to [130]). The following Table A7 and Table A8 are summarising, how the Smart Networks and Services Partnership proposal is addressing these criteria.

A8.1 Key concepts and definitions

Additionality and directionality: The main added value of partnerships derives from the additional private and/or public R&I investments on EU priorities (additionality) that can be translated into a leverage effect resulting from the Union intervention. The alignment of these investments and contributions towards common objectives (directionality) and the achievement of impacts that cannot be created by other Framework Programme actions or national action alone is a main justification for using a partnership approach.	• Additionality: The Smart Networks and Services Partnership is expecting a leverage factor of additional private investment plus a significantly higher private investment during the commercial economic exploitation phase (Section 2.2). • Directionality: With respect to the complexity of researching and designing a new communications system by means of additional intelligence in networks and in-built cybersecurity only a European Partnership can solve the problem, which is directly supporting common objectives such as digital autonomy of Europe, a secure communication infrastructure, the support of many vertical sectors towards digitalization and global impact on internationally accepted standards (Sections 1.2.4, 1.3 and 2.2). • Globally accepted standards are a precondition for economic exploitation, creation of jobs in application domains and to serve the global market. • Due to the diversity of many involved industry sectors (Section 1.4), which are based in different EU Member States and Associated Countries a European approach is necessary. Where possible, activities will be coordinated with national programmes.
Union added value: Partnerships must facilitate the creation and expansion of R&I networks that bring together relevant and competent actors from across Europe, thus contributing to the realization of the ERA. Union investment in Partnerships will be limited to areas of high European added value and relevance for agreed European political priorities. The EU added value needs to be reflected in the outcome of the strategic planning process of Horizon Europe. They should clearly demonstrate delivery of results for the EU and its citizens, notably global challenges and competitiveness, which cannot be achieved by the Programme alone.	• The proposed Partnership directly fits to the Horizon Europe Specific Programme under the Area of Intervention “Next Generation Internet” and supports European policy objective such as Cybersecurity, digital autonomy (alternative European offer in certain areas) and digitalization of society and economy to improve global competitiveness (Section 1.1 and 1.2). • It will bring together many stakeholders from different sectors in the ICT domain as well as vertical sectors and related areas such as IoT, clouds, Cybersecurity, components and devices. The example of 5G PPP shows that up to now nearly 500 beneficiaries are involved in 5G PPP projects. These stakeholders will be from industry, SMEs and academia. • This helps to support the policy objective to secure Europe • Advanced communication infrastructure will directly benefit European citizens and businesses by better public and private services, secure networks and other public infrastructures, which are connected to and controlled by such networks, job opportunities and economic growth. • Global challenges as the United Nations Sustainable Development Goals (Section 1.2) are addressed by the Partnership. • The preparation of the coordinated SRIA as input to the Work Programme will be developed in an open process by the Community in the context of the Networld2020 ETP. • These activities support the further development and strengthening of the European research community.

	• With respect to the scale of the issues these activities must take place at European level in a Partnership with all stakeholders. Individual projects are too small to address the overall objectives.
Transparency and openness: Partnerships should be transparent in the process of their selection, as well as during their preparation and implementation, and use of results beyond the partnerships themselves. They should demonstrate high level of openness towards relevant partners and stakeholders in priority setting, implementation and participation in its activities. During their lifetime, they should actively facilitate the participation of new members at programme and project level, aim at a broader stakeholder involvement and improve openness for dissemination of and access to results.	• Partnerships are selected by the EU Commission and Member States based on an impact assessment. The private side is not involved in this selection. • The private side is involved in the implementation of the Partnership. The proposed governance model (Section 2.3) is building on the example of 5G PPP, which ensures openness for participation and independence of being a member of the Association. Details on openness and transparency are described in Section 2.4. • The participation in 5G PPP was growing from around 200 beneficiaries in Phase I to around 500 beneficiaries from Phases I to III. Due to the change of focus from exploratory research in Phase I towards bigger trials in Phase III especially with vertical sectors the composition of the constituency was changing during the lifetime of 5G PPP. With respect to the phased approach in the Smart Networks and Services Partnership a similar dynamic composition of the constituency is also expected (c.f. Section 2.1). • The SRIA is developed in an open process with the wider community followed by public consultations (Section 2.4.4). • The private side will continue activities similar like in 5G PPP to promote and mobilize the involvement of SMEs by an SME Working Group (in 5G PPP such activities mobilized an SME participation close to 20 % in terms of funding budget). • Additional means are a cartography of necessary expertise and an associated brokerage platform for matching partners to proposal consortia, information days of Calls for Proposals and a proposed pre-structuring model to map call objectives to potential research areas as a recommendation to the community for proposal preparation to achieve a good coverage of the call objectives by minimising overlaps for an efficient use of public funding. • Projects under the umbrella of the Partnership will organize public workshop and especially with vertical sectors to discuss results with the wider community. The example of the Vertical Sector Working Groups in 5G PPP will be continued.

Impact:
Progress towards achieving the objectives should be measured building on the impact pathway indicators of the Horizon Europe regulation that allow to capture and communicate on progress in short-, medium- and long-term towards a wide variety of potential impacts (scientific, societal and economic). These indicators can be complemented by other indicators at project and partnership level. Overall the indicator system will be one of the inputs to evaluations of partnerships
	• According to the draft Horizon Europe Regulation and Annex V to the Regulation the Impact Pathway is described as follows
	  • Scientific impact: related to supporting the creation and diffusion of high-quality new knowledge, skills, technologies and solutions to global challenges;
	  • Societal impact: related to strengthening the impact of research and innovation in developing, supporting and implementing Union policies, and support the uptake of innovative solutions in industry and society to address global challenges;
	  • Economic impact: related to fostering all forms of innovation, including breakthrough innovation, and strengthening market deployment of innovative solutions.
	• The proposed Smart Networks and Services Partnership is expecting many different impacts on scientific results, contributions to global standardization, economic exploitation and the digitalization of society and economy (c.f. Section 1.2 and especially Sections 1.2.4 and 2.2).
	• Scientific impact is expected in research and development of new systems and solutions.

that will notably include case studies and other qualitative elements.	• Societal impact is expected by deployment of these systems, new services and positive impact on employment and inclusion of citizens in all regions. • Economic impact is expected in economic exploitation of results in global standards, product development and deployment as well as usage in services. This opens opportunities for new business models and future-oriented job creation in the communications domains and in the emerging European platform economy. • Additionally, the research and innovation activities in Smart Networks and Services contribute to detailed skill development and are impacting curricula for the education of experts for example in cooperation with the EIT. • Students will be involved in research and innovation projects, trials etc. • Especially Research and Development Centres in Partnership projects and industry may use incubation hubs for start-ups and their scale-up. • The close cooperation with vertical sectors, the IoT, artificial intelligence and cloud community as well as the components and devices domain will provide mutual impacts on the different sectors.
Leverage effect: The leverage effect of R&I partnerships has a quantitative and a qualitative dimension. The quantitative dimension describes the mobilized national and/or industrial resources that are invested in partnerships and the corresponding leverage effect that the EU co-funding creates for exploiting or scaling-up results (financial additionality). The quantitative leverage effect needs to be reported on the basis of a harmonized calculation methodology. The qualitative dimension describes the wider impacts according to its intervention logic.	• The private side is estimating a leverage factor for a total public funding in the time frame 2021 to 2027 (Section 2.2), which is related to the overall expected cost for research and development of a new system. • This factor is based on global standardization and company internal research, innovation and development activities beyond the activities in the Partnership. The global economic exploitation of new systems by considering deployment and operation and application development and provision will exceed many hundreds of billions € investment and revenues including job creation in the communications sector and the emerging European platform economy. • These activities are taking place in fierce international competition and require a huge amount of qualified work. • The harmonized calculation methodology as mentioned in [130] will be provided by the EU.

Long-term financial commitment:
The long-term financial commitment of participating countries and/or industry and other stakeholders is a pre-condition for considering the establishment of a European Partnership. The commitment should be clear from the outset, and ensured during the lifetime of the partnership, including beyond Union support, where appropriate. The endured commitment over the lifecycle of the European Partnership, including adequate human resources, is a core indicator for ensuring its relevance. The potential combination of cash and in-kind contributions has to be
	• The proposed Smart Networks and Services Partnership is not expecting co-funding by Member States for Horizon Europe activities. The coordination and cooperation between national and EU-level activities under the CEF2 programme will require co-funding for CEF2 deployment projects.
	• The private side is supporting during the lifetime of the programme from 2021 until the end of the last Partnership projects around 2029/30 (details are summarized in Section 2.2):
	  • In case of an Institutionalized Partnership the contribution by the private side to finance the Office including a potential upfront investment at programme start to ensure a positive cash flow between the income of the Office and its expenditures for managing the programme.
	  • In-kind contributions to and financing the Association and its activities.
	  • The private side is committed to support the Association as its representation and other administrative tasks depending on the selected Partnership instrument.

defined individually per partnership and requires appropriate and transparent calculation methodologies across the different partnership approaches.	• In-kind contributions to the activities of the Networld2020 European Technology Platform for the development and regular updates of the Strategic Research and Innovation Agenda as input to the Work Programme of the Partnership and the Calls for Proposals • The participation in Partnership projects depends on the submitted proposals and the granted proposals. The private side is not involved in the evaluation and selection of proposals for funding. Therefore, the private side cannot guarantee a certain long-term commitment in accepted projects. • The private side is committed to contribute continuously to the preparation of proposals and to actively support granted projects with human resources and the private financial contributions according to the cost models in the Horizon Europe Regulation. • The private side is committed to a leveraging factor and further investment outside the Partnership for huge internal research and innovation activities towards global standardization, product development, deployment of new systems and operation with a huge impact on digitalization and economic growth. The overall society, infrastructure, utilities and the overall society are increasingly dependent on communication systems and applications. Experience for example with the GSM systems and later generations is showing that such systems are operated and further developed for decades, which is proving the long-term commitment of the private to deploy and exploit earlier research results for the benefit of European citizens.
Flexibility: Partnerships should demonstrate flexibility in implementing their activities, resource allocation and/ or partner composition to changing market and/or policy needs. A partnership is expected to deploy a wider set of modalities and activities necessary to achieve its objectives, beyond the calls for proposals.	• Participation in the Partnership and its projects is open based on open Calls for Proposals (Section 2.4). Therefore, participation and necessary expertise depends on the Work Programme, open action lines in respective Calls and which organizations are successful with their proposals. Resources are allocated on Call basis depending on the proposal evaluation. • The research and innovation agenda will regularly be updated from Work Programme to Work Programme and will be adapted to changing conditions in an open process. • With respect to the envisaged phased approach of the Partnership (Section 2.1) and changing objectives in the different phases with lower TRLs (Technology Readiness Level) in the beginning of the Programme to higher TRLs in later phases also the constituency of beneficiaries in projects will change. The participation on projects will reflect the wide scope of communications networks and systems as well as stakeholders, from IoT, clouds, artificial intelligence, cybersecurity and components and devices. • Global market forces and impacts, e.g. from global standardization, may change conditions, where adaptations in the Partnership Work Programme and activities may be needed to ensure that the Partnership remains relevant and ensures global impact during its lifetime. • Flexibility of the programme is in the direct of the private side, because technology and global conditions are changing rapidly. This requires adaptation to the programme on regular basis through an open process for the SRIA by considering the views of the wider community.
Coherence and complementarity: European Partnerships need to be designed and implemented in a way that ensures coherence among partnerships, and between partnerships and Framework Programme activities, other EU	• The Partnership will be implemented according to one of the instruments in Article 8 – European Partnerships in the Horizon Europe Regulation based on the impact assessment between the EU Commission and Member States. This will ensure coherence of implementation across different Partnerships. • The Smart Networks and Services Partnership is focused on domains, which are not covered by other proposed Partnerships. However, it will use technical means from other planned European Partnerships under Horizon Europe such as cybersecurity (Cybersecurity Agency), artificial intelligence (AI, Data and

action and national/sectorial action. This coherence should be demonstrated at the level of objectives and impacts sought, partners involved and activities implemented. Complementarity ensures added value and synergies between R&I initiatives while avoiding unnecessary duplication.	Robotics PPP), and components (Key Digital Technologies), which are relevant for the research and innovation activities in Smart Networks and Services. Therefore, overlaps in activities in different Partnerships will be limited to these areas, which are needed to develop the future networks. Therefore, cooperation with BDVA/Robotics and ECSEL/KDT Partnerships as well as AIOTI and the NESSI European Technology Platform are established, which are focused on topics related to communication networks and systems.
	• The Partnership will cooperate with Member States on EU-level and national activities either via (Section 2.3)
	  • the Member State Forum in the case of a Co-programmed European Partnership or
	  • the Public Members Board and the Governance Board in the case of an Institutionalized European Partnership without co-funding.
	However, national interests in Member States need to be respected.

Time-limited and phasing out: European Partnerships need to be established with a clear time-limitation and put forward measures for orderly phasing-out from the Framework Programme funding, according to the foreseen conditions and timeline, without prejudice of continued existence ensured by partners / transnational funding by Member States / Associated Countries.	• The proposed Partnership is targeted for the time frame 2021 to 2027, where the last projects under the Smart Networks and Services Partnership will be finished around 2029/20. Therefore, the Partnership activities have a clear ending date corresponding to the end of Horizon Europe. • Such projects a focused on pre-competitive activities, where cooperation between different stakeholders is possible. • Depending on the selected instrument Co-programmed European Partnership of Institutionalized European Partnership a different exit strategy is necessary. Details are described in Section 1.2.6.Towards the end of the programme the private side – especially industry and SMEs – are increasingly moving towards additional competitive activities outside of the Partnership for product development, customer trials and early deployments of systems.

Table A7 Partnership criteria according to [130]

A8.2 Key factors for identifying the best-suited form of European Partnerships

Partner composition and contributions: The variety of actors that need to be involved as partners and their expected contributions over time, as well as their ambition to integrate their contribution and activities within the planned partnership.	• The partner composition and target groups are described in Section 1.4. • Major players from all relevant technology areas are necessary to ensure exploitation of results. SMEs and academia will provide specific expertise, which are necessary to develop new ideas and concepts. • For the actual research work participation in the Partnership is open based on open calls for proposals. Therefore, participation depends on the work programme, open action lines and which organizations are successful with their proposals. Resources are allocated on call basis depending on proposal evaluation (Section 2.4). • The Strategic Research and Innovation Agenda of the Partnership will regularly be updated from Work Programme to Work Programme and will be adapted to changing conditions in global standardization and the market. • With respect to changing activities in the different programme phases also the involved constituency of projects will change. Details are described in Sections “Transparency and openness” and “Flexibility” in Annex A8.1.

	• In is in the interest of the private side that the involved constituency in the programme is changing with the different phases and with the necessary expertise to ensure success in research and exploitation. • The Smart Networks and Services Partnership will do whatever it takes to have an evolving community as it was done for example in 5G PPP.
Target group: The target group addressed by the partnership as participants in their activities, potential down-stream and end-users, public authorities and broader stakeholder communities.	• The main target groups will be the ICT industry, vertical sectors and end customers as well as public authorities for regulatory purposes (Section 1.4). • Beyond industrial and research communities also user groups and associations are targets for results to ensure early adoption of solutions.
Flexibility: That is needed in the range of activities, partner composition and resource allocation to adapt to changing R&I and market developments.	• Details are described in Section “Flexibility” in Annex A8.1.
Governance: The complexity of the governance model that is required to support the policy objectives.	• The governance and its complexity depend on the selected instrument, whether a Co-programmed European Partnership or an Institutionalized European Partnership is selected. • Details are described in Section 2.3, where independent of the Instrument the cooperation between the EU Commission, Member States and the private are organized by governing bodies.

Table A8 Key factor for identifying Partnership according to [130]

Annex 9 Association Statutes and modus operandi of Association

A9.1 Commitments of the Association

The commitments to be undertaken by the Association are understood as being global sector commitments. Individual Members fully support the global sector commitments but do not incur any legal liability for the undertakings or the obligations of the Association. The commitments are further explained in the purpose of the Association.

A9.2 Characteristics of the Association

It is intended to use the already established 5G Infrastructure Association AISBL by letting it evolve for the purpose of Smart Networks and Services Partnership. The name and the scope of this Association will be adapted to the Smart networks and Services Partnership.

The Association is a not for profit international association under Belgian law (AISBL/IVZW), for unlimited duration, based in Brussels, Belgium. This is a flexible form of a legal entity, often used in the context of EU Commission programmes and cooperation.

Board and General Assembly

The Association should be industry-led to ensure relevance of research and later economic exploitation of results.

There will be a Board and a General Assembly in the Association. In the General Assembly all the Members of the Association are present or represented, the Board will be composed of a limited number of directors. The Board members will be elected by the General Assembly based on nominations of Association members for a period of two fiscal years. A good representation of industry, SMEs and the research community needs to be ensured.

The chair and the vice-chairs of the Board are Board members and will be elected by the Board from amongst its members

In minimum two annual meetings of the General Assembly of the Association are organized. General Assembly meetings can be organized as physical meetings or electronic meetings depending on the agenda and with respect to an efficient use of financial and human resources.

Transparency is ensured by disseminating relevant documents and especially proposals for decision well ahead of General Assembly meetings to members as well as minutes of the General Assembly of the Association.

Purpose of the Association

The proposed purpose of the Association is (key points):

- Signature of the Partnership Contract with the EU Commission.
- Confirm the SRIA as developed by the ETP Working Groups, the relevant Association Working Groups and the Smart Networks and Services Infrastructure Collaboration Agreement Technology Board.
- Initiation of continuous updates of the SRIA.
- Initiation and confirmation of continuous update of the industry roadmap.
- Define research questions with the largest relevant constituency base in cooperation with ETP bodies.
- Evaluation of Partnership Projects after Grants have been provided by the EU Commission to projects for the purpose of verifying, whether the Partnership projects contribute to the SRIA and to the research and innovation objectives.
- Monitor the leveraging effect between public funding and private investment.
- Liaise with external bodies and other research initiative to contribute to the major outcomes of the Partnership.

- Represent and look after the interest of the Research and Development actors in the involved sectors as well as related sectors like for components and devices.
- Collaborate and communicate with the EU Commission regarding all Partnership matters and its implementation.
- Represent and address the legitimate interests of the Association Members and the wider community towards the EU Commission, other public authorities and stakeholders on relevant topics for the success of the Smart Networks and Services domain, the standardization, technology adoption, frequency spectrum and other regulatory matters, however without the authority to legally bind Members.
- Share information of common interest among the Members to the purpose mentioned, as far as legally permitted.
- Organize dissemination and publicity of important publicly available results and events.

A9.3 Statutes of the Association

The full text of the Statues of the Association will be prepared or adapted based on the statutes of the 5G Infrastructure Association after more details of the envisaged Partnership model and contract will be available. A sketch is hereafter provided

Chapter 1: Definitions

Chapter 2: Name, form, head office, purpose, duration

- Name: To be determined. It will be related to the final name of the Partnership.
- Place: Belgium.
- Form: International non-profit Association with scientific purpose based on Belgian law.
- Purpose: See Section A9.2.
- Duration: Indefinite period of time (in minimum the lifetime of the Partnership).

Chapter 3: Membership

- Members with voting rights: Any legal entity being active in research in Europe, which is registered in an EU Member State, Associated or Candidate counties can apply for membership. Membership should be sufficiently wide in order to have a complete representation of different stakeholder groups and technology areas of the Smart Networks and Services sector.
- New Members with voting rights: The admission procedure is based on an application process and the willingness to support the objectives of the Association.
- Associate Members without voting rights in the Association: Any legal entity being active in research in Europe and complements expertise in the Association can apply for associated membership in order to have a complete representation of different stakeholder groups and technology areas of the Smart Networks and Services sector.
- Rights of the Members.
- Obligations of the Members.
- Termination for Members and Associate Members,
- Exclusion: In case of noncompliance with Statutes, By Laws and if membership criteria are no longer fulfilled.
- Effects of termination.
- Assets of the Association: Among others, subsidies, membership contributions.

Chapter 4: General Assembly

- Powers of the General assembly: Among others
  - Set membership fees.
  - Approve/reject annual accounts, annual budgets.

- Elect and dismiss members of the Board of the Association and grant discharge to Board members.
- Approve the Partnership Contract.

- Composition of the General Assembly.
  - Voting Members: Each voting Member shall have one representative and shall have one vote.
  - Non-voting Associate Members: Each non-voting Member shall have the right to attend the General Assembly and shall have the right to speak at that meeting but shall have no voting rights.
- Quorum, majority of Members with voting rights of the Association.
- Meetings, agenda, resolutions.

Chapter 5: Board

- Functions: Among others
  - Monitor progress of activities of the Association.
  - Manage budget.
  - Annual accounts.
  - Represent the Association towards the EU Commission.
- Term of Board members, Chairman, Term.
- Meetings, quorum, majority.

Chapter 6: Membership fees, financial year, annual accounts

Chapter 7: By Laws

- Providing for the internal regulation of the Associations.

Chapter 8: Amendments to the Statutes, dissolution of the Association

Annex 10 Governance model of the Partnership – Smart Networks and Services Collaboration Agreement

This Collaboration Agreement is describing the internal organization of the Partnership.

A10.1 Smart Networks and Services Collaboration Agreement bodies

The governance of the Partnership will be laid down in a **Smart Networks and Services Collaboration Agreement** to be established between the partners involved in the programme projects under consideration. Experience from the 5G PPP in Horizon 2020 will be considered, where many of the necessary documents are basically available (5G PPP Collaboration Agreement, description of governance structure). The specific legal situation for Horizon Europe will have to be considered.

The basic principle should be a collaborative approach by respecting the legitimate interests of all programme partners, which excludes top-down decision making by a small number of organizations.

Bodies in the 5G Infrastructure Collaboration Agreement (Figure 25):

- Smart Networks and Services **Steering Board**, where all active projects (Coordinators) are represented. The Commission is represented as observer.
- Smart Networks and Services **Technology Board**, where all Technical Managers of all active projects are represented. The Commission is represented as observer. This group is responsible for building and updating the roadmap of the collaboration of projects based on the SRIA and associated architectures based upon input from its subcommittees. The Technology Board also evaluates proposals for new architectures and concepts, organizes technical meetings and workshops, and establishes calls within the organization for research proposals to address research gaps.
- Under the Smart Networks and Services Collaboration Agreement, it may be provided that **Working Groups** can be established on a need basis for activities, which require the involvement of more than one project.

In order to avoid legal uncertainties, it is desirable to have the same Consortium Agreement for all projects to establish a consistent legal framework.

The governance structure will be acknowledged in the Smart Networks and Services Collaboration Agreement and it will be provided that the Association is receiving the necessary information from the Smart Networks and Services Collaboration Agreement in order to allow the Association to fulfil its tasks.

A10.2 Principles regarding the sharing of information and dissemination of results and handling of IPR benefits of the involved sectors, as will be applicable for projects in the Smart Networks and Services Collaboration Agreement

The cooperation between the Smart Networks and Services Collaboration Agreement projects will be handled by a Smart Networks and Services Collaboration Agreement, which is signed by all programme participants. The approach will be similar like in the Horizon 2020 5G PPP.

Principles of access rights will be dealt with according to the Grant Agreement and eventually Article 41 (in Horizon 2020) or its equivalent in Horizon Europe. Left open options in the Grant Agreement have to be fixed in the Smart Networks and Services Collaboration Agreement for and Consortium Agreement for the individual Projects.

Details will have to be worked out further, based also on the Rules for Participation for Horizon Europe and the Model Grant Agreement, which are both still under discussion and elaboration in the EU Commission.

Dissemination of results should be encouraged by considered legitimate interests of partners and should be based on agreed approval procedures like in the MCARD model.

Joint dissemination events should be organized to promote achieved results and concepts with the final objective of adoption in global standards.

A10.3 Smart Networks and Services Collaboration Agreement

The following Chapters will be addressed in the Smart Networks and Services Collaboration Agreement in the context of the development of the other legal documents:

Chapter 1: Definitions

- Grant Agreement Definitions
- Additional Definitions

Chapter 2. Purpose and general provisions

Chapter 3: Governing bodies, roles and responsibilities

- 3.1 The Steering Board
- 3.2 The Technology Board
- 3.3 Secretariat
- 3.4 Working Groups
- 3.5 Relation to the Industry Advisory Group in the Association
- 3.6 No Decision Authority
- 3.7 Observer Status for the Commission
- 3.8 Responsibilities of each Party

Chapter 4: IPR and Access Rights

- 4.1 Intellectual Property Rights
- 4.2 Access Rights
- 4.3 Confidentiality
- 4.4 Publications and Standards

Chapter 5: Liability and indemnification

- 5.1 Liability
- 5.2 Claims between the Parties
- 5.3 Force Majeure

Chapter 6: Miscellaneous

- 6.1 Miscellaneous
- 6.2 Assignment
- 6.3 Term and Termination
- 6.4 Settlement of Disputes
- 6.5 Language and Headings
- 6.6 Notices
- 6.7 Applicable Law
- 6.8 Entire Agreement - Amendments - Severability
- 6.9 Accession

Annex 11 Member organisations of the Networld2020 Expert Group for the SRIA development

The participation in the Expert Group of the Networld2020 European Technology Platform is based on a call for interest and on voluntary basis. Figure 36 and Table A9 show the membership and its regional distribution.

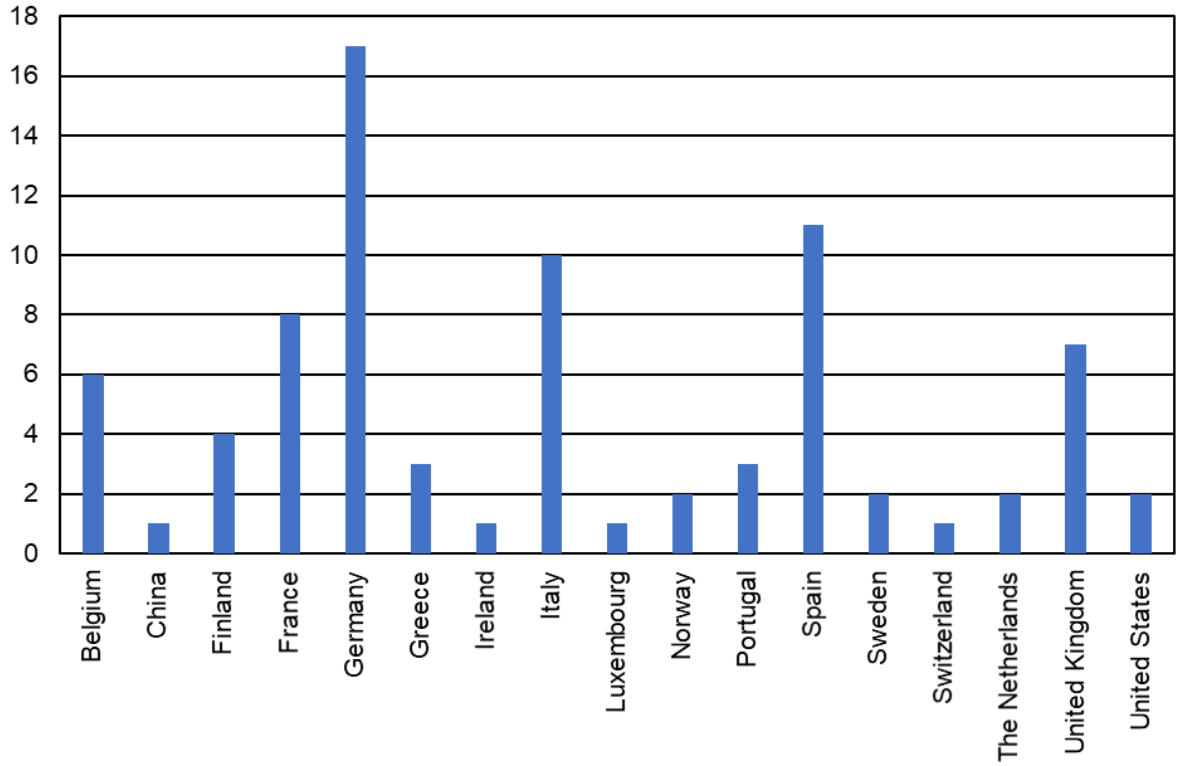


Figure 36 Regional membership distribution of Networld2020 Expert Group

Table A9 Networld2020 Expert Group membership list Spring 2020

No.	Organisation	Country
1	ADVA	Germany
2	Altice Labs	Portugal
3	ATOS Spain	Spain
4	Barkhausen Institut, Germany	Germany
5	CEA-LETI	France
6	Chalmers University of Technology, Sweden	Sweden
7	CNIT	Italy
8	CTTC (Centre Tecnologic de Telecomunicacions de Catalunya)	Spain
9	DLR	Germany
10	EBU	Switzerland
11	ECSO	Belgium
12	ECSO, IMT	France
13	Enercoutim	Belgium
14	Ericsson	Sweden
15	EURECOM	France
16	fortiss GmbH - Forschungsinstitut des Freistaats Bayern für softwareintensive Systeme und Services	Germany
17	Fraunhofer Heinrich Hertz Institute	Germany
18	Fraunhofer Institute for Integrated Circuits	Germany
19	Georgia Institute of Technology	USA
20	Gradiant, AIOTI	Spain
21	Huawei	China
22	Huawei	France
23	Huawei	Germany

24	Huawei European Research Institute	Belgium
25	IMDEA Networks, Spain	Spain
26	IMEC	Belgium
27	IMEC-NL	The Netherlands
28	IMT	France
29	Infinera	Germany
30	Instituto de Telecomunicações, Univ. de Aveiro	Portugal
31	Instituto de Telecomunicações (IT) / Nova University of Lisbon	Portugal
32	Instituto Tecnológico de Informática (ITI)	Spain
33	Integrasys	Spain
34	Intel	Germany
35	InterDigital	U.K.
36	i2CAT Foundation	Spain
37	KIT	Germany
38	MBI	Italy
39	National and Kapodistrian University of Athens	Greece
40	National Research Council – Italy	Italy
41	NCSR Demokritos	Greece
42	Nextworks	Italy
43	Nokia	Finland
44	Nokia	Germany
45	Nokia Bell Labs	France
46	Paderborn University	Germany
47	Siemens	Germany
48	SINTEF (Stiftelsen for industriell og teknisk forskning)	Norway
49	State University of New York at Buffalo	USA
50	Tampere University of Technology	Finland
51	Technical University of Berlin	Germany
52	Technical University of Delft	The Netherlands
53	Technical University of Dresden	Germany
54	Technical University of Munich	Germany
55	Texas Instruments, AIOTI	Belgium
56	Thales	France
57	TIM (Telecom Italia)	Italy
58	Trinity College Dublin	Ireland
59	University Autonoma Barcelona	Spain
60	Universidad de Alcalá	Spain
61	University of Bologna	Italy
62	University of Bristol	U.K.
63	University Carlos III of Madrid, Imdea Networks	Spain
64	University College London	U.K.
65	University of Edinburgh	U.K.
66	University of Genoa and CNIT S2N National Lab, Italy	Italy
67	University of Genova	Italy
68	University of Luxembourg	Luxembourg
69	University of Oslo	Norway
70	University of Oulu	Finland
71	University of Peloponnese	Greece
72	University of Pisa	Italy
73	University of Rome Tor Vergata	Italy
74	University of Surrey	U.K.
75	University of Sussex	U.K.
76	University of Wupperthal	Germany
77	UPC	Spain
78	Vodafone	U.K.
79	VTT Techical Research Centre of Finland	Finland
80	Yncréa– Méditerranée	France
81	5G-PPP	Belgium