European Commission

Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe

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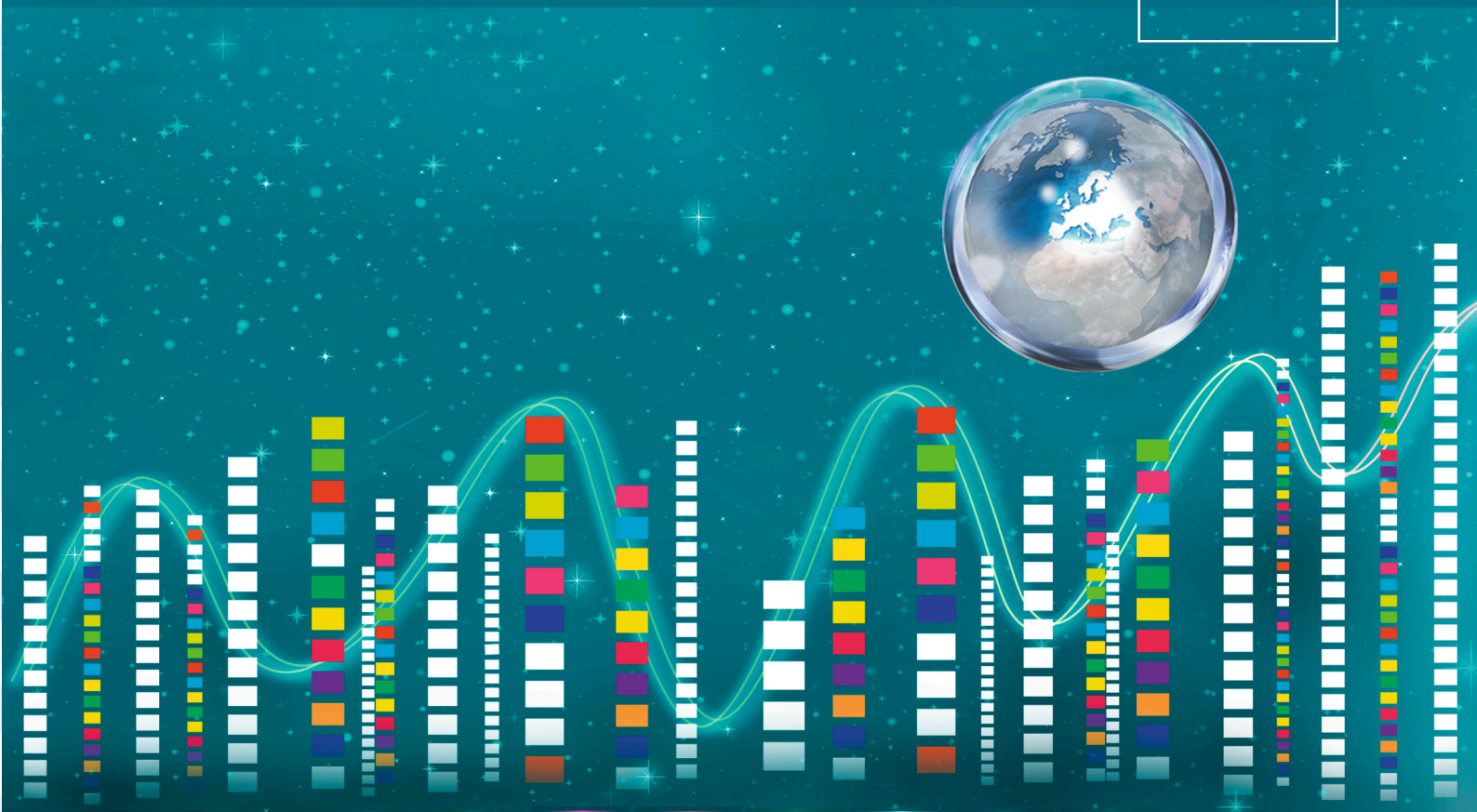
Report



Research and Innovation

Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe

European Commission
Directorate-General for Research and Innovation
Directorate A — Policy & Programming Centre
Unit A.2 — Programme Analysis & Regulatory Reform
Contact Ann-Sofie Ronnlund
Email RTD-A2-SUPPORT@*ec.europa.eu*
Ann-Sofie.Ronnlund@*ec.europa.eu*
RTD-PUBLICATIONS@ec.europa.eu
European Commission
B-1049 Brussels

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EUROPEAN COMMISSION

Impact Assessment Study for Institutionalised European Partnerships under Horizon Europe

In collaboration with

2020 Directorate-General for Research and Innovation EN

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Introduction

This Impact Assessment Study had the primary objective to support and provide input to the impact assessments of the first set of 13 European Institutionalised Partnerships based on Articles 185 and 187 of the Treaty on the Functioning of the EU (TFEU) that are envisaged to be funded under the new Framework Programme for Research and Innovation, Horizon Europe.

In addition, the Impact Assessment Study team contributed to future European policymaking on the overall European Partnership landscape by means of a horizontal analysis of the coherence and efficiency in the implementation of European partnerships. The purpose of this analysis was to draw the lessons learned from the implementation of the impact assessment methodology developed for this study and to formulate recommendations for the refinement and operational design of the criteria for the selection, implementation, monitoring, evaluation and phasing-out for the three types of European Partnerships. Finally, an impact modelling exercise was conducted in order to estimate the potential for longer-term future impacts of the candidate Institutionalised European partnerships in the economic and environmental sustainability spheres.

Technopolis Group was responsible for the overall coordination of the 13 specific impact assessment studies, the development of the common methodological framework, and the delivery of the horizontal analysis. It also conducted specific analyses that were common to all studies, acting as a 'horizontal' team, in collaboration with CEPS, IPM, Nomisma, and Optimat Ltd. For the implementation of the individual impact assessment studies, Technopolis Group collaborated with organisations that are key experts in specific fields covered by the candidate Institutionalised European Partnerships. These partner organisations were Aecom, Idate, Steer, Think, and Trinomics. Cambridge Econometrics took charge of the impact modelling exercise.

The Impact Assessment Study was conducted between July 2019 and January 2020. The 13 Impact Assessment Studies were conducted simultaneously, based upon a common methodological framework in order to maximise consistency and efficiency. The meta-framework reflected the Better Regulation Guidelines and operationalised the selection criteria for European Partnerships set out in the Horizon Europe Regulation. The 'Horizontal analysis of efficiency and coherence of implementation' was conducted in the same time period, building upon the information available on the 44 envisaged European Partnerships landscape as in May 2019, complemented with information on five envisaged European Partnerships as decided by the European Commission in October and November 2019.

This final report contains the reports of all individual impact assessment studies and the 'horizontal' analyses. It is structured in two parts, reflecting the two strands of analysis:

PART I. Impact Assessment Studies for the Candidate Institutionalised European Partnerships

1. Overarching context to the impact assessment studies

This report sets out the overall policy context and methodological framework underlying the impact assessment studies for the candidate Institutionalised European Partnerships. It describes the changes in approach to the public-private and public-public partnerships under Horizon Europe compared to the previous EU Framework Programmes. An example is the requirement that all envisaged European Partnerships be implemented as either co-programmed, co-funded or institutionalised. The impact assessment studies will consider these three scenarios as the different options to be assessed, in compliance with the Better Regulation guidelines and against the functionalities that the candidate partnerships are expected to fulfil. The report describes the common methodological framework to assess the envisaged initiatives accordingly. The report also presents the landscape of European Partnerships at the level of Horizon Europe Pillar 2 clusters, which lay the grounds for all

of the impact assessment studies except the candidate Institutionalised European Partnership for Innovative SMEs.

2. EU-Africa Global Health Candidate Institutionalised European Partnership

This initiative focuses on research and innovation in the area of infectious diseases, with a particular focus on sub-Saharan Africa. It will address the challenges of a sustained high burden of infectious diseases in Africa, as well as the (re)emergence of infectious diseases worldwide. Its objectives will thus be to contribute to a reduction of the burden of infectious diseases in sub-Saharan Africa and to the control of (re)emerging infectious diseases globally. It will do so through investments in relevant research and innovation actions, as well as by supporting the further development of essential research capacity in Africa. The study concluded that an Institutionalised Partnership under Art. 187 of the TFEU is the preferred option for the implementation of this initiative.

3. Candidate Institutionalised European Partnership on Innovative Health

This initiative focuses on supporting innovation for health and care within the EU. It will address the EU-wide challenges raised by inefficient translation of scientific knowledge for use in health and care, insufficient innovative products reaching health and care services and threats to the competitiveness of the health industry. Its main objectives are to create an EU-wide health R&I ecosystem that facilitates translation of scientific knowledge into innovations; foster the development of safe, effective, patient-centred and cost-effective innovations that respond to strategic unmet public health needs currently not served by industry; and drive cross-sectoral health innovation for a globally competitive European health industry. The study concluded that an Institutionalised Partnership based on Article 187 of the Treaty on the Functioning of the EU (TFEU) is the preferred option for the implementation of this initiative.

4. Candidate Institutionalised European Partnership in High Performance Computing

The initiative focuses on coordinating efforts and resources in order to deploy a European HPC infrastructure together with a competitive innovation ecosystem in terms of technologies, applications, and skills. It will address the challenges raised by underinvestment, the lack of coordination between the EU and MS, fragmentation of instruments, technological dependency on non-EU suppliers, unmet scientific demand, and weaknesses in the endogenous HPC supply chain. The initiative has as its main objectives to enhance EU research in terms of HPC and related applications, continued support for the competitiveness EU HPC industry, and fostering digital autonomy in order to ensure long-term support for the European HPC ecosystem as a whole. The study concluded that an Institutionalised Partnership is the preferred option for the implementation of this initiative as it maximises benefits in comparison to the other available policy options.

5. Candidate Institutionalised European Partnership in Key Digital Technologies

This initiative focusses on enhancing the research, innovation and business value creation of European electronics value chains in key strategic market segments in a sustainable manner to achieve technological sovereignty and ultimately make European businesses and citizens best equipped for the digital age. It will address the risks of Europe losing the lead in critical industries and services and emerging KDTs. It will also tackle Europe's limited control over digital technologies that are critical for EU industry and citizens. It has as main objectives to strengthen KDTs which are critical for the competitive position of key European industries in the global markets, to establish European leadership in emerging technologies with high socioeconomic potential and to secure Europe's technological sovereignty to maintain a strong and globally competitive presence in KDTs. The study concluded that the Institutionalised Partnership is the preferred option for the implementation of this initiative.

6. Candidate Institutionalised European Partnership in Smart Networks and Services

This initiative focuses on the development of future networks infrastructure and the associated services. This includes bringing communication networks beyond 5G and toward 6G capabilities, but also the development of the Internet of Things and Edge Computing technologies. It will address the challenges raised by Europe delay in the deployment of network infrastructure and failure to fully benefit from the full potential of digitalisation. It has as main objective to ensure European technological sovereignty in future smart networks and digital services, to strengthen the uptake of digital solutions, and to foster the development of digital innovation that answers to European needs and that are well aligned with societal needs. The study concluded that an institutionalised partnership under article 187 is the preferred option for the implementation of this initiative.

7. Candidate Institutionalised European Partnership in Metrology

This initiative focuses on metrology - that is the science of measurement and the provision of the technical infrastructure that underpins accurate and robust measurements throughout society; measurements that underpin all domains of science and technology and enable fair and open trade and support innovations and the design and implementation of policy and regulations. It will address challenges in the fragmentation of national metrology systems across Europe and the need to meet ever-increasing demands on metrology infrastructure to support the measurement needs of emerging technologies and important policy domains in climate, environment, energy and health. The main objective of the initiative is to establish a sustainable coordinated world-class metrology system in Europe that will increase and accelerate the development and deployment of innovations and contribute to the design and implementation of policy, regulation and standards. The study concluded that an A185 Institutionalised Partnership is the preferred option for the implementation of this initiative.

8. Candidate Institutionalised European Partnership on Transforming Europe's Rail System

This initiative focuses on the development of a pan-European approach to research and innovation in the rail sector. It will address the challenges raised by the lack of alignment of research and innovation with the needs of a competitive rail transport industry and the consequent failure of the European rail network to make its full contribution to European societal objectives. It will also strengthen the competitiveness of the European rail supply industry in global markets. Accordingly, the objectives of the initiative are to ensure a more market-focused approach to research and innovation, improving the competitiveness and modal share of the rail industry and enhancing its contribution to environmental sustainability as well as economic and social development across the European Union. The study concluded that an institutionalised partnership under article 187 is the preferred option for the implementation of this initiative.

9. Candidate Institutionalised European Partnership for Integrated Air Traffic Management

This initiative focuses on the modernisation of the Air Traffic Management in Europe - an essential enabler of safe and efficient air transport and a cornerstone of the European Union's society and economy. The proposed initiative will address the challenges raised by an outdated Air Traffic Management system with a non-optimised performance. The current system needs to be transformed to enable exploitation of emerging digital technologies and to accommodate new forms of air vehicle including drones. The objective is therefore to harmonise European Air Traffic Management system based on high levels of digitalisation, automation and connectivity whilst strengthening air transport, drone and ATM markets competitiveness and achieving environmental, performance and mobility goals. This would create €1,800b benefits to the EU economy if the current initiative can

be built on and accelerated. The study concluded that an Institutionalised Partnership under Art. 187 TFEU is the preferred option for the implementation of this initiative.

10. Candidate Institutionalised European Partnership on Clean Aviation

This imitative focuses on further aeronautical research and innovation to improve technology leading to more environmentally efficient aviation equipment. It will address the challenges raised by the growing ecological footprint of aviation and the challenges and barriers faced by the aviation industry towards climate neutrality. It will also strengthen the competitiveness of the European aeronautical industry in global markets. Accordingly, the objectives of the initiative are to ensure that aviation reaches climate neutrality and that other environmental impacts are reduced significantly by 2050, maintain the leadership and competitiveness of the European aeronautics industry and ensure safe, secure and efficient air transport of passengers and goods. The Impact Assessment study assessed the options for implementation that would allow for an optimal attainment of these objectives. The study concluded that an institutionalised partnership under Art. 187 TFEU is the preferred option for the implementation of this initiative.

11. Candidate Institutionalised European Partnership on Clean Hydrogen

The report assesses the impact of potential initiatives to support, through research and innovation, the growth and development of clean hydrogen, among which an Institutionalised European Partnership is one of the options assessed. The existing challenges for clean hydrogen include the limited high-level scientific capacity and fragmented research activities, the insufficient deployment of hydrogen applications, and consequently weaker EU scientific and industrial value chains. Environmental, health and mobility pressures are also driving the need for cleaner hydrogen generation, deployment and use. An initiative for clean hydrogen must have as a main objective the strengthening and integration of EU scientific capacities, to support the creation, capitalisation and sharing of knowledge. This is necessary to accelerate the development and improvement of advanced clean hydrogen applications, the market entry of innovative competitive clean solutions, to strengthen the competitiveness of the EU clean hydrogen value chains (and notably the SMEs within them), and to develop the hydrogen-based solutions necessary to reach climate neutrality in the EU by 2050. The study concluded that an Institutionalised Partnership under Art. 187 TFEU is the preferred option for the implementation of this initiative.

12. Candidate Institutionalised European Partnership on Safe and Automated Road Transport

This initiative focuses on Connected, Cooperative and Automated Mobility: the use of connected and automated vehicles to create more user-centred, all-inclusive mobility, while also increasing safety, reducing congestion and contributing to decarbonisation. With current road traffic collisions and negative local and global environmental impacts not reducing quickly enough, it will address the challenges raised by the current fragmentation of research across the field, and the threat to European competitiveness if the research agenda does not advance quickly enough. The initiative will focus on strengthening EU scientific capacity and economic competitiveness in the field of CCAM, whilst contributing to wider societal benefits including improved road safety, less environmental impact, and improved accessibility to mobility. The study concluded that a co-programmed partnership is the preferred option for the implementation of this initiative.

13. Candidate Institutionalised European Partnership for a Circular Bio-based Europe

This initiative focuses on intensifying research and innovation allowing to replace, where possible, non-renewable fossil and mineral resources with biomass and waste for the production of renewable products and nutrients, in order to drive forward sustainable and climate-neutral solutions that accelerate the transition to a healthy planet and respect

planetary boundaries. It will address the challenges raised by the fact that the EU economy does not operate within planetary boundaries, is not sufficiently circular and is predominantly fossil based. It will also address the insufficient research and innovation (R&I) capacity and cross-sectoral transfer of knowledge and bio-based solutions, as well as risks posed to the European bio-based industry's global competitiveness. The study concluded that Institutionalised European Partnership based upon Article 187 TFEU is the preferred option for the implementation of this initiative.

14. Candidate Institutionalised European Partnership for Innovative SMEs

The initiative is envisaged as a continuation of the Eurostars 2 programme which is managed by the Eureka network. The initiative focuses on international collaborative R&D of innovative companies, facilitated through a network of national funding organisations as included in the Eureka network. The funded projects are bottom-up and involve small numbers of project partners. The candidate partnership addresses a niche issue namely limited opportunities for international bottom-up collaboration. The partnership provides thus an opportunity for SMEs for international R&D collaboration but does not address specific technological, social, or environmental challenges. Its main objective is to improve the competitiveness of European SMEs through collaborative funding. The study concluded that a co-funded partnership is the preferred option for the implementation of this initiative.

PART II. Horizontal studies

1. Horizontal Analysis of Efficiency and Coherence in Implementation

The focus of this report is on the coherence and efficiency in the current European Partnership landscape under Horizon Europe and the potential to enhance efficiency in the European Partnerships' implementation.

European Partnerships are geared towards playing a pivotal role in tackling the complex economic and societal challenges that constitute the R&I priorities of the Horizon Europe Pillar II and are in a unique position to address transformational failures. Multiple potential interconnections and synergies exist between the candidate European Partnerships within the clusters, but few are visible across the clusters.

As for the improvement of the efficiency in implementation of institutionalised partnerships under Art. 187, potential efficiency and effectiveness gains could be achieved with enhanced collaboration. An option for a common back-office sharing operational implementation activities is worth exploring further through a detailed feasibility study in order to assess whether efficiency gains can be made. Ideally this would be co-designed as a common Partnership approach, leading to a win-win situation for all partners.

2. Impact Modelling of the Candidate Institutionalised European Partnerships

This report presents the results of the use of a macroeconomic model to assess the economic and environmental impacts of the preferred options identified in the individual 13 impact assessment studies. The model used is E3ME. It includes explicit representation for each EU Member State with a detailed sectoral disaggregation.

The impact modelling estimated the impacts of the envisaged initiatives at an aggregated as well as individual level. In total, 14 macroeconomic models have been run, one per reviewed initiative with a time horizon of 2035 and one that combines all initiatives with a time horizon of 2050. The results of each of these models were compared with those of a baseline scenario, which corresponds to a situation where the initiatives would be funded through regular Horizon Europe calls rather than European Partnerships.

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Part I. Impact Assessment Studies for the Candidate Institutionalised European Partnerships

1. Overarching Context to the Impact Assessment Studies

Authors

Bea Mahieu, Paul Simmonds, Maria del Carmen Calatrava, Julien Chicot, Diogo Machado, Stijn Zegel (Technopolis Group)

Andrea Renda (CEPS)

2020 Directorate-General for Research and Innovation EN

Introduction

This report sets out the overall policy context of the impact assessment studies for the candidate Institutionalised European Partnerships and the methodological framework that was developed for the impact assessment studies.

It describes the changes in approach to the public-private and public-public partnerships under Horizon Europe compared to the previous EU Framework Programmes. An example is the requirement that all envisaged European Partnerships be implemented as either co-programmed, co-funded or institutionalised. The impact assessment studies will consider these three scenarios as the different options to be assessed, in compliance with the Better Regulation guidelines and against the functionalities that the candidate partnerships are expected to fulfil. The report describes the common methodological framework to assess the envisaged initiatives accordingly.

The report also presents the landscape of European Partnerships at the level of Horizon Europe Pillar 2 clusters, which lay the grounds for all of the impact assessment studies except the candidate Institutionalised European Partnership for Innovative SMEs. This analysis is presented in more depth in the report on the 'Horizontal analysis of efficiency and coherence of implementation' in Part II of the Impact Assessment Study report.

The report is structured around two main headings:

- Chapter 1: Background and context to European Partnerships in Horizon Europe and focus of the impact assessment– What is decided
- Chapter 2: The Candidate European Partnerships under Horizon Europe – What needs to be decided

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1 Background and context to European Partnerships in Horizon Europe and focus of the impact assessment– What is decided

1.1 The political and legal context

1.1.1 Shift in EU priorities and Horizon Europe objectives

Horizon Europe is to be set in the broader context of the pronounced **systemic and holistic approach** taken to the design of the new Framework Programme and the overarching Multi-annual Financial Framework (MFF) 2021-27.

The future long-term budget will be a budget for the Union's priorities. In her Political Guidelines for the next European Commission 2019 – 2024, the new President of the European Commission put forward six overarching priorities for the next five years, which reach well beyond 2024 in scope: A European Green Deal; An economy that works for people; A Europe fit for the Digital Age; Protecting our European way of life; A stronger Europe in the world; and A new push for European democracy. These priorities build upon A New Strategic Agenda for 2019–2024, adopted by the European Council on 20 June 2019, which targets similar overarching objectives. Together with the United Nations Sustainable Development Goals (SDGs), they will shape future EU policy responses to the challenges Europe faces and will steer the ongoing transitions in the European economy and society,

The MFF 2021-27 strives to provide a framework that will ensure a more coherent, focused and transparent response to Europe's challenges. A stronger focus on European added value, a more streamlined and transparent budget, more flexibility in order to respond quickly and effectively to unforeseen demands, and above all, an effective and efficient implementation are among the key principles of the MFF. The objective is to strengthen the alignment with Union policies and priorities and to simplify and reform the system in order to "unlock the full potential of the EU budget" and "turn ambitions into reality". Investment from multiple programmes is intended to combine in order to address key crosscutting priorities such as the digital economy, sustainability, security, migration, human capital and skills, as well as support for small businesses and innovation.[1]

These principles underlying the MFF 2021-27 are translated in the intent for Horizon Europe "to play a vital role, in combination with other interventions, for creating new solutions and fostering innovation, both incremental and disruptive." [2] The new Framework Programme finds its rationale in the daunting challenges that Europe is facing, which call for "a radical new approach to developing and deploying new technologies and innovative solutions for citizens and the planet on a scale and at a speed never achieved before, and to adapting our policy and economic framework to turn global threats into new opportunities for our society and economy, citizens and businesses."

In the Orientations towards the first Strategic Plan for Horizon Europe, the need strategically to prioritise and "direct a substantial part of the funds towards the areas where we believe they will matter the most" is emphasised. The Orientations specify, "Actions under Pillar II of Horizon Europe will target only selected themes of especially high impact that significantly contribute to delivering on the political priorities of the Union."

Figure 1, below, which gives an indicative overview of how the EU political priorities are supported under Horizon Europe, shows the major emphasis placed on contributing to the priority 'A European Green Deal', aimed at making Europe the first climate-neutral

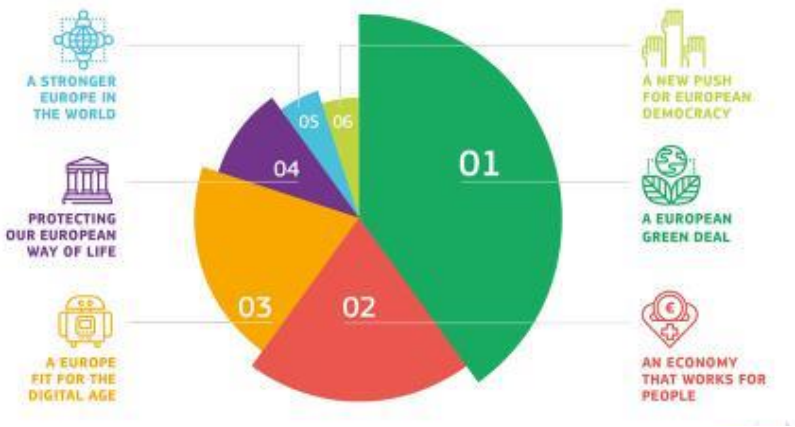
[1] EC (2018) *A Modern Budget for a Union that Protects, Empowers and Defends. The Multiannual Financial Framework for 2021-2027*. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2018) 321 final

[2] EC (2019), *Orientations towards the first Strategic Plan for Horizon Europe*.

continent in the world. At least 35 % of the expenditure from actions under the Horizon Europe Programme will address the Sustainable Development Goal 13: Climate Action.

Especially the R&I activities funded under Pillar II, including seven Partnership Areas (see below), are expected to contribute to the attainment of these objectives in an interconnected manner.

Figure 1: Targeted impacts under Horizon Europe by priority



Note: Preliminary, as described in the General orientations towards the first Strategic Plan implementing Horizon Europe.
Source: European Commission (2019) Orientations towards the first Strategic Plan for Horizon Europe, December 2019.

1.1.2 Renewed ambition for European Partnerships

Reflecting its pronounced systemic nature aimed at 'transformation' of the European R&I system, Horizon Europe intends to make a more effective use of these partnerships with an **ambitious approach** that is impact oriented and ensures complementarity with the Framework Programme. The **rationalisation** of the partnership landscape, both in terms of number of partnership forms and individual initiatives, constituted a first step in the direction of the strategic role that these policy initiatives are expected to play in the context of Horizon Europe. Future partnerships are expected to "provide mechanisms to consistently aggregate research and innovation efforts into more effective responses to the policy needs of the Union".[3] The expectation is that they will act as **dynamic change agents**, strengthening linkages within their respective ecosystems and with other related ecosystems as well as pooling resources and efforts towards the common objectives in the European, national and regional landscape. They are expected to develop *close synergies* with national and regional programmes, bring together a *broad range of actors* to work towards a common goal, translate *common priorities* into concrete roadmaps and coordinated activities, and turn research and innovation into *socio-economic results and impacts*.

The exact budget dedicated to European Partnerships under Horizon Europe will be agreed only upon decisions on the multiannual financial framework (MFF) 2021-2017 and the overall budget for Horizon Europe. In December 2017, the Council nevertheless introduced the principle of a "possible capping of partnership instruments in the FP budget".[4] Accordingly, it reached the common understanding, with the European Parliament, that "the majority of the budget in Pillar II [€52.7bn] shall be allocated to actions outside of

[3] European Commission (2019) *Orientations towards the first Strategic Plan implementing the research and innovation framework programme Horizon Europe*. Co-design via web open consultation. Summer 2019.

[4] Council of the European Union (2017) *From the Interim Evaluation of Horizon 2020 towards the ninth Framework Programme*. Council conclusions 15320/17.

European Partnerships" (Article 8.2(a) of the Common Understanding on the proposal for a regulation establishing Horizon Europe).[5]

1.1.3 Key evolutions as regards the partnership approach

The European R&I partnerships were initially conceived as a means to increase synergies between the European Union and the Member States (Article 181 of the Treaty on the Functioning of the European Union TFEU). Their objectives were to pool the forces of all the relevant actors of R&I systems to achieve breakthrough innovations; strengthen EU competitiveness; and, tackle major societal challenges. The core activities of the European partenrships consist therefore of building critical mass mainly through collaborative projects, jointly developing visions, and setting strategic agendas. They help accelerate the emergence of a programming approach in European R&I with the involvement of all relevant actors and provide flexible structures for partnerships that can be tailored to their goals.[6]

In the consecutive Framework Programmes up to the current Horizon 2020, the partnerships and their forms have mushroomed, leading to an increasing complexity of the partnership landscape. The Horizon 2020 interim evaluation highlighted that the overall landscape of EU R&I funding had become overly complex and fragmented, and a need to improve the partnerships' openness and transparency. The Lamy report suggested that the European Partnerships should focus on those areas with the greatest European Added Value, contribute to EU R&I missions and would need a simplified and flexible co-funding mechanism.

The Competitiveness Council conclusions of December 2017 called on the Commission and the Member States to jointly consider ways to rationalise the EU R&I partnership landscape. In 2018, the ERAC Ad-hoc Working Group on Partnerships concluded, "the rationalisation of the R&I partnership landscape is needed in order to ensure that the portfolio of R&I partnerships makes a significant contribution to improving the coherence, functioning and quality of Europe's R&I system and that the individual initiatives are able to fully achieve their potential in creating positive scientific and socio-economic impacts and/or in addressing societal challenges".

Horizon Europe has taken on board these concerns. The Impact Assessment of Horizon Europe gave a clear analysis of the achievements of Partnerships so far as well as the expectations for the new generation of Partnerships. Greater transparency and openness of the partnerships were considered as essential, as well a clear European added value and long-term commitments of the stakeholders involved.

A list of criteria to decide how European Partnerships will be selected, implemented, monitored, evaluated and phased-out was attached as an Annex III to the proposal to establish Horizon Europe (as revised by the partial political agreement). The rationalisation of the Partnership portfolio in Horizon Europe is expected to allow for a reduction from the current 120 to between 45 and 50 partnerships.

[5] Council of the European Union (2019) *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 rule for participation and dissemination*. Common understanding 7942/19.

[6] European Commission (2011) Partnering in Research and Innovation. Communication from the Commission COM(2011) 572 final.

1.1.4 Overview of legal provisions

The Horizon Europe Regulation (common understanding) defines 'European Partnership' as "an initiative where the Union, prepared with early involvement of Member States and/or Associated Countries, together with private and/or public partners (such as industry, universities, research organisations, bodies with a public service mission at local, regional, national or international level or civil society organisations including foundations and NGOs), commit to jointly support the development and implementation of a programme of research and innovation activities, including those related to market, regulatory or policy uptake." It stipulates that "parts of Horizon Europe may be implemented through European Partnerships".

The Horizon Europe Regulation (common understanding) also stipulates that the European Partnerships are expected to adhere to the "principles of Union added value, transparency, openness, impact within and for Europe, strong leverage effect on sufficient scale, long-term commitments of all the involved parties, flexibility in implementation, coherence, coordination and complementarity with Union, local, regional, national and, where relevant, international initiatives or other partnerships and missions." The provisions and criteria set out for the selection and implementation of the European Partnerships reflect these principles.

1.1.5 Overview of the eight Partnership areas

The Horizon Europe Regulation also identifies the following "Areas for possible institutionalised European Partnerships on the basis of Article 185 TFEU or Article 187 TFEU":

- Partnership Area 1: Faster development and safer use of health innovations for European patients, and global health.
- Partnership Area 2: Advancing key digital and enabling technologies and their use, including but not limited to novel technologies such as Artificial Intelligence, photonics and quantum technologies.
- Partnership Area 3: European leadership in Metrology including an integrated Metrology system.
- Partnership Area 4: Accelerate competitiveness, safety and environmental performance of EU air traffic, aviation and rail.
- Partnership Area 5: Sustainable, inclusive and circular bio-based solutions.
- Partnership Area 6: Hydrogen and sustainable energy storage technologies with lower environmental footprint and less energy-intensive production.
- Partnership Area 7: Clean, connected, cooperative, autonomous and automated solutions for future mobility demands of people and goods.
- Partnership Area 8: Innovative and R&D intensive small and medium-sized enterprises.

Considering the realm of these partnership areas, potential synergies exist with the future **missions**. Horizon European introduced these cross-discipline and cross-sector policy instruments as part of its core objective of stimulating further excellence-based and impact-driven R&I. In contrast with the challenges targeted in Horizon 2020, the missions aim at the achievement of well-defined goals to provide solutions, within a specified timeframe, to scientific, technological, economical and/or societal problems. As part of the preparation of Horizon Europe, the European Commission set up five boards to formulate the future missions in the following areas:

- Adaptation to climate change including societal transformation

- Cancer
- Healthy oceans, seas, coastal and inland waters
- Climate-neutral and smart cities
- Soil health and food

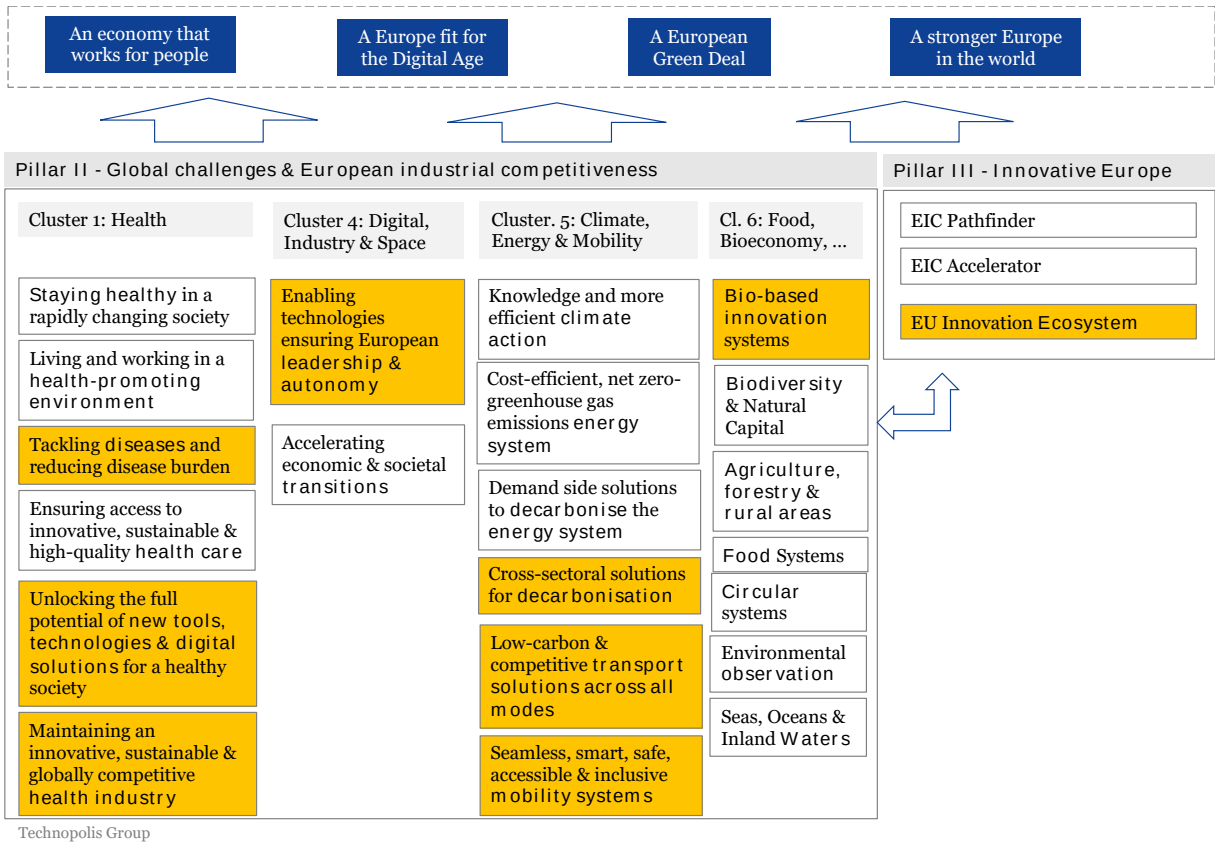
1.2 Typical problems and problem drivers

The European Partnerships are integral part of the framework programme and its three-pillar structure. They are predominantly funded under Pillar 2 "Global Challenges and European industrial competitiveness" and four of its thematic clusters. These clusters cover sectors and technologies, in which research and innovation activities are deemed of crucial importance in solving pressing scientific, societal or economic challenges and ensuring the scientific, technological and industrial leadership of Europe. Only one European Partnership, targeting innovative and R&D intensive SMEs, will instead act under Pillar 3 "Innovative Europe".

The European Partnerships are intended to contribute to the attainment of the pillars' and clusters' **challenges and R&I priorities**. Overarching EU policy priorities addressed are predominantly the European Green Deal, a people-centred economy, the fit for the Digital Age, and a stronger Europe in the world.

In Figure 2, below, the R&I priorities in the Pillars II and III to which the candidate *Institutionalised* Partnerships intend to contribute are highlighted in yellow.

Figure 2: Contribution of Candidate European Institutionalised Partnerships to the Horizon Europe priorities in Pillars II and III



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The European Partnerships under Horizon Europe most often find their rationale in addressing **systemic failures**. Their primary function is to create a platform for a strengthened collaboration and knowledge exchange between various actors in the European R&I system and an enhanced coordination of strategic research agenda and/or R&I funding programmes.

The concentration of efforts and resources and pooling of knowledge, expertise and skills on common priorities in a view of solving complex and multi-faceted societal and economic challenges is at the core of these initiatives. Enhanced cross-disciplinary and cross-sectoral collaboration and an improved integration of value chains and ecosystems are among the key objectives of these policy instruments. In the light of Horizon Europe, the aim often is to drive system transitions and transformations.

Especially in fast-growing technologies and sectors such as ICT, the envisaged European Partnerships also react on emerging opportunities and address systemic failures such as shortage in skills or critical mass or cross-sectoral cooperation along the value chains that would hamper attainment of future European leadership and/or strategic autonomy.

Transformational failures addressed aim at reaching a better alignment of the strategic R&I agenda and policies of public and private R&I funders in order to pool available resources, create critical mass, avoid unnecessary duplication of research and innovation efforts, and leverage sufficiently large investments where needed but hardly achievable by single countries.

Market failures are less commonly addressed and relate predominantly to enhancing industry investments thanks to the sharing of risks.

1.3 Description of the options

The proposal for a regulation establishing Horizon Europe[7] stipulates that parts of the Horizon Europe Framework Programme may be implemented through European Partnerships and establishes three implementation modes: Co-programmed European Partnerships, Co-funded European Partnerships, and Institutionalised Partnerships in accordance with Article 185 TFEU or Article 187 TFEU.

1.3.1 Baseline option – Traditional calls under the Framework Programme

Under this option, strategic programming for research and innovation in the field will be done through the mainstream channels of Horizon Europe. The related priorities will be implemented through traditional calls under the Framework Programme covering a range of activities, but mainly calls for R&I and/or innovation actions. Most actions involve consortia of public and/or private actors in ad hoc combinations, some actions are single actor (mono-beneficiary). There will be no dedicated implementation structures and no further support other than the Horizon Europe actions foreseen in the related Horizon Europe programme or cluster.

Strategic planning mechanisms in the Framework Programmes allow for a high level of flexibility in their ability to respond to particular needs over time, building upon additional input in co-creation from stakeholders and programme committees involving MS. The broad scope of the stakeholders providing their input to the research agenda, however, implies a lower level of directionality than what can be achieved through the partnerships. Often, the long-term perspective of the stakeholder input is limited, which risks reducing strategic capacity in addressing priorities.

The Horizon Europe option also implies a lower level of EU budgetary long-term commitment for the priority. Without a formal EU partnership mechanism, it is also less likely that the stakeholders will develop a joint Strategic Research Agenda and commit to its implementation or agree on mutual financial commitments beyond the single project participation.

[7] Proposal for a Regulation of the European Parliament and of the Council stablishing Horizon Europe - the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination - Common understanding', March 2019

1.3.2 European Partnership

All European Partnerships will be designed in line with the new policy approach for more objective-driven and impactful partnerships. They are based on the common criteria in Annex III of the Horizon Europe Regulation, with few distinguishing elements for the different forms of implementation. All European Partnerships will be based on an agreed Strategic Research and Innovation Agenda / roadmap agreed among partners and with the Commission. For each of them the objectives, key performance and impact indicators, and outputs to be delivered, as well as the related commitments for financial and/or in-kind contributions of the partners will be defined ex-ante.

Option 1 - Co-programmed European Partnership

This form of European Partnership is based upon a *Memorandum of Understanding* or a *Contractual Arrangement* signed by the European Commission and the private and/or public partners. Private partners are typically represented by one or more industry association, which also functions as a back-office to the partnership. It allows for a *high flexibility* in the profile of organisation involved, objectives pursued, and/or activities implemented.

Co-programmed European Partnerships address *broader communities* across a diverse set of sectors and/or value chains and where the actors have *widely differing capacities and capabilities*. They may encompass one or more associations of organisations from industry, research, NGOs etc as well as foundations and national R&I funding bodies, with no restriction on the involvement of international partners from Associated and non-associated third countries. Different configurations are possible: private actors only, public entities only, or a combination of the two.

The basis, as for all European Partnerships, is the rationale is to create a *platform for 'concertation'*, i.e. in-depth and ongoing consultation of the relevant actors in the European R&I system for the co-development of a strategic research and Innovation agenda, typically covering the period of the next 10 years. The primary ambition is to generate *commitment to a common strategic research and innovation agenda* (SRIA). For the private actors involved, this would allow for a de-risking of their R&I investments and provide predictability of investment paths, for the public actors, it serves as a means to: inform national policy-makers on EU investments and allows for coordination and alignment of their efforts to support R&I in the field at the national level.

The *level of 'additionality is possibly lower than for other partnerships*. There is no expectation of a legally binding commitment from the partners to taking an integrated approach in their individual R&I implementation and it is based on 'best efforts'. However, the Union contribution to the partnership is defined for the full duration and has a comparable level of certainty for the partnerships than in the other forms of implementation. The priorities for the calls, proposed by the partnership members for integration in the Framework Programme Work Programmes, are subject to further input from Member States (comitology) and Commission Services. The full implementation of the Union contribution in the Framework Programme implies that the full array of Horizon Europe funding instruments in the related Pillar can be used, ranging from RIAs to CSAs and including grants, prizes, and procurement.

Option 2 – Co-funded European Partnership

The Co-funded Partnership is based on a Grant Agreement between the Commission and the consortium of partners, resulting from a call for a proposal for a programme co-fund action implementing the European Partnerships in the Horizon Europe Work Programme. Programme co-fund actions provide co-funding to a programme of activities established and/or implemented by entities managing and/or funding research and innovation programmes. Therefore, this form of implementation only allows to address public partners

at its core (comparable to the Article 185 initiatives below), while industry can nevertheless be addressed by the activities of the partnerships, but not make formal commitments and contributions to it. The expectation is that these entities would cover most if not all EU Member States (MS). Also 'international' funding bodies can participate as partners, which creates the potential for an efficient interaction with strategic international partners. Legal entities in countries that are not part of the programme co-fund consortium, are usually excluded from funding under the calls launched by the consortium.

The basic rationale for this partnership option is to bring MS together to invest at scale in key R&I issues of general and common interest. The joint programme of activities is agreed by the partners and with the EU and typically focuses on societal grand challenges and specifically, areas of high public good where EU action will add value while reflecting national priorities and/or policies. The ultimate intent is to create the greatest possible impact by pooling and/or coordinating national programmes and policies with EU policies and investments, helping to overcome fragmentation of the public research effort. Member States that are partners in this partnership become the 'owners' of the priority and take sole responsibility for its funding. Commitments of the partners and the European Union are ensured through the Grant Agreement.

Based on national programmes, this partnership option shows a particularly high level of flexibility in terms of activities to be implemented - directly by the national funding bodies (or governmental organisation "owning" institutional programmes), or by third parties receiving financial support (following calls for proposals launched by the consortium). The broad range of possible activities include support for networking and coordination, research, innovation, pilot actions, and innovation and market deployment actions, training and mobility actions, awareness raising and communication, dissemination and exploitation, any relevant financial support, such as grants, prizes, procurement, as well as Horizon Europe blended finance or a combination thereof.

Option 3 – Institutionalised European Partnership

This type of Partnership is the most complex and high-effort arrangement and will be based on a Council Regulation (Article 187) or a Decision by the European Parliament and Council (Art 185) and implemented by dedicated structures created for that purpose. The legal base for this type of partnership limits the flexibility for a change in core objectives, partners, and/or commitments as these would require amending legislation.

The basic rationale for this type of partnership is the need for a strong integration of R&I agenda's in the private and/or public sectors in Europe in order to address a strategic challenge or realise an opportunity. The focus is on major long-term strategic challenges and priorities beyond the framework of a single Framework Programme where collective action – by private and/or public sectors – is necessary to *achieve critical mass* and *address the full extent of the complexities* of the ecosystem concerned.

The long-term commitment expected from the European Union and its partners is therefore much larger than for any of the other options, given the considerably higher investment in the preparation and implementation of the Partnership. As a result, this type of partnership can be selected only if other parts of the Horizon Europe programme, including other forms of European Partnerships, would not achieve the objectives or would not generate the necessary expected impacts. The commitment for contributions by the partnership members is expected to be at least equal to 50% and may reach up to 75% of the aggregated European Partnership budgetary commitments.

The partnership members have a high degree of autonomy in developing the strategic research agenda and annual work programmes and call topics, based on a transparent and accessible process, and subject to the approval of the Commission Services. The choice of topics addressed in the (open) calls are therefore strongly aligned with the needs defined. Normally, the strategic priorities are fully covered by the annual work programmes in the

partnership, even though it is in principle possible to keep certain topics for calls in the FP thus complementing the activities in the partnership. The full integration in the Framework Programme implies that the full array of Horizon Europe funding instruments in the related Pillar can be used, ranging from RIAs to CSAs and including grants, prizes, and procurement.

Two forms of Institutionalised Partnerships are of direct relevance to this study, influencing the constellation of partners involved.

Institutionalised Partnerships based upon Art 185 TFEU

Article 185 of the TFEU allows the Union to participate in programmes jointly undertaken by Member States and limits therefore the scope of partners to Member States and Associated Third countries. This type of Institutionalised Partnership aims therefore at reaching the greatest possible impact through the integration of national and EU funding, aligning national strategies in order to optimise the use of public resources and overcome fragmentation of the public research effort.

It brings together R&I governance bodies of most if not all EU Member States (legal requirement: at least 40% of Member States) as well as Associated Third Countries that designate a dedicated legal entity (Dedicated Implementation Structure) for the implementation. By default, membership of non-associated Third Countries is not foreseen. Such membership is possible only if it is foreseen in the basic act and subject to conclusion of an international agreement. Eligibility for participation and funding follows by default the rules of the Framework programme, unless a derogation is introduced in the basic act.

Institutionalised Partnerships under Art. 187 TFEU

This type of Institutionalised Partnership aims at reaching the greatest possible impact by integrating the strategic R&I agendas of private and/or public actors and by leveraging the partners' investments in order to tackle R&I and societal challenges and/or contribute to Europe's wider competitiveness goals.

It brings together a stable set of partners with a strong commitment to taking a more integrated approach and requires the set-up of a dedicated legal entity (Union body, Joint Undertaking) that carries full responsibility for the management of the partnership and implementation of the calls.

Different configurations are possible: partnerships focused on creating strategic industrial partnerships where, most often, the partner organisations are represented by one or more industry associations, or in some cases individual private partners; partnerships coordinating national ministries, public funding agencies, and governmental research organisations in the Member States and Associated Countries; or a combination of the two (the so-called tripartite model). By default, membership of non-associated Third Countries is not foreseen. Such membership is possible only if it is foreseen in the basic act and subject to conclusion of an international agreement. Eligibility for participation and funding follows by default the rules of the Framework programme, unless a derogation is introduced in the basic act.

2 The Candidate European Partnerships under Horizon Europe – What needs to be decided

2.1 Portfolio of candidates for Institutionalised Partnerships under Horizon Europe

2.1.1 The process for identifying the priorities for Institutionalised Partnerships under Horizon Europe

In May 2019, the European Commission consulted the Member States on a list of 44 possible candidates for European Partnership which it had identified as part of the preparation of the first Strategic Planning of Horizon Europe. This list was also part of the

Orientations towards the first Strategic Plan implementing Horizon 2020[8] which served as a basis for an Open Public Consultation from July to October 2019. In October and November 2019, the European Commission and the Member States agreed on increasing the number of candidate European partnerships to 49. Subsequent discussions until the adoption of Horizon Europe will focus on ensuring the overall consistency of the EU partnership landscape and its alignment with the EU overarching priorities and on defining the precise implementation modalities.

In parallel, the European Commission completed inception impact assessments on the candidate institutionalised European partnerships. Stakeholders had the opportunity to provide their feedback on these inception impact assessments in August 2019. A web-based open public consultation to collect opinions on all candidate institutionalised partnerships (but the candidate EuroHPC partnership) was organised between September and October 2019.

2.1.2 Overview of the overall landscape of candidate European Partnerships subject to the impact assessment

Figure 3, below, gives an overview of all European Partnerships that are currently envisaged for funding under Horizon Europe. The candidate Institutionalised Partnerships that are the subject for this impact assessment study are coloured in dark orange.

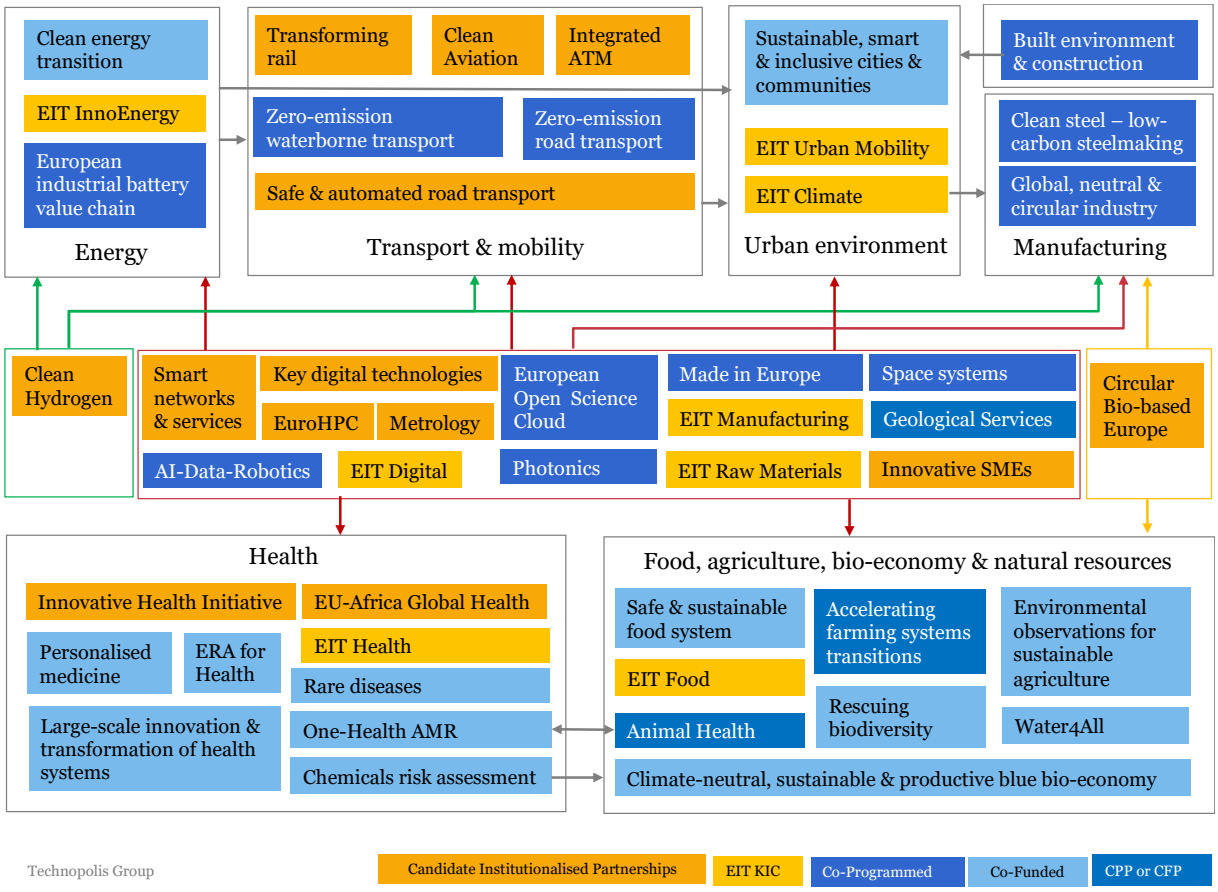
The European Partnerships can be categorised into two major groupings: *'horizontal' partnerships* focused on the development of technologies, methods, infrastructures and resources/materials, and *'vertical' partnerships* focused on the needs and development of a specific application area, be it industrial or societal.

The diagram below shows the central position of the **'horizontal' partnerships** in the overall landscape, developing methodologies, technologies or data management infrastructures for application in the other priority areas. These 'horizontal' partnerships are predominantly proposed as Institutionalised or Co-programmed Partnerships, in addition to a number of EIT KICs. The European Open Science Cloud (EOSC) partnership, for example, will support research partnerships by providing an infrastructure for the storage, management, analysis and re-use of research data.

The upper banner of the diagram groups the **industry-oriented 'vertical' partnerships**. Under Horizon Europe, they have in common a pronounced focus on enhancing sustainability. In this context, the banner includes also one of the most recent agreed-upon partnerships focused on the urban environment. This partnership illustrates the introduction under Horizon Europe of *challenge-oriented* cross-cluster partnerships. Multiple interconnections are envisaged among the 'vertical' partnerships in the different industry sectors covered. In the transport sector, the partnerships are predominantly proposed as Institutionalised Partnerships. In the other sectors, we see a mix of Co-Programmed Partnerships and EIT KICs. There are only two Co-Funded Partnerships.

[8] Orientations towards the first Strategic Plan implementing the research and innovation framework programme Horizon Europe, Co-design via Web Open Consultation (2019), see more here https://ec.europa.eu/research/pdf/horizon-europe/ec_rtd_orientations-towards-the-strategic-planning.pdf

Figure 3: Landscape of European Partnerships under Horizon Europe (2019)



The lower banner includes the '**vertical' partnerships in the societal application areas**. Striking is the dominance of the Co-Funded Partnerships (to be noted that in the Food/agriculture cluster, the partnership type still needs to be decided for several envisaged partnerships). We also note the limited interconnections that are envisaged between the two areas. An exception is the newly envisaged cross-cluster European Partnerships 'One Health AMR'.

2.2 Assessing the necessity of a European Partnership, possible options for implementation and their cost-effectiveness

In this section we set out the methodological framework that underpins the impact assessment studies. In line with the Better Regulation Guidelines, the impact assessment is intervention logic-based and impact-oriented.

The impact assessment allowed also for the conduct of the 'necessity test' for a European Partnership as set out in the Horizon Europe regulation. Pivotal in this context was the identification of the Horizon Europe calls as Option 0 as well as Baseline Option, allowing for a comparative analysis of the three partnership forms (Options 1-3) along all of the assessment dimensions – in relation to each other as well as to the Horizon Europe calls. The options assessment therefore incorporated the required 'necessity test'.

2.2.1 Assessment of the selection criteria

The common methodological framework that we defined for the 13 individual Impact Assessment studies reflects the approach defined in the Better Regulation guidelines. It also integrates the specific criteria for the use of the different types of European Partnerships as they are defined in the Horizon Europe Common Understanding (Article 8 and Annex III). Specifically this regards the **selection criteria** which have to be demonstrated as a minimum in order to justify the necessity of a European Partnership instead of regular Horizon Europe calls only and the implementation criteria in Article 8

1(a), (b) and (c) with certain elements distinguishing the use of the different partnership implementation modes (Table 1).

Table 1: Horizon Europe selection criteria for the European Partnerships

Common selection criteria and principles	Specifications
More effective (Union added value) clear impacts for the EU and its citizens	• delivering on global challenges and research and innovation objectives
	• securing EU competitiveness
	• securing sustainability
	• contributing to the strengthening of the European Research and Innovation Area
	• where relevant, contributing to international commitments
Coherence and synergies	• within the EU research and innovation landscape
	• coordination and complementarity with Union, local, regional, national and, where relevant, international initiatives or other partnerships and missions
Transparency and openness	• identification of priorities and objectives in terms of expected results and impacts
	• involvement of partners and stakeholders from across the entire value chain, from different sectors, backgrounds and disciplines, including international ones when relevant and not interfering with European competitiveness
	• clear modalities for promoting participation of SMEs and for disseminating and exploiting results, notably by SMEs, including through intermediary organisations
Additionality and directionality	• common strategic vision of the purpose of the European Partnership
	• approaches to ensure flexibility of implementation and to adjust to changing policy, societal and/or market needs, or scientific advances, to increase policy coherence between regional, national and EU level
	• demonstration of expected qualitative and significant quantitative leverage effects, including a method for the measurement of key performance indicators
	• exit-strategy and measures for phasing-out from the Programme
Long-term commitment of all the involved parties	• a minimum share of public and/or private investments
	• In the case of institutionalised European Partnerships, established in accordance with article 185 or 187 TFEU, the financial and/or in-kind, contributions from partners other than the Union, will at least be equal to 50% and may reach up to 75% of the aggregated European Partnership budgetary commitments

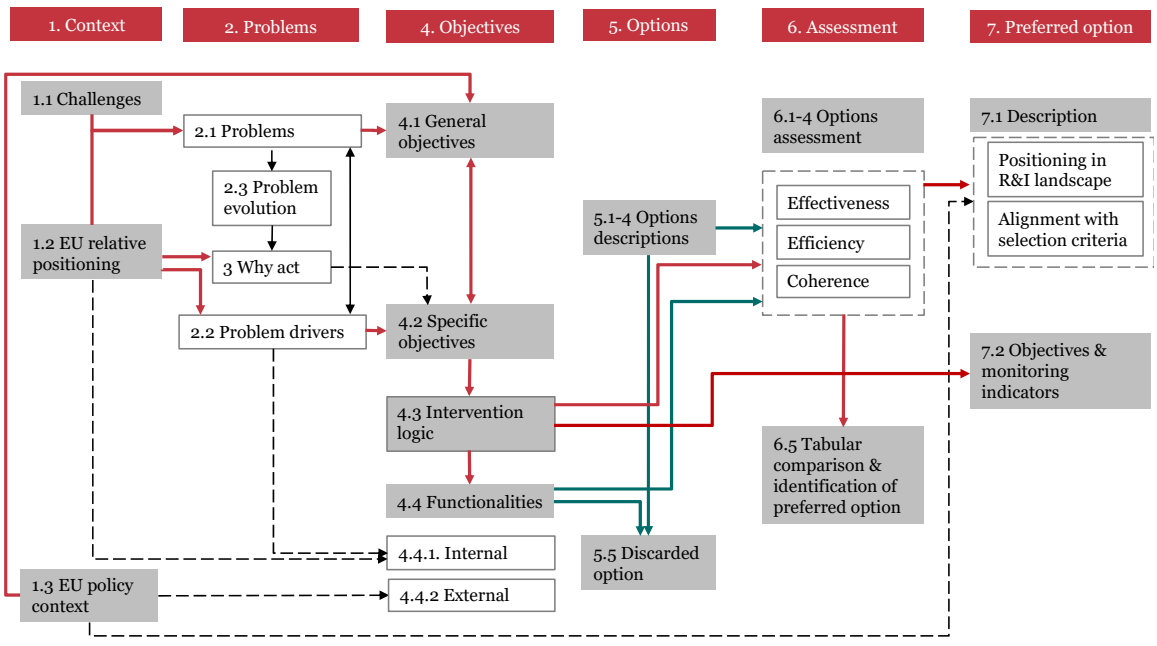
The **Better Regulation guidelines** remained the primary point of reference for the 13 individual Impact Assessment studies. The different steps of the IA process were carried out in a consistent manner in the 13 individual IA studies, supported by horizontal analyses (i.e. common to all studies) such as bibliometrics/patent analysis, social network analysis, the partnership portfolio mapping and analysis, as well as the analysis of the Open Public Consultation data.

The **selection criteria** for the European Partnerships related to effectiveness and coherence fit reasonably well in the Better Regulation impact assessment structure. More problematic was the coverage of the other three criteria groupings, i.e. the criteria of Openness and Transparency, Additionality and Directionality, and the Ex-ante demonstration of commitment.

The solution was the introduction of a section on the **'Functionalities of the initiative'**, in which set out our view on *how* the initiative should *concretely* respond to the selection criteria of 'coherence and synergies', 'openness and transparency' and 'additionality and directionality' in order to reach its objectives. We focused on those aspects that are not covered in other sections of this report, such as coherence and synergies, and covered those elements that from our analysis of the partnership options resulted being **key distinguishing features** of the partnership options, i.e. the composition of the partnership ('openness', including from a geographical perspective), the type of activities implemented ('flexibility'), and the level of directionality and integration of the stakeholders' R&I strategies needed ('directionality and additionality').

The logical process is summarised in Figure 4, below. The diagram shows how the 'functionality' sections constituted an important passage from the objectives and intervention logic sections to the options assessment. Building upon information collected in the previous sections (context, problem and objectives analysis) and in combination with the description of the available options, the description of the desirable 'functionalities' allowed for, on the one hand, the identification of the discarded option(s) and, on the other hand, the options assessment against coherence and against the selection criteria of 'Openness and Transparency' and 'Additionality and Directionality'. In the final chapter of the Impact Assessment report, the alignment of the preferred option with the criteria for the selection of European Partnerships was described, emphasising the outcomes of the 'necessity test'.

Figure 4: Flow of the analysis



Notes: the numbers indicate the related chapters or sections in the Impact Assessment reports

2.2.2 Methodological approach

Overview of the methodologies employed

The understanding of the overall context of the candidate institutionalised European Partnerships relies on a desk research partly covering the main impacts and lessons learned

from their predecessor partnerships (if any). This was complemented with a set of quantitative analyses of the Horizon 2020-funded partnerships, or in case these did not exist, the H2020-funded projects in the field. The analyses included a portfolio analysis, a stakeholder and social network analysis in order to profile the actors involved as well as their co-operation patterns, and an assessment of the partnerships' outputs (bibliometrics and patent analysis). A cost modelling exercise was performed in order to feed into the efficiency assessments of the partnership options (see below).

Public consultations (open and targeted) supported the comparative assessment of the policy options. Each study interviewed up to 50 relevant stakeholders (policymakers, business including SMEs and business associations, research institutes and universities, and civil organisations, among others). They also used the results from the Open Public Consultation organised by the European Commission (Sep – Nov 2019) and the feedback on the Inception Impact Assessments of the 13 candidate institutionalised European Partnerships that the European Commission received in September 2019.

The timing of the Impact Assessment studies, in parallel to the negotiations between the European Commission and the existing Joint Undertakings on the specific implementation of the rules for the future European Partnership, as well as the ongoing discussions within the existing partnership on their future research directions, has set potential limits to the validity of the input and feedback collected from the stakeholders during the consultations.

A more detailed description of the methodology is provided in the Annexes C of each impact assessment report.

Method for identifying the preferred choice

The four policy options were compared along a range of key parameters. The comparison along these parameters was carried out in an evidence-based manner. A range of quantitative and qualitative evidence was used, including ex-post evaluations; foresight studies; statistical analyses of Framework Programmes application and participation data and Community Innovation Survey data; analyses of science, technology and innovation indicators; econometric modelling exercises producing quantitative evidence in the form of monetised impacts; reviews of academic literature on market and systemic failures and the impact of research and innovation, and of public funding for research and innovation; sectoral competitiveness studies; expert hearings; etc.

Options assessment related to effectiveness and coherence

On the basis of the evidence collected and gathered, the Impact Assessment study teams assessed the effectiveness of the retained policy options along three dimensions corresponding to the different categories of likely impacts: scientific, economic and technologies, and societal (including environmental) impacts. The Impact Assessment study teams considered to which extent the retained policy options fulfilled the desirable 'functionalities' and were therefore likely to produce the targeted impacts. This analysis resulted in a scoring of the policy options along a three-point scale.[9] Instead of a compound score, the assessment of the effectiveness of the policy options concluded on as many scores as there are expected impacts.

Likewise, the impact assessment study teams attributed scores (using the same approach as above) reflecting the potential of each retained policy option for ensuring coherence with programmes and initiatives within (internal coherence) and beyond (external coherence) Horizon Europe.

[9] Scores vary from + to +++, where + refers to low potential for presenting a low potential for reaching the likely impacts, ++ to a good potential, and +++ to a high potential.

Scores were justified in a consistent and detailed manner in order to avoid arbitrariness and spurious accuracy. A qualitative or even quantitative explanation was provided of why certain scores were given to specific impacts.

When assessing the respective efficiency of the retained policy options, the Impact Assessment study teams considered the scores related to effectiveness and the identified costs to conduct a "value for money" (or cost-effectiveness) analysis. They accordingly attributed a comparative score to each of the options ranging from 1 (option with the highest costs) to 3 (options with the lowest costs).

Options assessment related to efficiency

A standard cost model

The 'horizontal' team has reviewed the cost categories and costs for each of the four policy options, at some length. Our first model used published data from past partnerships and Horizon 2020 calls working with the Commission's standard accounting codes (Title 1, Title 2, Title 3). The analysis revealed wide-ranging differences in costs across partnerships and functions, which was thought to be too complex to be helpful to the current exercise. As a result, we created a static, common model using average costs as a means by which to indicate the order of magnitude of effort and thereby reveal the principal differences between each of the policy options.

The model was developed jointly with the European Commission services and is presented in the study Data report (D1.2), along with an explanation of the data sources used and the assumptions made.

It is important to note that the costs identified are theoretical and do not reflect the actual costs of any existing individual partnership. In light of this fact, and to avoid any risk of misunderstanding, we have transposed the financial estimates into a qualitative presentation using + / - system in order to compare the various cost elements for each policy option with the equivalent costs for the baseline policy options (see Table 2).

The principal differences in costs as compared with regular Horizon Europe calls relate to the European Partnerships' one-off costs (e.g. developing the proposal and Strategic Research and Innovation Agenda), additional supervision by the European Commission and any additional programme management effort. The main difference between the three types of European Partnership are twofold: (i) the extent to which a partnership will need to run a limited or comprehensive programme management unit and (ii) the extent to which a new partnership may benefit from a pre-existing programme management unit that will greatly reduce or eliminate the set-up costs that would apply to a wholly new partnership.

Table 2: Intensity of additional costs compared with HEU Calls (for Partners, stakeholders, public and EC)

Cost items	Option 0	Option 1	Option 2	Option 3 -Art. 185	Option 3 -Art. 187
Preparation and set-up costs					
Preparation of a partnership proposal (partners and EC)	0	++	++	++	++
Set-up of a dedicated implementation structure	0	0	0	Existing: + New: ++	Existing: ++ New: +++
Preparation of the SRIA / roadmap	0	++	++	++	++

Cost items	Option 0	Option 1	Option 2	Option 3 -Art. 185	Option 3 -Art. 187
Ex-ante Impact Assessment for partnership	0	0	0	+++	+++
Preparation of EC proposal and negotiation	0	0	0	+++	+++
Running costs (Annual cycle of implementation)					
Annual Work Programme preparation	0	+	0	+	+
Call and project implementation	0	0 In case of MS contributions: +	+	+	+
Cost to applicants	Comparable, unless there are strong arguments of major differences in oversubscription				
Partners costs not covered by the above	0	+	0	+	+
Additional EC costs (e.g. supervision)	0	+	+	+	++
Winding down costs					
EC	0	0	0	0	+++
Partners	0	+	0	+	+

Notes: 0: no additional costs, as compared with the baseline; +: minor additional costs, as compared with the baseline; ++: medium additional costs, as compared with the baseline; +++: higher costs, as compared with the baseline

Rationale for the comparative scoring on 'overall costs' and 'cost-efficiency' in the scorecard

In the scorecard analysis, the scores related to the set-up and implementation costs will allow the study teams to consider the scale of the expected benefits and thereby allow a simple "value for money" analysis (cost-effectiveness).

Table 3 shows how we translated the cost analysis into a series of numerical scores.

Table 3: Cost-efficiency matrix

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 2: Co-funded	Option 3: Institutionalised
Overall cost	3	2	1	1
Cost-efficiency	3	3	2	2

For the 'overall cost' dimension, we assigned a score 1 to the option with the highest additional costs and a score 3 to the option with the lowest additional costs compared to the baseline. This was based on the following considerations:

- **Horizon Europe regular calls** will have the lowest overall cost among the policy options and have therefore been **scored 3** on this criterion, using a scale of 1-3 where 3 is best (lowest additional costs). This adjudged score is based on two facts: firstly, that Horizon Europe will not entail any additional one-off costs to set up or discontinue

the programme, where each of the other policy options will require at least some additional set-up costs; and secondly, that Horizon Europe will not require any additional running costs, where each of the other policy options will involve additional efforts by the Commission and partners in the carrying out of necessary additional tasks (e.g. preparing annual work programmes).

- A **co-programmed partnership** (Option 1 - CPP) will entail slightly higher overall costs as compared with the baseline policy option and has therefore been given a **score of 2**, using a scale of 1-3 where 3 is best (lowest additional costs). There will be some additional set-up costs linked for example with the creation of a strategic research and innovation agenda (SRIA) and additional running costs linked with the partners role in the creation of the annual work programmes and the Commission's additional supervisory responsibilities. A CPP will have lower overall costs than each of the other types of European Partnership, as it will function with a smaller governance and implementation structure than will be required for a Co-Funded Partnership or an Institutionalised Partnership and – related to this – its calls will be operated through the existing HEU agencies and RDI infrastructure and systems.
- The **Co-Funded Partnership (**Option 2 – CFP) has been **scored 1** on overall cost, using a scale of 1-3 where 3 is best (lowest additional costs). This reflects the additional set-up costs of this policy option and the substantial additional running costs for partners, and the Commission, of the distributed, multi-agency implementation model.
- The **Institutionalised Partnership** (Option 3 - IP) has been **scored 1** on overall cost, using a scale of 1-3 where 3 is best (lowest additional costs). This reflects the substantial additional set-up costs of this policy option – and in particular the high costs associated with preparing the Commission proposal and negotiating that through to a legal document – and the substantial additional running costs for the Commission associated with the supervision of this dedicated implementation model.

In relation to **cost-efficiency**, we considered that while there is a clear gradation in the overall costs of the policy options, the cost differentials are less marked when we take into account financial leverage (co-financing rates) and the total budget available for each of the policy options, assuming a common Union contribution. From this perspective, there are only one or two percentage points that split the most cost-efficient policy options – the baseline and CPP policy options – and the least cost-efficient – the CFP and IP. We have therefore assigned a score of 3 to the baseline Option 0 and CPP options for cost-efficiency (no or minor additional costs, as compared with the baseline) and a score of 2 for the CFP and IP policy options (medium additional costs, as compared with the baseline).

Scorecard analysis for the final options assessment

The scorecard analysis built a hierarchy of the options by individual criterion and overall. The scorecard exercise supported the systematic appraisal of alternative policy options across multiple types of monetary, non-monetary and qualitative dimensions. It also allowed for easy visualisation of the pros and cons of alternative options.

Each option was attributed a value of 1 to 3, scoring the adjudged performance against each criterion with the three broad appraisal dimensions of effectiveness, efficiency and coherence.

Scores were justified in a consistent and detailed manner in order to avoid arbitrariness and spurious accuracy. A qualitative or even quantitative explanation was provided of why certain scores were given to specific impacts, and why one option scores better or worse than others.

The scorecard analysis allowed for the identification of a single preferred policy option or in case of an inconclusive comparison of options, a number of 'retained' options or hybrid. The final selection is a policy decision.

2.3 Cross-partnership challenges in Horizon Europe clusters

In this section we set the envisaged and candidate partnerships in the context of the Horizon Europe clusters and the related higher-level EU policy objectives and priorities. We focus on the evolution of the policy context including the new European Green Deal/climate neutrality objectives, the Horizon Europe Framework relevant to this cluster, and the link to the relevant Sustainable Development Goals. Seeing the focus on the Pillar II clusters, this section excludes the candidate *Institutionalised Partnership for Innovative SMEs*.

2.3.1 Cluster 1 – Health

Research and innovation (R&I) actions under this cluster will aim at addressing the major socio-economic and societal burden that diseases and disabilities pose on citizens and health systems of the EU and worldwide.

The R&I activities funded under the Pillar II Cluster Health aim at contributing to the achievement of the Sustainable Development Goal 'Ensuring healthy lives and promoting well-being for all at all ages' resulting from investments in research and innovation focused on three overarching EU policy objectives: 'An economy that works for people', 'A Europe fit for the Digital Age', and 'A European Green Deal' (see Figure 5, below). The Horizon Europe proposal for a regulation defined the areas for possible institutionalised European partnerships on the basis of Article 185 TFEU or Article 187 TFEU as "*Partnership Area 1: Faster development and safer use of health innovations for European patients, and global health".*

At the core in this cluster are the R&I orientations that aim at ensuring that citizens *stay healthier throughout their lives* due to improved health promotion and disease prevention and the adoption of healthier behaviours and lifestyles, the development of *effective health services* to tackle diseases and reduce their burden, and an improved access to *innovative, sustainable and high-quality health care*. These objectives require an unlocking of the full potential of *new tools, technologies and digital solutions* and ensuring a *sustainable and globally competitive health-related industry* in the EU, allowing for the delivery of, e.g. personalised healthcare services. Last but not least, the citizens' health and well-being need to be *protected from environmental degradation and pollution*, addressing a.o. climate-related challenges to human health and health systems.

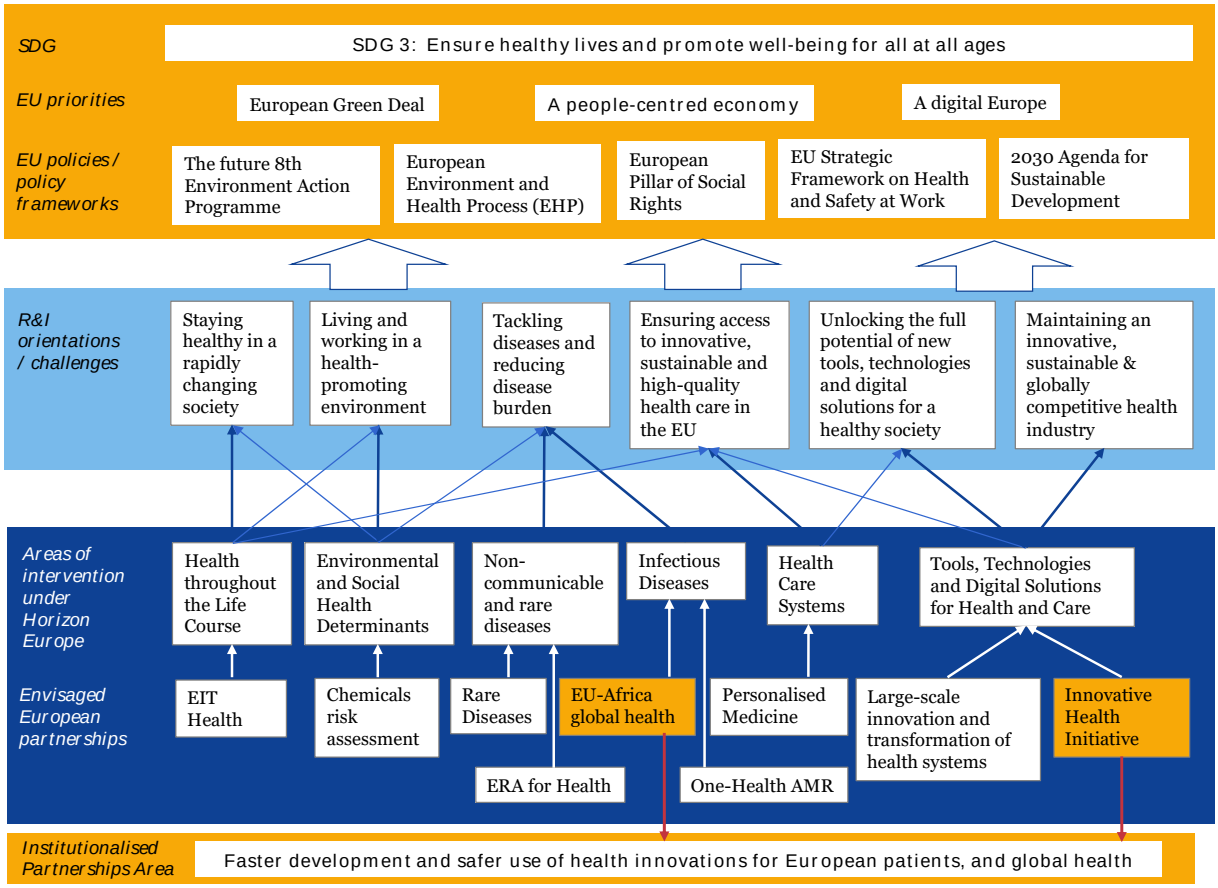
Figure 5, below, shows that the portfolio of envisaged European Partnerships in this cluster[10] aims to contribute to all of the R&I orientations in this cluster. However, there is a pronounced focus on the 'tackling diseases and reducing the disease burden' objective, addressed by five out of the ten partnerships (amongst which there is one candidate Institutionalised Partnership). The objectives focused on an improved exploitation of digital solutions and competitiveness of the EU health-related industry are addressed by two partnerships amongst which one is a candidate Institutionalised Partnership.

In this context, it should be noted that the portfolio of European Partnerships in this cluster predominantly encompasses Co-funded Partnerships, focused on joining the R&I programmes and investments at the national level. There is therefore overall a limited level of involvement of the private sector in the development of the SRIAs (i.e. as partners of the envisaged partnerships), be it from the supply or user side in the value chains. The only exceptions are the Innovative Health Initiative and the EIT KIC Health. European Partnerships also provide limited support for the assessment of environmental and social health determinants, uniquely addressed from a chemical risks perspective.

[10] As proposed in the Horizon Europe 'Orientations towards the first Strategic Plans', dd. December 2019

The description of the interconnections between the partnerships in this cluster and the ones funded in the context of other clusters, provided in the reports of the individual impact assessment studies, sheds more light on this topic.

Figure 5: R&I priorities and higher-level objectives of the Horizon Europe Cluster 1 – Health



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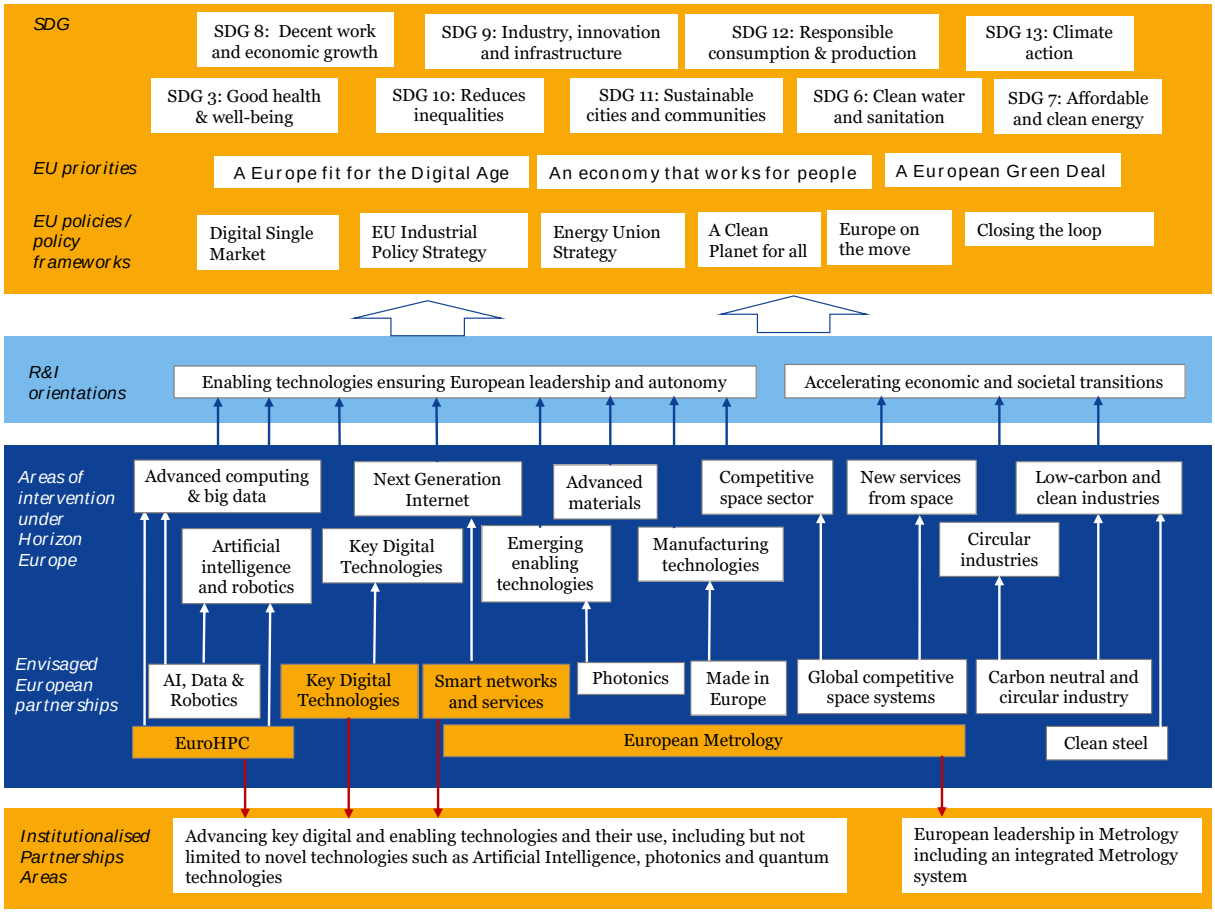
2.3.1 Cluster 4 – Digital, Industry and Space

In this cluster the focus is on the digitisation of European industry and on advancing key enabling, digital and space technologies which will underpin the transformation of our economy and society at large. The overarching vision for R&I investments in this cluster is "a European industry with global leadership in key areas, fully respecting planetary boundaries, and resonant with societal needs – in line with the renewed EU Industrial Policy Strategy." The expected effects on the European economy and society imply that the R&I activities under this cluster will contribute to various Sustainable Development Goals and respond to three key EU policy priorities: 'A European Green deal', 'A Europe fit for the digital age', and 'An economy that works for people' (Figure 6).

The cluster pursues three objectives: 1) ensuring the competitive edge and sovereignty of EU industry; 2) fostering climate-neutral, circular and clean industry respecting planetary boundaries; and 3) fostering social inclusiveness in the form of high-quality jobs and societal engagement in the use of technologies. A human-centred approach will be taken, i.e. technology development going hand in hand with European social and ethical values.

The key R&I priorities are grouped in two general categories: (I) Enabling technologies ensuring European leadership and autonomy; and (II) Accelerating economic and societal transitions (these will be complemented by priorities of other clusters). European Partnerships envisaged to support the R&I in the specific intervention areas are mainly co-programmed partnerships. Exceptions are the three candidate Institutionalised Partnerships in the digital field and the candidate Institutionalised Partnership in metrology, reflecting their related Partnership Areas.

Figure 6: R&I priorities and higher-level objectives of the Horizon Europe Cluster 4 – Digital, Industry and Space



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Multiple convergences exist between the technologies that are covered in the first strand of the priorities in this cluster, i.e. "enabling technologies ensuring European leadership and autonomy". In their function of 'enabling' technologies, they will also make critical contributions to the attainment of the desired 'transitions' in the 'vertical' industry sectors targeted in the second strand of priorities in this cluster as well as in the other clusters. A major contribution from this perspective can be expected from the four candidate Institutionalised Partnerships as well as from the 'Made in Europe' partnership, focused on manufacturing technologies.

2.3.2 Cluster 5 – Climate, Energy and Mobility

The main objectives of this cluster are to fight climate change, improve the competitiveness of the energy and transport industry as well as the quality of the services that these sectors bring to society. This is supportive of several Sustainable Development Goals including affordable and clean energy (SDG7); industry, innovation & infrastructure (SDG9); sustainable cities & communities (SDG11); sustainable consumption & production (SDG12); and climate action (SDG13). The cluster is most closely aligned to the EU priority for 'A European Green Deal' but also has synergy with two of the other five priorities; 'An economy that works for people' and 'A Europe fit for the Digital Age'. This extends across various policies including a Clean Planet for all, the Energy Union strategy, Single European Railway Area, European ATM Master Plan, Single European Sky, and Europe on the Move (Figure 7).

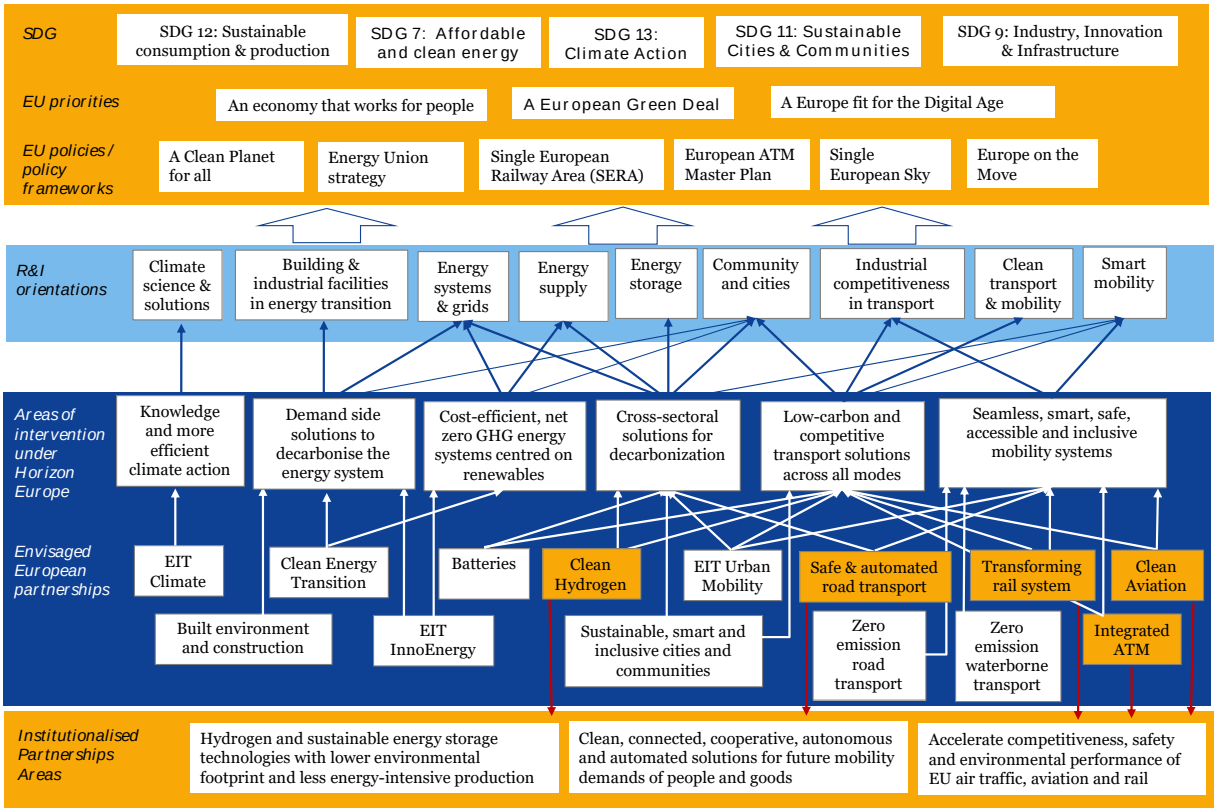
The cluster is directly relevant to several of the areas for possible institutionalised European partnerships on the basis of Article 185 TFEU or Article 187 TFEU, namely:

- Partnership Area 4: Accelerate competitiveness, safety and environmental performance of EU air traffic, aviation and rail

- Partnership Area 6: Hydrogen and sustainable energy storage technologies with lower environmental footprint and less energy-intensive production
- Partnership Area 7: Clean, connected, cooperative, autonomous and automated solutions for future mobility demands of people and goods

Cluster 5 is structured under six areas of intervention under Horizon Europe and nine R&I orientations. Figure 7, below, shows the portfolio of envisaged European Partnerships that are relevant to this cluster and their link to the areas of intervention.

Figure 7: R&I priorities and higher-level objectives of the Horizon Europe cluster Climate, Energy and Mobility



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There are 14 candidate Partnerships that align with this cluster of which eight are possible Institutionalised Partnerships, including five Article 187 initiatives and three EIT-KICs. There are no candidate Article 185 Partnerships in this cluster. The other partnerships are envisaged as either Co-programmed and/or Co-funded Partnerships.

The diagram above shows the strong orientation of the possible Institutional Partnerships towards the mobility area and more limited direct synergies between the envisaged Partnerships and the 'climate science & solutions' priority. Of course, the climate change challenge underpins the whole of this cluster, except where the focus is on industrial competitiveness, but this will also be at least partially dependent on innovation related to clean energy and mobility products and services.

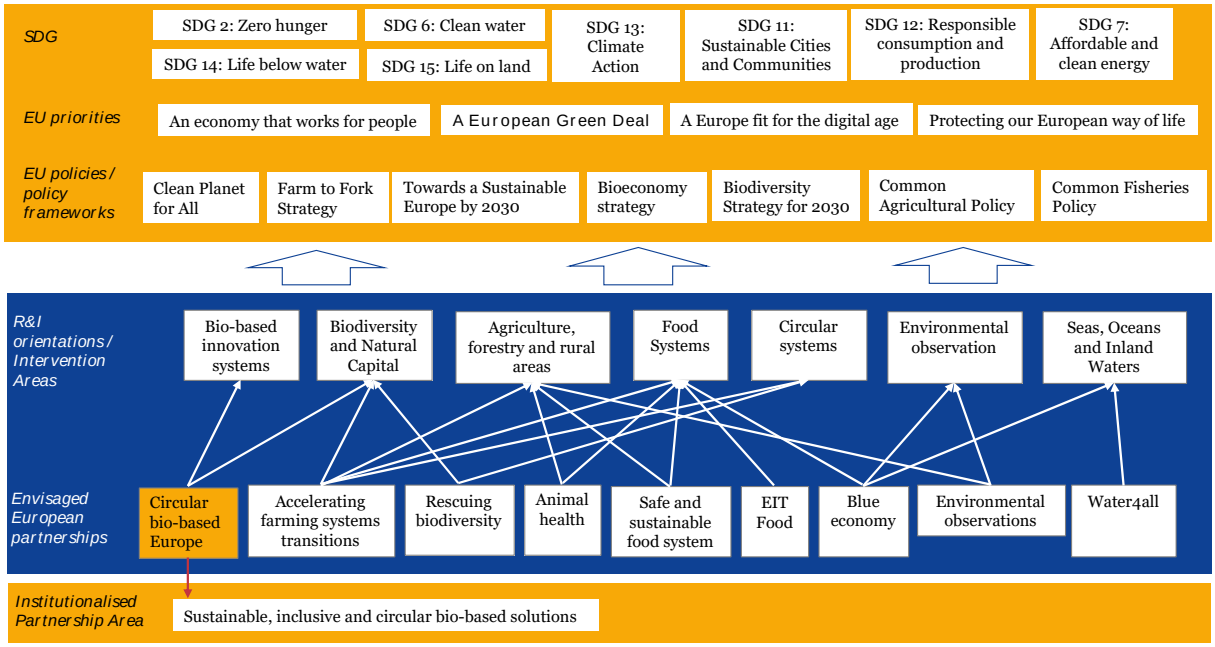
2.3.3 Cluster 6 – Food, Bioeconomy, Natural Resources, Agriculture and Environment

The key objective of Cluster 6, 'Food, Bioeconomy, Natural Resources, Agriculture and Environment' is to advance knowledge, expand capacities and deliver innovative solutions to accelerate the transition towards the sustainable management of natural resources (such as biodiversity, water and soils). The cluster has a large realm and aims to address a wide range of challenges relating to climate change, biodiversity and ecosystems, natural resources, and the production and consumption patterns that may affect them. It encompasses a single area for possible institutionalised European Partnerships aimed at the development of "sustainable, inclusive and circular, bio-based solutions".

The R&I activities funded under the Pillar II Cluster 6 contribute first and foremost to the 'European Green Deal'. More precisely, they will be instrumental to the announced climate change actions, the Biodiversity Strategy for 2030, the "Farm to Fork Strategy", the zero-pollution ambition, the New Circular Economy Action Plan, and the comprehensive strategy on Africa and trade agreements. However, through cooperation with the other clusters, Cluster 6 may make some contribution to the other EU overarching policy priorities. The R&I activities funded under this cluster therefore aim to contribute to the achievement of several United Nations SDGs including: SDG 2: Zero hunger; SDG 6: Clean water and sanitation; SDG 7: Affordable and clean energy; SDG 11: Sustainable cities and communities; SDG 12: Responsible consumption and production; SDG 13: Climate action; SDF 14: Life below water; and, SDG 15: Life on land.

Cluster 6 is structured around six targeted impacts and seven research and innovation orientations, as shown in Figure 8, below. The R&I activities funded under this cluster aim to (1) develop solutions for mitigation of, and adaptation to, *climate change*; (2) halt the *biodiversity* loss and foster the restoration of *ecosystems*; (3) encourage the sustainable (and circular) management and use of *natural resources*; (4) stimulate inclusive, safe and health *food and bio-based systems*; (5) a better understanding of the determinants of *behavioural, socio-economic and demographic changes* to accelerate system transformation; and, (6) improve solutions for *environmental observations and monitoring systems*.

Figure 8: R&I priorities and higher-level objectives of the Horizon Europe Cluster 6 – Food, Bioeconomy, Natural Resources, Agriculture and Environment



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The European Commission envisages nine partnerships under Cluster 6, two of which would be institutionalised (Circular bio-based Europe and EIT Food), four would be either co-programmed or co-funded (Animal Health; A climate-neutral, sustainable and productive Blue Economy; Safe and Sustainable Food Systems for People, Planet and Climate; Water4All), and three would be co-funded (Accelerating Farming System Transition; Agriculture for Data; Rescuing Biodiversity to safeguard life on Earth).

There is seemingly a good balance between the three types of partnerships. However, industry may have some interest in being involved in the design of the Strategic Research and Innovation Agendas regarding living labs and other research infrastructure ('Towards more sustainable Farming' envisaged partnership) to develop solutions for accelerating the transition of farming systems, and technologies to collect agriculture data.

The proposed portfolio of European Partnerships covers the full range of R&I orientations under Cluster 6.

All but one of the proposed partnerships contribute to orienting R&I activities towards the development of food systems that will ensure both sustainable and healthy diets and food and nutrition security for all. The food system has an impact on several challenges. It directly relates to nutrition and diets, access to food, food security, and has an influence on the use of natural resources, water and soil pollution, climate change. Food waste is a key component of circular systems and biomass has strong potential to offer bio-based energy solutions. Finally, the transformation of food systems should take into consideration demographic changes and the accelerating urbanisation (which reduces lands available for food production but offers opportunities for new types of agriculture such as urban farming).

Two R&I orientations are covered by less than half of the proposed partnerships: Environmental Observations (even though achievement in this area could make significant contribution to the other areas) and Bio-based innovation systems (which is nevertheless at the core of the candidate institutionalised partnership for a circular bio-based Europe).

EUROPEAN COMMISSION

Part I. Impact Assessment Studies for the Candidate Institutionalised European Partnerships

6. Candidate Institutionalised European Partnership in Smart Networks and Services

Authors

Bertrand Copigneaux, Vincent Bonneau, Tiana Ramahandry, Frédéric Pujol, Basile Carle, Emarildo Bani

2020 Directorate-General for Research and Innovation EN

Abstract

This document is the final report of the Impact Assessment Study for the candidate Institutionalised European Partnership on Smart Networks and Services under Horizon Europe. The study was conducted by IDATE Digiworld from July to December 2019, under coordination of Technopolis. The methodological framework reflects the Better Regulation Guidelines and operationalises the selection criteria for European Partnerships set out in the Horizon Europe Regulation.

This initiative focuses on the development of future networks infrastructure and the associated services. This includes bringing communication networks beyond 5G and toward 6G capabilities, but also the development of the Internet of Things and Edge Computing technologies. It will address the challenges raised by Europe delay in the deployment of network infrastructure and failure to fully benefit from the full potential of digitalisation. It has as main objective to ensure European technological sovereignty in future smart networks and digital services, to strengthen the uptake of digital solutions, and to foster the development of digital innovation that answers to European needs and that are well aligned with societal needs.

The study concluded that an institutionalized partnership under article 187 is the preferred option for the implementation of this initiative.

Executive Summary

This document is the final report of the Impact Assessment Study for the candidate Institutionalised European Partnership on Smart Networks and Services under Horizon Europe. The study was conducted by IDATE Digiworld from July to December 2019, under coordination of Technopolis. The methodological framework for this study (described in the report on the overarching context to the impact assessment studies), reflects the Better Regulation Guidelines and operationalises the selection criteria for European Partnerships set out in the Horizon Europe Regulation. This report contains the findings of this specific study.

This initiative focuses on the development of future networks infrastructure and the associated services. This includes bringing communication networks beyond 5G and toward 6G capabilities, but also the development of the Internet of Things and Edge Computing technologies. This initiative will build upon and expand the activities of the H2020 5G-PPP (5G Public Private Partnership).

The initiative will address the challenges that Europe faces in terms of development, deployment and adoption of connected applications. This includes the delays in the deployment of network infrastructure and European failure fully to benefit from the potential of digitalisation. It also includes the important societal issues raised by the development of digital applications and the threats to European technological sovereignty in a context of increased global competition.

To address these challenges, the initiative will have as main objectives to strengthen the uptake of digital solutions, to foster the development of digital innovation that answers to European needs and that are well aligned with societal needs, and to ensure European technological sovereignty in future smart networks and digital services.

This will require the involvement of a large and diverse range of stakeholders in the initiative, from the traditional research and industrial community of telecommunication and digital services to new actors such as SMEs, players from the vertical industries (automotive, manufacturing, energy, health, transportation), and EU Member States.

To be successful the initiative will have to support key research and innovation activities, but also extend toward large scale pilots and deployments validating the technologies. Furthermore, the success of the initiative will be conditioned by its ability to create synergies with other initiatives at the European, national or regional level. This includes deployment-oriented initiatives such as CEF2 Digital, but also national 5G and 6G initiatives or innovation funding initiatives.

The relevant policy options for this assessment were Horizon Europe calls (Option 0), Co-Programmed Partnerships, and institutionalised partnership under Article 187. Our conclusion is that the institutionalised partnership under Article 187 is the preferred option. We considered that this option will result in a better ability to mobilize the broad ecosystem required to face the challenges identified, and to ensure a stronger commitment of the involved stakeholders. Furthermore, this option appears having a better ability to ensure the necessary liaison and synergies with other initiatives. Finally, it will allow for a stronger ability to foster necessary regulations and legislative adaptation in the field of spectrum allocation and usage, energy consumption or ethics, privacy and cybersecurity.

Résumé exécutif

Ce document est le rapport final de l'étude de support à l'analyse d'impact de la proposition de partenariat européen institutionnalisé sur les réseaux et services intelligents dans le cadre d'Horizon Europe. L'étude a été menée par l'IDATE Digiworld et coordonée par Technopolis de juillet à décembre 2019. Le cadre méthodologique de cette étude (décrit dans le rapport sur le cadre général des études de support aux analyses d'impact) tient compte des lignes directrices pour une meilleure réglementation et opérationnalise les critères de sélection des partenariats européens définis dans le règlement d'Horizon Europe. Le présent rapport contient les conclusions spécifiques à cette étude.

Cette initiative se concentre sur le développement des futures technologies et infrastructures réseaux et des services numériques associés. Il s'agit notamment d'amener les réseaux de communication au-delà de la 5G et vers des capacités 6G, mais aussi de développer l'Internet des objets et les technologies d'informatiques en périphérie de réseau (« Edge Computing »). Cette initiative s'appuiera sur les activités du H2020 5G-PPP (partenariat public-privé 5G) et les développera.

L'initiative ciblera les défis auxquels l'Europe est confrontée en termes de développement, de déploiement et d'adoption d'applications connectées. Cela inclut les retards dans le déploiement des infrastructures de réseau et l'incapacité de l'Europe à tirer pleinement parti du potentiel de l'économie numérique. Mais cela inclut également les importantes questions sociétales soulevées par le développement du numérique et les menaces qui pèsent sur la souveraineté technologique européenne dans un contexte de concurrence mondiale accrue.

Pour relever ces défis, l'initiative aura pour principaux objectifs de renforcer l'adoption de solutions numériques, de favoriser le développement d'une innovation numérique qui réponde aux besoins européens et qui soit bien alignée sur les besoins de la société et de garantir la souveraineté technologique européenne dans les futurs réseaux de télécommunications et services numériques intelligents.

Cela nécessitera la participation d'un large éventail de parties prenantes à l'initiative, depuis les industriels et communautés de recherche dans le domaines des télécommunications et des services numériques jusqu'aux nouveaux acteurs tels que les PME, les acteurs des industries verticales (automobile, fabrication, énergie, santé, transport) et les États membres.

Pour atteindre ses objectifs, l'initiative devra soutenir les activités de recherche et d'innovation du domaine, mais aussi s'étendre à des projets pilotes et à des déploiements à grande échelle qui permettront de valider les technologies. En outre, le succès de l'initiative sera conditionné par sa capacité à créer des synergies avec d'autres initiatives au niveau européen, national ou régional. Cela inclut des initiatives orientées vers le déploiement, telles que CEF2 Digital, mais aussi des initiatives nationales 5G et 6G ou des programmes de financement de l'innovation.

Les options politiques pertinentes pour cette analyse étaient les appels à projets traditionnels d'Horizon Europe (option 0), les partenariats co-programmés et les partenariat institutionnalisés au titre de l'article 187 du TFUE. Notre conclusion est que le partenariat institutionnalisé au titre de l'article 187 est l'option privilégiée. Nous avons estimé que cette option permettra de mieux mobiliser les différents écosystèmes nécessaires pour relever les défis identifiés et de garantir un engagement plus fort des parties prenantes concernées. En outre, cette option semble mieux à même d'assurer la liaison et les synergies nécessaires avec d'autres initiatives. Enfin elle permettra de mieux favoriser le développement ou l'adaptation des législations et régulations nécessaires dans le domaine de l'attribution et de l'utilisation du spectre, de la consommation d'énergie ou de l'éthique, de la vie privée et de la cyber-sécurité.

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Glossary

3GPP	3rd Generation Partnership Project
5G AA	5G Automotive Association
5G ACIA	5G Alliance for Connected Industries and Automation
5G IA	5G Industry Association
5G NR	5G New Radio
5G-PPP	5G Public Private Partnership
AI	Artificial Intelligence
AIOTI	Alliance for Internet of Things Innovation
AR	Augmented Reality
ARPU	Average Revenue Per Unit
CAM	Connected and Automated Mobility
CAPEX	Capital Expenditure
CEF	Connecting Europe Facilities
COSME	Competitiveness for Small and Medium Enterprises
cPPP	contractual Public Private Partnership
CRM	Customer Relationship Management
CSA	Coordination and Support Action
DAE	Digital Agenda for Europe
DEP	Digital Europe Programme
DSM	Digital Single market
DVB	Digital Video Broadcasting
EC	European Commission
ECH	European Connected Health Alliance
EIT	European Institute of Innovation and Technology
EMF	Electro Magnetic Field
EPRS	Parliamentary Research Service
EPSC	European Political Strategy Centre
ERA	European Research Area
ERP	Enterprise Resource Planning
ESA	European Space Agency
ESOA	EMEA Satellite Operators Association
ETSI	European Telecommunications Standards Institute
EU	European Union

EUTC	European Utility Technology Council
GCC	Gulf Cooperation Council
GSMA	Global System for Mobile Communications Association
HPC	High Performance Computing
IA	Innovation Action
ICT	Information and Communication Technologies
IETF	Internet Engineering Task Force
IMT-2020	International Mobile Telecommunications-2020 telecom standard
IoT	Internet of Things
IoT LSP	IoT Large Scale Pilots (Horizon 2020 projects)
IPR	Intellectual Property Rights
ISG	Industry Specification Group
ITU	International Telecommunication Union
KPI	Key Performance Indicator
LPWA	Low Power Wide Area
LTE	Long Term Evolution
M2M	Machine to Machine communications
MEC	Mobile Edge Computing
MFF	Multi-annual Financial Framework
MIMO	Multiple Input Multiple Output
mMTC	Massive Machine Type Communications
MR	Mixed Reality
MS	Member States
NACE	Nomenclature Statistique des activités économiques dans la Communauté européenne (NACE)
NB IoT	Narrow Band IoT
NFV	Network Function Virtualisation
OEM	Original Equipment Manufacturers
OSM	Open Source Management
OTT	Over The Top
PCSE	Public Safety Communication Europe
PMR	Progress Monitoring Report
PPP	Public Private Partnership
RAN	Radio Access Network

RIA	Research and Innovation Action
ROI	Return On Investment
SDG	Sustainable Development Goals
SDN	Software Defined Networks
SEP	Standard Essential Patents
SME	Small Medium Enterprises
SNS	Smart Networks and Services
TCCA	The Critical Communication Association
TRL	Technology Readiness Level
uRLLC	Ultra Reliable Low Latency communications
V2I	Vehicle to Infrastructure communications
V2V	Vehicle to Vehicle communications
VC	Venture Capital
VR	Virtual Reality
XMBB	Extended Mobile Broadband
XR	Extended Reality
ZSM	Zero touch network and Service Management

1 Introduction: Political and legal context

This document presents the impact assessment of the candidate institutionalised partnership Smart Networks and Services, which is one of the initiatives that will implement the Commission's vision for the period beyond 2020 under the Horizon Europe Pillar II, specifically the Cluster 4. It is one of the envisaged European Partnerships in the Partnership Area "Advancing key digital and enabling technologies and their use, including but not limited to novel technologies such as Artificial Intelligence, photonics and quantum technologies."

1.1 Emerging challenges in the field

The table below provides a wrap-up of the main challenges for the Smart Network and Services candidate initiative that are not really addressed today by 5G. Europe is lagging behind in terms of adoption of digital technologies in various industries, which are nonetheless key enablers for their transformation. Europe is also challenged regarding 5G itself both in terms of demand, as roll-outs of 5G are much slower than in other parts of the world (especially Asia-Pacific), and of supply, with European champions only on a limited part of the value chain (mainly regarding connectivity) in a context of value moving more and more towards software and services. Finally, there are still many societal challenges not fully addressed by 5G that should be better covered with beyond 5G and 6G technologies.

Appendix E presents a more detailed vision, and backing material to this analysis.

Table 1: Overview of main challenges

Social	5G is not fully capable to enable the digital transformation of verticals, especially for the most advanced and critical services that will bring high value to the society EMF (Electro Magnetic Field) concerns by citizens due to the higher number of base stations in 5G networks could be significant roadblock for 5G. EMF limits set by cities might also delay deployment by network operators. As more vertical will rely on 5G, issues of trust with regards to privacy and cybersecurity at a societal level, as well as issues of trust in the robustness of networks and vertical applications will become even more important. Low trust around more critical services could slow down the market adoption.
Technical and technological	New technical challenges have to be tackled around new spectrum THz bands to enable advanced use case, like reaching high speed connectivity in a context of large numbers of simultaneous real-time connections. Stakeholders will have to develop new chipset paradigms. New disruptive technologies such as Artificial Intelligence, blockchain or edge computing (and upcoming quantum computing) are used for 5G and their usage will be extended for beyond 5G networks. Ensuring a smooth integration will become even more complex and likely require more time. The proliferation of 5G-enabled services around new services and new devices will put pressure on energy consumption targets for future networks.
Economic	Long time to market (R&D and full deployment) and huge investments required in infrastructure are major challenges for telecom operators that operate already in most of the cases on broadband markets that are flat at best. Rural areas and indoor coverage will indeed be very CAPEX intensive. Value chains will be transformed and existing players might be under pressure, both in the networking area as well as in vertical industries.

	The market could be captured by stakeholders from other ICT industries, which are mainly non-EU, leading to a loss of sovereignty.
Environmental and societal	Better integration of access nodes in the cities needed to ensure accessibility
Political, policy and regulatory framework	In a context of trade wars, there is a need for strategic technological sovereignty in Europe in order to be able to implement and maintain end-to-end 5G networks. Europe is only a real contender in the ICT industry for network aspects, but could lose its position as the value moves towards computing/software/Internet services. Beyond the economic considerations for the telecom industry, there is a big risk of loss of sovereignty in a context of digitalisation of verticals leveraging 5G. The lack of coordination of spectrum policies in EU creates uncertainties for the operators and has direct consequences in terms of delays for roll-out.

1.2 EU relative positioning

1.2.1 Competitive positioning of Europe in the field

European current digital ecosystem

Europe represents in 2017 around 23% of the world digital markets (including network equipment, devices, IT and software, telecom, Internet services and digital contents). **The growth of digital markets in Europe is slower than in the USA or more importantly Asia-Pacific.** As a consequence, the European digital markets have lost some 2% market share since 2015 but remain with a size similar to Asia-Pacific (benefiting from a larger population) or USA (with a smaller population, but better monetization, digital contents or cloud).

The weak growth rate in Europe can be explained by the absence of a competitive advantage in the most dynamic digital segments, such as the Internet services market (apart from e-commerce) , as well as by difficulties in the telecom services sector, which is suffering from very strong internal competition in Europe.

But while Europe is well positioned in term of demand and adoption of digital solutions, the European actors are overall loosing market shares. EU-headquartered digital players represents only 14% of the revenues.[1] Europe has even lost 5% of market share from 2012 to 2017. EU telecom operators represent 50% of revenues and 83% of investments of digital players in Europe (whereas telecom operators represent only around 25% in other regions of the world).

Europe is partly competitive regarding the telecom industry, despite biggest telecom operators in the World being from China and USA,[2] and is still a major region for telecom equipment (close to 50% for mobile infrastructure). But on the

[1]https://www.orange.com/fr/content/download/30450/882715/version/2/file/L_Europe_a_la_peine_dans_l_economie_numerique_Mai_2015.pdf (2015 version on 2013 figures). Note from June 2019 updating figures not public yet

[2] EU telecom operators represent over the last 7 years 10 players in the top 30 telecom operators in the World, but their share of revenues in the top 30 has gone down from 32% in 2012 to 25% in 2018 (Source: IDATE Digiworld, Telecom Markets and Players).

latter, Huawei has become progressively the biggest vendor and the share of Europe was around 65% 10 years ago[3] (source: IHS market).

It is a widely known fact: apart from some rare exceptions, major digital players have not emerged in Europe, and the continent must cope with US dominance and the emergence of Chinese players. Although telecom operators are still thriving – with major traditional players like Deutsche Telekom, Telefónica, Vodafone and Orange – there are leading European players in the telecom equipment and infrastructure market, also challenged by Chinese stakeholders. As for software and IT services, there is more variability. Germany's SAP and France's Capgemini and Atos are all in the global top ten.

Figure 1: Digital companies and their ranking

Rank	Telecom operator	Smartphone manufacturer	Computer hardware	Programming and software	Software company	Internet services
1	AT&T	Samsung	Apple	Microsoft	IBM	Amazon
2	Verizon	Huawei	HP	Oracle	Fujitsu	Alphabet
3	China Mobile	Apple	Lenovo	SAP	HPE	JD.com
4	NTT	Xiaomi	Canon	CDW	Dell	Facebook
5	Deutsche Telekom	Oppo	Quanta	Salesforce	DXC	Alibaba
6	SoftBank	Vivo	HPE	VMware	Accenture	Tencent
7	China Telecom	LG	NEC	HCL	Capgemini	Netflix
8	Vodafone	Motorola	ASUS	Adobe	Atos	Booking
9	America Movil		Acer	Fiserv	CGI	Baidu
10	Comcast		Fujitsu	Amadeus	NEC	Salesforce

Notes: In blue: European companies

Source: Digital Europe 2030, IDATE Digiworld (2019), based on Forbes, ranking by 2017 turnover except smartphones (market share)[4]

On most other markets, Europe is often not even a challenger. Smartphone markets are dominated by Asia-Pacific with Samsung and more and more Chinese vendors (including Huawei).[5] Apple is the only non-Asian major player. Europe is doing better for IoT devices with Telit and Gemalto (now part of Thales) in the top 5 of the market (for a total of 20%) and 9 of the top 20 companies.[6] The situation is similar for cloud but with a domination of US players (especially Amazon and Microsoft),[7] progressively being challenged by Chinese players like Alibaba and China Telecom (Europe is only represented in the top 10 by OVH). European companies are virtually absent from internet services, such as communication services (social media and chat), video services, e-commerce, and the cloud and payment services. These segments are dominated by US players, like Amazon, Google, Facebook, Apple, Microsoft and Netflix. These players are themselves being challenged by Chinese players, like Alibaba, Tencent and to a lesser extent Baidu.

Finally, regarding other segments of the digital markets, Europe is not the leader, but still a real challenger for both software and IT services (with world class companies like SAP, Capgemini and Atos or more specialized Dassault Systems) and to a lesser extent digital content, even though the market is led by US players in both companies. Digital European content players are not world leaders but remain strong on the domestic markets (mostly

[3] https://www.economist.com/business/2018/12/15/can-huawei-survive-an-onslaught-of-bans-and-restrictions-abroad

[4] https://fr.idate.org/produit/digital-europe-2030/

[5] https://press.trendforce.com/node/view/3200.html

[6] https://www.visiongain.com/report/top-20-machine-to-machine-m2m-companies-2018/

[7] https://www.canalys.com/newsroom/cloud-market-share-q4-2018-and-full-year-2018

due to cultural reasons and language barriers). Digital European content players are otherwise weak outside Europe.

Opportunities for the European digital ecosystem: a new paradigm

Having a strong industrial tradition, Europe has established many global leaders in a wide variety of sectors, from insurance to agri-food to pharmaceuticals (hereafter called vertical sectors). For example, the groups Nestlé, L'Oréal, LVMH, Philip Morris, Lafarge, BASF, Areva, Veolia, Maersk, Transdev, Novartis, Compass and Allianz are all world leaders in their respective sectors.

Table 2: European groups that are global leaders

Industry	Global leaders (1st, 2nd or 3rd largest in their sector)
Manufacturing	Lafarge, Schneider Electric, Airbus, Bayer, BASF, Daimler, Volkswagen, Michelin
Agri-food	Nestlé, Danone, Syngenta, Ferrero, Lactalis, Compass (catering)
Consumer goods	L'Oréal, Unilever, Adidas, Philip Morris
Luxury	LVMH, Kering, Richemont
Energy/water	Areva, EDF, Engie, Shell, Veolia, Suez
Maritime	Maersk, CMA CGM
Transport	SNCF, Deutsche Bahn, Transdev
Pharmaceuticals	Novartis, Sanofi
Satellite	SES, Eutelsat, ADS (Airbus), Thales
Banking/Insurance	HSBC, Allianz, Axa
IT	SAP
Media	Vivendi
Advertising	Publicis

Source: IDATE DigiWorld from Forbes, *Digital Europe 2030*, June 2019[8]

These leaders are concentrated in just a few countries: France, Germany, the United Kingdom, Italy and Switzerland. The latter, which does not belong to the EU, is home to some major players, especially in the chemical and agri-food sectors.

European vertical leaders are nonetheless now facing competition from Chinese groups: e.g. EDF has now become the second largest electricity producer following the merger of China Guodian and Shenhua in 2017. At the same time, Chinese players are trying to gain a foothold in Europe via investments and acquisitions: e.g. Jin Jiang acquired a 15% stake in Accor group, and Dongfeng's stake in PSA. These deals can be limited by public authorities for security, domestic strategy and labour reasons: e.g. Germany blocked the purchase of Aixtron, an equipment manufacturer in the semiconductor industry, by Fujian Grand Chip Investment in 2017.

Digital is now developing alongside vertical expertise. After being rolled out to the public on a wide scale, digital services are developing along with specific core businesses, like health and transport. Services are being developed by combining vertical expertise with opportunities tied to digital. The offerings are no longer based solely on IT (like ERP

[8] https://fr.idate.org/produit/digital-europe-2030/

or CRM); they integrate in-depth knowledge of certain industries, which gives traditional players an advantage.

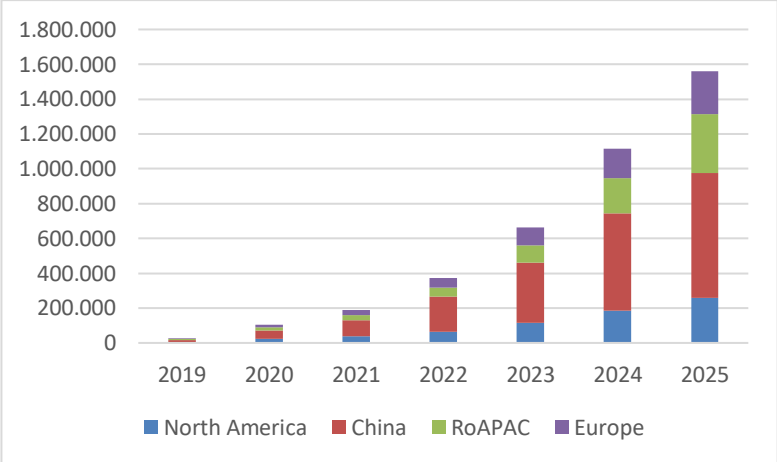
These new developments represent an opportunity for digital Europe. Sector leaders could develop digital services from their core business and make Europe competitive again in digital services. Machines could be seen as the new devices for B2B markets, while vertical services enabled by digital technologies and smart networks would reposition Europe in Internet and IT services.

Usages & deployment of 5G: a slow start in Europe

A number of mobile operators have already announced the number of 5G cell sites they are using or planning to use for their 5G trials and commercial deployments. Deployment in Europe is very limited with a small number of base stations compared to front-runners such as South Korea (South Korean operators, which launched 5G service in early April, surpassed the 3 million 5G subscriber mark on 9 September), USA or China.

Table 27 in Appendix D provides additional perspective on the number of cell sites/base stations for 5G trials and networks.

Figure 2: Number of 5G subscribers



Source: 5G Markets, IDATE Digiworld (2019) [9]

Complementary technologies for 5G: focus on IoT & Edge computing

The candidate initiative will also integrate key technologies and features from IoT and edge computing.

Regarding IoT, Europe has long been the leading geographical market for cellular M2M (Machine to Machine), leveraging several vertical regulations (especially around smart metering) and the involvement of leading telecom operators (Vodafone, Telenor, Orange, etc…) and specialized OEMs (Telit, Wavecom [now Sierra Wireless, from Canada], Cinterion [now Gemalto/Thales], etc…). **However, Europe has been surpassed since the by Asia-Pacific (leveraging the sheer size of the domestic market) and North America, with the involvement of large telecom operators.** Specialized OEMs are increasingly Chinese providers.

This is also true in general for the whole IoT market.[10] **Europe is nonetheless ahead of North America for IoT in general.** This is due to **new vertical regulations favouring**

[9] https://fr.idate.org/produit/5g-markets-in-europe-dataset-report/

[10] IDATE Digiworld, World IoT Markets (2018) https://fr.idate.org/produit/iot-markets-4/

IoT (eCall for cars, public policies around utilities, etc.) and to the faster development of new markets around LPWA solutions (Low Power Wide Area) that have emerged first in Europe around smart cities and asset management/tracking markets. Europe is overall a competitive market for IoT, but not the leader (China is already far ahead in terms of volumes, contributing a lot to the leading status of Asia-Pacific expected to represent 57% of connections in 2030 against 16% for Europe, the second region in the World)[11] and a close contender for many sub-markets.

Edge computing[12] per se is not very developed yet in all regions of the world, with mainly pilots so far. It will become a €13.8 billion market by 2024, thanks to close to 40% of growth per year.[13] It could enable close to €110 billion around various use cases like V2X, predictive maintenance or industrial IoT. Like for cloud, North America is the leading region, but Europe should capture 27% of the market by 2024.

Edge computing has developed for now mainly outside networks (Mobile Edge Computing has failed to develop for now and should only represent 11% of the market by 2024), around industrials for private cloud and leading providers of public cloud computing and datacentres and some specialised software vendors. These latter players are essentially US providers and have taken an early lead in what is still a very emerging market. Europe is clearly lagging behind in this area, despite involvement of vendors like Nokia and Ericsson or industrials like Siemens, Bosch, Dassault and Schneider Electric. But **Europe could leverage its strong position in equipment markets to develop a distributed cloud industry and differentiate from Chinese vendors, whereas USA is not much present in the equipment market.**

The main technical challenges for edge computing still to be solved are around consumption energy (which could increase significantly with distributed solutions), security (edge will open new backdoors), orchestration and management (a challenge not yet solved around network virtualisation) and the capacity to provide ultra-low latency. But there are also numerous business challenges to be considered, as CAPEX to develop distributed edge servers will be significant, even if developed in combination with 5G roll outs.

1.2.2 Support for the field in the previous Framework Programme

The main support for the field of Smart Networks and Services in the previous Framework Programme is the contractual PPP on 5G (5G-PPP: 5G Public Private Partnership) launched through an agreement with the 5G Infrastructure Association at end of 2013. We present here the main achievements of the programme and the lesson learnt.

Through 5G-PPP, the goal of Europe is to put in place the right framework to tackle 5G challenges and bring the appropriate solutions, architectures, technologies and standards to the next generation of communication networks.

The main target objectives of the 5G-PPP are the technological development of 5G and the contribution to growth and jobs. Considered as EU flagship initiative, the **5G-PPP** comprises public and private partners. The latter also agreed on KPIs to leverage the €700 million public investment by a factor of 5 bringing **total funding into 5G-PPP to €4.2 billion**.

[11] IDATE Digiworld, World IoT Markets (2018) https://fr.idate.org/produit/iot-markets-4/

[12] Edge computing corresponds to the optimisation used in cloud computing where data is processed at the edge of the network

[13] https://fr.idate.org/produit/edge-computing-report/

5G-PPP is organized in 3 phases, each comprising several call for projects with a variable duration of 24-36 months:

1. Phase 1 with 19 projects (2014-2016) focusing on 5G infrastructure, automotive projects and 5G validation trials across multiple vertical industries
2. Phase 2 (2017-2019) with 21 new projects targeting a move towards demonstrations and experimentations in order to establish closer links between 5G community and verticals industries.
3. 3rd and last phase ending in 2020 (still running) consolidating the results of the previous phases to support implementation and applicability of 5G and will be dedicated to a number of projects in vertical industries use cases. Many projects are yet to be chosen and there are still calls in April 2020.

The global objectives of the 5G programme is to build the next generation of wireless communication network technologies. This new generation is expected to improve the existing (4G) wireless network capabilities (in term of bandwidth, capacity, coverage, and reliability). But beyond this incremental progress, the 5G technologies also aim to provide new capabilities (ultra-low latencies, ability to connect very large numbers of devices, high dependability and quality of service, etc.) that would enable the wireless network to be used in scenarios that are essential for vertical industries.

Stakeholder analysis of the 5G-PPP

Stakeholders involved so far in the 5GPPP[14] are mainly from the telecom industry or from the public research centres and universities with a strong background in telecommunications. **The majority of funding was directed towards private research** (56% of funding), and within that the vast majority for the telecom (operators, OEMs (Original Equipment Manufacturers) and IT industries. The involvement of verticals is still modest but growing. This is globally consistent with the analysis done for just Phase 1 project [15] (65% of private research)

Three main groups of players are mainly involved in the 5G-PPP, as designed by the European Commission and the 5G IA (5G Industry Association):

- Current connectivity providers (MNOs, MVNOs) are taking the opportunity of these new technologies to try to diversify their offer and address new market segments (in specific verticals, including manufacturing) as a way to compensate declining consumer revenues. They have engaged into many projects within the 5G-PPP and trials[16] targeting key vertical markets like automotive, healthcare, industry 4.0, energy and media, and additional vertical markets targeted in a second step like public safety and smart city[17]. In Europe, Orange, Telefonica, Telecom Italia and BT (plus to a lesser extent Altice, Deutsche Telekom and OTE) have been leading the efforts on 5G.
- Providers of enabling technologies include software and hardware vendors. Hardware equipment manufacturers can also see 5G as an opportunity to diversify their business modelling, by bundling equipment with connectivity service provisioning in, for example, the small cell area. The need for an upgraded infrastructure, supported by virtualisation

[14] note that the analysis is only based on projects funded from the 5GPPP during Phase I and Phase II, i.e. projects funded before 2018

[15] Mid-term review of the contractual Public Private Partnerships under Horizon 2020 (2007), Report of the Independent Expert Group https://publications.europa.eu/en/publication-detail/-/publication/6de81abe-a71c-11e7-837e-01aa75ed71a1

[16] Vertical trials may not involve a vertical stakeholder

[17] 5G IA (2019) available at https://5g-ppp.eu/verticals/

and allowing for edge computing, is also an opportunity, partly challenged nonetheless by the development of pure software players. Traditional OEMs (especially Nokia and Ericsson, but also Huawei and NEC) and their counterpart software and/or electronics companies (Atos, Samsung, and Intel) are well represented within the 5GPPP projects.

- Fundamental building blocks may also be developed by academic and public research institutes/centres also well represented in the 5GPPP. Close to 40% of participants in 5GPPP (and 36% of funding)[18] was allocated to either high education and research centres (with a slight bigger proportion for education).
- Some content providers (including OTT players) and **industrial solution providers, and potentially manufacturers (a.k.a. vertical stakeholders)**, will also play a role in the new communication value chains, not only as content and service providers, but also as **connectivity providers**, and infrastructure providers. This is reinforced by the integration of **direct, proximity communications** (such as public safety services or V2V (Vehicle to Vehicle communication), V2I (Vehicle to Infrastructure)) in the 5G standards, thereby **removing partially or even entirely in some cases the need for a mobile operator in the value chain.** Their engagement as participants in projects is still modest (5% overall for Phases 1 and 2) but increasing with close to 17% of funding in 2017 (see Appendix D for details). Most vertical stakeholders have participated to only 1 project.

Vertical industries were not very active around 5G developments before 2018-2019. **Among the active vertical industries, a few already really stand out:** the automotive industry (thanks to the creation of the 5G AA (5G Automotive association)) and to a lesser extent manufacturing industries (5G ACIA - 5G Alliance for Connected Industries and Automation) and utilities. These vertical stakeholders are often not involved around business use cases but rather focus on specific technologies development. Details on participants are provided in Appendix D.

This limited participation of actors from the vertical industries to the 5G-PPP can be explained mainly by the natural phasing of the 5G-PPP, with earlier phases dedicated to technology development and later phases to validation, testbeds and trials, especially around platforms. The increase overtime of the vertical stakeholders' presence in project and access to funding shows positive signs of uptake.

This is in addition confirmed by analysis of the Phase 3 projects already started or about to start, reaching even at least 22% of vertical participants (some projects even with more than a third of vertical participants), when excluding platforms. Verticals industries with the most contributors are by far automotive (with a specific call), transport and industry 4.0, with a mix of very large companies and smaller ones. Details on participants are provided in Appendix D.

Lessons learned

The following table present an analysis of the main needs for actions and potential failures linked with the current partnership.

[18] NACE code analysis

Table 3: Current failures in the field requiring policy interventions

Market failures	
Market power	High global competition with many important actors in both network technologies and in digital services outside of Europe. Risk of Europe losing its technological sovereignty on network and digital services.
Externalities	Huge need for investments in R&D from private organisations to address technologies beyond traditional telecom activities. With limited budget, a risk exists that the private investment that goes to networks and digital services R&D is below the necessary level as private organisations have to handle multiple, sometimes conflicting, R&D priorities.
Information asymmetry	N/A
Systemic failures	
Capability	N/A
Network	There is a necessity for a real integration of verticals industries into the design of 5G. Otherwise 5G would be just another generation of telecom industry R&D with a risk of not bringing larger societal benefits (digitalisation of the industry). Limited impact of vertical stakeholders on standardisation work (3GPP)
Institutional	Required evolution of spectrum allocation
Infrastructural	Huge need for investments in infrastructure from private organisations for large scale roll-outs. The prospects of large scale deployment is essential to motivate industrials (inside and outside of the telecommunication value chain) to invest in beyond 5G R&D. This is especially true for vertical industries who won't see an interest in investing in 5G / beyond 5G R&D if no clear infrastructure roll-out plan is scheduled (as they will eventually be dependent upon the infrastructure).
Transformational failures	
Directionality	Lack of shared vision with some vertical industries (strong progress mainly with a few verticals like automotive)
Demand articulation	Demand not enough qualified in terms of expectations for some verticals. Vertical industries have to formalized clear requirement and be involved in the definition of the future networks and services capabilities to ensure that the future technologies are adequate to the societal needs.
Policy coordination	Weak coordination of national efforts in the EU (25 countries have some national effort/programme in place), particularly with regards to spectrum allocations.
Reflexivity	N/A

Source: Based on taxonomy of failures by Technopolis Group (2018), Modified from Weber & Rohracher (2012)

KPIs were defined by 5GPPP on business, performance and societal aspects (through a contractual arrangement)[19] and are still difficult to assess completely as a large amount of the funding of the cPPP has not been allocated yet. We can nonetheless identify some early success and areas for improvement. KPIs are defined in details in Appendix D.

Positive impacts of the cPPP

The 5G cPPP has been able to successfully address the market failures, especially through achievements of some KPIs in phases 1 and 2, with a leverage of factor of 10.12 in 2018 of public funds for large industry and SMEs players, ensuring enough private investments. The cPPP is helping EU technology providers (especially Nokia and Ericsson) to maintain their market shares in a context of a global competition (especially with Huawei). EU players have also a significant share of patents for 5G RAN and to a lesser extent of 5G patents in general (see next section).

The systemic failures have only been partly addressed. The participation of verticals in R&D projects is encouraging (especially in a context in which verticals were not associated also much with previous generations like 4G, essentially players from rail transportation and energy), but remains limited only to a few industries like automotive/transport, plus recently industry 4.0 and to a lesser extent energy (see Appendix D).

Another positive outcome of the cPPP is the participation of SMEs (with close to 20% of participants) that can bring additional innovations (see Appendix D).

5G-PPP has had significant influence in building pre-standardization consensus across key actors. Major impact on the 5G architecture ideas has also been achieved through 610 activities leading to standardization (Phase 1: 315; Phase 2: 295). The table below shows a breakdown of the inputs for the development of 5G standardization tracked between June 2018 and June 2019:

Table 4: Input to 5G standardisation

Number of contributions per category tracked	
Overall architecture: Mostly to 3GPP, with many inputs on the implementation of 5G V2X systems and multimedia broadcast or streaming services.	70
Core and transport architecture: Mostly to 3GPP, with most of the inputs related to terminals.	58
Management and orchestration architecture: Mostly to three ETSI groups, namely, the ZSM ISG, NFV ISG and OSM.	50
Radio and edge architecture: Mostly to 3GPP, with many inputs on 5G NR enhancements for V2X and multimedia broadcast.	41
Other 3GPP WGs: RAN 3 (new radio); SA1 (service requirements); SA5 (network management, including energy efficiency and architecture); SA4 (codec); SA6 (northbound APIs); SA4-5-6 (media and broadcasting).	21
ETSI Multi-Access Edge Computing (e.g. Instantiating a Network Slice integrating MEC applications, using 3GPP elements).	6
Industry groups (e.g. DVB for media and broadcasting); other standards organisations (e.g. IETF for network virtualisation, fog computing and northbound interfaces); not specified	49
Total	**295**

[19] https://5g-ppp.eu/contract/

Late involvement of vertical stakeholders has led to limited involvement in standardisation work but the phase 2 and phase 3 H2020 R&D projects involve a significant number of vertical players and this should lead to more impact on standardisation.

Room for improvement

The biggest room for improvement relates to transformational failures. Directionality and demand articulation are addressed really so far by a limited number of vertical players that have regrouped in association like the automotive industry (5GAA). Other initiatives (often with MoUs) are too recent (mostly from 2018) to evaluated yet and restricted to a few industries. But such associations can be leveraged to get faster results for beyond 5G initiatives. Some societal targets have been not well identified from the start and are therefore unlikely to be met. This is especially the case for privacy control and reduction of energy consumption, and also of security. Those KPIs are not clearly measured and should be part with explicit KPIs in the next initiative. The issue is partly due to the requirements given to the initiative.

The other major issue is around spectrum, whose coordination remains weak. Indeed, the overall framework with the three pioneer bands gives a long term vision. But the implementation is so far hectic and some MS will not meet the 2020 deadline (see 1.2.1). The early identification of the three "pioneer" 5G bands (700 MHz, 3.6 GHz and 26 GHz) is very positive for Europe as it sent clear signals to the industry on the new resources to be made available before the end of 2020. However, spectrum allocation and assignment should be more coordinated throughout the EU with more common licence conditions and close timetables between Member States. Assignment of dedicated spectrum to verticals should also be coordinated between MS as it would facilitate the planning of 5G networks use across the EU by multinational companies either with their own private networks of by using commercial 5G networks. Availability of other mm-wave bands (such as 42 or 60 GHz) should be anticipated in order to give industry certainty and allow development of a solid ecosystem for next stages of 5G.

Finally, as detailed in previous section, Europe is lagging behind in terms of network roll-outs (with some major EU Member States still without any live commercial offering). The 5G cPPP was indeed focused on technology developments and trials (no KPIs were defined on roll outs) and the next initiative should try to take large scale roll-outs into account.

For the two latter items, spectrum and roll-outs, issues can be attributed at least partly to weak coordination of MS, developing 5G with their own agenda/timing with different objectives in terms of industrial policy and expected revenues from auctions. This is so far structural, i.e. not due to the initiative itself, as there were no elements in the cPPP to influence the developments.

1.3 EU policy context beyond 2021

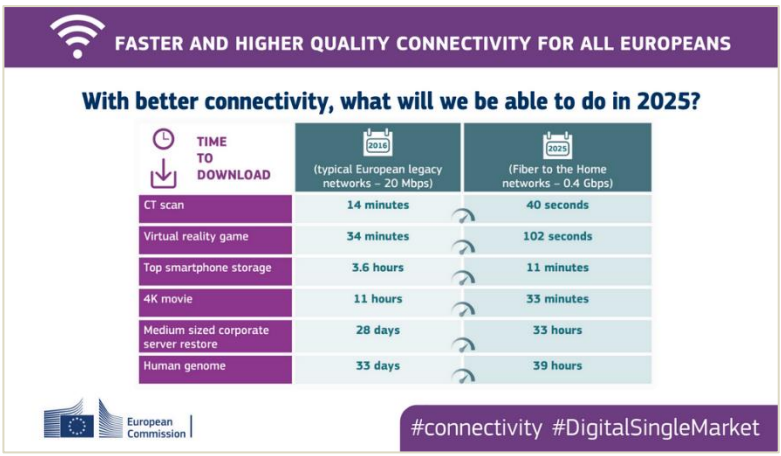
As set out in the report on the overarching context to the impact assessment studies, the R&I activities funded under the Pillar II Cluster Digital, Industry, Space aim at contributing to the attainment of three overarching EU policy objectives: 'A Europe fit for the Digital Age', 'An economy that works for people', and 'A European Green Deal'.

Their critical role in facilitating transitions in multiple 'vertical' sectors in our economy and society imply that the R&I actions under this cluster will contribute to addressing several Sustainable Development Goals. Specifically in the field of smart network and services, the development and deployment of a smart connectivity infrastructure beyond 5G will enable online services and connected objects in all parts of consumer/citizens and businesses daily life, thus contributing to several SDGs. Directly addressing the *SDG9-Industry Innovation and Infrastructure,* industry 4.0 connections leveraging 5G, Industrial IoT and edge computing will strengthen the global competitiveness of multiple sectors in the European

economy, starting with the telecommunication/ICT industry. In this context, the Electronic Communication Code that entered into force at the end of 2018, paved the way for the deployment of 5G networks with spectrum licensing periods over 20 years (to ensure RoI for operators) and facilitates the roll-out of high-capacity fixed networks.

The overhaul of telecom rules was also undertaken through the **Electronic Communication Code** adopted in 2016[20] and entered into force in December 2018. More specifically to Smart Networks and Services, **this initiative is in line with several European policies where the Commission proposals want to place the EU at the forefront of innovation and digitization, regarding the telecommunication industry**. In the target of creating a "European Gigabit society" by 2025, the EC has promoted a various number of initiatives to deliver "the best possible access to the online world for individuals and businesses". Indeed a number of rules linked to connectivity like the new European Electronic Communications Code, proposed by the Commission and agreed on by the European Parliament and the Council end of 2018 have been set in order to boost investment, competition level playing field and innovation in very high capacity networks across the EU to meet the DSM policy.

Figure 3: Objectives of the European Gigabit Society



Source: European Commission[21]

But there are also numerous other policies beyond the telecommunication/ICT industry that will benefit from the smart connectivity infrastructure of the SNS partnership deployed at large scale, including the transport, healthcare, energy and manufacturing industries to name a few:

- As part of a forward-looking strategy on Connected and Automated Mobility (CAM)[22] focused on mobility and completing Europe on the Move[23] package, Europe aims to be a world leader for fully autonomous safe mobility. Hence, EU initiatives include policies for the future of road safety with measures for vehicles and infrastructure safety, and

[20] https://ec.europa.eu/digital-single-market/en/news/european-electronic-communications-code-updating-eu-telecom-rules

[21] https://ec.europa.eu/digital-single-market/sites/digital-agenda/files/telecoms_package2.png

[22] European Commission, Communication from the commission May 2018. On the road to automated mobility: An EU strategy for mobility of the future: https://ec.europa.eu/transport/sites/transport/files/3rd-mobility-pack/com20180283_en.pdf

[23] European Commission, Europe on the move, 2018 http://europa.eu/rapid/attachment/IP-18-3708/en/Factsheet%20Connected%20and%20Automated%20Mobility%20%20For%20a%20competitive%20Europe.pdf

where pan European 5G corridors is required thanks to cross border cooperation between Member States.

- Smart connectivity systems will be key enablers for the energy industry evolving towards distributed energy systems and grid transformation systems, in a context of cities turning to intelligent energy consumption, to meet targets set by the EC for 2020,[24] 2030[25] and 2050.
- Healthcare industry will need smart connectivity systems to operate its transformation towards telemedicine (remote operations) and home care (monitoring of patients at home) to reduce the overall costs and provide better treatments to the whole population.
- Industry is also a key sector for the European economy where technologies like 5G connectivity, cloud computing, IoT and big data are identified as critical assets and priority areas to invest in for the digitalisation of the Society and the industry.[26] With leadership and investment in digital infrastructures, Europe will be able to remain competitive across all sectors from manufacturing, to food and construction. The move towards Industry 4.0 (supported by Industrial Internet of things) is indeed crucial for Europe to maintain industrial production in Europe by developing more intelligent systems and machines to increase the value and remain competitive on the high end markets.

Many of the Industries mentioned above have been identified as part of the 6 key strategic value chains announced[27] early 2019 (connected, clean and autonomous vehicles, smart health, industrial IoT) in order to help EU industry players to stay global leaders by providing more value added services. The institutionalized partnership candidate would play a key a role to support such developments aiming to reinforce the global industrial policy of Europe.

Also, Smart Network and Services is seen as primordial in securing economic development and ensuring the European strategic autonomy in the digital age.[28] Indeed, the development of key digital technologies, critical infrastructure for Society, will help to become independent especially with regards to China and the US. 5G connectivity infrastructures as well as Artificial Intelligence and quantum computing are considered as key elements ensuring the development of Europe's competitiveness and jobs creation. As highlighted in the EPSC (European Political Strategy Centre) Strategic Note of July 2019[17]: "As 5G will soon be the de facto 'central nervous system' of the economy and form the backbone of a wide range of services essential for the operation of vital societal functions and critical public infrastructures, guaranteeing its integrity is key to ensuring the Union's strategic autonomy". In addition, in order to develop this strong industrial and technological base, it will be necessary to guarantee cybersecurity for those critical

[24] https://ec.europa.eu/energy/en/energy-strategy/2020-energy-strategy

[25] https://ec.europa.eu/clima/policies/strategies/2030_en

[26] European Commission, Commission sets out path to digitise European industry, 2016 : https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=15279

[27] https://s3platform.jrc.ec.europa.eu/-/european-commission-announces-the-key-strategic-value-chains?inheritRedirect=true

[28] European Political Strategy Centre, Rethinking Strategic Autonomy in the Digital Age, July 2019 : https://ec.europa.eu/epsc/sites/epsc/files/epsc_strategic_note_issue30_strategic_autonomy.pdf

infrastructures. The EC has set measures[29] across the Member States to ensure a high level of cybersecurity of 5G networks.

Finally, technologies play an integral role in innovation and are also required to reach the ambition of the European Green Deal.[30] As part of this guideline, investment in innovation are pushed such as Horizon Europe. Digital technologies, including 5G, are considered in the Green Deal (reaffirmed in December 2019) are key enablers to develop sustainable mobility to have transport more efficient and cleaner around automated mobility, smart management systems and MaaS (mobility as a Service) applications.[31]

Smart connectivity systems will also be key enablers for the delivery of more value-added services in industry sectors such as transport, healthcare, energy and manufacturing, many of which have been identified in early 2019 as part of the key strategic value chains for EU industry players to remain global leaders., They will be central for the transformation of the healthcare sector towards telemedicine (remote operations) and home care (monitoring of patients at home) in order to reduce the overall costs and provide better services (*SDG 3 Good Health and Well-being*). Connected infrastructure/IoT will also be key enablers for the energy industry evolving towards distributed energy systems and grid transformation systems, in a context of cities turning to intelligent energy consumption (*SDG 11 Sustainable Cities and Communities*) and ensure optimization of production of energy (*SDG 7 Clean and Affordable Energy*). They will facilitate precision farming and food monitoring that will help increase agricultural productivity and reduce the need for scarce inputs (*SDG 2 Zero Hunger* and *SDG 15 Life on Land*), while IoT/smart systems that reduce the usage of water resources will improve water use efficiency and protection of oceans and water quality (*SDG 6 Clean Water and Sanitation* and *SDG 14 Life below Water*).

Figure 4 below, maps out the positioning of the candidate Institutionalised Partnership in this field in the landscape of the envisaged partnerships in Cluster 4, with a specific focus on the ones in the digital field. The three candidate Institutionalised Partnerships covering enabling technologies are all related to digital technologies, i.e. electronic components and systems, 5G infrastructure and high-performance computing. Together with photonics, AI, data technologies and robotics, these partnerships are intended to enable digitalisation of vertical industries such as transport, automotive, manufacturing, energy and health, enable new services and ensure the development and deployment of the 'Industrial Internet of Things' (IIoT). The move towards Industry 4.0 (supported by Industrial Internet of things) is crucial for Europe to maintain industrial production in Europe by developing more intelligent systems and machines to increase the value and remain competitive on the high-end markets.

The diagram shows that developments in the field of IoT will in the first instance be to the benefit of the other envisaged partnerships in this cluster. It also lists the most important initiatives related to the 'vertical' industries in the other Pillar II clusters that can be expected to draw benefit of these developments in the digital sphere, allowing for the development of 'smart health', 'smart mobility', 'smart grids', 'smart cities', precision farming etc. Metrology research will support the initiatives in the digital sphere by providing accurate state-of-the-art measurement capabilities. Better measurement and calibration systems will especially make a direct contribution to the rolling out of 5G applications and

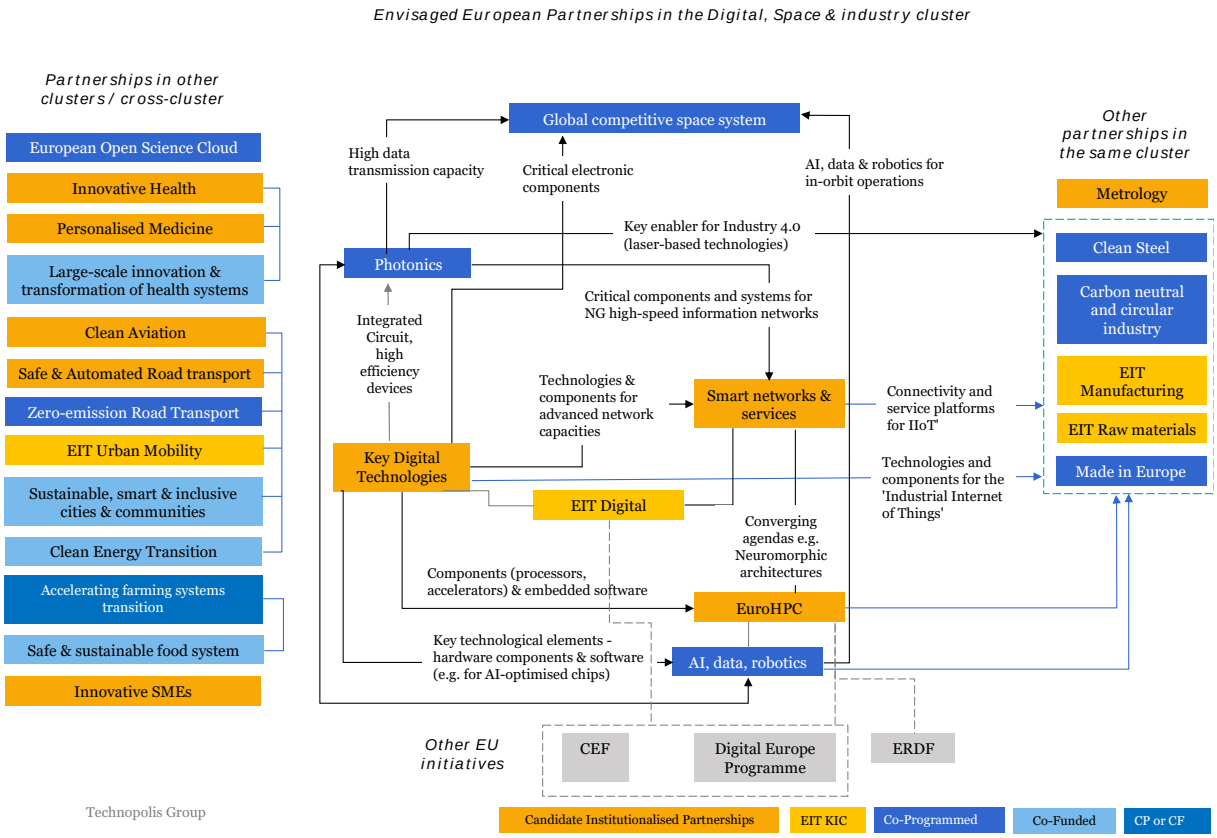
[29] European Commission, Recommendation on Cybersecurity of 5G networks, 2019 : https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=58154

[30] Ursula von der Leyen, A Union that strives for more, political guidelines, 2019 : https://ec.europa.eu/commission/sites/beta-political/files/political-guidelines-next-commission_en.pdf

[31] https://ec.europa.eu/commission/presscorner/detail/en/fs_19_6726. More details expected in second half of 2020.

to test and validate and design standards for future generation communication technologies and systems.

Figure 4: Interconnections with and among the envisaged partnerships in the Digital, Industry, Space cluster.



The mapping of the partnerships landscape in Figure 4 shows a close interconnection between the various initiatives in the digital field, taking a full value chain approach and building upon each other for the attainment of future technological advancements. Technologies like 5G connectivity, cloud computing, and Internet of Things (IoT), which find a point of convergence in the Smart Networks and Services initiative, are key elements leading the technological evolution of digital infrastructures towards 'beyond 5G' and later 6G networks. In order to develop a strong industrial and technological base, it will be necessary to guarantee also cybersecurity for these critical infrastructures. While the Smart Networks and Services initiative is expected to set in place the overall architecture of future networks and services (from component to application level), close collaboration with the Key Digital Technologies initiative that complements the value chain at the device level, creating technological breakthroughs on the individual components, will allow for the creation of the service platforms required for, e.g., the 'Industrial Internet of Things', smart cities or the 5G corridors for Connected and Automated Mobility.

The High-Performance Computing initiative, in close interaction with the AI-data-robotics envisaged partnership, will be pivotal in addressing the need to integrate and analyse information for building smarter applications in emerging Smart Cities and the Internet of Things. Addressing future challenges requires scaling to extreme performance levels by means of HPC solutions as well as bringing compute closer to data sources, i.e. enabling computing at the edge. Connected sensors and IoT devices, smart grid, smart cities, software-defined networks, network function virtualisation, data-driven cognitive networking and cyber security utilise edge computing networks to support data transmission over significant distances via distributed and connected communication devices.

The Cluster 4 envisaged European Partnerships and, especially, those related to digital technologies will benefit from the infrastructure developed in the European Open Science Cloud partnership for the storage, management, analysis and re-use of data. In turn, the technological advancement allowed by the research and innovation activities in Cluster 4 could help further improve the infrastructures and related serviced offered by the European Open Science Cloud.

The Innovative SMEs partnership may also interact closely with the Cluster 4 candidate European Partnerships, as its main beneficiaries (SMEs) compose a large share of the digital companies.

The Smart Networks and Services initiative envisages the need for large-scale testing and experimentation activities in order to validate and integrate the innovative technological building blocks. It therefore foresees synergies to be created with other programmes and facilities under the MFF 2021-27 such as the *Connecting Europe Facility* and *Digital Europe*.

2 Problem definition

This section provides a discussion of the problems to be addressed in relation to the emerging challenges presented in Section 1.1, drawing on evidence from desk research and the findings of the stakeholder consultation undertaken as part of this study. A problem tree portraying related problems, their drivers and consequences is presented in Figure 5 and described in detail in the following sections.

2.1 What are the problems?

2.1.1 Limited European sovereignty on critical technologies of Smart network and service value chains

Smart Networks and Services technologies becomes a critical infrastructure since it is the prerequisite of operations like connected cars, connected energy grids or connected healthcare essential for the industry and society at large; and on which numerous other vertical solutions will be built, answering the needs of many industries and societal demands.[32] Yet there is a significant risk that Europe will be dependent on technologies outside its control, and even on knowledge and know-how that is not mastered by any European actor, leaving European sovereignty at risk.

In essence, 3 key building blocks are needed to realise the SNS vision, namely smart devices and connected objects, connectivity platforms and cloud computing service platforms. Europe has still a world class industry and R&I ecosystem related to networking technologies but has lost its position on the device /connected object markets. In addition, European industry is also virtually absent from the cloud computing market, despite excellent academic skills in computer science and software design.

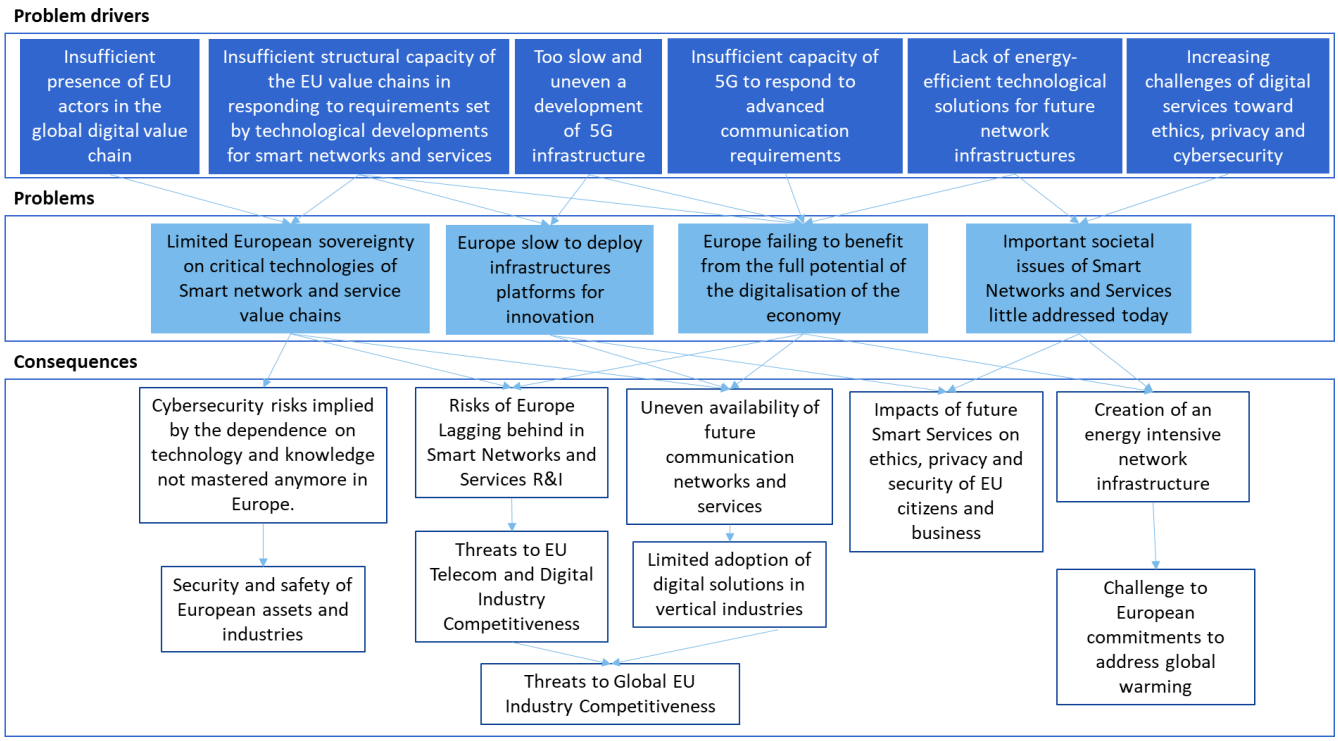
The problem is further aggravated by the trend to design system with a vertically integrated perspective from device to service provision. So far, the 3 key building blocks of the value chain could be conceived with a relative level of independence. The very high-performance level targeted for industrial and professional use cases forces industry to revisit the system design principles with an end to end approach from the start. This is potentially a threat to European actors, whilst actors which already master vertically integrated value chain (e.g. Samsung, Huawei) would clearly be at an advantage. The pressure will only increase over time, as this domain is subject of fierce international competition with hegemonic approaches being promoted by some of our main competitors, clearly looking for full dominance of the smart connectivity value chain. Already today,

[32] European Commission, Cybersecurity for 5G recommendation, 26 March 2019

China, South Korea, the USA and Japan to a certain extent have kicked off 6G initiatives whilst in Europe, Finland is the only member states that has officially done so, and exploratory work is about to start under the current H2020 programme.

The current lack of European leadership in the value chain has been highlighted by most of the **interviewees** with the fear of losing technology independence towards international players. With no distinction of specific categories of stakeholders, several interviewees thus mentioned the limited European sovereignty that is at stake especially when it comes to infrastructures supporting critical services. In that sense, interviewees underline the necessity to take into account the notion of security and cybersecurity as part of Smart Networks and Services development technologies.

Figure 5: Problem tree for the initiative on Smart Networks and Services



2.1.2 Europe slow to deploy infrastructures platforms for innovation

Smart Network and Services, in the wake of early 5G developments, are expected to become a platform for innovation particularly for vertical industry segments, with a level of openness allowing innovators to develop novel applications based on the network . A future initiative would have to address the slow speed of take up of such platforms in Europe to ensure competitiveness of European industry. In particular, the current deployment of the initial 5G infrastructure in Europe is not as fast as in other regions, due to non-uniform regulations and legislation as well as uncoordinated efforts of both industries and institutional initiatives.

Whilst this problem is further amplified by the limited investment capabilities of key players like European operators, this is not the only reason. New players in the industry 4.0 domain would potentially have capability to invest in new 5G infrastructure, but the complexity of integrating such technology with a complete connected ecosystem requires significant time to fully validate the solutions in operational conditions. This is exemplified by the currently 165 trials running today in Europe[33] on 5G across a multiplicity of use cases. For a simple

[33] Source: 5G Observatory

technology like C-ITS G5 providing vehicle to vehicle connectivity for safety application, the automotive industry requires 3 years from early test to commercial deployments. This is a problem that in Europe is further complicated by the need to ensure cross border service continuity for mobile services.

Deployment is critically dependent on applicable regulation which may not be fully addressed in an R&I based partnership but has to be taken into account very early in the process as it has important design consequences on infrastructures.

2.1.3 Europe failing to benefit from the full potential of the digitalisation of the economy

In today's context, ICT native sectors (e-commerce, Internet, VoD…) represent in average 30% of the GDP and generate 70% of the ICT investments. In comparison, other industrial sectors represent 70% of the GDP and only 30% of the ICT investments. Also, digital industries have experienced an average growth rate of about 2.7 % over the last 15 years, whilst other industries lagged behind at 0.7% growth rate.[34]

The economic potential of digitalisation of large sectors of the economy is hence significant, and McKinsey estimates that it represents a potential economic impact of 3.9 to 11 T€ a year by 2025 in future digital automation across a multiplicity of business domains.[35] Other studies by Ericsson (Accenture)[36] suggest similar results and conclude that an about 10% of this value should be captured by connectivity service providers, which would double the current revenue perspective of the sector, largely dependent today from the revenues generated by broadband offers, a currently stagnating market.

These opportunities, largely represented by the Industrial IoT (IIoT) cannot be fully captured today as they require the emergence of smart connectivity platforms, with smart connectivity becoming a full part of the business process and a business asset. This is also fully acknowledged by the Strategic Forum put in place by DG GROW[37] which also suggest the need for a better integration of several technological domains, notably cloud computing (data processing and service delivery) connectivity (real time collaborative and synchronised processes) and devices (robots, drones...) to reach the full potential of IIoT

As the existing smart connectivity technologies are not efficient enough to systematically permeate a large number of industrial/use cases domain, early 5G implementations in selected industrial environments are not planned before 2023-25, and only a limited set of use cases. A large number of use cases requires performance capabilities that are beyond the capabilities of the current 5G developments, notably in terms of positioning (sub centimetre object positioning in factories for automated production), response time (lower than 1ms) e.g. for remote surgery, data rates (higher than 1Gb/s/user), reliability or "zero touch" capability (fully automated network configuration and management) to improve flexibility and decrease cost for operations.

A wide-ranging collaboration across numerous actors is needed, with stakeholders from different technological horizons and different application and business model perspectives. This collaboration aspect was initiated with the existing 5G PPP but to a limited extent, at this stage. Smart connectivity infrastructures will by definition support critical processes with a high public policy value, for instance connected cars, connected healthcare, smart

[34] The coming productivity boom, Michael Mandel, Brett Swanson, The Technology CEO Council

[35] McKinsey: The Internet of Things, mapping the value beyond the hype

[36] Ericsson Mobility Report, November 2019 available at: https://www.ericsson.com/4acd7e/assets/local/mobility-report/documents/2019/emr-november-2019.pdf

[37] European Commission, Strengthening strategic value chains for a future ready EU industry, 6 Nov 2019.

energy networks, public safety networks. The framework policy constraints surrounding these use cases in terms of security, privacy, reliability, deployment and even business models that may include public actors in the value chain, require an early involvement of public actors in the overall R&I process, in view of maximising public good.

According to the **Open Public Consultation**, the majority of almost all categories of stakeholders including academics, SMEs, large organizations, European citizens and NGOs find relevant or very relevant the important role of innovation in order to tackle the insufficient level of digitalisation.

In addition, for **most of interviewees** (no distinction of categories), there is a need to deliver an adapted network infrastructure to accompany industries in their digitalisation transformation program. Also, the importance of taking into account the impact of Smart Networks and Services on European industry tissue was as well highlighted by interviewees.

Finally, a comment from the **Open Public Consultation** emphasizes the necessity to bring a variety of stakeholders together considering the increasing cross-sectoral dimension of digitalisation programmes with industries including automotive, IIoT and energy.

2.1.4 Important societal issues of SNS little addressed today

A future initiative on smart networks and services would also have to address the potential conflict between the industrial incentive to develop and deploy a new smart network platform and the associated services, and the concerns of European citizens related to the impact of this new infrastructure on the environment and on their fundamental rights.

In particular, citizen are increasingly concerned by the processing of and access to the data generated on connectivity platforms and there is a potential disconnection between the objectives of the public interest and those of business driven entities, as exemplified by the current debate on the ePrivacy legislation. Also, citizens are increasingly concerned with the EMF exposure levels generated by wireless communication systems and these are already potentially hampering the take up of new technologies like 5G. Another important societal issue currently not well addressed is the accessibility: today, more than 3.5 billion people on the planet do not have Internet access, mostly because of lack of an affordable infrastructure. Finally, energy consumption is a well identified area of concern, as it is expected that the combined cloud plus network energy consumption will increase by a factor of 10 by 2030, reaching unsustainable levels in the absence of any significant technological improvement.

According to the **Open Public Consultation**, the relevance of considerations of societal or user needs varies according to the stakeholders. For most of the citizens, NGOs and academia, the issue is very relevant while for other categories of stakeholders, the majority of respondents indicated an average level of relevance.

2.2 What are the problem drivers?

The key problem drivers affecting R&I performance in the field of Smart Networks and Services in Europe are discussed in more detail in the following paragraphs.

2.2.1 Insufficient presence of EU actors in the global digital value chain

As presented above in section 1.2.1, the European current digital ecosystem is not in a very strong or favourable position. This threatens the future European technological sovereignty in not only future smart networks and services as the current players, will be under threats of rising , competition but also those industry segments and society at large

- "the verticals" that will need to use the Smart Networks Services, will be subject to increasing competition by their correspondents in other regions.

This problem is further reinforced by two factors:

- The Smart Networks and Services field is a sector with a strong R&D intensity, illustrating a high-risk research and innovation process. This puts European players at further risk as sustaining a leading position requires important investment in research and innovation.
- The Smart Networks and Services field is a sector that relies heavily on standardization, and ensuring a strong presence in Standardization requires a coordinated approach at the European level to ensure a critical mass of European contributions.

A fragile position of European actors in the global digital ecosystem

Europe cannot be considered as the leader for the 5G R&D (no specific advantage in terms of 5G technology), but is still a contender and stands out regarding some specific initiatives around verticals:

- Europe has major and very active 5G infrastructure manufacturers (Ericsson & Nokia), but the rest of the EU ecosystem developing the R&D is more limited: no smartphone manufacturer, some test equipment manufacturers (Rohde & Schwarz), software players and minor activities for chipsets (Sequans).
- Collaboration has started with various industries (Automotive, ports…) in Europe through R&D projects and represent a significant potential for 5G B2B services provision. The relatively strong position of European industry (as presented in section 1.2.1) present an opportunity for future European digital ecosystem.
- New form factors for devices (such as IoT) might provide an opportunity for Europe to regain a presence in the device industry.

Although satellite is likely to have a limited impact on 5G and beyond 5G research as well as business wise, it should also be noted that Europe has two of the world major satellite manufacturers.

Companies outside Europe participating to European R&D programs are mainly equipment vendors that have R&D laboratories in Europe. Countries present in past R&D programs mainly come from the USA (Intel, Interdigital, IBM…), China (Huawei), Japan (NEC, Mitsubishi) and South Korea (Samsung).

A key statement coming up from **interviews** commonly to all categories deals with the position of Europe lagging behind Asia and US. Indeed almost all interviewees mention the need to keep or regain European leadership in the value chain. Indeed, on network infrastructure, interviewees recognize the leadership of Europe with the presence of two mastodons – Nokia and Ericsson. On the rest of the value chain, Europe has lost its position on devices but for most of interviews there could be an opportunity to gain a leadership position on other fields like IoT devices and other emerging technologies like edge computing considered as critical topic. Europe should have the capacity to both support areas where Europe is good at in the value chain and create European alternatives in the whole supply chain.

Also, **interviewees** from academia categories draw the attention on the necessity to invest more in research in Europe in order to develop its potential, to remain competitive and to avoid shortage of skills and lack of ventures and start-ups.

High risk R&D reinforces the risks for European actors

Telecommunication equipment is among the sectors that have the highest research intensity, with an average value around 15% and going up to 30% for some actors. This level of R&D intensity is comparable to other R&D intensive sectors such as Pharmaceuticals and Semiconductors and is the sign of a R&D process that involves significant risks and requires huge investments.

The Table 33 in Appendix E illustrates this high research intensity and shows the limited presence of European actors in the field.

The interviews of stakeholders' further support this view of a risk prone R&D in the sector, and more importantly that R&D efforts need to be sustained overtime at all stage of the innovation process:

- from long-term R&D with low Technology Readiness Levels (TRL) (which prepare future generations of communication equipment and investigate very long term technological vision),
- to mid-term R&D (necessary to investigate how identified technology opportunities can transform into potential products),
- to short-term R&D (which investigate deployment issues and the future services enabled by the new infrastructure).

Without long term commitment and sustained R&D efforts at all stages of the innovation process, European industry players would take a significant risk of being, in short or long term relegated to secondary players or even disappear.

A need for critical mass in standardization

Being in the forefront of standardisation means that those driving standardisation will have a competitive advantage with respect to know how in development but also possibility to file systems and standards blocking (essential) patents and by this being able to position the products and services complying to standards and by this control the market. Generally, those that control the standards arena will have a competitive advantage.

Regarding standardization of 5G: European vendors are at the forefront of contributions to mobile standards. This can be attributed to the dedicated efforts toward standardizations in the 5G PPP programme. These joint collaborations facilitates submitting standards inputs in a concerted fashion with several partners undersigning and by this creating a European momentum. However, this place remains fragile, and Asia has a strong lead on 5G patents. A lack of future coordinated efforts of European actors in standardization, would lead to lack of the critical mass necessary to sustain the position of Europe.

At the end of March 2019, China had filed for 34% of standard essential patents (SEP) for 5G communication systems, an increase of more than 50% compared with its share of 4G patents, according to IPlytics.[38] South Korea had 25% of key 5G patents, while the share of filings by Japanese and U.S. entities was similar to the one for 4G. As mentioned in Appendix D (analysing KPIs of the 5GPPP), Europe has around 25% of 5G patents (but more than 50% on RAN), therefore behind China and South Korea. Figure 63 in Appendix E provides additional data on patent holders for 4G and 5G technologies.

However, the analysis of essential patents is complicated and an analysis taking into account the number of 3GPP contributions shows that **Nokia and Ericsson rank second**

[38] IPLytics, *Who is leading the 5G patent race?*, July 2019 available at: https://www.iplytics.com/wp-content/uploads/2019/01/Who-Leads-the-5G-Patent-Race_2019.pdf

and third behind Huawei. These contributions correspond to work item (WI) or study item (SI) level in the 3GPP standardisation work. Figure 64 and Figure 65 in Appendix E provide additional perspective on the number of submitted and accepted 5G contributions to the 3GPP. In the 3GPP standardisation process between 2015 and the first half of 2018, Nokia and Ericsson had a little bit more than 5000 contributions approved which is more than Chinese vendors Huawei and ZTE.

According to the **Open Public Consultation**, the potential lack of global standards has been seen as very relevant as a barrier to exploitation according to the majority of stakeholders in the categories of business association, large organization, EU citizen, NGO and public authority.

2.2.2 Insufficient structural capacity of the EU value chains in responding to requirements set by technological developments for smart networks and services

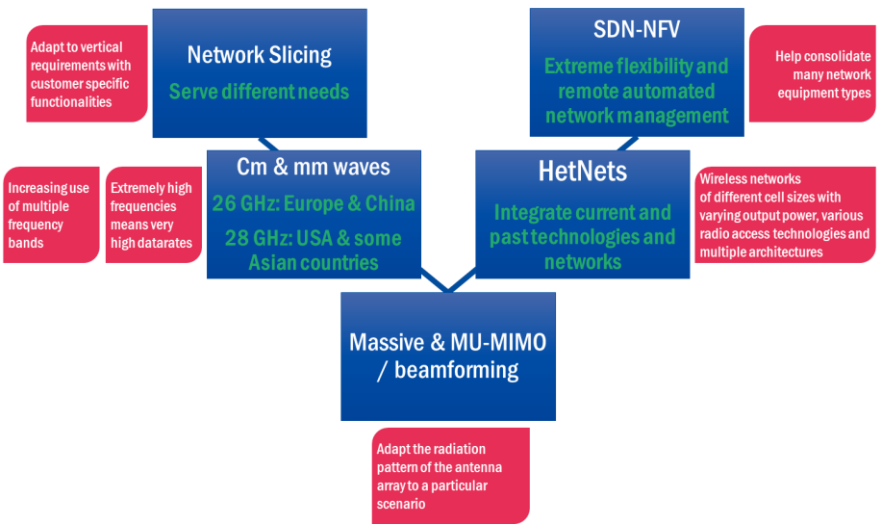
The future smart networks will be an infrastructure relying heavily on advanced digital solutions, that to be developed requires the involvement of actors beyond the traditional telecommunication value chain. Furthermore, the services that would be built on top of this infrastructure will have to address the needs of multiple vertical industries (ranging from automotive and manufacturing to transportation, energy, and health). For these industries the future infrastructure and the associated digital services will become critical, which requires their involvement in both defining the requirements and validating its implementation.

A future infrastructure relying heavily on advanced digital solutions

The development of future smart networks and services will require important interactions between the research on future telecommunication networks technologies and other digital technologies. A lack in synergies between these research activities would significantly reduce the potential impact of the initiative.

With 5G, software technologies have taken a critical role in the development of the future generations of telecommunication networks. The development of network slicing and SDN (Software Defined Networks) and NFV (Network Function Virtualisation) are key components of the 5G technological stack.

Figure 6: Examples of 5G Technology Enabler



Source: IDATE DigiWorld, 5G IoT – Market Opportunities in the Vertical Industries, 2018.

This rising importance of software is impacting the research ecosystem of the telecommunication industry. It requires dedicated investment in software technologies,

potentially reaching out of the traditional telecom value chain. A primary example of this need to reach beyond traditional research ecosystem is around the question of cybersecurity. A more important role of software in the network architecture increases the importance of research collaborations between cybersecurity players and telecommunication actors.

Furthermore, the development of an infrastructure able to fit the needs of the future "Smart Services" also requires integration and cooperation with other fields of research that reach beyond pure telecom infrastructure research.

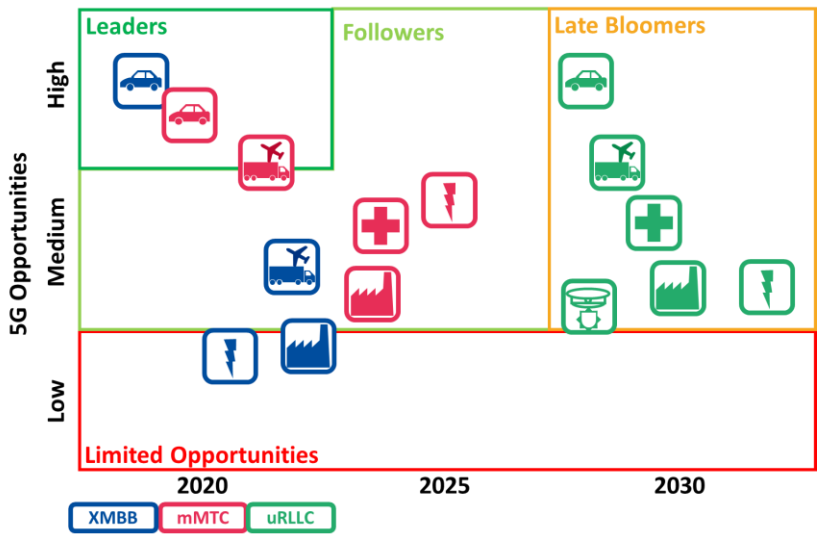
As such it appears necessary to many **stakeholders' interviewed** to ensure that future Smart Networks and Services research is sufficiently connected to research in IoT, but also edge computing, artificial intelligence (especially at the edge of the network), cybersecurity and cloud. These technologies will indeed by essential for the development of the future smart services and will also be directly applied to the network infrastructure themselves.

This also appears as a **feedback from the inception impact assessments**, which encourage the initiative to go beyond traditional telecommunication research and include both new technologies but also extend toward industrial applications and digital services.

An infrastructure critical for the adoption of digital solutions in many industries

The future network infrastructure is set to become a critical infrastructure for numerous industries that are transforming themselves by progressively adopting digital technologies. The initial research on 5G (as presented above in Section 1) has started to mobilise actors beyond the telecommunication industry and dedicated professional associations (such as the 5G AA and 5G ACIA) have been set-up to facilitate the collaboration between the fields.

Figure 7: Prospects of adoption of 5G in vertical use cases



Note: by sector (Automotive, Transport, Energy, Health, Manufacturing, Public Services) and technologies (eXtended Mobile Broadband, massive Machine Type Communication, ultra-Reliable Low Latency Communications).

Source: IDATE DigiWorld, 5G IoT – Market Opportunities in the Vertical Industries, 2018.

Future research on 5G, beyond 5G and 6G capabilities will thus have to take into account the requirements from the vertical players. The integration of the players from the vertical industries into Smart Networks and Services research will have to be strengthened. This investment of vertical players is necessary in order to develop both the research on future smart services needed by the various industries to transform themselves and an infrastructure able to meet their requirements.

The **stakeholders interviewed** support this vision and insist on the need to have a movement from both the telecommunication industry and the vertical industries to build future smart networks and services and on the necessity of a future programme to encourage such movement. Indeed, vertical industries role is key from the definition of the topics of the research (meeting their requirements) to the evaluation of the technology (applicability) but also in measuring the business approach (value creation) brought by the network technologies.

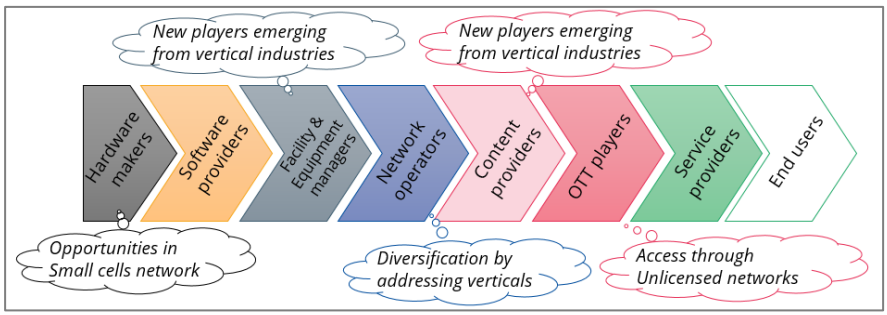
For the majority of **interviewees** with no clear distinction of specific category of stakeholders, the involvement of industries is key so that the expansion of the value chain beyond the traditional telecom one is required with notably the integration of vertical players. As a consequence, interviewees insist on the necessity to involve a wide variety of players in the structure of the research program, which is key to understand and to take into account the diversity of verticals' requirements like security, network coverage, energy consumption, ultra-low latency round trip.

An infrastructure that will require structural changes in various value chains

The telecommunication industry has been characterized by rapid changes triggered by the deregulation of markets, the increased competition and advancing technologies. At the industry level, mobile network operators have traditionally controlled and managed most of the value chain (with the support of OEMs developing the technologies), but the mobile ecosystem has evolved from a linear relationship into a network of specific companies involved at different stages in the value chain.

The emergence of new modes of communication like 5G is impacting the existing connectivity ecosystem. Indeed, 5G will not only enable new applications and services but also enable more new players to provide connectivity, services and even infrastructure. The virtualisation principle of 5G, for instance, will provide from the end-user perspective a unified network relying on several connectivity providers exploiting various technologies and infrastructures. It can be thus expected that more players will participate in the connectivity value chain.

Figure 8: Opportunities of evolution of the value chain



Source: IDATE DigiWorld, *5G IoT*, November 2018

Current connectivity providers (MNOs, MVNOs) will take the opportunity of these new technologies to try to diversify their offer and address new market segments (in specific verticals, including manufacturing) as a way to compensate declining consumer revenues.

Hardware equipment manufacturers can also see these new technologies as an opportunity to diversify their business modelling bundling equipment with connectivity service provisioning for example in the small cell area.

Some industrial solution providers, and potentially manufacturers, will also play a role in the new communication value chains, not only as content and service providers, but also as connectivity provider, infrastructure providers. The opening of vertical markets will also open up space for existing actors of the wireless industry to target specific roles for vertical

industries. The emergence of new possible roles will offer opportunities for both new and existing players within the vertical value chains.

Figure 9: New connectivity business models enabled by 5G

Source: IDATE DigiWorld, *5G IoT*, November 2018

This is reinforced by the integration of direct, proximity communications (such as public safety services or V2V, V2I) in the 5G standards, removing partially or even entirely in some case the need for a mobile operator in the value chain.

These evolutions of the value chain have a potential to disrupt existing businesses, and could threaten established European actors. They could also be seen as opportunities for Europe to reposition its industry and take a larger part in the digital value chain by relying on its strong existing industries. This will require dedicated actions to support the evolution of the European industrial ecosystems and support synergies between industries.

According to **interviewees** with no clear distinction of specific category of stakeholders, the value chain needs to evolve with players emerging from vertical industries. It will give the opportunity to provide new business models such as "Anything as a Service" model allowed by new technologies that provide flexible and open infrastructure.

This also appears as **a feedback from the inception impact assessments**, were several stakeholders pointed out the necessity to extend to a large ecosystem reaching out to vertical industries.

2.2.3 Too slow and uneven a development of 5G infrastructure

It is important to note that, although deployment issues are clearly beyond the scope of research programme, the investment need for the deployment of future network can strongly impact future research on smart networks and services.

Indeed, an insufficient investment in the deployment of 5G network in Europe would result both in delays in future research on networks by European players (no need to research solutions beyond 5G if 5G is not deploying), and in researches on the associated smart services (which require a deployed infrastructure).

Addressing deployment issues, and ensuring synergies between deployment and research activities is thus important to support R&I activities in the field, it is also of critical importance to ensure the development the European digital market.

The current deployment of 5G in Europe suffers from several factors that delay it in comparison to other regions of the world:

- A lack of investment in the deployment of the new infrastructure
- Insufficient synergies between national and European initiatives supporting 5G
- A lack of coordination of spectrum policies

A lack of investment in the deployment of the new infrastructure

The early development of 5G technology shows an increasing competition at the global level on network technologies and deployments of future infrastructure. The current state of play can be seen as a menace for European telecommunication equipment providers.

According to GSMA, a first stage of 5G investments corresponds to early deployments between 2018 and 2020 with $ 140 billion spent in the USA, South Korea, Japan, and China. It corresponds to two thirds of the global 5G CAPEX. The five largest European countries will contribute for $30 billion and GCC players will spend roughly $5 billion.

During the 2021-2023 period, Europe should double its 5G Capex reaching $100 billion as more EU Member States get 5G commercial services. In Asia and in the USA, 5G geographical deployment continue to expand.

After 2024, lagging countries in Latin America, Commonwealth of Independent States Middle East North Africa and other African countries will start to implement 5G infrastructures.

Some mobile operators have already announced their investments in 5G networks for the coming years:

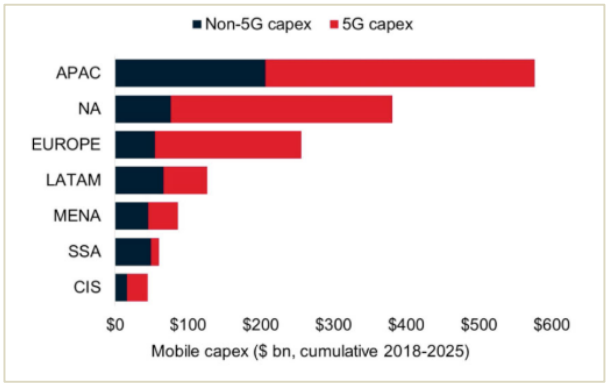
- Deutsche Telekom will invest €20 billion in its 5G network for the 2018-2021 period and targets 99% population coverage in 2025.
- U.K. operator Three has indicated that it will invest $2.57 billion in getting ready for 5G.
- In South Korea, SKT invested $5 billion between 2017 and 2019 to build the first part of its 5G network and KT announced a 5G investment of $20.5 billion between 2018 and 2023.
- Japanese incumbent, NTT Docomo will spend $8.8 billion between 2018 and 2023 on its 5G network.
- The US mobile operators have awarded multi-year contracts for 5G deployment to Samsung, Ericsson and Nokia. T-Mobile signed two contracts of $3.5 billion each to Nokia and Ericsson.

It is expected that the Radio Access Network (RAN) will represent 80% of the total CAPEX whereas the core network will amount for 20% of the total.

In China, the share of network equipment awarded to foreign vendors is controlled by the government. Huawei and ZTE are expected to get the lion’s share of network equipment for 5G networks in China. Consequently, Nokia and Ericsson are likely to get a lower share of the 5G infrastructure market in China compared to 4G.

China is expected to deploy hundreds of thousands of 5G base stations in the coming years whereas South Korea had already installed more than 90,000 5G base stations in October 2019. Ramp-up is going to be much slower in Europe with only hundreds of 5G base stations installed at the same date. This discrepancy in investment timetables might favour Chinese vendors against European ones.

Figure 10: Mobile capex by region



Source: GSMA Intelligence

According to the **Open Public Consultation**, a very large majority of respondents from the categories of academia, business association, SMEs, large organizations and EU citizen agree on the high relevance to address the innovation gap in the Europe in translating the results of connectivity, cloud and Internet of Things devices research.

This vision is also supported by almost all **interviewees** in the need from Europe to invest in the development of such technologies but above all to help bringing them to commercialization with trials and development of adapted use cases.

A lack of synergies between national and European initiatives supporting 5G

Past activities around 5G have seen the multiplication of initiatives supporting 5G research as well as 5G deployments in Europe at the European, Member States or Local level. These initiatives often miss opportunities for synergies and coordination.

The European 5G Infrastructure Public Private Partnership (5G-PPP) represents a €3.5 billion investment in 5G with €700 million of public investment. Public funding for Phase 1 (2014-2016) was €128 million and it should be noted that overall EU investments from 2007 to 2013 amount to more than €600 million in research on future networks, half of which was allocated to wireless technologies contributing to development of 4G and beyond 4G. Phase 2 of the 5G PPP represented €149 million and Phase 3 the remaining budget (€423 million). Work has already started on beyond 5G as €18 million have been granted by the European Commission for 6 projects.

Many European countries have launched national R&D programmes which are generally restricted to national participants. As an illustration, the table below shows national 5G research & development programs in Finland, Germany, Spain and in the United Kingdom. Even though the share dedicated to 5G cannot be identified exactly, this amount is quite high already in the UK and in Germany.

Table 5: National 5G R&D programmes

Country	National 5G R&D programmes
Finland	Business Finland is a publicly funded expert organisation for financing research, development and innovation in Finland with 467 MEUR of funding in 2016 (including 6 MEUR from EU structural funds) for 3,760 projects. Business Finland pushed the 5thGear program with €200 million funding for 2015-2019.
France	Many R&D projects on 5G financed by the national research agency ANR
Germany	€100 million from the "Gigabit Germany Initiative for the Future" €80 million from the "5G Initiative for Germany"

Country	National 5G R&D programmes
Spain	In March 2019, the Spanish Administration announced it will give €20 million in public funds to two 5G pilot schemes to be carried out by Telefonica and Vodafone
UK	£740 million (€834 million) to 5G trials and full fibre deployment across the UK by 2020/2021

Source: IDATE DigiWorld

It should be noted that 5G projects financed by national authorities often overlap the research and development thematic covered by European programs.

Even though players involved in national R&D programs and H2020 projects are mainly the same (vendors, universities, operators…), there is a risk of duplication of the financing effort at national and European level. More coordination is needed at European level in order to optimise resources dedicated to 5G research and development.

According to the **Open Public Consultation**, the market fragmentation due to lack of industrial policy and implementation strategies is seen as very relevant for R&I efforts at Europe level especially clearly expressed by the majority of SMEs. For the other categories including academics, business association, large organization and EU citizen, the topic remains relevant but at a lesser level.

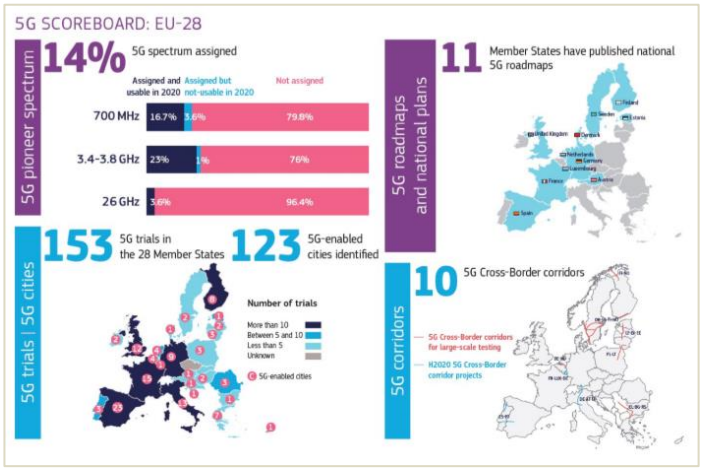
This vision is in accordance with **interviews** where they outline the need to make a link between research and deployment, especially requiring a focus on services and supporting use cases very early in the research program. A pragmatic approach is required in order to have the ability to translate innovation in commercialization. Also, many interviewees from different categories of players mentioned how Europe is good at technologies research but should work on business models and value generation. Lastly, interviewees also mention the lack of coordination to target a single market, lack of incentives to take research to commercialization stage and lack of global vision.

A lack of coordination of spectrum policies

5G pioneer bands identified at EU level are the 700 MHz, the 3.6 GHz (3.4-3.8 GHz) and the 26 GHz (24.25-27.5 GHz) frequencies. Whereas the 700 MHz band has been harmonised through an EC Implementing Decision (EU) 2016(687) of 28 April 2016, a '5G-ready' amendment of the 3.6 GHz implementing decision has been adopted in January 2019. The European Commission adopted an Implementing Decision to harmonise spectrum in the 26 GHz frequencies in May 2019.

Member States have adopted a common deadline for the effective usability of pioneer spectrum in the European Electronic Communications Code, namely the 3.6 GHz band and at least 1 GHz within the 26 GHz band have to be assigned in all Member States by end of 2020.

Figure 11: 5G scoreboard – June 2019



Source: European Commission[39]

However, there is no coordination between EU Member States regarding spectrum allocation conditions and at the end of June 2019**,** only 14.2% of the Pioneer Bands had been assigned in the EU (China is in a similar position). Bands are different in other regions of the world and can therefore not be totally compared. USA has already allocated all its spectrum for low bands, Japan and South Korea have almost allocated all their spectrum for mid and high bands (while Europe is lagging behind).

Lack of coordination of spectrum policies in EU creates uncertainties for the operators. This is already the case for bands as mentioned above. The use of frequency bands above 100 GHz will mean more R&D and more certainty regarding availability timetable for experimentations and future commercial use. A common approach to spectrum allocations is needed in order to limit the risk for the industry, as there is a risk that Member States will use the sales of spectrum as an alternative to general taxation, as has been done in the past.

With combination of verticals, combination of multiple regulatory environments become a challenge, whilst public actors may be called upon to play an increased role considering that many of the targeted verticals (healthcare, automotive/transport..) have a clear public policy dimension, different from broadband which is primarily driven by commercial forces (so regulation is mainly about fair competition, accessibility and consumer protection).

According to the **Open Public Consultation**, business associations, SMEs and large organizations find very relevant the regulation in the field of radio spectrum allocation.

For several **interviewees** from different categories, a strong coordination in Europe is required for spectrum harmonization involving the implication of Member States very early in the program. Indeed the spectrum fragmentation in cost and allocation is seen as a key issue (very irregular depending on the countries).

[39] European 5G Observatory, *5G Scoreboard*, June 2019 http://5gobservatory.eu/observatory-overview/5g-scoreboards/

2.2.4 Insufficient capacity of 5G to respond to advanced communication requirements

Future digital use cases such as super-immersive multimedia and super-high definition video, massive scale communications (IoT) for anything and anywhere, use cases requiring super-precision 3D positioning, and XR experience (AR+VR+MR) will have very demanding telecommunication requirements that exceed the foreseen capabilities of 5G, even in its most advanced roadmaps.

These future use cases include:

- **Super-immersive multimedia and super-high definition video:** going from 8K to 64 K video, with the integration of sensing, imaging and highly accurate positioning capabilities with mobility to enable the provision of new applications. The development of Five-dimension (5D) services, integrating all human sense information (sight, hearing, touch, smell and taste) is in early development and should be available in about 10 years from now. It will provide a truly immersive experience and new services such as telepresence.
- **Holographic telepresence:** Within a 10 year's timeframe, new forms of interaction will become possible leading to a true immersion into a distant environment. Holographic communications, using multiple-view cameras, will require data rates in the order of Tbps, which are not supported by 5G.
- **XR Experience (AR+VR+MR):** XR reality encompasses virtual reality (VR), augmented reality (AR) and mixed reality (MR). Future devices will include haptic interfaces, earphones, glasses and wearable displays that will replace smartphones and provide a totally new user experience.
- **Massive-scale communications (IoT) for anything and anywhere:** 6G networks will support extreme massive connectivity, with more than 500 billion connected things are expected worldwide by 2030. 6G will target capacity expansion to offer high throughput and continuous connectivity. Wider coverage is also planned, including bringing connectivity at sea and in the air.
- **Smart City:** The objectives are improvements of life quality, environmental monitoring, traffic control and city management automation. 6G smart city applications will include support for user-centric M2M communication and use low-cost and low-energy consuming sensors that will interact with each other. Autonomous vehicles will combine wireless networks, sensing and distributed AI.
- **Use cases requiring super-precision 3D positioning:** Many use cases will require super-precision 3D positioning such as commercial UAVs, ground-robotics navigation, lane-level navigation, industrial navigation and tracking, and heavy-machine navigation. 6G will foster the Industry 4.0 revolution and will see new semiconductor and integrated circuit innovations.

Based on this long-term perspective, the early requirement of future communication networks are starting to appear. Some of them can be considered as extensions of 5G requirements, but other are clearly disruptive, requiring major evolutions beyond the state of the art.

Figure 12: 5G and 6G technology requirements

KPI	5G	6G
Traffic capacity	10 Mbps/m²	~1-10 Gbps/m³
Peak data rate DL	20 Gbps	1 Tbps
Peak data rate UL	10 Gbps	1 Tbps
Uniform user experience	50 Mbps 2D everywhere	10 Gbps 3D everywhere
Latency (radio interface)	1 msec	0.1 msec
Jitter	Not specified	1 micro second
Reliability (frame error rate)	10^{-5}	10^{-9}
Energy/bit	Not specified	1 pJ/bit
Localisation precision	10 cm on 2D	1 cm on 3D

Legend: evolution, disruptive

Source: IDATE DigiWorld based on *6G - The Next Frontier*, 2019, Emilio Calvanese Strinati,et al., *6G: So, what happens in 2030?*, November 2019

Reaching these future requirements, will require new technological paradigms through the use of spectrum in the THz range (frequencies from 300 GHz to 10THz), innovations in semiconductors, optics and new materials, through a new architecture combining computation and communication resources, and relying heavily on artificial intelligence and machine learning. Energy-efficient communication strategies are also expected to become increasingly important, especially in view of a pervasive deployment of the Internet of Things, with myriads of tiny sensors. Energy harvesting mechanisms and advanced wireless-charging technologies will be developed with a focus on laser-charging techniques (potential of delivery of 2W of power up to a distance of about 10 metres).

According to respondents from both the **Open Public Consultation and interviews**, and for a high proportion of SMEs, there is an agreement on the necessity to enlarge the technological scope of the research program beyond 5G. Typically, in order to address critical applications, security should be addressed as well as a wide array of technologies including network intelligence, network automation, network softwarisation, network slicing, edge computing, cybersecurity, machine learning, Artificial Intelligence, IoT, robotics, high performance computing…

2.2.5 Increasing challenges of digital services toward ethics privacy and cybersecurity

The development of digital services in recent years has seen the rise of several challenges for EU citizen regarding their privacy, data protection, cyber security or more generally ethical concerns.

Several fundamental human principles can be challenged by the development of future smart networks and services, such as:

- **Identity and Reputation:** Several innovative smart services challenges the notions of Identity (relation that one bears to oneself) and of Reputation (relation that others bears to oneself). The limitation of digital technologies to define rationally such notions that are, by human nature, multiple, complex and changing raises several challenges. From the right to be forgotten to the right to have complex and evolving identities that cannot rely on a single online or offline identity. As future smart services are likely to more and more store but also increasingly generate automatically (through profiling and presentation) identities and reputation, serious challenges can be envisioned on the definition of human identity and reputation. The rise in profiling approach and the rising use of digital profile as a basis for real life services and interactions, and technologies

such as Artificial Intelligence can be seen as threatening these human fundamental notions.

- **Relationships:** Digital services based relationships also face the same danger as identity: to try to define rationally, in a Boolean approach the complexity and evolving nature of human relationships. The rise of digitally mediated relationships questions the future of human relationships as physical interactions and non-verbal language, key to human interactions, are for now mostly left out of digital relationships. Concerns can be raised both for those who are left out of the online conversation and for those for which the online conversation replace to a large extent real relationships. Questions of how to consider and handle relationships with purely digital avatars will also have to be handled as such relationships, once considered as farfetched science fiction become closer and closer to our reality.
- **Culture:** The disappearance of traditional boundaries of time and space enabled by smart networks and services is fuelling the definition of ever multiplying alternative cultures as group cutting across traditional boundaries come to define their own set of symbols and values that are coherent and meaningful in their understanding. At the same time the rapid ubiquitous communication mechanisms offered by new digital services enable the rapid spread of cultural elements. The application of evolutionary principles to cultural elements shows that faced to this increased creativity and competition traditional cultural elements could be put to risk. The human impact of putting cultures at risks, with the risk of violent reaction and protective isolative move is a serious challenge.
- **Motivation and Attention:** The collective data and knowledge production, publication, archiving and research capacity has since long far exceeded the human brain ability to process it. This raises serious challenges to both human attention (capacity to freely focus) and human motivation (capacity to freely choose on which information to process).
- **Responsibility:** The rising complexity of digital systems, often based on networks and sometimes decentralized, combined with the multiple roles of stakeholders result in near to impossible attribution of responsibilities in case of failure, error, or denegation of complex digital services. This will have stronger and stronger consequences as such systems get more complex and more intertwined with Physical devices in the vertical industries. Difficulty to attribute responsibility raises the double risk of either putting too much constraint on smart services providers (impeding their innovation capacity), or to the contrary that the risk entirely reposes on end users.
- **Fairness:** The existing risk of "Digital divide" can in a near future be significantly increased both in scale and impact. The differences in access to future network infrastructure and digital services, is being reinforced in a knowledge divide, which create the risk of a 2 speed society with a strong divide between those who master and understand digital technologies and their impact on society and life and those who don't. Additionally, questions of fairness, linked with responsibility, of automated decisions and algorithms will have to be raised. The intentions, and views of the world of the designer are embedded in every creation, therefore the fairness of the decisions can always be questioned even for supposedly neutral and machine automated choices.
- **Safety and Privacy:** Safety concerns are on the rise as digital technologies are having a stronger and stronger impact on everyday lives not only in online world but also increasingly offline. The rise of privacy concerns is also a well-documented risk as personal data collection; archiving, processing, transfer becomes the norm in many digital scenarios. Although these two notions are for now well covered by regulations, past example shows that these regulations were often put into place after the technology development, and that future development could challenge the status quo.

The relevance of this topic has been asked among stakeholders through the **Open Public Consultation** especially regarding the concerns with using Smart Networks and Services platforms for ethical, privacy, security, or EMF reasons. For a majority of respondents in several categories including academia, SMEs, large organizations, EU citizen the topic is evaluated as very relevant. For business association and public authority, the topic is seen as relevant but at a lower degree (which can be taken as a hint that this issue is unlikely to resolve only through market dynamics).

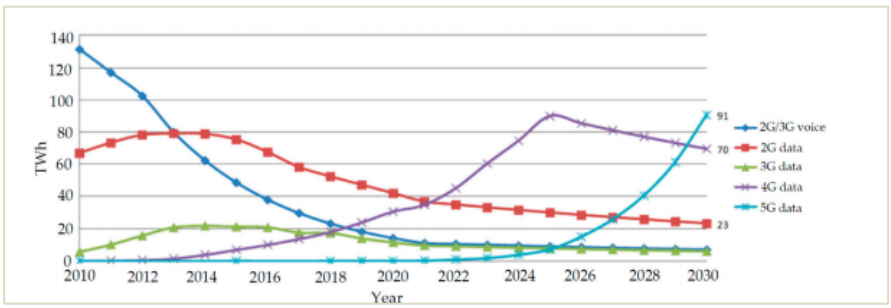
2.2.6 Lack of energy efficient technological solutions for future network infrastructures

The development and deployment of any infrastructure at a European scale will require significant energy consumption, resulting in increased emissions of greenhouse gases. Beyond this simple fact, the current lack of energy efficient technological solutions for future smart networks and services raise a significant threat in term of future energy consumption throughout the lifespan of the infrastructure.

Current feedbacks on the deployment of early 5G networks points toward an increase in energy consumption of the network. Furthermore, the development of new solutions, such as Edge Computing, that are likely to complement rather than replace cloud-based solutions will result in the deployment of additional computing resources, with increased energy consumption.

Current perspective on the electricity consumption of mobile network generation point to several years of steep growth of the energy consumption of new networks while legacy solution decreases slowly as they are rolled back.

Figure 13: Expected electricity usage of wireless networks



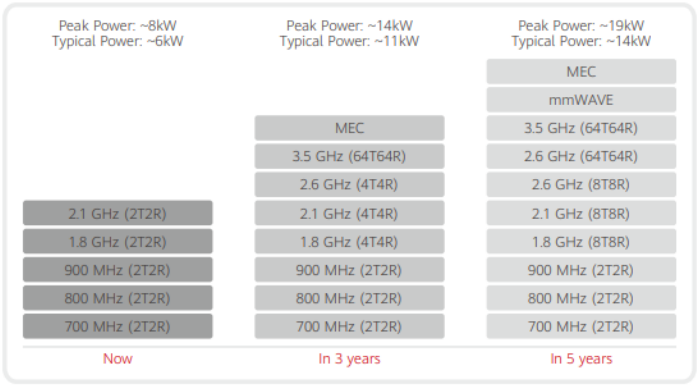
Source: Symetry/MDPI[40]

About 80% of the energy consumption in a network is due to base stations. In a recent whitepaper,[41] Huawei indicates that "According to the measured data of multiple operators, the power consumption of one band 5G equipment (64T64R, 3.5 GHz Massive MIMO, including one BBU and three AAU/RRUs) is 300% to 350% of 4G with the same configuration. A 5G BBU is about 300 W while an AAU is about 900 W at 30% load rate (peak is about 1200 W to 1400 W)."

[40] https://www.mdpi.com/2073-8994/11/3/408/pdf

[41] https://carrier.huawei.com/~/media/CNBGV2/download/products/network-energy/5G-Telecom-Energy-Target-Network-White-Paper.pdf

Figure 14: Power consumption of frequency evolution



Source: Huawei.

Furthermore, beyond energy issues, the development and deployment of a new infrastructure, as well as the development of new services requiring new devices (including new forms of devices, such as advanced AR/VR solutions or IoT devices) will require the extraction and transformation of primary resources that is very likely to have negative impacts on local environments.

As such and without a specific attention to mitigate these effects, the development of a future smart networks and services is likely to have major environmental impacts, which may not be compatible with other engagements and policies of the European Union and its member states.

Based on **interviews**, this topic is especially seen as primordial for the category of verticals who mention the importance of energy evoking the need to reduce energy consumption as well as the ability to use renewable energies (with the suggestion of new regulation).

This is a cross-referenced vision with the **Open Public Consultation** in which drastically reducing energy consumption of future smart network and service platforms is seen as very relevant for a couple of categories including academia, SMEs, large organizations, EU citizen and public authority; only the category of business association finds the issue at a lesser level of relevance.

2.3 How will the problem(s) evolve?

2.3.1 Limited European sovereignty on critical technologies of Smart network and service value chains

The limited European sovereignty on critical technologies of Smart Networks and Services value chains is set to have important consequences on European economies in the medium and long term

First it pauses a significant risk for the European players in the communication networks and digital services industry. They risk lagging behind in term of Smart Networks R&I, technological knowledge and deployment expertise. They also face a direct menace to their competitiveness and even survival in a competitive field.

Secondly, the potential loss of technological sovereignty of Europe on a future critical infrastructure, raises significant cybersecurity and safety issues

Third, a loss of expertise in Smart Networks and Services R&I is likely to translate into an uneven availability of the future infrastructure at the European level. If such infrastructure

is indeed to be a critical asset for many industries, this would in turn translate threats to several EU industry competitiveness.

2.3.2 Europe slow to deploy infrastructures platforms for innovation

The delay Europe is taking in the deployment of the critical infrastructures of Smart Networks and Services is also likely to have important consequences.

This raises a significant risk of an uneven availability of the future communication networks and services throughout Europe, leading to limited and fragmented adoption of new digital services by EU industries. This lack in adoption of digital solutions by European industries would translate into direct threats to their competitiveness.

Furthermore, this is also likely to ensure the development of digital services that are not directly adapted to the European market and thus not aligned with the European orientations on ethics, privacy and security, potentially threatening the well-being of EU citizens.

2.3.3 Europe failing to benefit from the full potential of the digitalisation of the economy

A future inability of Europe to benefit from the full potential of the digitalisation of its economy would translate in the long term into important issues.

First as, the future digital innovations will require important scientific progresses, there is a risk to see Europe being left behind in the global competition. Research on 6G infrastructure being developed mainly outside of Europe would have strong consequences on the long term competitiveness (and survival) of the European smart networks and services actors.

Moreover delays in European research on the next step of telecommunication and digital services research would also impact in the long term future deployments, limiting the availability of future infrastructure in Europe and impacting the industries that will require it.

Finally, the development of beyond 5G and 6G capabilities would also be essential in a perspective of developing technologies that limit the energy consumption and environmental footprint of the network.

2.3.4 Important societal issues of SNS little addressed today

If future smart networks and services fail to take into account the important societal issues, this is likely to have important consequences for European societies.

This includes potential impacts of future digital services on EU citizen privacy and cybersecurity, but also on the equal availability and safety of the other infrastructures that depend on the Smart Networks and Services. The development of new immersive digital services could also raise other ethical concerns such as threats to users' capacity for attention and memory.

Furthermore, the creation of a new communication network represent an expenditure of energy that will result in greenhouse gas emissions. The extent to which the future infrastructure is energy intensive may further contribute to negative environmental impacts all over the life cycle of the infrastructure. Without dedicated actions to mitigate this risk, the development of smart networks and services would challenge European commitments to address global warming.

3 Why should the EU act?

Two major elements support the necessity of the action to be done at the European Union level: a need for cooperation and mobilization of resources at the scale of the continent and a necessity to reach a critical mass to ensure Europe position in the global competition.

3.1 Subsidiarity: Necessity of EU action

3.1.1 An action at the scale of the continent

Future research on smart networks and services necessitate to mobilize resources, knowledge and stakeholders that are across Europe.

This is the case for industrial players both inside the telecom value chain and in other vertical industries. The development of the next generation of communication equipment, networks and services requires cooperation between actors across the telecom value chain that are most often found outside of a single country.

The necessity to gather requirements, harmonize research activities, and invest collectively into test deployments and proof of concepts with actors from the vertical industries further amplify this need for cooperation between actors from various member states.

Furthermore, from a purely research and academic perspective, the cooperation between research centres, universities and other academic partners all across Europe, is of key importance for the scientific excellence of Europe.

At the member state and institutional level coordination is also needed between the different local initiatives and policies regarding the spectrum allocations and support to deployment.

3.1.2 A need for a critical mass to position Europe

The commercial success of future networks technologies depends strongly on efficient standardization. To be able to achieve this push toward standardization, coordination is needed between actors across the value chain and across countries. The relative success of European standardization efforts on 5G so far can be attributed at least in part to the efficient coordination of activities through the 5GPPP programme.

As presented above, the global competition in the telecommunication ecosystem is high and further reinforces the need for a critical mass of efforts at the scale of Europe to ensure the technological sovereignty of Europe, the persistence of European actors in the global competition, and the timely development of an infrastructure that will be critical for many industries in Europe.

3.2 Subsidiarity: Added value of EU action

An action at the EU scale is seen as necessary to ensure long term support, stability of the initiative and to make sure it is aligned and in synergy with other EU policies and funding.

3.2.1 A long term, stable support

An action at the scale of EU is seen by many stakeholders as an opportunity to ensure long term vision and support to the field of smart networks and services. The importance of a long term vision for the next generation of communication networks (which will be a critical infrastructure) has been voiced by various actors.

Furthermore, the stability of funding mechanisms and reliability of payment systems appear as important elements to encourage the research activities and the investment of both industrials and SME actors.

Action done at Member State level is often criticized by the stakeholders **interviewed** as having a risk of facing national political instability that can push for rapid changes of priorities. An action at the EU level on the contrary is perceived as more stable and reliable for long term issues.

3.2.2 Coordination with other EU policies and funding

Another potential added advantage of an action at the level of the European Union, is the possibility to ensure better liaison and coordination with other EU policies and funding.

This argument has been put forward both in the **member state consultation** and in **interviews** with the stakeholders.

Future research activities in Smart Networks and Services would benefit from synergies with other initiatives and partnership supported by Horizon Europe. They would also benefit from coordination with the actions supported by CEF and Digital Europe, and also with potential liaison with the Invest Europe fund activities, or with structural and regional funds that could be mobilized to support local deployment of innovative technologies and services and innovative business opportunities.

3.2.3 Support to the development of a single market and the deployment of EU critical infrastructure

An action at the EU level would also facilitate the development of a unified market for telecommunication and digital goods at the European Level, by pushing for more harmonization between national legislations and regulations.

Furthermore, the initial deployments enabled by the research activities would pave the way for the deployment of a communication infrastructure that will be critical for many European industries and services as well as society at large.

4 Objectives: What is to be achieved?

4.1 General objectives

In order to tackle the problems identified in Section 2, it is important to clarify the objectives of EU action in the field of research and innovation. We have identified four general objectives corresponding to the main problems discussed in Section 2.1.

Ensure European technological sovereignty in future smart networks and services

An initiative on Smart Networks and Services would also have to help to ensure a European technological sovereignty over the field of smart networks and services.

As seen above, the European technological sovereignty in the field is seriously at risk. The already insufficient presence of European actors in the global telecommunication value chain risk to be further challenged by structural issues in a value chain that is set to evolve and involve new actors. This leads to serious concerns on the place of Europe in Smart Networks and Services R&I, but also on the security of European assets and industries and on the deployment of the future infrastructure in Europe.

This objective is in line with the objectives of Horizon Europe of fostering the competitiveness of European industries, of delivering economic impact and strengthening the attractiveness of the European Research Area. It is also aligned with the political

orientations of a "Europe fit for the digital age" as defined by the president-elect of the European Commission[42] that insist on the need for European technological sovereignty and with orientation supported by the European Political Strategy Centre.[43] This objective would contribute to SDG8 and SDG9.

Strengthen the uptake of digital solutions in the European markets

Another essential objective of the initiative would be to strengthen the European digital market by supporting the deployment of an infrastructure that will be critical both for numerous European industries and for answering important societal needs.

The current European deployment of the 5G infrastructure is being delayed by various factors, ranging from lack of investment of private actors to lack of synchronization of national initiatives, or regulation and spectrum allocation issues. Furthermore, the necessary reshuffling of the connectivity value chain, with the emergence of new actors, risk to further delay deployments and adoption. This requires dedicated efforts to ensure both that a market for 5G and beyond 5G infrastructure and services develops and Europe and that this development is done at the scale of the European continent.

This objective is in line with the objectives of Horizon Europe of supporting the uptake of innovative solutions in European industries and with the European policy objective of establishing a digital single market. This objective would contribute to SDG 8, SDG 9 and SDG 11.

Develop digital innovations answering European needs

An initiative on Smart Networks and Services would also have to ensure the European contribution to the development of the future digital services, through the invention of new solutions and the development of new technologies.

The current technological capabilities of 5G, and even the capabilities foreseen within the 5G roadmap will not be sufficient to meet the most advanced requirements in term of telecommunication of future digital services. These future smart services, ranging from super-high definition and immersive multimedia, to pervasive IoT and ultra-reliable and responsive automation in transportation and industry will require a new infrastructure. Lack of European participation to the development of 6G would result in important negative impacts on the place of Europe in the field, and the competitiveness of its industry.

This objective is in line with the objectives of Horizon Europe of developing, promoting and advancing scientific excellence.

Ensure the alignment of future smart networks and services with EU policy and societal needs

Finally, the initiative should make sure that the development of future smart networks and services are fully aligned with EU policy and societal needs.

The increasing challenges raised by digital services toward ethics, privacy and cybersecurity of European citizen, raise serious questions about how the future Smart Networks and Services would impact European citizen lives. Furthermore, the environmental cost of developing and deploying a new communication infrastructure are significant, challenging the European commitments to address global warming and to limit

[42] https://ec.europa.eu/commission/sites/beta-political/files/political-guidelines-next-commission_en.pdf

[43] European Political Strategy Centre, Rethinking Strategic Autonomy in the Digital Age, July 2019 : https://ec.europa.eu/epsc/sites/epsc/files/epsc_strategic_note_issue30_strategic_autonomy.pdf

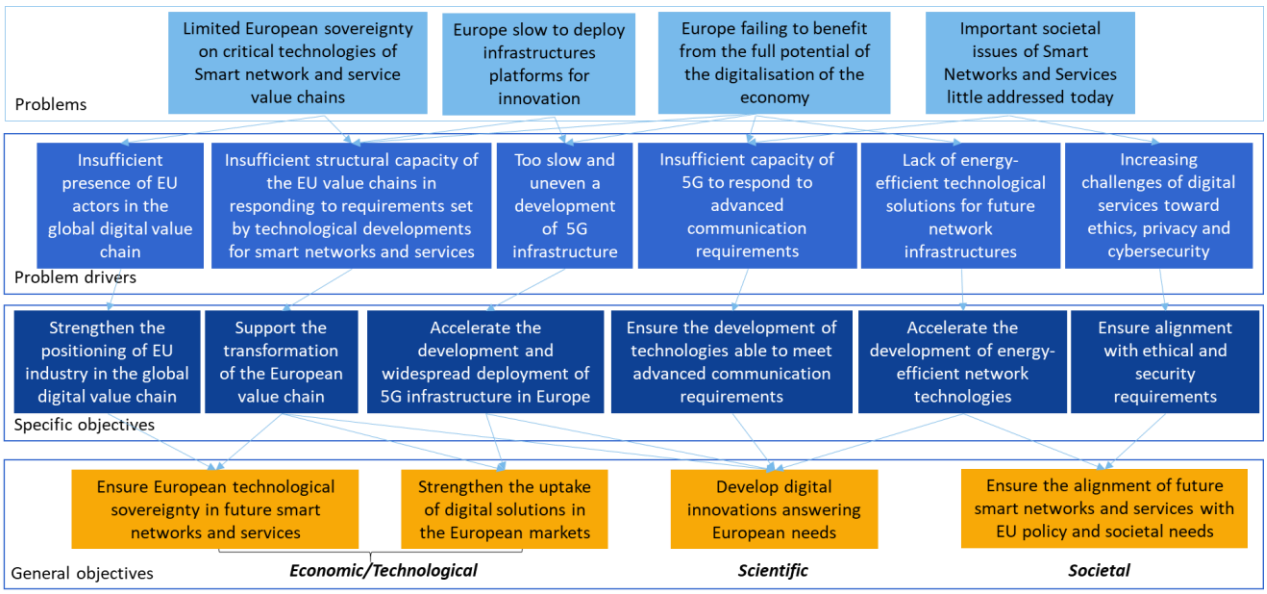
environmental impacts. As such it appears necessary to ensure the alignment of a future initiative with the core principle of a human-centric, sustainable internet.

This objective is in line with the Horizon Europe objectives of the political orientations of a "European Green Deal" as defined by the president-elect of the European Commission[44]. This objective would contribute to SDG 10, SDG 12, and SDG 13.

4.2 Specific objectives

In order to achieve the general objectives, we defined 6 specific objectives. These specific objectives respond to each of the problem drivers discussed in Section 2.2. The relationship between the general and specific objectives is shown in Figure 15.

Figure 15: Objectives tree for the initiative on Smart Networks and Services



Ensure the development of technologies able to meet advanced communication requirements

To support long term evolution of telecommunications networks and digital services, a Smart Networks and Services initiative would have to ensure the development of technologies that are able to meet advanced communication requirements of future applications.

The current (and foreseen) 5G infrastructure capabilities will not be able to meet the most advanced requirements of future digital applications, ranging from end-to-end very low latencies, extreme high reliability, extreme coverage, significant improvement of battery life and extreme massive connectivity (scaling to trillions of devices). This inability of 5G to meet the most advanced requirements could result in potential delays and limitation in the foreseen future digital services, with consequences for the future industries that will need them for their digital transformation.

As such the future initiative should have dedicated activities targeting the long term evolution of 5G and setting up the basis of the 6G infrastructure.

[44] https://ec.europa.eu/commission/sites/beta-political/files/political-guidelines-next-commission_en.pdf

Accelerate the development of energy-efficient network technologies

To ensure that the future smart networks and services are aligned with the EU policy and societal needs, it is essential to accelerate the development of energy efficient network technologies.

There is a current lack of technological solutions able to significantly reduce the energy and resource consumption of the whole infrastructure. This applies throughout the digital infrastructure from cloud services, to the communication network core, to the base stations, potential edge computing solution, and ultimately to the connected devices. This also applies throughout their lifecycle, from their conception to their deployment, lifetime activity and disposal. Digital infrastructure and solution as a rapidly increasing impact on the environment and the development of future Smart Networks and Services is a serious challenge to European commitment in term of environmental policy.

As such, the initiative should aim for the development of scientific and technological solutions aiming at reducing the impact of communication networks and digital services.

Accelerate the development and widespread deployment of 5G infrastructure in Europe

To strengthen the development of the European digital market, the initiative should aim at accelerating the development and widespread deployment of 5G and beyond 5G infrastructures in Europe.

The current deployment of the 5G infrastructure is showing significant signs of delays in Europe compared to other regions of the world. As seen above, this is linked with multiple failures ranging from a lack of private investment, to a lack of synchronization of European initiatives, to uneven policies and regulations regarding spectrum allocation. The delay of Europe in the field raise serious challenges for multiple European industries and their competitiveness.

As such the initiative should ensure coordination and support to activities aiming at accelerating the deployment of the communication infrastructure.

Support the transformation of the European value chains

To both ensure the European industrial leadership and sovereignty in the field of Smart Network and Services and support the uptake of digital solutions in Europe, the initiative should support the transformation of the European value chains.

As we have seen the development of the future Smart Networks and Services raises several structural challenges in various value chains: the traditional telecommunication value chain will have to evolve to integrate new actors and technologies from the digital value chain, and the connectivity and digital transformation of the industries will imply evolutions of their connectivity value chains with new roles, offering and actors. A lack of evolution of the existing ecosystems and value chain will result in both threat to the industry competitiveness and to the development and uptake of the infrastructure.

As such, the initiative should support these evolutions of value chains by setting up activities that incentivise industrial actors to rethink their roles, positions and connections.

Strengthen the positioning of EU industry in the global digital value chain

To ensure the European technological sovereignty in future smart networks and services, a future initiative would have to strengthen the positioning of the EU industry in the global digital value chain.

As presented above, the position of the European industry in the global digital value chain is uneven and fragile. It also faces important challenges such as the need sustain a high

level of research intensity to remain competitive in the field and the need to establish a critical mass presence in standardization activities. This threatens existing European industrial actors in telecommunication and digital services, but moreover, it also represents a security risk for European assets and industries.

As such the initiative should promote initiative aiming at increasing the presence of European actors in the digital value chain and supporting the emergence of new actors such as new types of connectivity providers or producers of new forms of connected devices.

Ensure alignment with ethical and security requirements

To ensure the alignment of future smart networks and services with EU policy and societal needs, a future initiative should ensure that future developments are in line with the European ethical and security requirements.

The challenges raised by digital technologies toward ethics, privacy and cybersecurity have been rising in recent years as these technologies take a more and more important part in EU citizen lives. The development of new digital services enabled by the future smart networks is likely to create new challenges. These potential impacts severity risk to be reinforced as the new infrastructure aim to become a critical component of numerous essential services (transportation, health, energy).

As such the initiative should define activities to ensure that future technology development remains aligned with the ethical and security expectations of European citizens.

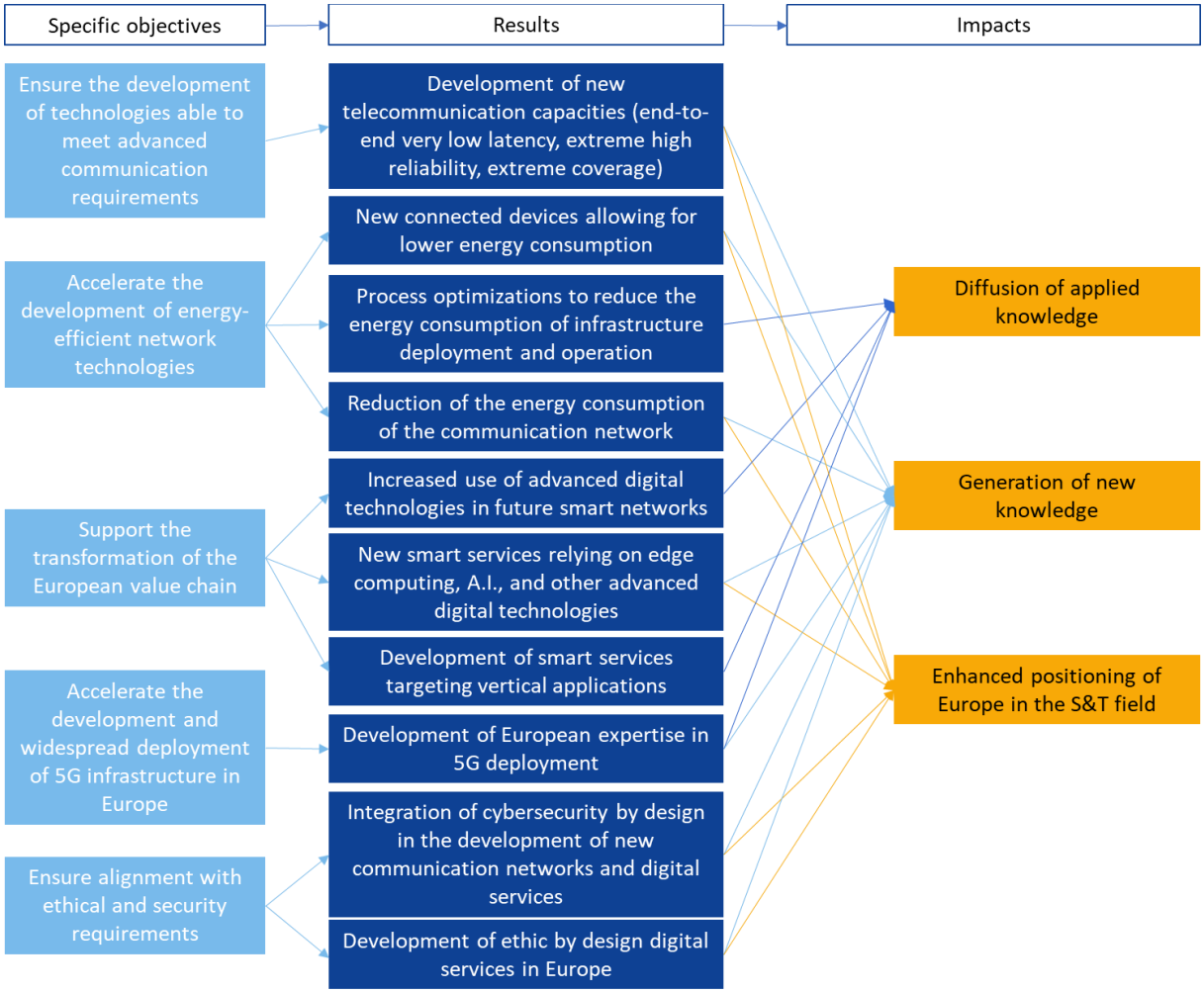
4.3 Intervention logic and targeted impacts of the initiative

4.3.1 Likely scientific impacts

The initiative is likely to lead to three key scientific impacts, as illustrated in Figure 16 and further described below.

The following figure presents a mapping of the scientific impact pathway of a future initiative on Smart Networks and Services.

Figure 16: Impact pathway leading to scientific impacts



The future initiative on smart networks and services would have a direct impact **on the generation of new knowledge in the field.** This impact will enfold on medium to long term perspective and is relevant for both scientific and research communities in the field of Smart Networks and Services as well as European industrials. This will be achieved through the results of multiple activities of the initiative:

- The development of long term telecommunication capabilities will require the creation of new knowledge to meet the most advanced requirement of future digital services
- The development of an energy efficient network will also requires major scientific breakthrough in both the consumption of devices and of the network infrastructure itself
- The development of new digital services for the industries that will go through a digital transformation will require the use of advanced technological solutions (Edge computing, A.I., etc.)
- The need to accelerate the development and deployment of the infrastructure will also require the creation of new knowledge and expertise in 5G deployments.
- Finally work to ensure that future solutions are aligned with European ethics and cybersecurity requirement will also contribute to scientific progress in the field.

The generation of this new knowledge through the initiative will contribute significantly to **European competitive positioning in the field** ensuring the excellence of the European research field. This impact will be very relevant for the European research and academic communities in a medium to long term perspective.

The initiative will also have important impacts on the **diffusion of more operational and applied knowledge** through several activities especially around two points:

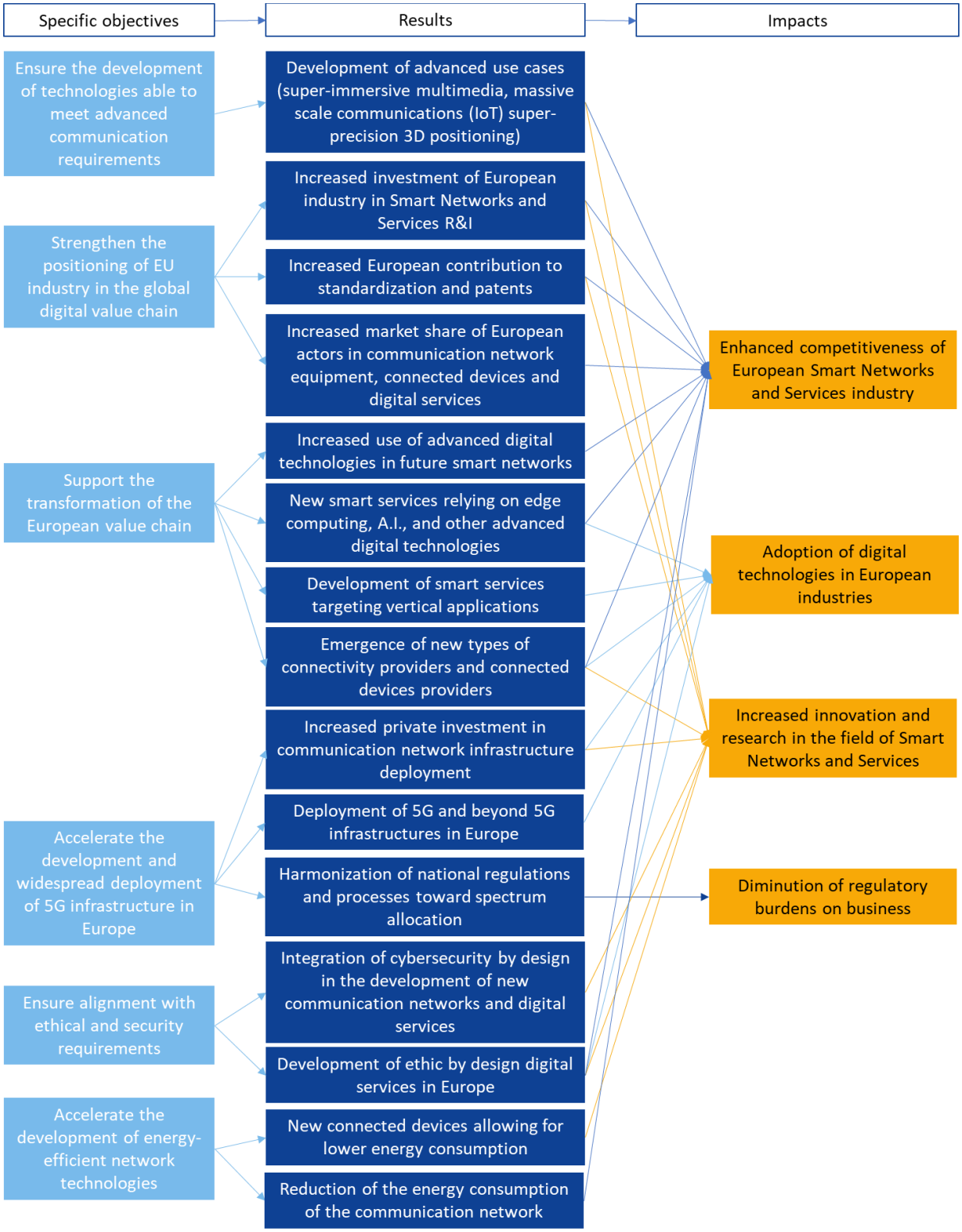
- The development of operational knowledge around the deployment and operation of future network infrastructures, including specific knowledge on processes necessary to reduce the energy consumption of the network.
- The development of applied knowledge through the increased adoption of digital applications and services in various vertical industries (automotive, transport, health, energy, manufacturing, etc.).

This impact will be somewhat relevant mainly for the European industry both specific to the Smart Networks and Services and in the vertical industries.

4.3.2 Likely economic/technological impacts

The likely key economic/technological impacts of the initiative are mapped in Figure 17.

Figure 17: Impact pathway leading to economic/technological impacts



As such an initiative on Smart Networks and Services should contribute to **an enhanced competitiveness of the European industrial ecosystem** on the field of Smart Networks and Services. This should be achieved through the support that the initiative can bring to the private investment of the European industry and the coordination of standardization efforts. But also through the support of elements that could become differentiators for future European actors (existing or emerging): the increasing use of advanced digital technologies, the development of new and disruptive use cases, or the differentiation on ethics behaviour and energy use. This impact will be very relevant for the European Smart Networks and Services industries and SMEs and can be achieved only in a medium to long term perspective.

The initiative can also aim to have a significant impact on **the adoption of digital technologies by European industries**. This can be achieved through an initiative that will support the development of new smart services, targeting explicitly the vertical industries and making a large use of advanced digital solutions (A.I., Edge, cybersecurity) while providing a high level of ethics, safety and security assurance. It will also be facilitated by an initiative that increase the overall availability and deployment of the new network infrastructure and that favours the emergence of new types of connectivity providers able to target European industries with dedicated offerings. This impact will be very relevant for the European industrials and SMEs of Smart Network and Services, in addition it will be also relevant more generally for the European industries (verticals) and the European citizens at large that will benefit from the adoption of digital technologies. Its first impact may be achieved in relatively short term, and should enfold fully in medium and long term.

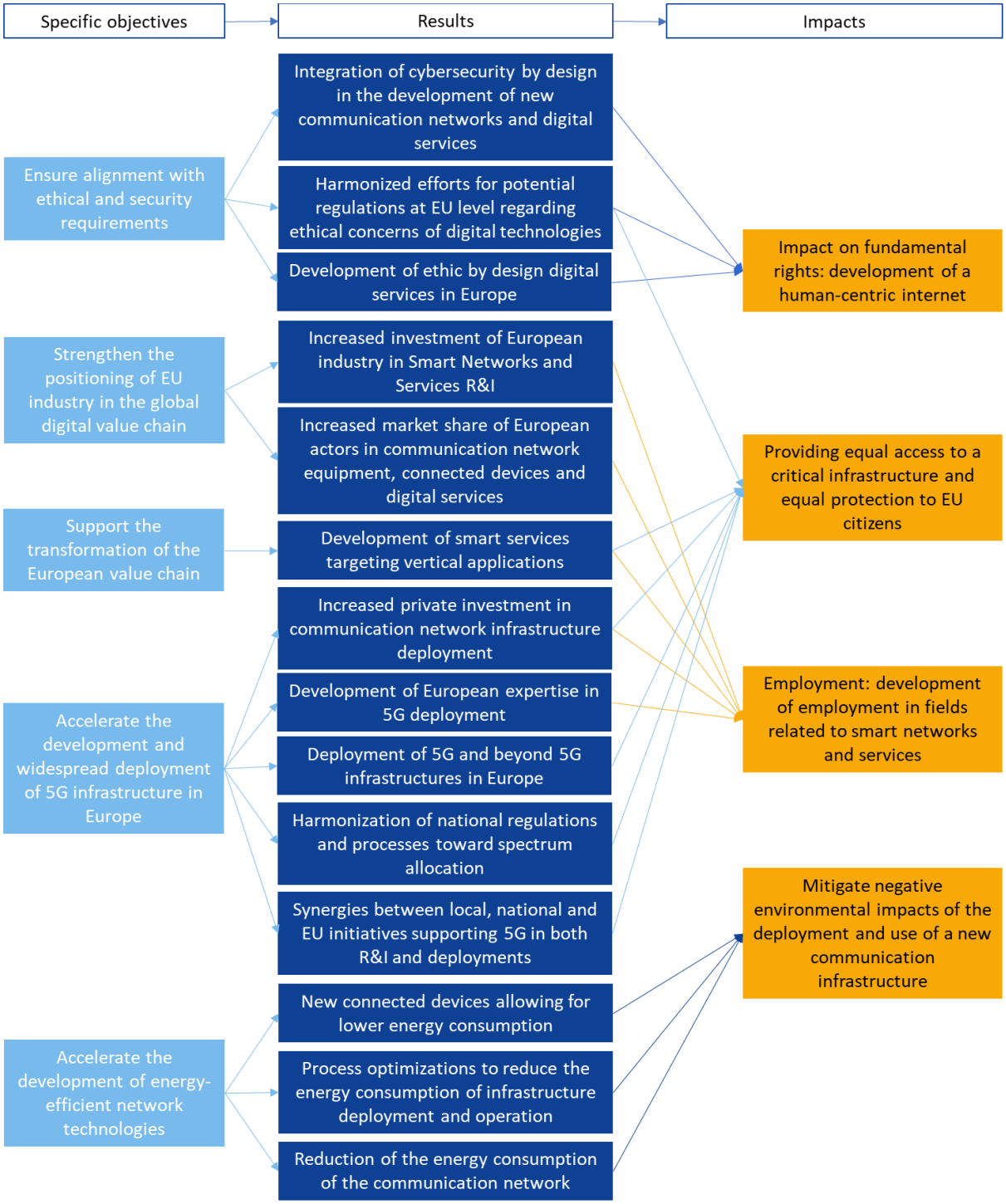
Another central goal of the initiative that should translate into impacts refers to **the increased innovation and research in the field**. This should be a result of the globally increased direct investment of the European industry in the field as well as of the deployment of the new infrastructure (which by itself will require innovation). It will also derive from thematic orientations promoted by a future initiative such as a focus on energy consumption, ethics and cybersecurity, or the support of a long term evolutions of communication networks. This impact will be mainly relevant for the stakeholders already involved in the digital economy, industrials and SMEs that are providing smart networks and services solutions as well as key digital technologies. This impact has a potential to materialize in relatively short term and in a longer term to extend to other stakeholders (vertical industries).

Finally the initiative should also have some impacts on **the regulatory burdens of businesses**, through dedicated actions toward the harmonization of national regulations and processes around spectrum allocation and usage. This impact will be somewhat relevant for member states and the industrials in the smart networks and service domain, especially the ones deploying and operating telecommunication networks (which can extend beyond traditional telecom operators in the 5G/6G perspective and reach toward vertical industries). It will materialize only in a medium to long term perspective.

4.3.3 Likely societal impacts

The scientific and economic/technological impacts discussed above will also support the attainment of societal impacts as shown in Figure 18.

Figure 18: Impact pathway leading to societal impacts



Likely environmental impacts

The development and deployment of a new network infrastructure in Europe is likely to have significant negative impacts both in term of use of resources and consumption of energy.

As such a potential desirable impact of the future initiative would be to **mitigate these negative impacts**. This could mainly be achieved by specific research targeting the energy consumption and resource use of future network installations and connected devices.

This impact would be very relevant for European societies, member states (who have established target of reduction of their environmental impacts) and European citizens. It will materialize in medium to long term.

Likely social impacts

A first social impact of the development of Smart Networks and Services will be on the ability **to provide equal access to a critical infrastructure to EU citizens.** The support brought by the initiative to the development and deployment of a new infrastructure, and the development of services that are centred on vertical domains applications is likely to result into a better availability of important services to European citizens.

This impact can start to materialize in relatively short term depending on the actions of the initiative supporting deployments. But will take medium to long term to have a real lasting impact. It is a relevant impact for European citizens.

Another important social impact of an initiative in the field of Smart Networks and Services would be on the **development of employment in the field**. The development of automation (that will be enabled by future Smart Networks and Services) may pause some threats to specific employments. However the development of the ecosystem in Europe (and especially the fact that the initiative could strengthen the relative position of Europe in the global market) is likely to provide benefits to EU citizens by providing employment opportunities.

This impact will materialize relatively rapidly through the investments of the partnership and of the industrials involved. It will develop steadily and provide positive impacts for European citizens and member states for which this impact is relevant.

4.3.4 Likely impacts on simplification and/or administrative burden

The initiative is unlikely to create impacts in terms of simplification or administrative burden of the R&I activities supported under Horizon Europe.

4.3.5 Likely impacts on fundamental rights

Finally, an initiative on Smart Networks and Services could have some **impacts on fundamental rights**. As exposed above, the development of digital services increasingly has ethical impacts on end users, affecting notions such as identity, responsibility, autonomy, motivation and attention or challenging their safety and privacy.

The foreseen activities of the initiative toward the integration of cybersecurity and ethics as by-design components of future smart services could mitigate this negative impact and combined with dedicated efforts in regulations and legislations could even attempt to have a positive impact at the European level.

This impact can only be achieved in a medium to long term. It is an impact that is relevant for EU citizens and Member States.

4.4 Functionalities of the initiative

This section outlines the functionalities that need to be considered when assessing the policy options in Section 6, reflecting the selection criteria for European Partnerships defined in the Commission proposal for the Horizon Europe Regulation.[45] In the following paragraphs, we discuss the implications of the criteria relating to the type and composition of the actors involved, the range of activities to be undertaken and the directionality required if the initiative is to deliver the objectives discussed above. We also consider the complementarities and synergies with other, related initiatives under Horizon Europe and beyond.

4.4.1 Internal factors

Type and composition of the actors involved

This functionality relates to the criterion "Involvement of partners and stakeholders from across the entire value chain, from different sectors, backgrounds and disciplines, including international ones when relevant and not interfering with European competitiveness". It concerns the need to involve the full range of stakeholders that can usefully contribute to delivering the future R&I agenda.

Core players: telecommunication research communities and industrials

A first type of players to involve in a future initiative around Smart Networks and Services would be the networking and telecommunication research communities and industrials of the telecommunication value chain, as they are likely to be at the core of any future European research on Smart Networks and Services. This has been demonstrated by the results of the 5G-PPP programme as well as by the participation to traditional R&I programmes

Along with the networking and telecommunication research communities it appears also as important to involve domains that are related to "pure networking" technologies such as Internet of Things research, edge computing, cybersecurity and some segment of artificial intelligence research. This is well illustrated by the problem driver defined in section 2.2.2.

On the industrial side, the participation of the whole value chain, from hardware and software telecommunication component and equipment manufacturers, to the telecom operators would be beneficial. Indeed while equipment manufacturers are likely to be leading in many research activities, the participation of operators allows both to address their requirements in term of deployment and to benefit from their early deployment capacity on the most mature scenarios.

Involving verticals: providers of requirements and validation

As mentioned above and presented in detail in the problem driver section 2.2.2, the future Smart Networks and Services have the ambition to become a critical and highly dependable infrastructure that would allow the "vertical" industries to transform themselves by adopting digital technologies.

As such the participation of research communities and industrials from various industries (mainly: automotive, manufacturing, transport, healthcare, and energy) would be

[45] European Commission (2018), 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, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018PC0435&from=EN

beneficial to the initiative. Their role should however be controlled and stay mostly around the following points:

- The definition of requirements and capabilities of the future network and smart services, to make sure they will meet their needs.
- The participation to proof of concepts and validations test, ensuring the requirements defined are met, testing the possibilities of integrations with other digital services and validating pre-commercial services.
- In some specific case, the possibility for some vertical actors to position themselves as communication services providers to support the evolution of the value chains (as described above in section 2.2.2.

Openness: room for SMEs and welcoming new players

As presented in the problem drivers sections 2.2.4 and 2.2.2, the future of smart networks and services will require the development of new solutions that involve technologies that reach beyond the usual scope of the telecommunication value chains (such as cybersecurity, artificial intelligence, or potentially some link with development of vertical industries). Furthermore one of the objective of the initiative would be to support the development of an industrial leadership in the domain at the European level (responding to the problem driver 2.2.1 "Insufficient presence of EU actors in the global digital value chain". Definitely, SMEs have a role in the development of new technologies but also in the development of use cases, directly applicable to the market.

As such, it appears as important to allow a significant involvement of SME and an ability to welcome new players in the initiative. These new entrants could indeed be essential in building up future European leaders.

There is a need to have a combination of different categories of players including universities and SMEs which are vital in the research program.

International cooperation: openness, with a requirement of reciprocity

Regarding the potential participation of international actors, our analysis has highlighted the following points:

- International cooperation in research is often beneficial and a necessity, especially regarding long term research, and pre-standardization research. It can allow to gain weight in future international standardization activities and can potentially attract talent to the European Research Area. However, it is important to ask for reciprocity and real commitment in international research initiatives.
- The telecommunication and networking equipment industry is globalised, with research centres and industrial development sites deployed across multiple continents. As such, even though the support for a European technological leadership would be desirable; to be realistic, a future initiative cannot be too closed on international actor participation.
- As presented above as part of the problem driver 2.2.1.1 "A fragile position of European actors in the digital ecosystem", the international competition on Smart Networks and Services industries is important, and the place of European actors can be at threat. Furthermore given the potential strategic nature of the future network infrastructure, a technological sovereignty of Europe would be desirable.

Taking this point into account, the approach of a future initiative should be a cautious openness, harnessing international cooperation and the participation of international actors as relevant, while keeping potentially some strategic subjects (such as cybersecurity related) more closed.

Participation of the Member States

The participation of member states to a future initiative could involve different activities and level of involvement. Our analysis highlight the following points:

- A need for synergies at the European level between national regulations and legislation regarding spectrum allocation, and electromagnetic emission regulations. This appears as an important point to allow the emergence of a European single market. This is described in detail as part of the problem driver 2.2.3.3 "Lack of coordination of spectrum policies"
- A potential for synergies between national initiatives regarding research and innovations. As presented above as part of the problem driver 2.2.3.2 "A lack of synergies between national and European initiatives supporting 5G", many member states have launched national initiatives focusing on Smart Networks and Services, ensuring liaison and synchronization between these initiatives and the R&I activities supported by the initiative would be beneficial.
- A potential support to projects that go into deployment activities such as proof of concepts, advanced large scale trials and early deployment operations. These project, needed to answer to the problem driver described in section 2.2.3 will require the basis of an infrastructure deployment in order to validate the technology and concepts researched. This infrastructure will be by essence a local development and as such likely to benefit the local ecosystem beyond the deployment. As such it could be argued that this type of project could also be supported by national, regional funding or by the Important Projects of Common European Interest (IPCEI) program[46].

Type and range of activities

A strong need for R&I activities

This functionality relates to the criterion "Approaches to ensure flexibility of implementation and to adjust to changing policy, societal and/or market needs, or scientific advances". It concerns the types of activity that the initiative is intended to encourage, such that it is able to respond effectively to the challenges and problems described in Section 2.

Regarding the activities of the initiative, the R&I activities will have a central place, similar activities to the ones used in Horizon 2020 are considered as mostly fit to address the R&I challenges of Smart Networks and Services. However the following observations have to be taken into account:

- A future initiative should be able to support activities all across the spectrum of TRLs and with perspective at long, medium and short term. As mentioned above, this appears as important to not only support research on the current and emerging generation of technologies but also to ensure long term commitment to research that prepare long term evolutions and potentially breakthrough technologies. As such, each iteration of the initiative activities could have dedicated activities targeting differently:
    - Short term research on technology applications, early deployment and novel usages, such as the use of the emerging 5G infrastructure on smart applications targeting essential vertical industries in large scale pilots.
    - Medium term research on specific feature development going beyond 5G capabilities and operational research addressing deployment and scaling up issues

[46] https://ec.europa.eu/commission/presscorner/detail/en/IP_14_673

for ultra-reliable low latencies communications and massive machine type communications.

- Long term research on fundamental of telecommunication science and technology, targeting a long term vision of future communication networks.

- Another element that appears as important in the activities of the future initiative is to ensure a complementarity of different projects and ensure their ability to cover strategic topics and interact and work together as a global initiative rather than as separated, isolated projects. This could be ensured by specifying cooperation conditions in the calls, through modifications of the projects in the evaluation and granting phase, and by dedicated activities supporting ongoing projects.
- Finally it also appears as important that the initiative is equally able to support roadmap-based activities and bottom-up activities, which could be supported by dedicated activities or through the use of cascade funding by project open calls.

Directionality and additionality required

This functionality relates to the criteria "Common strategic vision of the purpose of the European Partnership" and "Creation of qualitative and significant quantitative leverage effects". The former highlights the importance of ensuring that all participating stakeholders have a common understanding of the purpose of the policy intervention and the direction of the R&I activity it is intended to encourage. The leverage effects relate to the creation of spill over effects of the knowledge gained in the broader community as well as the crowding-in effects on private investments in R&I – both among participating stakeholders and in the broader community, and/or the pooling of resources from EU Member States.

Strategic focus

Our analysis of the stakes of future research on smart networks and services highlight the following points:

The importance of long term, clear commitment of support to R&D. This is directly in link with the identified problem driver (Section 2) of important risks in telecommunication equipment and services research and development. The research intensity of the sector is one of the highest, and the global competition is important with potential direct threat to European actors. As such only a long term significant commitment appears as able to support the ambitious objectives defined for the initiative.

Governance

The set-up of the adequate governance institution for a future potential initiative on smart networks and services appears as one of the issues that will be the most critical in the set-up of the initiative.

It is indeed faced with two conflicting requirements:

- A necessity to have an efficient organization, that is smooth and function with low friction while being able to tackle strategic issues at the European scale.
- A tendency of the initiative to involve a large variety of stakeholders ranging from networking technology research institutions, to telecommunication industrials but also potentially various European and member states governmental bodies and institutions, as well as vertical industry representative.

As such what appears as a viable solution would be distinguish between different levels of involvement in the initiative.

Strategic participation to the initiative should be kept with a focus on institutions financing the core research and innovation activities of the initiative (i.e. the European Union and a representation of the core industry participant through an association).

A second level of participation should be used to open the initiative to other institutions through thematic, focused sub-activities. Such as ensuring the participation of vertical industry representatives but limited to the sub-activities in which they are needed (requirements, pilots and validation), or ensuring the liaison with national initiatives and funding of local deployments while not making national participation a prerequisite for the funding of research activities.

4.4.2 External factors

The proposed Regulation for Horizon Europe also identifies the need to consider *"Coordination and complementarity with Union, local, regional, national and, where relevant, international initiatives or other partnerships and missions"* when assessing the case for a partnership. It concerns the potential for linkages with other relevant R&I initiatives proposed or planned for the forthcoming Framework Programme, at the EU level in the context of the MFF 2021-27, and beyond.

Beyond the necessary activities in research and innovation, it also appears as important for the initiative to be able to establish liaison and potentially coordination with other type of funding for related activities:

- Given, once again the ambition of the initiative to lay the technological basis for a future critical infrastructure, it appears as essential to ensure some relay and liaison with initiatives that could fund deployment activities of the future initiative. This is the case at the European Union level of CEF2 Digital but also could make sense at national and even regional level through the use of national or regional funding or through European structural and regional funds.
- Taking into account the ambition of the initiative to support the development of European industrial leadership in the sector and the potential emergence of new European industrial actors, the initiative should be able to liaise and interact with other initiatives that are dedicated to the funding of innovative actors, such as the European Investment Fund or private venture capital initiative such as Invest Europe.
- An initiative on Smart Networks and Services would also have to establish liaison and coordination with several aspects of regulations and legislation: this could range from an harmonization of European approach to spectrum allocation and regulation to the promotion of specific regulations on energy consumption (to favour or impose the use energy efficient solutions in the deployment of a new infrastructure) or of regulation toward the security and ethic impact of future digital services.

5 What are the available policy options?

In this section, we provide an overview of the key characteristics of the policy options for this initiative. The Horizon Europe regulations put forward three forms of European Partnerships that constitute the policy options for this initiative; standard Horizon Europe calls are a fourth option while acting also as a baseline against which the three partnership options will be compared.

To ensure a correct assessment of the different options and their effectiveness, it is crucial to take into consideration both the objectives and the functional requirements outlined in Section 4.4. The descriptions of the options in the sections below therefore focus on the implications of the options' characteristics related to these functionalities. They are based on the options' characteristics specifically related to the functionalities listed in Section 4.4.

A full description of the options is provided in the report on the overarching context to the impact assessment studies.

5.1 Option 0: Horizon Europe calls (baseline)

Based on the options standard description put forward in the report on the overarching context to the impact assessment studies, the baseline option would be traditional calls under the Framework Programme.

Table 6: Key characteristics of Option 0 – Horizon Europe calls (baseline)

	Implications of option
Enabling appropriate profile of participation (*actors involved*)	• The Commission would need to consult extensively with a wide range of stakeholders to translate the strategic R&I agenda for Smart Networks and Services into an annual work programme. This consultation would require to extend to different communities (with potentially their own strategic R&I agenda such as: 5G/6G, IoT, Edge, digital transformation of various vertical industries…) • A well-defined process would be needed to ensure that the programme committees were properly informed about R&I priorities, including key demonstration programmes. • The specification of calls over the period of the Framework Programme could reflect the need for an evolving profile of participation, with different consortia forming at different stages to take different types of activity forward.
Supporting implementation of R&I agenda (*activities)*	• Implementation would include traditional R&I activities ranging from research action to research and innovation actions (with the possibility to extend up to demonstration and validation activities). It would also include coordination and support actions. • Calls for proposals would be published in the work programmes of Horizon Europe. • Transparency and open publication of results would ensure their availability to interested parties.
Ensuring alignment with R&I agenda (*directionality*)	• Work programmes would need to reflect the requirement for R&I activity across TRLs, with input from representatives of all relevant stakeholders. • Specification of calls for activity at higher TRLs, particularly demonstration programmes, would need substantial input from industry. • R&I activity would focus on the short to medium term needs of the industry, although it would also include fundamental research. • Commission input into specification and oversight of calls would help to ensure alignment with overarching policy objectives but full integration with other programmes would require additional coordination. • Each project and activity would function individually without strong coordination.
Securing leveraging effects (*additionality*)	• Progress of R&I effort would depend largely on EU funding, with no expectation of significant leveraging of industry support. • Given more limited funding than in the past, critical R&I priorities would need to be identified at the outset.

5.2 Option 1: Co-programmed European Partnership

Based on the options standard description put forward in the report on the overarching context to the impact assessment studies, an initiative based on a co-programmed partnership would be based on a memorandum of understanding signed between the European Commission and third parties such as industrial associations in the field of Smart Networks and Services and possibly Member States.

Table 7: Key characteristics of Option 1 – Co-programmed European Partnership

	Implications of option
Enabling appropriate profile of participation (*actors involved*)	• The partnership would enable participation by all key stakeholders potentially contributing to the specification and delivery of the strategic R&I agenda. • The partnership is likely to build upon the existing structure of the 5GPPP but would have to include new stakeholders to fully cover the scope of the Smart Networks and Services topic. • It would need to consult with a wide range of stakeholders to ensure that the R&I agenda, and ultimately the work programme, was aligned with industry and market needs. • At the same time, it would offer the flexibility to change the profile of participation over time, with new partners joining to support new areas of activity in response to emerging results and changing priorities.
Supporting implementation of R&I agenda (*activities)*	• Implementation would rely on standard administrative infrastructure underpinning the open calls procedure, drawing on resources of relevant executive agencies and Commission IT systems. • Implementation would include traditional R&I activities ranging from research action to research and innovation actions (with the possibility to extend up to demonstration and validation activities). It would also include coordination and support actions. • Calls for proposals would be published in the work programmes of Horizon Europe. • Transparency and open publication of results would ensure their availability to interested parties.
Ensuring alignment with R&I agenda (*directionality*)	• Work programmes would need to reflect the requirement for R&I activity across TRLs, with input from the various partners to achieve an appropriate balance of activity directed towards different vertical markets (e.g. automotive, manufacturing, transport, health, energy). • The partnership would be responsible for ensuring that priorities for calls were specified in line with R&I priorities, including demonstration programmes. • Extensive efforts would have to be put in place to ensure coordination with other initiatives at the European level (CEF), National and Regional level. • The work programme would build on, but not be constrained by, the 5GPPP programme to ensure continuity where appropriate. • R&I activity would nevertheless be likely to focus on the medium-term needs of the industry.
Securing leveraging effects	• Aspirations for partner contributions would be clearly defined at the outset.

(*additionality*)	• Expected in-kind contributions from the private sector would be identified in the work programme. • The agreement to commit resources would be non-legally binding and subject to "best efforts" from the involved stakeholders

5.3 Option 2: Co-funded European Partnership

The Co-funded Partnership is based on a *Grant Agreement* between the Commission and the consortium of partners, resulting from a call for a proposal for a programme co-funded action implementing the European Partnerships in the Horizon Europe Work Programme.

Table 8: Key characteristics of Option 2

	Implications of option
Enabling appropriate profile of participation (*actors involved*)	• Partners can include any national funding body or governmental research organisation, Possible to include also other type of actors, including foundations. • It is not possible to have the Smart Networks and Services industry associations, or other vertical industry associations as partners. • Requires substantial national R&I programmes (competitive or institutional) in the field and therefore limited the participation to few MS with existing national SNS, 5G or 6G programmes. • Usually only legal entities from countries that are part of the consortia can apply to calls launched by the partnership, under national rules.
Supporting implementation of R&I agenda (*activities)*	• Activities may range from R&I, pilot, deployment actions to training and mobility, dissemination and exploitation, but according to national programmes and rules. • The decision and implementation are responsibility of the partners through institutional funding SNS programmes, or by "third parties" receiving financial support, following calls for proposals launched by the consortium. • The scale and scope of the initiative is limited and depends on the participating programmes. The resulting funded R&I actions are typically smaller in scale than FP projects.
Ensuring alignment with R&I agenda (*directionality*)	• The strategic R&I agenda/roadmap is agreed between the MS and EC without the participation of industry. • The annual work programme drafted by partners, approved by EC. • Objectives and commitments are set in the Grant Agreement. • The coherence of the partnership with other actions of the can be ensured by partners and EC. • There are strong synergies with national/regional programmes and activities, and they can be ensured by the MS. • Synergies with other European programmes or industrial strategies are limited.
Securing leveraging effects (*additionality*)	• Low possibilities for leverage of industry contribution as industry does not participate in the decision making.

5.4 Option 3: Institutionalised European Partnership

5.4.1 Institutionalised Partnerships under Art 185 TFEU

Article 185 of the TFEU is a complex and high-effort arrangement and is based on a Decision by the European Parliament and Council and implemented by dedicated structures created for that purpose. It allows the Union to participate in programmes jointly undertaken by MS and Associated Countries.

Table 9: Key characteristics of Option 3: Institutionalised Partnership Art 185

	Implications of option
Enabling appropriate profile of participation (*actors involved*)	• Partners can include MS and Associated Countries. • It is not possible to have the Smart Networks and Services industry associations, or other vertical industry associations as partners. • Non-associated third countries can only be included as partners if foreseen in the basic act and subjected to conclusion of dedicated international agreements. • Good geographical coverage is required with participation of at least 40% of Member States • The existence of substantial national R&I programmes (competitive or institutional) in the field is required • While by default the FP, rules apply for eligibility for funding/participation, in practice (subject to derogation) often only legal entities from countries that are Participating States can apply to calls launched by the partnership, under national rules.
Supporting implementation of R&I agenda (*activities)*	• Horizon Europe's standard actions that allow a broad range of coordinated activities from R&I to uptake apply. • In case of implementation based on national rules (subject to derogation) the activities follow the national programmes and rules. • The option allows the integration of national funding and Union funding into the joint funding of projects
Ensuring alignment with R&I agenda (*directionality*)	• The strategic R&I agenda/roadmap is agreed between partners and the EC • The objectives and commitments are set in the legal base. • The annual work programme is drafted by partners and approved by the EC • The commitments include the obligation for financial contributions (e.g. to administrative costs, from national R&I programmes).
Securing leveraging effects (*additionality*)	• Low possibilities for leverage of industry contribution as industry does not participate in the decision making.

5.4.2 Institutionalised Partnerships under Art. 187 TFEU

Based on the options standard description put forward in the report on the overarching context to the impact assessment studies, an initiative based on an institutionalized European partnership under article 187 would create a dedicated implementation structure through a decision of the European parliament and council.

Table 10: Key characteristics of Option 2 - Institutionalised Partnership under Art 187 TFEU

	Implications of option
Enabling appropriate profile of participation (*actors involved*)	• The partnership would enable participation by all key stakeholders potentially contributing to the specification and delivery of the strategic R&I agenda through a clearly defined membership structure. • It would provide a forum for consulting stakeholders on R&I priorities and the work programme, ensuring that they were aligned with industry and market needs. • Participation would be less flexible than under other options, but it might nevertheless be possible to change the profile of participation over time, with new partners joining to support new areas of activity in response emerging results and changing priorities.
Supporting implementation of R&I agenda (*activities)*	• A dedicated administrative structure would be established to coordinate the specification of R&I activity, manage implementation and report on the results. • Implementation would include traditional R&I activities conducted under Horizon Europe ranging from research action to research and innovation actions (including coordination and support actions). • Activities would also extend to demonstration and validation activities, actions fostering regulation and standardization, and support to infrastructure deployment and access to finance.
Ensuring alignment with R&I agenda (*directionality*)	• The partnership would be responsible for specifying a work programme fully in line with the R&I priorities identified by the industry, combining activity across the TRLs (including key demonstration programmes) and with application in different vertical industries (e.g. automotive, manufacturing, transport, health, energy). • The work programme would reflect the medium to long term needs of the industry, drawing on the perspectives of different stakeholders. • Commission participation in the partnership governance arrangements and approval of the work programme would help to ensure alignment with overarching policy objectives and enable integration with other programmes.
Securing leveraging effects (*additionality*)	• Legally binding funding requirements would be clearly defined at the outset, with private sector partners expected to provide between 50% and 75% of partnership resources through in-kind and/or financial commitments. • A contribution from the Member States in the form of in-kind contribution (such as access to spectrum frequencies and infrastructures) would also be likely in the case of the Smart Networks and Services initiative.

5.5 Options discarded at an early stage

The Co-Funded partnership (Option, 2) and an Institutionalised Partnership created under Article 185 of the TFEU (Option 3a) are not considered relevant for the impact assessment of the candidate Institutionalised Partnership on Smart Networks and Services.

In both of these options, the partnership is established only between the European Union and Member States, without representatives from the industry. This would make these option ill-fitted with the objectives and desired functionalities defined in Section 4 as:

- The general objective of ensuring the European technological sovereignty in future Smart Networks and Services, as well as the specific objectives of accelerating the development and deployment of 5G infrastructures and supporting the transformation

of European value chains, or strengthening the position of European industries in the global digital value chain, would require a strong and dedicated participation of the European Industry, which would in these two option not be a part of the partnership.

- The desired functionalities of the initiative point for a need of involvement of a broad ecosystem of stakeholders, ranging from traditional network and telecom actors to a large diversity of industries (verticals).
- The participation of the industrials to the definition of the research and innovation agenda in smart networks and services appears as important to ensure both that the development of the future infrastructure is aligned with the industrial needs (especially the needs of the vertical industries) and to ensure their take-up and strong commitment of the programme.

As such the fact that co-funded partnership and Art.185 partnership do not allow for participation of industry representative appears as a severe limitation of these instrument that would allow to discard them before the comparative assessment.

6 Comparative assessment of the policy options

6.1 Assessment of effectiveness

Based on the intervention logic, the initiative aims to deliver scientific, economic/technological and societal (including environmental) impacts through a set of pathways (Section 4.3), which require a set of critical factors in place to be achieved in the best possible way (Section 4.4).

This section assesses the extent to which each retained policy option has the potential to allow for the attainment of the likely impacts in the scientific, economic/technological and societal sphere, based upon its characteristics (Section 5). At the end of each section we summarise the outcomes of the assessment by assigning a non-numerical score to each option for each impact desired.

The assessments in this section sets the basis for the comprehensive *comparative* assessment of all retained options against all dimensions in Section 6.4.

Table 11 lists the desired impacts in the three impact areas.

Table 11: Likely impacts of the initiative

Impact area	Likely impacts
Scientific impact	• Generation of new knowledge
	• Diffusion of applied knowledge
	• Enhanced positioning of Europe in the S&T field
Economic / technological impact	• Enhanced competitiveness of European SNS Industry
	• Increased innovation and research in the field of SNS
	• Adoption of digital technologies in European industries
	• Diminution of regulatory burdens on businesses
Societal impact	• Development of a human-centric internet
	• Equal and safe access to a critical infrastructure
	• Development of employments in field related to SNS
	• Mitigate negative environmental impacts

6.1.1 Scientific impacts

Option 0: Horizon Europe calls (baseline)

Regarding the **generation of new knowledge**, an initiative using traditional calls could benefit from the traditional instruments of the Horizon programme, which are **well aligned with the need to promote research and to fund ambitious research through a competitive process** at the scale of Europe.As such this option would have a "good" impact on that dimension.

Regarding the **diffusion of applied knowledge**, this option is to be ranked lower than the alternatives. Although the traditional R&I instruments of the Horizon programme do enable the diffusion of knowledge, this option would lack the **synergies with larger deployments opportunities**, and **connections with vertical industries** foreseen in the other options. As such this option would have a "low" impact on that dimension.

Regarding **the enhanced positioning of Europe in the science and technology** field of Smart Networks and Services, this option is comparable with the other options as from a purely scientific positioning perspective, **traditional R&I instrument have demonstrated** their full ability to promote high quality research and ability to **promote the European scientific community**. As such this option would have a "good" impact on that dimension.

Option 1: Co-Programmed

Regarding the **generation of new knowledge**, an initiative using a co-programmed partnership would benefit from the traditional instruments of the Horizon programme, which are **well aligned with the need to promote research and to fund ambitious research through a competitive process** at the scale of Europe. In addition, the partnership would bring a **stronger coordination of the research** and a better **link of the generated knowledge to the industrial needs**. It would also bring a **stronger commitment** from the involved stakeholders to the research activities. As such this option would have a "high" impact on that dimension.

Regarding the diffusion of applied knowledge, this option would benefit from some synergies with larger deployments opportunities, and connections with vertical industries, brought by the ability of the partnership to establish liaison with other initiatives and to bring a stronger commitment from industrial players. However the impact of these synergies would likely be less important than for an institutionalized partnership which would benefit from the force of legally binding commitments. As such this option would have a "good" impact on that dimension.

Regarding **the enhanced positioning of Europe in the science and technology** field of Smart Networks and Services, this option is comparable with the other options as from a purely scientific positioning perspective, **traditional R&I instrument have demonstrated** their full ability to promote high quality research and ability to **promote the European scientific community**.

As such this option would have a "good" impact on that dimension.

Option 3: Institutionalised Art 187

Regarding the **generation of new knowledge**, an initiative using an institutionalized partnership would benefit from the traditional instruments of the Horizon programme, which are **well aligned with the need to promote research and to fund ambitious research through a competitive process** at the scale of Europe. In addition, the partnership would bring a **stronger coordination of the research** and a better **link of the generated knowledge to the industrial needs**. It would also bring a **stronger commitment** from the involved stakeholders to the research activities.

As such this option would have a "high" impact on that dimension.

Regarding the **diffusion of applied knowledge**, this option would benefit from some **synergies with larger deployments opportunities**, and **connections with vertical industries,** brought by the ability of the partnership to establish **liaison with other initiatives** and to bring a **stronger commitment from industrial players.** The force of l**egally binding commitment** brought by an institutionalized partnership would further reinforce this impact.

As such this option would have a "high" impact on that dimension.

Regarding **the enhanced positioning of Europe in the science and technology** field of Smart Networks and Services, this option is comparable with the other options as from a purely scientific positioning perspective, **traditional R&I instrument have demonstrated** their full ability to promote high quality research and ability to **promote the European scientific community**.

As such this option would have a "good" impact on that dimension.

Summary

Table 12 below, lists the scores we assigned for each of the policy options, based upon the assessments above, as well as taking into account the support expressed by the different stakeholders.

Table 12: Overview of the options' potential for reaching the scientific impacts

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Art 187
Generation of new knowledge	++	+++	+++
Diffusion of applied knowledge	+	++	+++
Enhanced positioning of Europe in the S&T field	++	++	++

Notes: Score +++: Option presenting a *high* potential; Score ++: Option presenting a *good* potential; Score +: Option presenting a *low* potential

6.1.2 Economic/technological impacts

Option 0: Horizon Europe calls (baseline)

Regarding the ability to increase the competitiveness of European Smart Networks and Services industry, this option would only benefit from the impact of R&I projects. But it would lack the stronger commitments of the industry brought by partnerships. It would also lack the impact of potential synergies with deployment activities that can be harnessed in partnerships. Furthermore, it would mostly concentrate R&I activities on stakeholders already active in the field, limiting opportunities for new entrants and SMEs to create space in the value chain.

As such this option would have a "low" impact on that dimension.

Regarding the increased innovation and research in the field of SNS, this option would have a significant impact. Traditional R&I instrument have demonstrated their ability to promote research and innovation and a dedicated initiative in the field, even only supported by traditional calls is likely to have an effect in that dimension.

As such this option would have a "good" impact on that dimension.

Regarding the ability to facilitate the adoption of digital technologies in European industries, this option would have a very limited impact. Traditional R&I activities supported by calls, may enable the creation of digital services that can be adopted by vertical industries. However, the research agenda, lacking the participation of industrials (both from the SNS field and from vertical industries) is likely to be misaligned with the needs and priorities of the industry. Furthermore, the participation of vertical industry stakeholders in calls is likely to be lower than in a partnership, and thus the potential for adoption of the innovation will remain low.

As such this option would have a "low" impact on that dimension.

Regarding the diminution of regulatory burdens on businesses, this option is unlikely to have major effects. It would lack the strong commitment and ability to influence policy and regulations that can only be achieved through a more institutionalized initiative. As such it is very unlikely that it could aim at the necessary harmonization of regulations and processes around spectrum allocation and usage.

As such this option would have a "low" impact on that dimension.

Option 1: Co-Programmed

Regarding the ability to increase the **competitiveness of European Smart Networks and Services industry**, this option would benefit from the impact of R&I projects, but with a **stronger commitments of the industry**. It would also be able to get some impact of **potential synergies with deployment activities** and **more deployment oriented projects** (large scale pilots). Furthermore, it would be able to diversify R&I activities by **involving a larger ecosystem of stakeholders**, creating **some opportunities for new entrants and SMEs** to create space in the value chain. However it would **lack the stronger, legally binding, commitment** of an institutionalized option and the **ability to establish more coordination and liaison** with related initiatives.

As such this option would have a "good" impact on that dimension.

Regarding the **increased innovation and research in the field of SNS**, this option would have a **significant impact**. Traditional R&I instrument have demonstrated their **ability to promote research and innovation** and a **dedicated initiative** in the field, even only supported by traditional calls is likely to have an effect in that dimension. The ability to **have a research agenda well in line with the industrial needs** through the

participation of the industry to the partnership would increase the potential research and innovation impact compared to traditional calls.

As such this option would have a "high" impact on that dimension.

Regarding the ability to **facilitate the adoption of digital technologies** in European industries, this option could have some **impact**. **The participation of industrials** (both from the SNS field and from vertical industries) is likely to ensure a **good coherence of the research production with the industry needs**. Furthermore, the **participation of vertical industry stakeholders in calls can be achieved** (as shown in the more recent calls of the 5GPPP) increasing the potential for **adoption of the innovation.** However, the co-programmed partnership may miss some additional impacts that could be brought by **more synergies and coordination with deployment oriented initiatives** and by a **stronger commitment of the industry**.

As such this option would have a "good" impact on that dimension.

Regarding the **diminution of regulatory burdens on businesses,** this option is **unlikely to have major effects.** It would **lack the strong commitment** and **ability to influence policy and regulations** that can only be achieved through a more **institutionalized initiative.** As such it is very unlikely that it could aim at the necessary harmonization of regulations and processes around spectrum allocation and usage.

As such this option would have a "low" impact on that dimension.

Option 3: Institutionalised Art 187

Regarding the ability to increase the **competitiveness of European Smart Networks and Services industry**, this option would benefit from the impact of R&I projects, but with a **stronger commitments of the industry**. It would also be able to get some important impact of **potential synergies with deployment activities** and **more deployment oriented projects** (large scale pilots), including through the **coordination of other initiatives** targeting deployments. Furthermore, it would be able to diversify R&I activities by **involving a larger ecosystem of stakeholders**, creating **some opportunities for new entrants and SMEs** to create space in the value chain. Finally it would **bring the stronger, legally binding, commitment** of an institutionalized option and the **ability to establish more coordination and liaison** with related initiatives.

As such this option would have a "high" impact on that dimension.

Regarding the **increased innovation and research in the field of SNS,** this option would have a **significant impact.** Traditional R&I instrument have demonstrated their **ability to promote research and innovation** and a **dedicated initiative** in the field, even only supported by traditional calls is likely to have an effect in that dimension. The ability to **have a research agenda well in line with the industrial needs** through the participation of the industry to the partnership would increase the potential research and innovation impact compared to traditional calls.

As such this option would have a "high" impact on that dimension.

Regarding the ability to **facilitate the adoption of digital technologies** in European industries, this option could have some **impact**. **The participation of industrials** (both from the SNS field and from vertical industries) is likely to ensure a **good coherence of the research production with the industry needs**. Furthermore, the **participation of vertical industry stakeholders in calls can be achieved** (as shown in the more recent calls of the 5GPPP) increasing the potential for **adoption of the innovation.** Finally, the institutionalized partnership could also brought by **more synergies and coordination with deployment oriented initiatives** and a **stronger commitment of the industries,**

including the verticals which could be better mobilized through **a strong political signal** (such as the set-up of an ambitious partnership at the European scale).

As such this option would have a "high" impact on that dimension.

Regarding the **diminution of regulatory burdens on businesses**, this option could have some **effects**. It would **bring strong commitment** and possibly an **ability to influence policy and regulations**. As such it may aim at the necessary harmonization of regulations and processes around spectrum allocation and usage.

As such this option would have a "good" impact on that dimension.

Summary

Table 13, below, lists the scores we assigned for each of the policy options, based upon the assessments above, as well as taking into account the support expressed by the different stakeholders.

Table 13: Overview of the options' potential for reaching the likely economic/technological impacts

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Art 187
Enhanced competitiveness of European SNS Industry	+	++	+++
Increased innovation and research in the field of SNS	++	+++	+++
Adoption of digital technologies in European industries	+	++	+++
Diminution of regulatory burdens on businesses	+	+	++

Notes: Score +++: Option presenting a *high* potential; Score ++: Option presenting a *good* potential; Score +: Option presenting a *low* potential

6.1.3 Societal impacts

Option 0: Horizon Europe calls (baseline)

Regarding the development of a **human-centric internet**, and the preservation of ethics, privacy and cybersecurity in future digital applications; this option would enable **some progresses** thanks to the R&I activities. The research agenda could indeed **be oriented toward the integration of cybersecurity as a priority** in the future communication networks and applications, as well as toward **minimizing the ethical impacts of future digital applications**. However this impact would **be overall limited** by the lack of coordination of the research activities with the definition of **future legislations and regulations**.

As such this option would have a "low" impact on that dimension.

Regarding the **equal and safe access of European citizens** to a communication infrastructure that will prove critical for many digital services, this option would have a **limited impact**. The traditional R&I activities would **enable the development of the technology** and could **support some initial deployments.** However the **scale and scope** of these deployments is likely to be **limited** and **concentrated in areas that are already strong and economically developed**, with a risk **of enhancing inequalities and the digital divide.**

As such this option would have a "low" impact on that dimension.

Regarding the **development of employment in Europe** in the field of Smart Networks and Services, this option would have **a very limited impact**. It would **lack the larger economic impacts on the European value chains** required to have a strong and favourable effects on employments. However, traditional **R&I activities** would still have a **modest positive impact** by supporting employment and the evolution of skills in the players involved in the field of research. As such this option would have a "low" impact on that dimension.

Regarding the **mitigation of environmental impacts**, although this option **may limit the most the deployment and adoption** of future communication networks and services in Europe, this option would not fully prevent it, and thus still be associated with negative environmental impact.

As such this option would have a "low" impact on that dimension.

Option 1: Co-Programmed

Regarding the development of a **human-centric internet**, and the preservation of ethics, privacy and cybersecurity in future digital applications; this option would enable **some progresses** thanks to the R&I activities. The research agenda could indeed **be oriented toward the integration of cybersecurity as a priority** in the future communication networks and applications, as well as toward **minimizing the ethical impacts of future digital applications**. However this impact would **be overall limited** by the non-legally binding commitment with the definition of **future legislations and regulations**. There is also a risk that, as industrial are more directly involved in the definition of the R&I priorities, they put **less emphasis on ethical perspective than on business requirements**.

As such this option would have a "low" impact on that dimension.

Regarding the **equal and safe access of European citizens** to a communication infrastructure that will prove critical for many digital services, this option would have a **significant impact**. The stronger focus on **large scale pilots' activities**, involvement of **vertical industries** and potential **liaison with deployment activities** would enable to strengthen the access of European citizens and industries to a critical infrastructure.

As such this option would have a "good" impact on that dimension.

Regarding the **development of employment in Europe** in the field of Smart Networks and Services, this option would have **a positive impact**. It would strengthen the **position of European actors in the value chain**, thus resulting in the **development of employment in Smart Networks and Services**. The involvement of a large scale ecosystem, **reaching toward vertical industries**, could reinforce this positive impact.

As such this option would have a "good" impact on that dimension.

Regarding the **mitigation of environmental impacts,** this option can be considered as the **having a negative impact.** Overall the initiative would result in a **development and deployment of an infrastructure** that is likely to **increase energy consumption** and **use important quantities of primary resources.** The development of new usages will also result in the creation, use and eventually destruction of **large number of connected devices** (therefore increasing the environmental footprint of the sector). **Only a fraction** of the use cases developed (mainly in energy and transport use cases) will actively target the optimization of energy consumption (and even in that case, they are likely to result in the long term in a rebound effect). Even though the research agenda is likely to promote **research on energy efficient devices and network** (which **may mitigate some of the effects**) the targeted energy requirements will **not be considered as legally binding** and are **likely to disappear** faced with **business and profitability constraints**. Furthermore the inability of the co-programmed partnership to **create liaison with**

regulations and legislation that could put **strict limit on energy and resource consumption** further increase the negative impact perspective.

As such this option would have a "low" impact on that dimension.

Option 3: Institutionalised Art 187

Regarding the development of a **human-centric internet**, and the preservation of ethics, privacy and cybersecurity in future digital applications; this option would enable **some progresses** thanks to the R&I activities. The research agenda could indeed **be oriented toward the integration of cybersecurity as a priority** in the future communication networks and applications, as well as toward **minimizing the ethical impacts of future digital applications**. The strong force of **a legally binding commitment** of the ecosystem and the **potential political weight** of an institutionalized partnership may enable these developments to **go beyond research and achieve an actual impact in the use of digital applications** in Europe. Furthermore the possibility of an institutionalized partnership to have **strong liaison and coordination with future regulations and legislation** would further reinforce this impact by ensuring that legislation development is done **at the same pace and in coordination with technological developments.**

As such this option would have a "good" impact on that dimension.

Regarding the **equal and safe access of European citizens** to a communication infrastructure that will prove critical for many digital services, this option would have a **significant impact**. The stronger focus on **large scale pilots' activities**, involvement of **vertical industries** and potential **liaison with deployment activities** would enable to strengthen the access of European citizens and industries to a critical infrastructure. Furthermore the ability of the institutionalized **partnership to better coordinate with other deployment oriented initiatives** would reinforce this impact.

As such this option would have a "high" impact on that dimension.

Regarding the **development of employment in Europe** in the field of Smart Networks and Services, this option would have **a positive impact**. It would strengthen the **position of European actors in the value chain**, thus resulting in the **development of employment in Smart Networks and Services**. The involvement of a large scale ecosystem, **reaching toward vertical industries**, could reinforce this positive impact.

As such this option would have a "good" impact on that dimension.

Regarding the **mitigation of environmental impacts,** overall the partnership would result in a **development and deployment of an infrastructure** that is likely **to increase energy consumption** and **use important quantities of primary resources.** The development of new usages will also result in the creation, use and eventually destruction of **large number of connected devices** (therefore increasing the environmental footprint of the sector). **Only a fraction** of the use cases developed (mainly in energy and transport use cases) will **actively** target the optimization of energy consumption (and even in that case, they are likely to result in the long term in a rebound effect).

This impact might be slightly more mitigated with an institutionalized partnership than with a co-programmed partnership. Indeed the research agenda could theoretically be more oriented to promote more strongly **research on energy efficient devices and network** (which **may mitigate some of the effects**). Furthermore the targeted energy requirements should **be considered as legally binding** and would as such be **less likely to disappear** faced with **business and profitability constraints**. Finally the ability of the institutionalized partnership to **create liaison with regulations and legislation**

could theoretically help put **strict limit on energy and resource consumption** further mitigating the negative impact.

However although the institutionalized partnership instrument in itself would **theoretically** offer mechanisms to mitigate the environmental effects, this mitigating effect would depend on a strong commitment of the initiative **to put a priority on environmental constraints over economic development** (that can be considered as highly unlikely in the current European context).

As such this option would have a "low" impact on that dimension.

Summary

Table 14, below, lists the scores we assigned for each of the policy options, based upon the assessments above, as well as taking into account the support expressed by the different stakeholders.

Table 14: Overview of the options' potential for reaching the likely societal impacts

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Art 187
Development of a human-centric internet	+	+	++
Equal and safe access to a critical infrastructure	+	++	+++
Development of employments in field related to SNS	+	++	++
Mitigate negative environmental impacts	+	+	+

Notes: Score +++: Option presenting a *high* potential; Score ++: Option presenting a *good* potential; Score +: Option presenting a *low* potential

6.2 Assessment of coherence

6.2.1 Internal coherence

In this section we assess the extent to which the policy options show the potential of ensuring and maximising coherence with other programmes and initiatives under Horizon Europe, in particular European Partnerships.

Option 0: Horizon Europe calls (baseline)

Regarding the ability to mobilize a broad ecosystem. This option would have a more limited ability than the alternatives to attract the broad ecosystem required by the future development of Smart Networks and Services.

The participation of core players from the industry and research communities would probably be ensured (as traditional R&I activities have proven their ability to mobilise such actors).

However the participation of other stakeholders, such as the vertical industries or the participation of a larger digital ecosystem (reaching out to cybersecurity, artificial intelligence, edge computing, robotics or data science) would be much more limited than with the other options.

Regarding SME participation, this option would rely solely on the traditional Horizon instruments and although some dedicated activities (in the form of cascade funding) could be considered, they are likely to be more limited and have a smaller reach than with a partnership.

International cooperation could also be envisioned through traditional R&I calls, but would lack the stronger positioning and visibility of a partnership, potentially reducing the impact.

Regarding the ability to have a strong strategic focus, this option would not allow for a strong cooperation and coordination between the funded projects, limiting the ability to have a strong and sound strategic focus shared at the level of a European industrial ecosystem.

However, as a positive point, this option would however face no governance issue as no partnership would be put in place.Overall, this option would have a "low" impact on that dimension.

Option 1: Co-Programmed

Regarding the ability to mobilize a broad ecosystem. This option would have a relatively good ability to attract the broad ecosystem required by the future development of Smart Networks and Services.

The participation of **core players from the industry and research communities** would be **ensured** (as previous co-programmed partnerships, including the 5GPPP have proven their ability to mobilise such actors).

The participation of **other stakeholders**, such as the **vertical industries** or the participation of a larger digital ecosystem (reaching out to cybersecurity, artificial intelligence, edge computing, robotics or data science) could be **realized to some extent** as long as **the right industrial associations are associated to the partnership**.

Regarding **SME participation**, this option would rely mostly on the traditional Horizon instruments and some dedicated activities (in the form of cascade funding) could be considered, the **good visibility of the partnership** would increase the reach of this instrument.

International cooperation could also be envisioned, it would benefit from the **strong positioning and visibility** of a partnership.

Regarding the ability to have a **strong strategic focus**, this option would **allow** for **some cooperation and coordination between the funded projects.**

This would be achieved thanks to the use of traditional R&I instruments (coordination and support actions) strongly reinforced by **the participation of a dedicated industrial association(s)**. The participation of a **large and active ecosystem of actors** to the industry association(s) would enable **a strong strategic vision**, although the **lack of legally binding commitments** and **lack of a formalized structure** may **limit the actual focus**.

This option would benefit from the **existing governance and process of previous partnerships** (such as the 5G PPP). As **most industrial actors in the field of SNS** are **already accustomed** to the governance and functionalities of a co-programmed partnership they would likely **adapt rapidly** to such an option and ensure an **efficient governance**.

It is to be noted that in the **interviews**, a large number of actors involved in the 5G PPP initiative supported this option mostly with regards to the governance aspects.

Overall, this option would have a "good" impact on that dimension.

Option 3: Institutionalised Art 187

Regarding the **ability to mobilize a broad ecosystem**. This option would have a **good ability to attract the broad ecosystem required** by the future development of Smart Networks and Services.

The participation of **core players from the industry and research communities** would be **ensured** (as previous co-programmed partnerships, including the 5GPPP have proven their ability to mobilise such actors).

The participation of **other stakeholders**, such as the **vertical industries** or the participation of a larger digital ecosystem (reaching out to cybersecurity, artificial intelligence, edge computing, robotics or data science) could be **realized to some extent** as long as **the right industrial associations are associated to the partnership**.

However this **ability to attract industrial stakeholders** could be **slightly diminished by the institutionalized partnership structure** depending on its actual organization. Industrial stakeholders could be reluctant to commit (especially in a legally binding agreement) to an initiative in which Member States participate due to fears of **political interference, short-termism and delay in decision-making**. This is seen as a factor able to **cause delays** in the gathering of the relevant stakeholders, but not as a factor that would significantly reduce the mid-long term ability of the institutionalized partnership to gather the right stakeholders.

Regarding **SME participation**, this option would rely mostly on the traditional Horizon instruments and some dedicated activities (in the form of cascade funding) could be considered, the **very good visibility of the partnership** would increase the reach of this instrument. It would also be possible to envisage specific SME oriented action within the institutionalized partnership on through liaison with other initiatives.

International cooperation could also be envisioned, it would benefit from the **strong positioning and visibility** of a partnership.

Overall the **commitment of the ecosystem** would be ensured by the **legally binding nature** of the institutionalized partnership agreement.

Regarding the ability to have a strong strategic focus, this option would allow for strong cooperation and coordination between the funded projects. The participation of a large and active ecosystem of actors to the industry association(s) would enable a strong strategic vision. The focus on that vision would be achieved thanks to the use of traditional R&I instruments (coordination and support actions) strongly reinforced by the participation of a dedicated industrial association(s) and by a dedicated governance within the partnership.

This option would however require the set-up of an active and efficient governance. Given the **broad range of stakeholders** that will have to be mobilized and the **need of participation of member states,** this option will require **dedicated efforts and negotiations** to ensure the **efficiency** of the governance structure.

Overall, this option would have a "good" impact on that dimension.

6.2.2 External coherence

In this section we assess the extent to which the policy options show the potential of ensuring and maximising coherence with EU-level programmes and initiatives beyond the Framework Programme and/or national and international programmes and initiatives.

Option 0: Horizon Europe calls (baseline)

Regarding the external coherence, the impact of an initiative using traditional calls under the Framework programme **would be very limited**.

Regarding the ability to **establish liaison with other R&I initiatives** in the field and in neighbouring domains (such as Key Digital Technologies, or research in digital services for vertical applications), the initiative would have to rely **solely on coordination and support actions** and on the willingness of the participants to exchange and collaborate. This would result in **a low level of liaison**.

Furthermore, the initiative using traditional calls would have **no real ability to coordinate** with the **initiatives from Member States** supporting R&I in the field of Smart Networks and Services. Finally **the coordination with deployment oriented initiatives** (such as CEF) would be **very limited**.

Regarding the ability to establish liaison with **initiatives and actors (such as VC)** able to provide **funding and dedicated supports** to **start-ups and innovators**, an initiative under the traditional calls would have a **very limited impact**. The relatively **low visibility of the action**, will leave little space to attract funding and investment in the field of Smart Networks and Services in Europe.

Regarding the ability to **link and potentially influence** future **regulations** (in spectrum allocation and usage, energy consumption of future networks and services, or ethical and security issues), an initiative using traditional calls would have a **very limited impact**. It would lack not only **the mandate,** but also **the visibility** and the **critical mass of industrial participants** necessary to really have an impact on future legislations and regulations.

Overall, this option would have a "low" impact on that dimension.

Option 1: Co-Programmed

Regarding the ability to **establish liaison with other R&I initiatives** in the field and in neighbouring domains (such as Key Digital Technologies, or research in digital services for vertical applications), the initiative could rely **not only on coordination and support actions** but also on **potential actions at the association(s) level**.

However, the initiative using a co-programmed partnership would have **a very limited ability to coordinate** with the **initiatives from Member States** supporting R&I in the field of Smart Networks and Services. Finally **the coordination with deployment oriented initiatives** (such as CEF) would also be **very limited**.

Regarding the ability to establish liaison with **initiatives and actors (such as VC)** able to provide **funding and dedicated supports** to **start-ups and innovators**, an initiative using a co-programmed partnership would have a **limited impact**.

The **visibility of the partnership**, could be exploited to some extent to attract investment. However it would likely **lack the ability to set-up dedicated coordination** and lack the **stronger visibility** brought by an institutionalized partnership.

The lack of **legally binding commitment** (including commitment to funding) could also **limit the leverage effect** as investors and industrials would be **less certain of the long term commitment** of the participants to the initiative.

Regarding the ability to **link and potentially influence** future **regulations** (in spectrum allocation and usage, energy consumption of future networks and services, or ethical and security issues), an initiative using a co-programmed partnership would have a **very limited impact**. It can be hoped that the **visibility** brought by the partnership could have **some minimal influence**. However it would lack not only **the mandate,** and the **critical mass and strong commitment of industrial participants** necessary to really have a strong impact on future legislations and regulations.

Overall, this option would have a "good" impact on that dimension.

Option 3: Institutionalised Art 187

Regarding the ability to **establish liaison with other R&I initiatives** in the field and in neighbouring domains (such as Key Digital Technologies, or research in digital services for vertical applications), the initiative could rely **not only on coordination and support actions** but also on **potential actions at the partnership level**.

Furthermore, the initiative using an institutionalized partnership would have **a real ability to coordinate** with the **initiatives from Member States** supporting R&I in the field of Smart Networks and Services.

Finally **the coordination with deployment oriented initiatives** (such as CEF) would also be **possible**, ensuring **liaison with all development and deployment activities of Smart Networks and Services at the local, national and European level.**

Regarding the ability to establish liaison with **initiatives and actors (such as VC)** able to provide **funding and dedicated supports** to **start-ups and innovators**, an initiative using an institutionalized partnership would have a **real impact**.

The **large visibility, and political weight of the partnership**, could be exploited to attract investment (including on an international scale). Furthermore the institution could provide **the ability to set-up dedicated coordination**.

Furthermore, the **legally binding commitment** (including commitment to funding) of an institutionalized partnership would also **strengthen the leverage effect** as investors and industrials would be **more certain of the long term commitment** of the participants to the initiative.

Regarding the ability to **link and potentially influence** future **regulations** (in spectrum allocation and usage, energy consumption of future networks and services, or ethical and security issues), an initiative using an institutionalized partnership would have a **real potential impact**.

This could be achieved through **dedicated actions at the institution level**, a potentially **more clear mandate**, and also the **large visibility** and **critical mass and strong commitment of industrial participants.**

Overall, this option would have a "high" impact on that dimension.

Summary

Table 15, below, lists the scores we assigned for each of the policy options, based upon the assessments above, as well as taking into account the support expressed by the different stakeholders.

Table 15: Overview of the options' potential for ensuring and maximizing coherence

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Art 187
Internal coherence	+	++	++
External coherence	+	++	+++

Notes: Score +++: Option presenting a *high* potential; Score ++: Option presenting a *good* potential; Score +: Option presenting a *low* potential

6.3 Comparative assessment of efficiency

In order to compare the policy options under common standards, we developed a standard cost model for all 13 candidate Institutionalised Partnership studies. The model and the underlying assumptions and analyses are set out in the report on the overarching context to the impact assessment studies.

Table 16, below, shows the intensity of additional costs against specific cost items for the various options as compared to the baseline, i.e. Option 0 (Horizon Europe calls). In this table we have taken into account that for Option 3 (Institutionalised Partnership) there would be a high additional costs for the set-up of a dedicated implementation structure seeing that such a structure is not yet existing. For Option 1 (Co-programmed), we did not consider an additional cost for the call and project implementation as, MS would not be providing financial contributions.

Table 16: Intensity of additional costs compared with HEU Calls (for Partners, stakeholders, public and EC)

Cost items	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised Art. 187
Preparation and set-up costs			
Preparation of a partnership proposal (partners and EC)	0	++	++
Set-up of a dedicated implementation structure	0	0	+++
Preparation of the SRIA / roadmap	0	++	
Ex-ante Impact Assessment for partnership	0	0	+++
Preparation of EC proposal and negotiation	0	0	+++
Running costs (Annual cycle of implementation)			
Annual Work Programme (AWP) preparation	0	+	+
Call and project implementation	0	0	+
Cost to applicants	0	0	0
Partners costs not covered by the above	0	+	+
Additional EC costs (e.g. supervision)	0	+	++
Winding down costs			
EC	0	0	+++
Partners	0	+	+

Notes: 0: no additional costs, as compared with the baseline; +: minor additional costs, as compared with the baseline; ++: high additional costs, as compared with the baseline; +++: very high additional costs, as compared with the baseline

The scores related to the costs set out above will allow for a "value for money" analysis (cost-effectiveness) in the final scorecard analysis in Section 6.4. For this purpose, in Table 17 where we provide the scores for the scorecard analysis, based on our insights and

findings and based on the scores above, we assign a score 1 to the option with the highest costs and a score 3 to the lowest.

Table 17: Matrix on 'overall costs' and 'cost-efficiency'

	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised
Overall cost	3	2	1
Cost-efficiency	3	3	2

Notes: Score 1 = Substantial additional costs, as compared with the baseline; score 2 = Medium additional costs, as compared with the baseline; score 3 = No or minor additional costs, as compared with the baseline

We considered that while there is a clear gradation in the overall costs of the policy options, the cost differentials are less marked when we take into account financial leverage (co-financing rates) and the total budget available for each of the policy options, assuming a common Union contribution. From this perspective, there are only one or two percentage points that split the most cost-efficient policy options – the baseline Option 0 and the Co-Programmed policy options – and the least cost-efficient – the Institutionalised Partnership options. We have therefore assigned a score of 3 to the Option 0 and the Co-Programmed policy options for **cost-efficiency** and a score of 2 for the Institutionalised Partnership policy options.

It should be noted that the potential for the creation of crowding-in effects for industry has been taken into account when assessing the effectiveness of the policy options, above.

6.4 Comprehensive comparison of the options and identification of the preferred option

Building upon the outcomes of the previous sections, this section presents a comparison of the options' 'performance' against the three dimensions of effectiveness, efficiency and coherence.

In Section 6.4.1, we first compare the policy options against each other for each criterion in the effectiveness and coherence dimensions, resulting in a scorecard with scores from 1 to 3 where 3 stands for a substantially higher performance. Combined with the results from the comparative assessment for efficiency in Section 6.3, above, the final scorecard will allow for the identification of the preferred option in Section 6.4.2, taking all dimensions and criteria into account.

6.4.1 Comparative assessment

Effectiveness

Regarding the **scientific impacts**, the impact of the three considered options would be relatively close. This is due to the overall good capacity of traditional R&I instruments to ensure the generation of new knowledge and to enhance the positioning of Europe in the S&T field. However, the partnerships options (institutionalized and to some extent, the co-programmed partnership as well) would be able to achieve more thanks to better capacity to support the diffusion of knowledge through a better connection with vertical industries. Furthermore, the partnership options (both institutionalized and co-programmed) would result in a higher impact in term of knowledge creation through a stronger commitment of industrial players to the R&I activities.

Regarding the **technological and economic impacts**, the Option 0 ranks significantly lower than the two other options. This is due to the limited ability of R&I activities alone to have a strong economic impact beyond a mere increase of the R&I in the field. Both partnership options (institutionalized and co-programmed) would thus be able to achieve more by harnessing a stronger commitment from the industrial actors, including vertical industries. The ability to have a R&I agenda that is well aligned with industrial needs but also to liaise and support deployment oriented activities further support the partnership options (institutionalized and co-programmed). However, the institutionalized partnership would provide further impact in that dimension by ensuring an even stronger commitment of the stakeholders and by its potential ability to influence policy and regulation that could diminish regulatory burdens on businesses.

Regarding the **societal impacts**, the Option 0 (Horizon Europe calls) ranks also significantly lower than the two other options. This can be explained by the limited ability of R&I activities to, by themselves and without coordination with other actions, have a strong societal impact. The Co-programmed option would provide slightly more significant societal impact, in specific dimensions such as the access to critical infrastructure and in the development of employment in the field. This is directly linked with the fact that the partnership would strengthen the deployment of the infrastructure. Option 3 (institutionalized partnership) would bring additional benefits by enabling a potentially more coordinated deployment of the infrastructure (resulting in more equal access) and by a stronger ability to influence future regulations (which could be used to foster the development of a human-centric internet).

Coherence

Regarding the internal coherence, Option 0 can be considered as significantly outranked by the two other options as the initiative would have difficulties to attract the broad range of stakeholders required. Option 1 and Option 3 (co-programmed and institutionalized partnerships) would be comparable in term of internal coherence as they would both have a good ability to attract the required stakeholders.

Regarding the external coherence, Option 0 would have little impact, unable to reach out efficiently to other initiatives. Option 1 (co-programmed partnership) would provide some impact by a larger visibility and ability to reach out to other initiatives, but it would lack the benefits brought by the institutionalized partnership (Option 3), that would benefit from a very high visibility, a clear mandate to negotiate and establish synergies with other programmes, as well as long term commitments.

Summary

Table 18: Scorecard of the policy options

	Criteria	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised
Effectiveness	**Scientific impacts**			
	Generation of new knowledge	2	3	3
	Diffusion of applied knowledge	1	2	3
	Enhanced positioning of Europe in the S&T field	2	2	2
	Economic/technological impacts			
	Enhanced competitiveness of European SNS Industry	1	2	3

	Criteria	Option 0: Horizon Europe calls	Option 1: Co-programmed	Option 3: Institutionalised
	Increased innovation and research in the field of SNS	2	3	3
	Adoption of digital technologies in European industries	1	2	3
	Diminution of regulatory burdens on businesses	1	1	2
	Societal impacts			
	Development of a human-centric internet	1	1	2
	Equal and safe access to a critical infrastructure	1	2	3
	Development of employments in field related to SNS	1	2	2
	Mitigate negative environmental impacts	1	1	1
Coherence	**Internal coherence**	1	2	2
	External coherence	1	2	3
Efficiency	**Overall cost**	3	2	1
	Cost-efficiency	3	3	2

Notes: Scores for effectiveness and coherence: 3 = *substantially higher performance*; 2 = *higher performance*; 1 = *lower performance*. Scores for efficiency: 1 = *substantial additional costs*, as compared with the baseline; 2 = *medium additional costs*, as compared with the baseline; 3 = *No or minor additional costs*, as compared with the baseline

6.4.2 Identification of the preferred option

The scorecard in **Error! Reference source not found.** shows that Option 0 performs less w ell against close to all dimensions and criteria compared to the Option 1 and Option 3. Even though it reached a higher score against the cost and cost efficiency criterion, we considered that this does not weigh up against its lower performance against the dimensions of effectiveness and coherence.

The scorecard also shows that benefits are clearly maximised under the institutionalized partnership option (Option 3). In particular, compared with the other options, Option 3 would:

- Provide greater effectiveness, especially in term of economic, technological and societal impacts by its ability to secure stronger commitment of the involved stakeholders and to foster regulation and standardization activities.
- Improve the external coherence by a good ability to reach out to other initiative and a clear mandate to establish synergies with programmes led at the European, National or Regional level.
- Offer a relatively good overall efficiency despite additional costs.

The conclusion of our assessment is that Option 3, institutionalized partnership, is the preferred option, showing a higher level of cost-effectiveness than the other options.

7 The preferred option - Description of the implementation and monitoring system

7.1 Description of the preferred option

Based on the assessment presented above, the preferred option appears to be the institutionalized partnership.

In Table 19, below, we indicate the alignment of the preferred option with the selection criteria for European Partnerships defined in Annex III of the Horizon Europe Regulation. Seeing that the design process of the candidate Institutionalised Partnerships is not yet concluded and several of the related topics are still under discussion at the time of writing, the criteria of additionality/directionality and long-term commitment are covered in terms of *expectations* rather than ex-ante demonstration.

Table 19: Alignment with the selection criteria for European Partnerships

Criterion	Alignment of the preferred option
Higher level of effectiveness	The analysis presented above in section 6 points out that an institutionalized partnership would have a high effectiveness than the other options in achieving the objectives defined in section 4 thanks mainly to the following points: • An institutionalized partnership would bring a stronger commitment from the whole ecosystem to a long term, sustained strategy. This appears as necessary in regards with the potential critical nature of the future network infrastructure and digital services for numerous European industries. • An institutionalized partnership would allow the necessary involvement of a broad ecosystem of stakeholders, ranging from incumbent in the field of Smart Networks and Services to vertical industries that will be future adopters of the solutions developed and potential new entrants.
Coherence and synergies	• An institutionalized partnership would allow to establish liaison with other related initiatives and partnerships. As shown above the development of smart networks and services will have to take into account and use numerous digital technologies (making liaison with the Key Digital Technologies initiative important) and will serve as the backbone of the digital transformation of numerous industries (Automotive, Health, Transport, Energy, Manufacturing) requiring the set-up of important synergies with other programmes. • An institutionalized partnership would allow a stronger liaison and coordination with R&I initiatives supported at the national level by national research programmes. • An institutionalized partnership would allow a stronger liaison with deployment oriented initiative (at the European, National and Local level) which as presented above in section 3 and 4 cannot be decoupled entirely from R&I perspectives. • An institutionalized partnership would allow a stronger ability to foster necessary regulations and legislative adaptation in the field of spectrum allocation and usage, energy consumption or ethics, privacy and cybersecurity.
Transparency and openness	• An institutionalized partnership would allow, as presented above, for more interdisciplinary research, highly needed for the future of networks and digital services • This option would also foster the creation of new value chain opportunities (new connectivity providers, new connected device providers), creating higher opportunities for new entrants and SMEs.

Criterion	Alignment of the preferred option
Additionality and directionality	• The committed participation of a broad ecosystem of stakeholders that will be developing but also using the future network infrastructure is required to ensure a strong strategic focus. The institutionalized partnership appears as a viable option to gather this directionality. • An institutionalized partnership would bring an added visibility and political weight that would be useful in the achievement of many objectives.
Long-term commitment	In the case of institutionalised European Partnerships, established in accordance with article 187 TFEU, the financial and/or in-kind, contributions from partners other than the Union, will at least be equal to 50% and may reach up to 75% of the aggregated European Partnership budgetary commitments. The 5GPPP programme has demonstrated the ability to have a high leverage on industrial investment in research and innovation activities, as illustrated in section 1 (a factor of 10.12 for phase 1 and 2).

7.2 Objectives and corresponding monitoring indicators

7.2.1 Operational objectives

Figure 19, below, lists a range of actions and activities, going also beyond the R&I activities that can be implemented under Horizon Europe (highlighted in yellow). This reflects the definition of European Partnerships in the Horizon Europe regulation as initiatives where the Union and its partners "commit to jointly support the development and implementation of a programme of research and innovation activities, including those related to market, regulatory or policy uptake." We introduce here in more details the operational objectives we foresee for the initiative.

Support high risk research in Smart Networks and Services: The initiative should aim at dedicated support for research in the field, to compensate with the high level of risk and high research intensity of the field, illustrated by the problem driver (see Section 2.2.1). This could be achieved by collaborative research actions (RIA and IA).

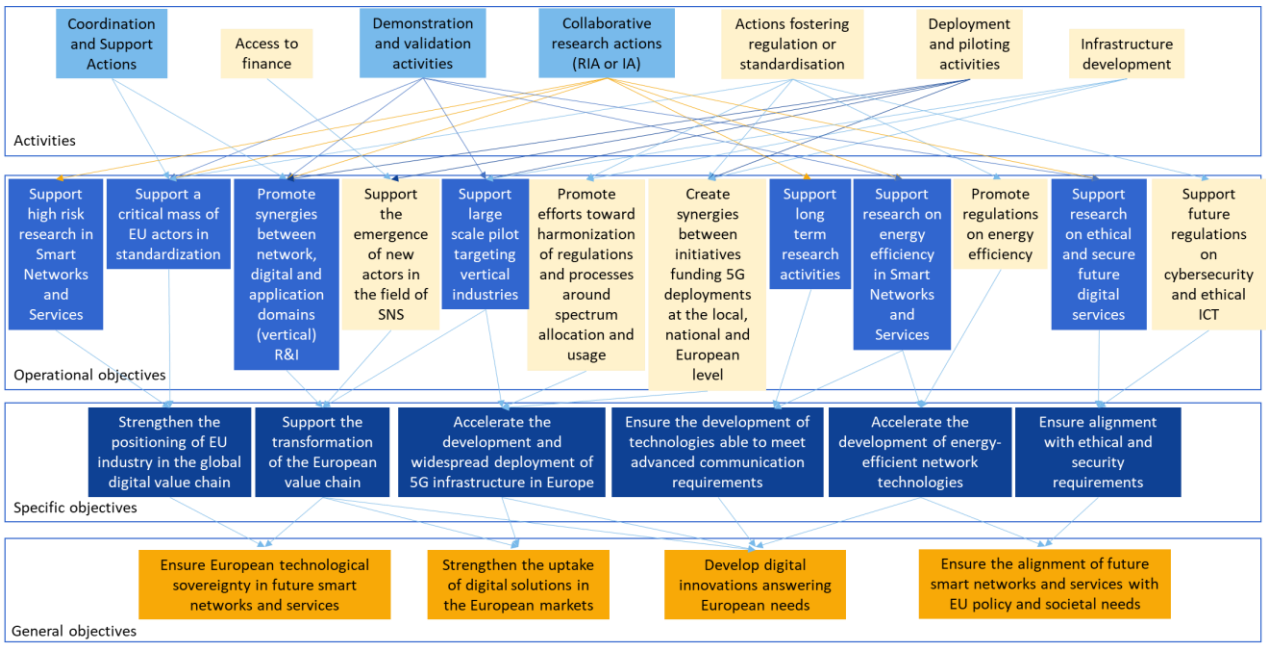
Support a critical mass of EU actors in standardization: a strong presence of European actors in standardization is necessary to ensure a critical mass of contributions, as illustrated in the problem driver (see Section 2.2.1). This could be achieved through collaborative research actions, coordination and support actions, as well as demonstration and validation activities, and actions fostering regulation and standardization.

Promote synergies between network, digital and application domains (vertical) R&I: The initiative should aim to promote collaborative research across research fields, from traditional network and telecommunication research to more digital technology research and research in the foreseen application domains (vertical industries). This would aim to address the problem drivers described in Sections 2.2.2. It could be achieved through collaborative research actions, coordination and support actions, as well as demonstration and validation activities, and deployment and piloting activities.

Support large scale pilots targeting vertical industries: The initiative should implement dedicated action to ensure the setup of large scale pilots targeting the future application domains of smart networks and services. These should target specifically the following vertical industries: automotive, transportation, manufacturing, healthcare, and energy. This would aim to address the problem drivers described in sections 2.2.2 and 2.2.3. It could be achieved through demonstration and validation activities, and deployment and piloting activities.

Support long term research activities: The initiative should have dedicated activities targeting the longer term evolutions of communication networks and digital services, namely 6G capabilities. This would answer to the problem driver described in section 2.2.4. It could be achieved through collaborative research actions.

Figure 19: Operational objectives of the initiative



Support research on energy efficiency in Smart Networks and Services: The initiative should aim for support to research in the field of energy efficiency of the future networks, devices and applications. This would aim to answer the problem driver described in section 2.2.6. It could be achieved through collaborative research actions, as well as demonstration and validation activities.

Support research on ethical and secure future digital services: The initiative should aim to support research to ensure that ethics, privacy and cybersecurity are integrated in the design of future smart networks and digital services. This would aim to answer to the problem driver described in section 2.2.5. It could be achieved through collaborative research actions, as well as demonstration and validation activities.

External actions

We present here actions that are external to the strict field of R&I but that would nonetheless be necessary to ensure that the initiative reach the designated objectives.

Support the emergence of new actors in the field: The initiative should support the transformation of the value chain by promoting the emergence of new actors in the field and the evolutions of the business models of existing actors (in both the telecom and vertical industries). This would answer to the problem drivers defined in section 2.2.2. It could be achieved through deployment and piloting activities as well as access to finance.

Promote efforts toward harmonization of regulations and processes around spectrum allocation and usage: The initiative should aim to support the harmonization at the European level the regulations and processes regarding the allocation of spectrum and its usage. This would aim at answering the problem driver defined in section 2.2.3 It could be achieved through actions fostering regulations and standardization.

Promote regulations on energy efficiency: To mitigate the environmental impacts of the future network infrastructure and digital services, the initiative should also aim at fostering regulations that promote energy efficiency and eventually enforce limitations to

usage. This would answer the problem driver defined in section 2.2.6. It could be achieved through actions fostering regulations and standardization.

Support future regulations on cybersecurity and ethical ICT: To promote a human-centric internet, and mitigate the impact of future digital services on cybersecurity, privacy and other ethical issues, the initiative should aim to foster regulations that enforce an ethical approach. This would aim to answer to the problem driver described in section 2.2.5. It could be achieved through actions fostering regulations and standardization.

Monitoring indicators

A monitoring system will have to be established to assess the effectiveness of the initiative.

It will particularly be looking at cost benefits and where some of the indicators listed below would be used as KPI benefits. Additionally cost, investments levels by the private side should be measured.

One should further divide the KPIs in qualitative and quantitative KPIS or system/performance measurements.

Monitoring indicators

The following table present a first set of potential indicators that could be used in addition to the traditional KPIs used to monitor Horizon Europe impact, in the field of Smart Networks and Services.

Table 20: Monitoring indicators in addition to the Horizon Europe key impact pathway indicators

Impact Dimension		Short-term (typically as of year 1+)	Medium-term (typically as of year 3+)	Long-term (typically as of year 5+)
Scientific impact	Development of new telecommunication capacities	Number of publications, patents and standardization contributions achieved by the partnership and related to beyond 5G capabilities	Number of publications, patents and standardization contributions achieved by the partnership and related to 6G capabilities	Number of publications, patents and standardization contributions achieved by the partnership and related to 6G capabilities
	Lower energy consumption devices and infrastructures	Number of publications, patents and standardization contributions achieved by the partnership and related to energy efficiency in connected devices and network infrastructures	Number of publications, patents and standardization contributions achieved by the partnership and related to energy efficiency in connected devices and network infrastructures	Energy consumption of telecommunicatio n networks

Impact Dimension		Short-term (typically as of year 1+)	Medium-term (typically as of year 3+)	Long-term (typically as of year 5+)
	Use of digital technologies in future networks	Number and share of projects including transdisciplinary research mixing network technologies with advanced digital solutions (A.I., Edge, etc.)	Number and share of projects including transdisciplinary research mixing network technologies with advanced digital solutions (A.I., Edge, etc.)	Uptake of advanced digital solutions and scientific results in future communication networks
	Vertical oriented applications in SNS	Participation of vertical industry representatives to R&I projects	Participation of vertical industry representatives to R&I projects	Uptake of Smart Networks and Services in vertical industries
	cybersecurity by design	Number of publications, patents and standardization contributions achieved by the partnership and related to Cybersecurity in Smart Networks and Services	Number of publications, patents and standardization contributions achieved by the partnership and related to Cybersecurity in Smart Networks and Services	Number of publications, patents and standardization contributions achieved by the partnership and related to Cybersecurity in Smart Networks and Services
	Ethics by design	Number of publications, patents and standardization contributions achieved by the partnership and related to Ethics and Privacy in Smart Networks and Services	Number of publications, patents and standardization contributions achieved by the partnership and related to Ethics and Privacy in Smart Networks and Services	Number of publications, patents and standardization contributions achieved by the partnership and related to Ethics and Privacy in Smart Networks and Services
Technological / economic impact	Investment of EU industry in SNS	Leverage effect, investment of EU SNS industry in R&I	Leverage effect, investment of EU SNS industry in R&I	Leverage effect, investment of EU SNS industry in R&I
	Contribution to standardization and patents	Share of EU actors contribution to standardization and patents on Smart Networks and Services	Share of EU actors contribution to standardization and patents on Smart Networks and Services	Share of EU actors contribution to standardization and patents on Smart Networks and Services
	Market share of EU actors	Market Share of EU actors in SNS	Market Share of EU actors in SNS	Market Share of EU actors in SNS
	Vertical oriented applications	Number of large scale pilots targeting vertical industries	Take-up of digital solutions in vertical industries	Take-up of digital solutions in vertical industries

Impact Dimension		Short-term (typically as of year 1+)	Medium-term (typically as of year 3+)	Long-term (typically as of year 5+)
	New types of connectivity providers and connected device providers		Numbers of new businesses in EU in connectivity provisioning and connected devices	Numbers of new businesses in EU in connectivity provisioning and connected devices
	Private investment in infrastructure deployment	CAPEX in network infrastructure deployment in Europe	CAPEX in network infrastructure deployment in Europe	CAPEX in network infrastructure deployment in Europe
	Deployment of 5G	Number of 5G subscription in Europe, Share of global 5G subscription	Number of 5G subscription in Europe, Share of global 5G subscription	Number of 5G subscription in Europe, Share of global 5G subscription
	Harmonization of regulations on spectrum	Share of 5G spectrum allocated	Share of 5G spectrum allocated	Share of 5G spectrum allocated
	Burden of spectrum allocation	Delay between identification of new spectrum bands and allocation of spectrum in Europe	Delay between identification of new spectrum bands and allocation of spectrum in Europe	Delay between identification of new spectrum bands and allocation of spectrum in Europe
Societal impact	Employment	Employment in the field of Smart Networks and Services	Employment in the field of Smart Networks and Services	Employment in the field of Smart Networks and Services
	Skills	Take up of digital skills and tools in EU Industries	Take up of digital skills and tools in EU Industries	Take up of digital skills and tools in EU Industries
	Ethics and privacy regulations	Set-up of regulations and legislations regarding ethics, security and privacy in the field of SNS	Set-up of regulations and legislations regarding ethics, security and privacy in the field of SNS	Set-up of regulations and legislations regarding ethics, security and privacy in the field of SNS
	Equal Access	Share of the EU population with access to 5G	Share of the EU population with access to 5G	Share of the EU population with access to 5G
	Environmental Impact	Energy consumption of telecommunication networks	Energy consumption of telecommunicatio n networks	Energy consumption of telecommunicatio n networks
	Environmental Impact	Lifecycle impact of connected devices	Lifecycle impact of connected devices	Lifecycle impact of connected devices

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Appendix B Synopsis report on the stakeholder consultation – Focus on the candidate European Partnership for Smart Networks and Services

Disclaimer: the views expressed in the contributions received are those of the respondents and cannot under any circumstances be regarded as the official position of the Commission or its services.

B.1 Introduction

Following the European Commission's proposal for Horizon Europe in June 2018,[47] 12 candidates for institutionalised partnerships within 8 partnership areas have been proposed, based on the political agreement with the European Parliament and Council on Horizon Europe reached in April 2019.[48] Whether these proposed institutionalised partnerships will go ahead in this form under the next research and innovation programme is subject to an impact assessment.

In line with the Better Regulation Guidelines,[49] the stakeholders were widely consulted as part of the impact assessment process, including national authorities, the EU research community, industry, EU institutions and bodies, and others. These inputs were collected through different channels:

- A feedback phase on the inception impact assessments of the candidate initiatives in August 2019,[50] gathering 350 replies for all 12 initiatives;
- A structured consultation of Member States performed by the EC services over 2019;
- An online public stakeholder consultation administered by the EC, based on a structured questionnaire, open between September and November 2019, gathering 1635 replies for all 12 initiatives;
- A total of 608 Interviews performed as part of the thematic studies by the different study teams between August 2019 and January 2020.

This document is the synopsis report for the initiative "Smart Networks and Services". It provides an overview of the responses to the different consultation activities. A full analysis of the results is provided in the study Data Report.

[47] https://ec.europa.eu/commission/presscorner/detail/en/IP_18_4041

[48] https://ec.europa.eu/commission/presscorner/detail/en/STATEMENT_19_2163

[49] https://ec.europa.eu/info/files/better-regulation-guidelines-stakeholder-consultation_en

[50] The full list of inception impact assessments is available here. They were open for public feedback until 27 August 2019.

B.2 Feedback to the inception impact assessment on candidate initiatives for institutionalised partnerships

Following the publication of the inception impact assessment, a feedback phase of 3 weeks allowed any citizen to provide feedback on the proposed initiatives on the "Have your say" web portal. In total 608 feedbacks were collected for all initiatives.

For the initiative "Smart Networks and Services", eight individual feedback were collected, mainly from business associations.[51] Among the elements mentioned were:

- The necessity for the initiative to reach beyond the traditional ecosystem of telecommunication actors and to reach toward vertical industries
- The necessity for the initiative to encompass technologies that go beyond telecommunication, reaching toward IoT, digital services, edge computing, A.I. and cybersecurity
- The necessity to go beyond infrastructure development and include research on end-to-end industrial applications and related services that contribute to socio-economic development

B.3 Structured consultation of the member states on European partnerships

A structured consultation of Member States through the Shadow Strategic Configuration of the Programme Committee Horizon Europe in May/ June 2019 provided early input into the preparatory work for the candidate initiatives (in line with the Article 4a of the Specific Programme of Horizon Europe). This resulted in 44 possible candidates for European Partnerships identified as part of the first draft Orientations Document towards the Strategic Plan for Horizon Europe (2021-2024), taking into account the areas for possible institutionalised partnerships defined in the Regulation.

The feedback provided by 30 countries (all Member States, Iceland and Norway) has been analysed and summarised in a report, with critical issues being discussed at the Shadow Strategic Programme Committee meetings.

B.3.1 Key messages overall for all candidate Institutionalised Partnerships

Overall positive feedback on the proposed portfolio, but thematic coverage could be improved

The results indicate a high level of satisfaction with the overall portfolio, the level of rationalisation achieved, and policy relevance. While delegations are in general satisfied with the thematic coverage, the feedback suggests the coverage could be improved in cluster 2 "Culture, creativity and inclusive society" and cluster 3 "Civil Security for Society".

Large number (25) of additional priorities proposed for partnerships by delegations

Despite high satisfaction with the portfolio and candidates put forward by the Commission, countries put forward a high number of additional priorities to be considered as European Partnerships. A closer examination suggests that these additional proposals are motivated by very different reasons. Whilst some proposals are indeed trying to address gaps in the portfolio and reach a critical mass, then, others are driven by the wish to maintain existing networks, currently not reflected in the Commission proposal (e.g. those based on JPIs,

[51] Feedback on inception impact assessment to be found on https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2019-4972300/feedback_en?p_id=5722191

ERA-NETs). In addition, some proposals reflect worries over some topics not being sufficiently covered in the existing proposals but could be possibly well covered within the scope of existing partnerships, or by traditional calls under the Framework Programme.

Critical view on the high number and openness of Joint Undertakings

Country feedback suggests dissatisfaction with the high number of proposed Article 187 TFEU partnerships. Notably smaller as well as EU-13 countries raise concerns with regards to the potential insufficient transparency and openness of the partnership model. In the feedback, countries either directly support or ask to carefully analyse whether the objectives of this proposal could be reached with the co-programmed model.

For those partnerships that will be set up on the basis of Article 187, the country feedback stresses the need to ensure a clear shift towards openness in the governance, membership policy and allocation of funding of these partnerships. Notably, it is emphasised that the JU rules should not have any limitations or entry barriers to the participation of SMEs and other partners, including from academia.

Although the feedback suggests a general criticism, there are few concrete and broadly supported proposals, including to reduce the number of institutionalised partnerships mergers or by alternative implementation modes.

Lack of cross-modal perspective and systematic approach to mobility

The current proposal foresees 5 partnerships in the area of transport (for rail, air traffic management, aviation, connected and automated driving, zero-emission road transport), and 2 that in closely related technologies for radically reducing carbon emissions (hydrogen, batteries). Several delegations would wish to see a systemic approach to developing mobility and addressing related challenges (optimisation of overall traffic, sustainable mobility solutions for urbanisation), and do not support a mode-dependent view only. This suggests the need to discuss how to ensure greater cooperation between transport modes and cross-modal approaches in establishing partnerships in the area of mobility.

Partnership composition: the role of Member States in industry partnerships

The composition and types of partners is an important element for the success of a partnership, e.g. to ensure the right expertise and take-up of results. Ensuring broad involvement without overly complicating the governance of the partnership remains an important an important challenge in the design of future partnerships.

In the feedback, several Member States express their interest to join as a partner in partnerships that have traditionally been industry-led. However, individual comments suggest there are different views on what their involvement means in practice, with some countries expressing readiness to commit funding, while others support limiting their involvement to alignment of policies and exploiting synergies. This suggests the need to discuss further what the involvement of Member States means in practice (notably in terms of contributions, in the governance), and what would be possible scenarios/options in Horizon Europe. There is special interest in testing and deployment activities, in synergies with Cohesion Funds and CEF priorities and investments.

Although it is too early to determine the interest of industry/ businesses in the topics proposed for partnerships where the main partners are public authorities, their involvement in in public centric partnerships will also be an important question in the design and preparation of future proposals.

Some proposals are more mature than others

The analysis of feedback per partnership candidates suggests that some proposals are more mature, while others would need more time to determine the scope, objectives, partner composition and contribution and appropriate mode of implementation. This relates to in particular to partnerships with no predecessors and those where the main partners are public. It suggests that the proposals would need to be developed at different paces in order to achieve good quality, and thus, not all partnership proposals may be ready for implementation at the start of Horizon Europe.

B.3.2 Overall feedback on the initiative "Smart Networks and Services" from Member States.

For the initiative "Smart Networks and Services" the following overall feedback was received from Member States.

- The results of the Member State consultation confirm strongly the overall relevance of the proposed Smart Networks and Services partnership. Almost all (96%, with more than 80% very relevant) underline its relevance for national policies and priorities, for their research organisations, including universities, as well as for industry
- The majority of countries (52%) are at this stage interested to participate.
- All countries expressed interest in having access to results produced in the context of the partnership.

Member states delegations identified a number of aspects that could be reinforced in the proposal for this partnership that would increase its relevance for national priorities, e.g.:

- Include aspects related to standardisation (and related bodies), since interoperability of the development of smart networks could be a technological barrier for smooth services deployment;
- Provide support to the satellite segment, the light fidelity (LiFi) technology and the cross-border aspects in the Smart Network and Services;
- Ensure links and alignment with relevant policies, initiatives and partnerships in the mobility domain;
- Ensure the strong involvement of national competences and strengths in the area of Smart Networks and Services;
- Ensure actions that enforce the cooperation with the relevant industries in the areas of Industry 4.0 and Automotive (Industrial Communications);
- Ensure that ethical issues are appropriately addressed;
- Include 5G-based rural connectivity solutions as an area of emphasis.

B.4 Targeted consultation of stakeholders related to the initiative "Smart Networks Services"

In addition to the consultation exercises coordinated by EC services, the external study thematic teams performed targeted consultations with businesses, research organisations and other partners on different aspects of potential European Partnerships.

B.4.1 Approach to the targeted consultation

The interviews were conducted as an important part and key support to the Impact Assessment of the Smart Networks and Services initiative. The objectives of the interviews were to better understand the different perspectives of the stakeholders on the problems

to be addressed by the initiative, and to identify the desired objectives and features of a future initiative.

The large range of stakeholders that would have to be involved in a Smart Networks and Services initiative required a consultation of diverse stakeholders, ranging from academics and telecom / ICT industrials (which are likely to be the core players of a future initiative) to other perspectives from SMEs, vertical industries (automotive, manufacturing, transport, health, energy) and Member States.

B.4.2 Overview of respondents to the targeted consultation

The following table present the distribution of interviews over the different stakeholders' categories. In total 30 interviews were conducted, out of more than 75 contacts initiated.

The distribution of interviews shows a good balance between academic players (23%), the telecom industry (34%), SMEs (17%), industry associations, including verticals, (16%) and Member States (10%).

Table 21: Number of interviews per stakeholder category

Stakeholder category	Number	Share (%)
Academics	7	23%
Telecommunication Equipment / Hardware / Software Providers	8	27%
Telecom Operators	2	7%
Networks, Telecommunications and Digital Services SMEs	5	17%
Other Telecom Representatives (Industry Association, Regulators, Think tanks, etc.)	1	3%
Representatives from Vertical Industries (companies and industrial associations)	4	13%
Representatives from Member States	3	10%
TOTAL	**30**	**100%**

B.4.3 Key results/messages from the targeted consultation

Problem definition

Industries' stakes is to deliver appropriate infrastructure and technologies

The common challenge shared by half of the interviewees (no leading type of categories of players) is the necessity **to target industries** thanks to an adapted network infrastructure for their transformation program and essentially by taking into account how Smart Networks and Services will **impact on European industry** tissue.

Indeed, assuming that it will not be any more a consumer market, interviewees pointed out the common following points:

- The necessity to involve **players outside the traditional telecom value chain** in the structure of the research program, mainly targeting vertical players, which is key to understand and to take into account the diversity of verticals' requirements like security, network coverage, energy consumption, ultra-low latency round trip;
- The necessity to focus on services and to support use cases very early in the research program. A pragmatic approach is required in order to have the ability to translate **innovation in commercialization**;
- The necessity to provide a flexible and open infrastructure to support the paradigm change in **new kind business models towards like "Anything as a Service"** model;
- The necessity to take into account **context of sovereignty and security for networks** that will be increasingly used in critical applications.

Another major part of interviewees, especially from SMEs voices, were more focused on the **technological scope** of the research program because "networks have the potential to provide higher value to the society". Typically, there is a demand to **enlarge the scope of technologies with a major focus on security** especially for critical applications. Other technologies to be covered include network intelligence, network automation, network softwarization, network slicing, edge computing, cybersecurity, machine learning, Artificial Intelligence, IoT but also robotics, high performance computing.

Europe needs to keep or regain leadership in the value chain

Common statement between all interviewees is that in the context of increasing fierce global competition, **Europe is lagging behind Asia (especially driven by China) and US.** So there is a need to keep or regain European leadership in the value chain also to reach a technological independence mainly for security reasons.

Indeed, the **lack of funding into research in Europe** has been said as an issue from handful players. There is a necessity to invest more in research in Europe in order to develop its potential, to remain competitive and to build sovereignty but also to avoid shortage of skills and lack of ventures and start-ups."We are good in research and we have very capable institutions to further develop solutions as the past revealed with 2G and 3G".

Typically, there is a need to **support areas where Europe is good at in the value chain and to position on emerging topics:**

- Necessity for Europe to keep the strong position on network infrastructure with the presence of two mastodons;
- Necessity to support emerging technologies. Some interviewees outlined the need to gain leadership on edge computing for instance (critical topic);
- Support IoT specialists;
- Position of IoT devices;
- Support verticals like smart grid and industries (Industry 4.0);
- Innovation from European SMEs.

Also, many interviewees from different categories of players mentioned the need to **facilitate the deployment**. "Europe is very good in research but it has mainly focused on technological aspects, not business models and how to generate value". Even though most of interviewees agreed on the fact that deployment should not be funded by research program and relies on private side, they also agreed on the fact that there is a **lack of coordination** to target a single market, lack of incentives to take research to commercialization stage and lack of global vision.

Key stakeholders to involve in the definition of research program

Globally, all interviewees agreed on the necessity to have the **whole value chain represented in the partnership** beyond the traditional telecom players especially the **verticals**. There is a need to have a combination of different categories of players including **universities and SMEs** that are vital in the research program.

Regarding the structure of the partnership, interviewees outlined the necessity to have a **proper balance between every player in order to have a good cooperation and all good skills united but not necessary at the same weight.** Having an open and flexible mechanism is required without necessarily to set up quotas. Typically, for SMEs, the mechanism should include incentives to attract and facilitate the involvement this category of players bit without force strict provisions.

For most of interviewees, **Member States involvement in the definition and funding of the research program is not welcome** due to political influence and the difficulty "to get 27 different visions and priorities". Though, interviewees also outlined the necessity to discuss with Member States to set up the directions in order to be aligned with national projects allowing synergies for **regulation harmonization especially around spectrum and security issues** (maybe pushing cybersecurity topic) or for deployment phase.

Only few players want Member States on board since the beginning arguing necessary to have them early to take into account national issues; few players also mentioned their possible role in funding cross border infrastructure.

Preferred form of the partnership

Option 0: Traditional calls

Only 2 interviewees out of the 30 were in favour of traditional calls thanks to the great flexibility brought by this option.

For the rest of interviewees, especially for the SMEs, vertical players and Member States representatives, this **option should be ruled out** because partnership is required to face the global competition. Also, this option lacks of coordination between all players and engagement and thus is not adapted.

Option 1: Co-programmed partnership

Co-programmed partnership is **clearly the preferred option among the majority of the interviewees,** especially backed by those already having experience in 5GPPP, mainly from the categories of telecom operators and telecom infrastructure providers. Indeed, those players found good achievement with the actual PPP. Even though they agree on improving the partnership form, they think that there is "no reason to change" the structure at the "risk of losing momentum".

Other categories like academics and SMEs are also in favour of the co-programmed partnership but they are **also open to the Institutionalized Partnership too.** Arguments for this option include the ability to involve all the players, the great coordination between the projects, and also that it is the most flexible, productive and efficient compared to other options.

Option 2: Co-funded partnership

For all interviewees, this **option should be ruled out** for different reasons:

- For some interviewees, Member States should not be part of the funding of the research program;
- For others, industry is missing in this option;

- For other, there is a lack of coordination.

Option 3: Institutionalized partnership

The **second preferred option by some of the interviewees** is the Institutionalized Partnership. The advantages outlined include:

- The ability to have all players involved including Member States, EC and the industrial partners, thus maximising cooperation and synergies. It is also seen as a "reasonable option if Member States really needed";
- The ability to engage in a long-term contract that is legally binding which would be a strong commitment for the implementation to reach scale;
- The ability to have higher ambition face to the global competition.

For the other interviewees, the drawbacks for this option are related to the **organisation structure**:

- Doubts on the rules of governance;
- Fear of being an organisation that is too cumbersome;
- Too much overhead and heavy procedures;
- Lack of agility
- Presence of the Member States that introduces political issues and delays. Though, some interviewees would be in favour of Institutionalized Partnership option without the Member States.

Functionalities of the initiative

For the majority of interviewees, the level of funding should be **at least the same amount than for 5GPPP or more**, so between 1 billion and 1.3 billion for a 6- or 7- year research program. Arguments for this amount were diverse:

- Wide scope of research (more technologies, more verticals);
- More players involved so effort required on time and costs;
- Effort required to regain the whole value chain for geopolitical reason (technological independence of Europe;
- Finance for tests.

B.5 Open public consultation on the Candidate institutionalised European Partnerships

B.5.1 Approach to the open public consultation

The consultation was open to everyone via the EU Survey online system.[52] The survey contained two main parts and an introductory identification section. The two main parts collected responses on general issues related to European partnerships (in Part 1) and specific responses related to 1 or more of the 12 candidate initiatives (as selected by a participant).

[52] https://ec.europa.eu/eusurvey/runner/ConsultationPartnershipsHorizonEurope

The survey contained open and closed questions. Closed questions were either multiple choice questions or matrix questions that offered a single choice per line, on a Likert-scale. Open questions were asked to clarify individual choices.

The survey was open from 11 September till 12 November 2019. The consultation was available in English, German and French. It was advertised widely through the European Commission's online channels as well as via various stakeholder organisations.

The analysis of the responses was conducted by applying descriptive statistic methods to the answers of the closed questions and text analysis techniques to the analysis of the answers of the open questions. The keyword diagrams in this report have been created by applying the following methodology: First, the open answer questions were translated into English. This was followed by cleaning of answers that did not contain relevant information, such as "NA", "None", "no comment", "not applicable", "nothing specific", "cannot think of any", etc. In a third step, common misspellings were corrected, such as "excellence" instead of "excellence", or "partnership" instead of "partnership". Then, then raw open answers were tokenised (i.e. split into words), tagged into parts of speech (i.e. categorised as a noun, adjective, preposition, etc) and lemmatised (i.e. extraction of the root of each word) with a pre-trained annotation model in the English language. At this point, the second phase of manual data cleaning and correction of the automatic categorisation of words into parts of speech was performed. Finally, the frequency of appearance and co-occurrences of words and phrases were computed across the dataset and the different sub-sets (e.g. partnerships, stakeholder groups). Data visualisations were created based on that output.

The keyword graphs in the following sections have been built based on the relationships between words in the open responses of the survey participants. It features words that appear in the same answer either one after the other or with a maximum distance of two words between them. Each keyword is represented as a node and each co-occurrence of a pair of words is represented as a link. The size of the nodes and the thickness of the links vary according to the number of times that keywords are mentioned and their co-occurrence, respectively. In order to facilitate the visualisation of the network, the keyword graphs have been filtered to show the 50 most common co-occurrences. Although the keywords do not aim to substitute a qualitative analysis, they assist the identification of the most important topics covered in the answers and their most important connections with other topics, for later inspection in the set of raw qualitative answers.

B.5.2 Overview of respondents to the open public consultation

Profile of respondents

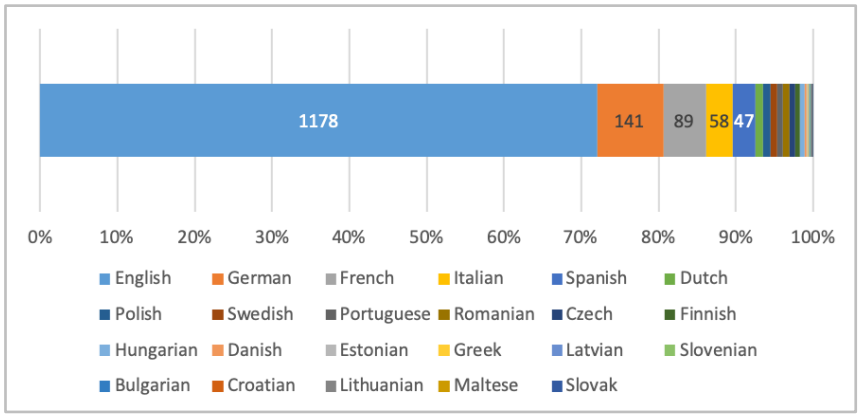
In total, 1635 respondents filled in the questionnaire of the open public consultation. Among them, 272 respondents (16.64%) were identified to have responded to the consultation as part of a campaign (coordinated responses). Based on the Better Regulation Guidelines, the groups of respondents where at least 10 respondents provided coordinated answers were labelled as *'campaigns',* segregated and analysed separately and from other responses. In total 11 campaigns were identified. In addition, 162 respondents in the consultation also display similarities in responses but in groups smaller than 10 respondents. Hence, these respondents were not labelled as campaigns and therefore were not analysed separately from the general analysis.

Among the 1635 respondents, 1178 (72.05%) completed the online consultation in English, 141 (8.62%) in German, 89 (5.44%) in French, 58 (3.55%) in Italian and 47 (2.87%) in Spanish, see Figure 20. Respondents that belong to the 11 campaigns follow the same pattern of language distribution, with English being the dominant language of respondents in that group. Table 22 shows that over 50% of respondents come from 4 Western and Southern European countries – Germany, Italy, France and Spain. Overall,

the number of respondents from Eastern and Northern Europe is lower, while among non-EU countries the greater number of respondents come from Switzerland, Norway and Turkey, which are countries associated to the Framework Programme. In the group of respondents labelled as campaigns, most respondents are from Germany (48 respondents or 17.65%), France (39 respondents or 14.34%), Italy (37 respondents or 13.6%), Belgium (23 respondents or 8.46%), the Netherlands (21 respondents or 7.72%) and Spain (17 respondents or 6.25%). Hence, a similar pattern of country of origin is observed in the entire sample of respondents and for the campaigns.

Across all respondents 40.80% indicated to answer to the open public consultation in a public way (non-anonymous) and 20.67% of all respondents indicated their Transparency Register number.

Figure 20: Language of the consultation (N=1635)



Notes: Non-campaign replies; Aggregation of responses of all candidate initiatives

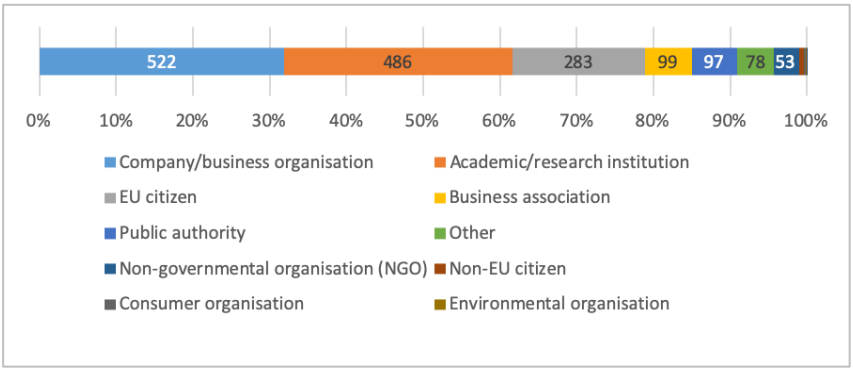
Table 22: Country of origin of respondents (N=1635)

Country	Number of respondents	Percentage of respondents
Germany	254	15.54%
Italy	221	13.52%
France	175	10.70%
Spain	173	10.58%
Belgium	140	8.56%
The Netherlands	86	5.26%
Austria; United Kingdom	61	3.73%
Finland	49	3.00%
Sweden	48	2.94%
Poland	45	2.75%
Portugal	32	1.96%
Switzerland	28	1.71%
Czechia	24	1.47%
Greece	23	1.41%

Country	Number of respondents	Percentage of respondents
Norway; Romania	22	1.35%
Denmark	20	1.22%
Turkey	19	1.16%
Hungary	14	0.86%
Ireland	12	0.73%
United States	11	0.67%
Estonia; Slovakia; Slovenia	10	0.61%
Bulgaria; Latvia	9	0.55%
Bosnia and Herzegovina	7	0.43%
Lithuania	4	0.24%
Canada; Croatia; Israel	3	0.18%
China; Ghana; Iceland; Japan; Luxembourg; Morocco	2	0.12%
Bhutan; Botswana; Cyprus; Iran; Malta; Mexico; Moldova; Mongolia; Palestine; Russia; Serbia; South Africa; Tunisia; Ukraine; Uruguay	1	0.06%

According to Figure 21, the three biggest groups of respondents are companies and business organisations (522 respondents or 31.93%), academic and research institutions (486 respondents or 29.72%) and EU citizens (283 respondents or 17.31%). Business associations, representing multiple businesses, were the fourth largest responding group (99 respondents or 6.05%), no other types of associations were presented amongst the selectable options for respondents. Among the group of respondents that are part of campaigns, most respondents are provided by the same groups of stakeholders, namely companies and business organisations (121 respondents or 44.49%), academic and research institutions (54 respondents or 19.85%) and EU citizens (42 respondents or 15.44%).

Figure 21: Type of respondents (N=1635)



Notes: Non-campaign replies; Aggregation of responses of all candidate initiatives

Respondents were asked to indicate the organisational size of the companies, organisations and institutions they work for. Based on Table 23, a greater number of respondents work in large companies and business organisations (295 respondents out of 522 or 56.51%) and large academic and research institutions (348 respondents out of 486 or 71.60%). A

greater number of respondents that are employed by business associations and NGOs indicated an organisation size of 1 to 9 employees. Among the group of respondents that are marked as campaigns, a greater number of respondents work in large companies and business organisations (82 respondents out of 121 or 67.77%) and academic and research institutions (39 out of 54 respondents or 72.22%).

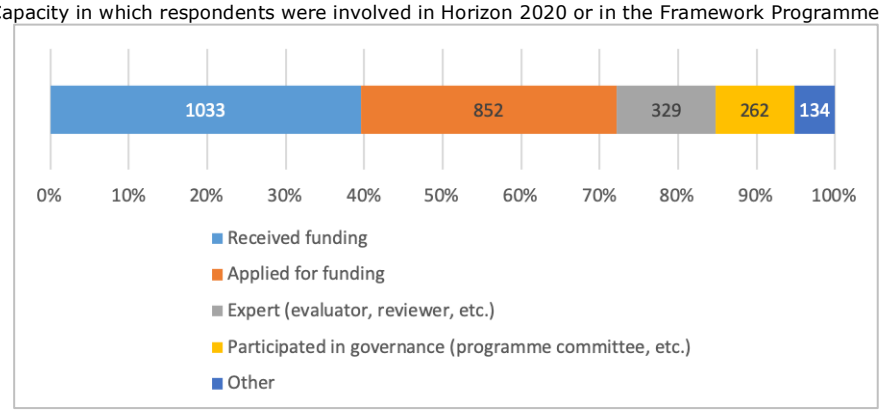
Table 23: Size of organisations that represent consultation respondents (N=1635)

	Organisation size			
Type of respondents' organisations	**Large (250 employees or more)**	**Medium (50 to 249 employees)**	**Small (10 to 49 employees)**	**Micro (1 to 9 employees)**
Company/business organisation	295	66	90	71
Academic/research institution	348	95	31	12
Business association	15	6	34	44
Public authority	58	33	6	0
Non-governmental organisation (NGO)	7	9	11	26
Consumer organisation	1	0	2	1
Environmental organisation	0	0	1	0
Trade union	0	0	1	0
Other	24	16	19	19

Among all consultation respondents, 1303 (79.69%) have been involved in the on-going research and innovation framework programme Horizon 2020 or the preceding Framework Programme 7, while 332 respondents (20.31%) were not. In the group of campaign respondents, the share of those who were involved in these programmes is higher (245 respondents out of 272 or 90.07%) than in the group of non-campaign respondents (1058 out of 1363 or 77.62%). When respondents that participated in the Horizon2020 or in the preceding Framework Programme 7 were asked to indicate in which capacity they were involved in these programmes, the majority stated that they were a beneficiary (1033 respondents or 39.58%) or applicant (852 respondents or 32.64%).

The main stakeholder categories, e.g. companies/business organisation, academic/research institutions, etc., show a similar distribution across the capacities in which they 'have been involved in Horizon 2020 or in the Framework Programme 7' as the overall population of consultation respondents (see distribution in Figure 22). However, a few stakeholder categories have mainly been involved in the capacity of "Received funding" and/or "Applied for funding", this applies to business associations, NGOs and public authorities.

Figure 22: Capacity in which respondents were involved in Horizon 2020 or in the Framework Programme 7 (N=1303)



Notes: Non-campaign replies; Aggregation of responses of all candidate initiatives

Among those who have been involved in the on-going research and innovation framework programme Horizon 2020 or the preceding Framework Programme 7, 1035 respondents (79.43%) are/were involved in a partnership. The share of respondents from campaigns that are/were involved in a partnership is higher than for non-campaign respondents, 89.80% versus 77.03% respectively. The list of partnerships under Horizon 2020 or its predecessor Framework Programme 7 together with the numbers, percentages of participants is presented in Table 24, the table also show the key stakeholder categories for each partnership.

Most consultation respondents participated in the following partnerships: Fuel Cells and Hydrogen 2 (FCH2) Joint Undertaking, Clean Sky 2 Joint Undertaking, European Metrology Programme for Innovation and Research (EMPIR) and in Bio-Based Industries Joint Undertaking. The comparison between the non-campaign and campaign groups of respondents shows that the overall distribution is quite similar. However, there are some differences. For the campaign group almost a half of respondents is/was involved in the Fuel Cells and Hydrogen 2 (FCH2) Joint Undertaking, a higher share of campaign respondents is/was participating in Clean Sky 2 Joint Undertaking and in Single European Sky Air Traffic Management Research (SESAR) Joint Undertaking.

Table 24: Partnerships in which consultation respondents participated (N=1035)

Name of the partnership	Number and % of respondents from both groups (n=1035)	Number and % of respondents from a non-campaign group (n=815)	Academic/research institutions	Business associations	Company/business organisations (<250)	Company/business organisations (250+)	EU citizens	NGOs	Public authority
Fuel Cells and Hydrogen 2 (FCH2) Joint Undertaking	354 (33.33%)	247 (30.31%)	97	9	37	43	41	8	5
Clean Sky 2 Joint Undertaking	195 (18.84%)	145 (17.79%)	57	2	10	27	37	1	7
European Metrology Programme for Innovation and Research (EMPIR)	150 (14.49%)	124 (15.21%)	64	0	13	9	14	2	19

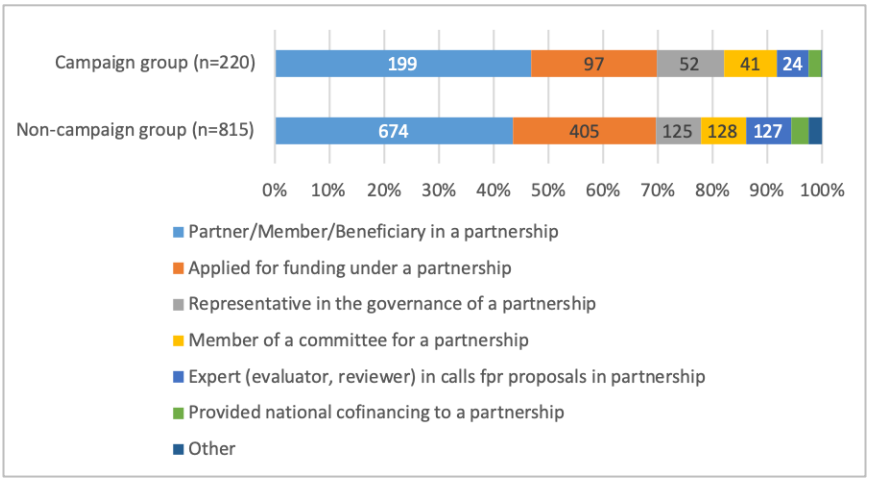
Name of the partnership	Number and % of respondents from both groups (n=1035)	Number and % of respondents from a non-campaign group (n=815)	Academic/research institutions	Business associations	Company/business organisations (<250)	Company/business organisations (250+)	EU citizens	NGOs	Public authority
Bio-Based Industries Joint Undertaking	142 (13.72%)	122 (14.97%)	39	8	20	27	14	1	6
Shift2Rail Joint Undertaking	124 (11.98%)	101 (12.40%)	31	7	5	31	14	3	7
Electronic Components and Systems for European Leadership (ECSEL) Joint Undertaking	111 (10.72%)	88 (10.80%)	42	2	7	20	12	0	5
Single European Sky Air Traffic Management Research (SESAR) Joint Undertaking	66 (6.38%)	46 (5.64%)	10	3	3	20	3	2	3
5G (5G PPP)	53 (5.12%)	47 (5.77%)	20	1	6	14	5	0	1
Eurostrars-2 (supporting research-performing small and medium-sized enterprises)	44 (4.25%)	40 (4.91%)	17	0	6	1	7	0	6
Innovative Medicines Initiative 2 (IMI2) Joint Undertaking	37 (3.57%)	35 (4.29%)	18	2	3	3	2	4	3
Partnership for Research and Innovation in the Mediterranean Area (PRIMA)	28 (2.71%)	26 (3.19%)	15	0	3	1	2	0	2
European and Developing Countries Clinical Trials Partnership	25 (2.42%)	24 (2.94%)	12	0	1	2	3	3	2
Ambient Assisted Living (AAL 2)	22 (2.13%)	21 (2.58%)	11	2	1	1	3	0	3
European High-Performance Computing Joint	22 (2.13%)	18 (2.21%)	6	0	2	3	5	0	2

Name of the partnership	Number and % of respondents from both groups (n=1035)	Number and % of respondents from a non-campaign group (n=815)	Academic/research institutions	Business associations	Company/business organisations (<250)	Company/business organisations (250+)	EU citizens	NGOs	Public authority
Undertaking (EuroHPC)									

When respondents were asked in which role(s) they participate(d) in a partnership(s), over 40% indicated that they act(ed) as partner/member/beneficiary in a partnership (see, Figure 23). The second largest group of respondents stated that they applied for funding under a partnership. The roles selected by non-campaign and campaign respondents are similar.

The few respondents that selected "Other" as their role were provided with the opportunity to outline their role. A total of 25 people did provided description. The answers provided were very varied and could not be clustered in sub-groups, a few examples are: former communication and stakeholder relationship officer, chair of steering board, system engineer, grant manager, Joint Programming Initiative (JPI), or a role in advocacy of the partnership.

Figure 23: Role of respondents in a partnership (N=1035)



Notes: Non-campaign replies; Aggregation of responses of all candidate initiatives

In the open public consultation respondents could provide their views on each of the candidate Institutionalised European Partnerships, and each respondent could select multiple partnerships to provide their views on. The table below presents the number and percentage of respondents for each partnership. It is visible that the majority of respondents (31.37%) provided their views on the Clean Hydrogen candidate partnership. More than 45% of respondents from the campaigns selected this partnership. Around 15% of all respondents provided their views for the candidate partnerships European Metrology, Clean Aviation and Circular bio-based Europe. The share of respondents in the campaign group that chose to provide views on the Clean Aviation candidate partnership is of 20%. The smallest number of respondents provided opinions on the candidate initiative 'EU-Africa research partnership on health security to tackle infectious diseases – Global Health'.

Table 25: Future partnerships for which consultation respondents provide responses (N=1613)

Name of the candidate Institutionalised European partnership	Number and % of respondents from both groups (n=1613)	Number and % of respondents from a non-campaign group (n=1341)	Academic/research institutions	Business associations	Company/business organisations (<250)	Company/business organisations (250+)	EU citizens	NGOs	Public authority
Clean Hydrogen	506 (31.37%)	382 (28.49%)	123	21		55	74	8	13
European Metrology	265 (16.43%)	225 (16.78%)	112	3	21	11	34	3	28
Clean Aviation	246 (15.25%)	191 (14.24%)	57	5	21	34	54	3	8
Circular bio-based Europe: sustainable Innovation for new local value from waste and biomass	242 (15%)	215 (16.03%)	63	19	36	35	31	7	13
Transforming Europe's rail system	184 (11.41%)	151 (11.26%)	29	14	23	39	31	2	7
Key Digital Technologies	182 (11.28%)	162 (12.08%)	55	13	20	22	35	5	7
Innovative SMEs	111 (6.88%)	110 (8.20%)	19	12	39	4	14	4	10
Innovative Health Initiative	110 (6.82%)	108 (8.05%)	35	6	9	12	16	16	5
Smart Networks and Services	109 (6.76%)	107 (7.98%)	34	9	12	17	21	2	6
Safe and Automated Road Transport	108 (6.70%)	102 (7.61%)	25	12	11	19	10	3	9
Integrated Air Traffic Management	93 (5.77%)	66 (4.92%)	8	7	4	24	9	2	7
EU-Africa research partnership on health security to tackle infectious diseases – Global Health	49 (3.04%)	47 (3.50%)	15	2	4	3	12	6	4

Campaigns per candidate Institutionalised European Partnership

As was mentioned above, 11 campaigns were identified, the largest of them includes 57 respondents. The table below presents the campaigns that replied for each candidate

partnership. As presented, the candidate Institutionalised Partnership Clean Hydrogen has the highest number of campaigns, namely 5. A few partnerships, such as Innovative SMEs, Smart Networks and Systems, were not targeted by campaigns. Some campaign respondents decided to provide opinions about several partnerships, therefore, campaign #2 and #6 feature in several partnerships.

Table 26: Overview of campaigns across partnerships

Name of the candidate Institutionalised European partnership	Number of a campaign group (total number of respondents in a campaign)	Number of respondents that provided views about a partnership
Clean Hydrogen	Campaign #1 (57 respondents)	57 respondents
	Campaign #2 (41 respondents)	25 respondents
	Campaign #7 (18 respondents)	18 respondents
	Campaign #9 (14 respondents)	13 respondents
	Campaign #11 (10 respondents)	9 respondents
Clean Aviation	Campaign #2 (41 respondents)	17 respondents
	Campaign #6 (19 respondents)	19 respondents
	Campaign #8 (14 respondents)	13 respondents
Integrated Air Traffic Management	Campaign #2 (41 respondents)	10 respondents
	Campaign #6 (19 respondents)	12 respondents
European Metrology	Campaign #3 (36 respondents)	35 respondents
Circular bio-based Europe: sustainable Innovation for new local value from waste and biomass	Campaign #5 (20 respondents)	20 respondents
Transforming Europe's rail system	Campaign #4 (31 respondents)	29 respondents
Key Digital Technologies	Campaign #10 (12 respondents)	12 respondents
Innovative SMEs	-	-
Innovative Health Initiative	-	-
Smart Networks and Services	-	-
Safe and Automated Road Transport	-	-

Name of the candidate Institutionalised European partnership	Number of a campaign group (total number of respondents in a campaign)	Number of respondents that provided views about a partnership
EU-Africa research partnership on health security to tackle infectious diseases – Global Health	-	-

B.5.3 Responses to the open public consultation at programme level

The following section of the report presents the analysis of responses at programme level, meaning all respondents (excluding campaigns) were included, independent of which candidate European Partnerships respondents selected to provide their views upon. The results for responses as part of campaigns are presented separately.

Characteristics of future candidate European Partnerships

Respondents were asked to assess what areas, objectives, aspects need to be in the focus of the future European Partnerships under Horizon Europe and to what extent. According to Figure 24, a great number of respondents consider that a significant contribution by the future European Partnerships is 'fully needed' to achieve climate-related goals, to the development and effective deployment of technology and to EU global competitiveness in specific sectors/domains. Overall, respondents' views reflect that many aspects require attention of the Partnerships. The least attention should be paid to responding towards priorities of national, regional R&D strategies, including smart specialisation strategies, according to respondents.

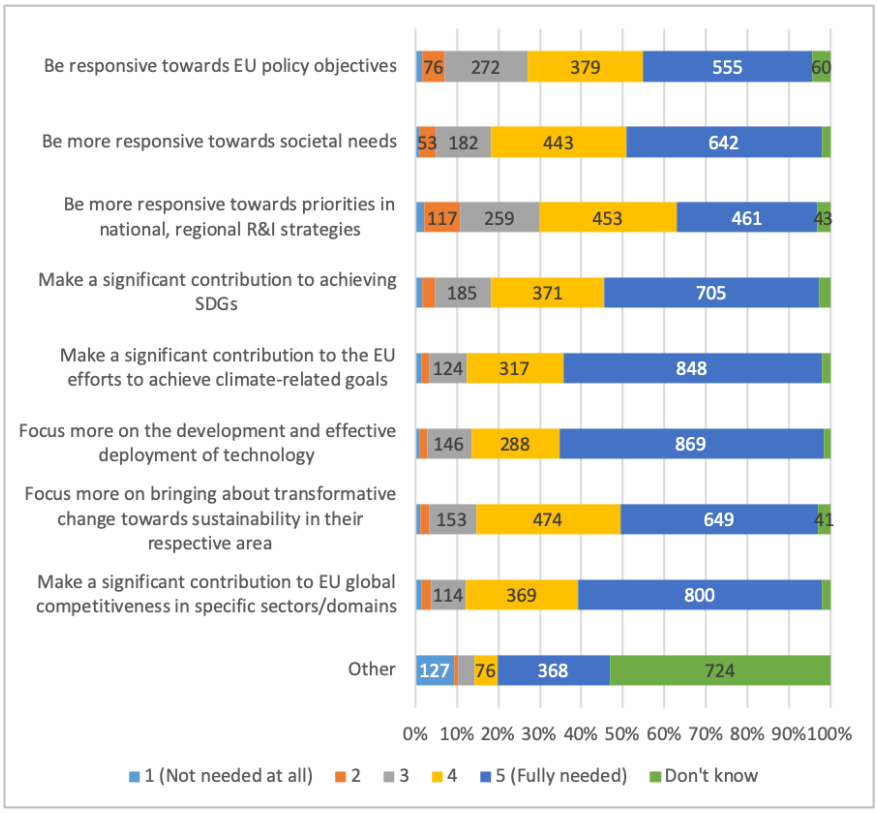
Overall, only minor differences can be found between the main stakeholder categories. Academic/research institutions value the responsiveness towards EU policy objectives and focus on development and effective deployment of technology a little less than other respondents. Business associations, however, find that the future European Partnerships under Horizon Europe should focus a little bit more on the development and effective deployment of technology than other respondents. Furthermore, business associations, large companies as well as SMEs (companies with less than 250 employees) value role of the future European Partnerships for significant contributions to EU global competitiveness in specific sectors domains a little higher than other respondents. Finally, both NGOs and Public authorities put a little more emphasis on the role of the future European Partnerships for significant contributions to achieving the UN SDGs.

The views of citizens (249, or 18.27%), both EU and non-EU citizens, that participated in the open public consultation do not reflect significant differences with other types of respondents. However, respondents that are/were directly involved in a partnership under Horizon 2020 or its predecessor Framework Programme 7 assign a higher importance of the future European Partnerships to be more responsive towards EU policy objectives and to make a significant contribution to achieving the UN's Sustainable Development Goals.

Among 272 respondents that are classified as **campaigns,** the majority (86.76%) indicated that the future European Partnerships should focus more on the development and effective deployment of technology. Other categories of presented needs that received a high score among many campaign respondents are the need to make a significant contribution to the EU efforts to achieve climate-related goals, Sustainable Development Goals and to EU global competitiveness in specific sectors/domains. The least number of campaign respondents valued the need to be more responsive towards priorities in national, regional R&I strategies (54 respondents gave a score "5 Fully needed", or 19.85%) and to be more responsive towards societal needs (71 respondents gave a score "5 Fully needed", or 26.10%).

Similarly as for non-campaign respondents, we find only minor differences between the main stakeholder categories amongst campaign respondents. Academic/research institutions indicated that the future European Partnerships need to focus a little less on development and effective deployment of technology than other respondents. On the contrary, large companies find the focus on the development and effective deployment of technology a little more needed than other respondents, as do public authorities. Furthermore, large companies feel responsiveness towards priorities in national, regional R&I strategies is a little less needed than other respondents. Public authorities, however, value the responsiveness towards societal needs and priorities in national, regional R&I strategies more than others.

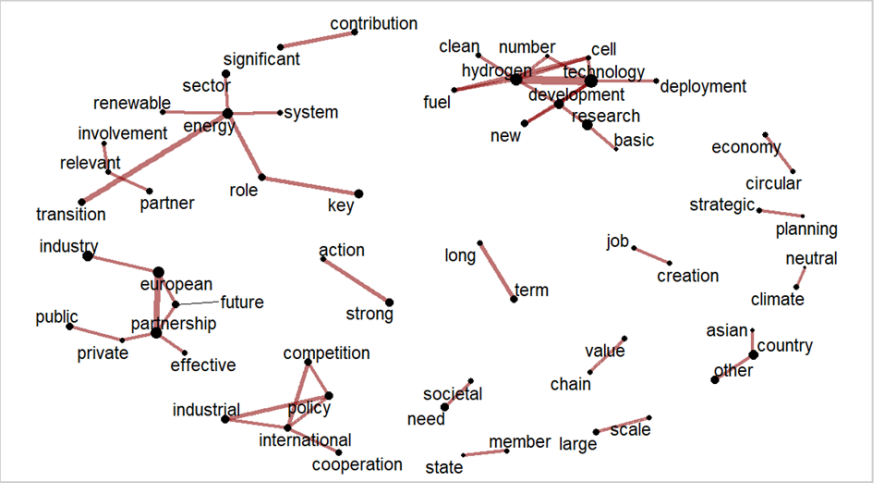
Figure 24: Needs assessment (N=1363)



Notes: Question: " To what extent do you think that the future European Partnerships under Horizon Europe need to …"; Non-campaign replies; Aggregation of responses of all candidate initiatives

The analysis of the open answers provided to explain the "Other" field show that many respondents included the set-up of public-private European partnerships and the link between industrial policy and international competition and cooperation (see Figure 25). This is confirmed through qualitative analysis of answers, many of which mention the importance of collaboration and integration of relevant stakeholders to tackle main societal challenges and to contribute to policy goals. Against this backdrop, fragmentation of funding and research efforts across Europe should be avoided. Additionally, several respondents suggested that faster development and testing of technologies, acceleration of industrial innovation projects, science transfer and market uptake are deemed as priorities. Next to that, many respondents provided answers related to the fields of hydrogen and the energy transition, which corresponds to the high number of respondents that provided answers to the candidate European Partnership specific questions related to these topics.

Figure 25: Needs assessment, open answers to "Other" field (N=734)



Notes: Question: " To what extent do you think that the future European Partnerships under Horizon Europe need to …"; 50 most common co-occurring keywords; Non-campaign replies; Aggregation of responses of all candidate initiatives

Many of the respondents that are classified as campaigns took the opportunity of the "Other" field to underline their key messages. The main aspects mentioned were:

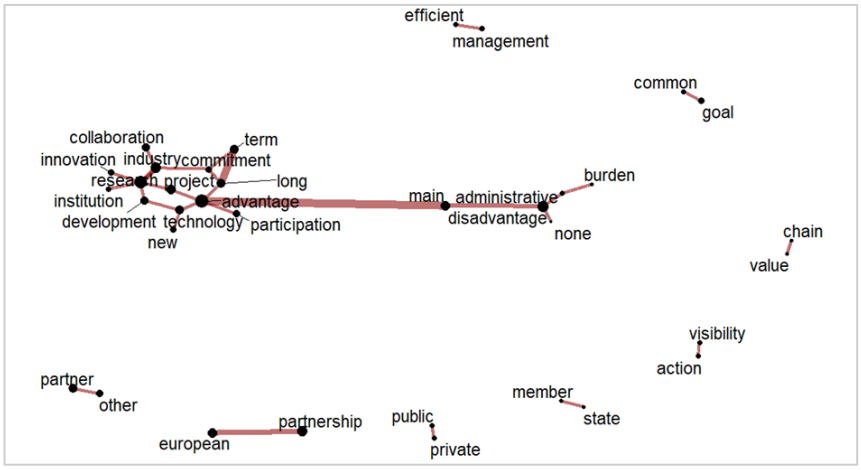
- The global positioning of Europe: outlining the role of global competition (including the role of technology), the importance of autonomy for Europe and the ability of Europe to act as a key player at the global level.
- The balance between policy objectives and private sector interests: Partnerships are regarded as an instrument to secure industry commitments due to the stability required for investments that serve policy goals.
- The importance of the transition between research and innovation (implementing research results in the market).
- The importance of multidisciplinary, and specifically cross-sectoral/cross-partnership collaboration.
- The importance of the long term commitment of a wide range of relevant stakeholders.

Next to that many respondents as part of campaigns stressed the importance of the energy transition, hydrogen and the environment, which corresponds to the high number of respondents that provided answers to the candidate European Partnership specific questions related to these topics.

Main advantages and disadvantages of Institutionalised European Partnerships

In the next question, respondents were asked to outline the main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) under Horizon Europe. This was an open question for which a keyword analysis was used (see the main results in Figure 26). As can be observed, the advantages mentioned focus on the development of technology, overall collaboration between industry and research institutions, and the long-term commitment. Disadvantages mentioned are mainly administrative burdens.

Figure 26: Main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) (N=1551)



Notes: Question: " What would you see as main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) under Horizon Europe?"; 30 most common co-occurring keywords; Non-campaign replies; Aggregation of responses of all candidate initiatives

When asked about the main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) under Horizon Europe, the following points were mentioned by respondents that are classified as campaigns:

Advantages:

- Long term commitment, stability, and visibility in financial, legal, and strategic terms
- Participation of wide range of relevant stakeholders in an ecosystem (large/small business, academics, researchers, experts, etc.)
- Complementarity with other (policy) initiatives at all levels EU, national, regional
- Efficient and effective coordination and management
- High leverage of (public) funds
- Some innovative field require high levels of international coordination/standardisation (at EU/global level)
- Ability to scale up technology (in terms of TRL) through collaboration
- Networking between members
- Direct communication with EU and national authorities

Disadvantages:

- Slow processes
- System complexity
- Continuous openness to new players should be better supported as new participants often bring in new ideas/technologies that are important for innovation
- Lower funding percentage compared to regular Horizon Europe projects
- Cash contributions
- Administrative burdens
- Potential for IPR constraints

Relevance of EU level efforts to address problems in selected areas of Partnerships

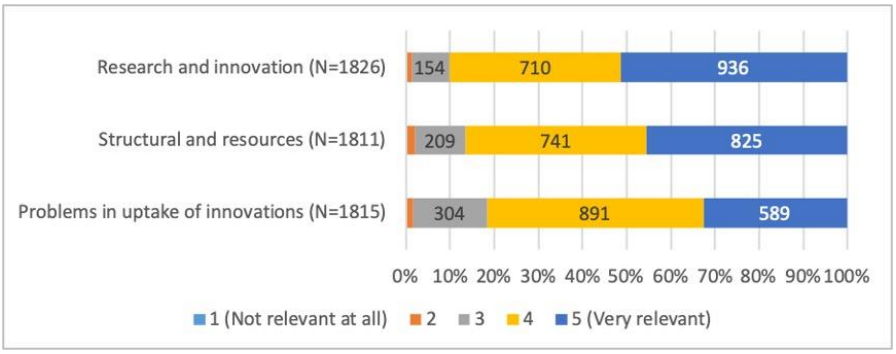
Per candidate European Partnership respondents were asked to rate the relevance of partnership specific problems in three main areas: Research and innovation problems, Structural and resource problems and Problems in the uptake of innovations. To aggregate results the average of the responses on partnership specific problems were calculated.

As presented in Figure 27, research and innovation related problems were rated as most relevant by the respondents across all candidate initiatives, followed by structural and resources problems and problems in the uptake of innovations. Overall, all three areas were deemed (very) relevant across the partnerships, as more than 80% of respondents found these challenges (very) relevant.

Only minor differences were found between the main stakeholder categories of respondents. Research and innovation problems were found slightly more relevant by academic/research institutions, yet slight less relevant by large companies and SMEs. Structural and resource problems were indicated as slightly more relevant by NGOs, but slightly less by academic/research institutions. While both NGOs and public authorities find it slightly more relevant to address problems in uptake of innovation than other respondents.

The views of citizens, both EU and non-EU citizens, are the same as other respondents (no significant differences). Respondents that are/were directly involved in a current/preceding partnership (Horizon 2020 or Framework Programme 7) find, however, the uptake of innovation problems slightly more relevant than other respondents.

Figure 27: Relevant problems to address



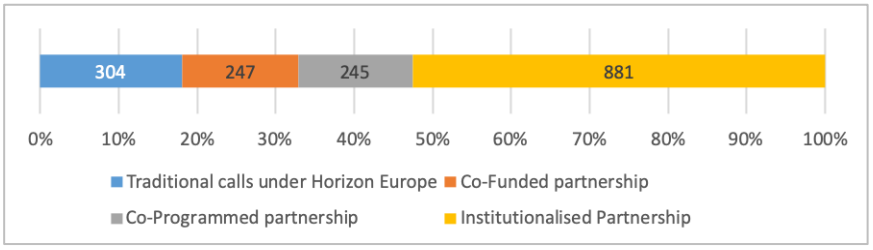
Notes: Question: "To what extent do you think it is relevant for research and innovation efforts at EU level to address the following problems in relation to the candidate partnership in question?"; Non-campaign replies; Aggregation of responses of all candidate initiatives

Horizon Europe mode of intervention to address problems

After providing their views on the relevance of problems, respondents were asked to indicate how these challenges could be addressed through Horizon Europe intervention. As shown in Figure 28, just over 50% of all respondents indicated that institutionalised partnerships were the best fitting intervention, however, relatively strong differences between stakeholder categories were found. The intervention of institutionalised partnerships was indicated more by business associations and large companies, but less by academic/research institutions and SMEs. While academic/research institutions valued traditional calls more often, this was not the case for business associations, large companies and public authorities. Public authorities indicated a co-programmed intervention more often than other respondents. Citizens, compared to other respondents, indicated slightly less often that institutionalised partnerships were the best fitting intervention. Respondents that are/were directly involved in a current/preceding

partnership, however, selected the institutionalised partnership intervention in far higher numbers (nearly 70%).

Figure 28: Options to address challenges



Notes: Question: "In your view, how should the specific challenges described above be addressed through Horizon Europe intervention?"; Non-campaign replies; Aggregation of responses of all candidate initiatives

When asked to reflect on their answers, respondents that pointed to the need for using the "institutionalised partnership" intervention mentioned the long-term commitment of collaboration, a common and ambitious R&I strategy as well as the overall collaboration between industry and research institutions. Respondents that referred to possible approaches, sometimes gave examples of good experiences in with other interventions:

- Traditional calls because of their flexibility and integration of a wide range of actors, as long as the evaluation panels do not deviate from the policy premier. This was mentioned by 94 participants, evenly distributed across companies (25 of them), academics (26) and EU citizens (25).
- Co-funded partnership, as a mechanism to ensure that all participants take the effort seriously, while allowing business partnerships to develop. This approach was deemed suitable based on previous experiences with ERANETs. This was raised by 84 participants, 36 of them academic respondents, 18 companies and 16 EU citizens.
- Co-programmed partnerships to tackle the need to promote and engage more intensively with the private sector. This was mentioned by 97 participants, most of them companies (34), followed by academics (22), business associations (15) and EU citizens (11).

Relevance of a set of elements and activities to ensure that the proposed European Partnership would meet its objectives

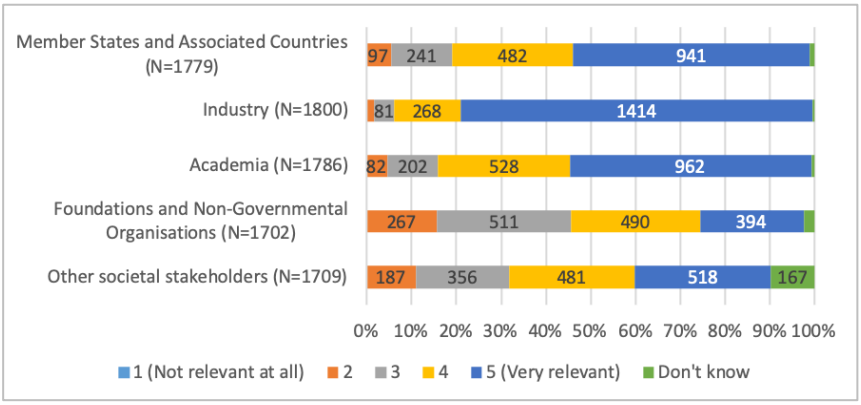
Setting joint long-term agendas

Respondents were asked how relevant it is for the proposed European Partnerships to meet their objectives to have a strong involvement of specific stakeholder groups in setting joint long-term agenda. As presented in Figure 29, collectively all respondents see stakeholders from industry as the most relevant, followed by academia and governments (Member States and Associated Countries). The involvement of foundations and NGOs as well as other societal stakeholders were, however, still found to be (very) relevant by more than 50% of the respondents.

When looking at the differences between the answers of the main stakeholder categories only minor differences could be found. Overall, it could be observed that most respondents indicated the stakeholder group they belong to themselves or that represent them as relevant to involve. Academic/research institutions find it more relevant to involve academia and less relevant to involve industry when compared to other respondents. The other way around large companies, SMEs and business associations find it more relevant to involve industry and less relevant to involve academia, Member States and Associated Countries and NGOs. The involvement of Member States and Associated Countries was found more relevant by academic/research institutions and public authorities. NGOs also

values their own involvement and those of other societal stakeholders more than other respondents. The views of citizens also show a slightly higher relevance for foundations and NGOs. This is less so the case for respondents that are/were directly involved in a current/preceding partnership (most predominantly companies and academia).

Figure 29: Stakeholders to involve in setting joint long-term agenda's



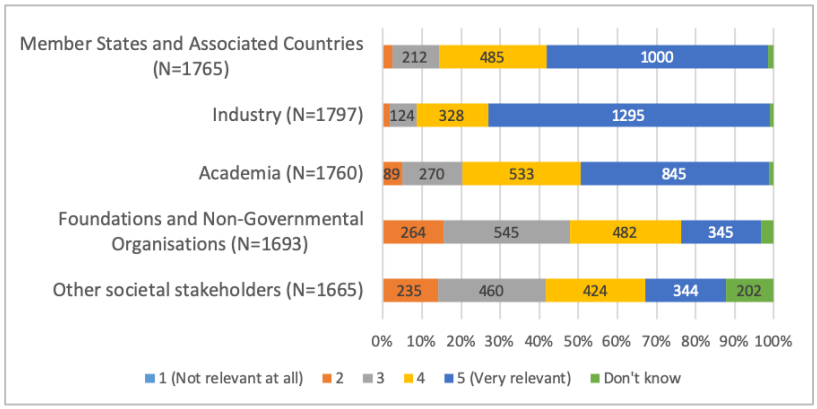
Notes: Question: "In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives - Setting joint long-term agenda with strong involvement of:"; Non-campaign replies; Aggregation of responses of all candidate initiatives

Pooling and leveraging resources through coordination, alignment and integration with stakeholders

Respondents were also asked how relevant it is for the proposed European Partnership to meet its objectives to pool and leverage resources (financial, infrastructure, in-kind expertise, etc.) through coordination, alignment and integration with specific groups of stakeholders. As shown in Figure 30 - similarly as for the previous questions, respondents also see stakeholders from industry as the most relevant, followed by academia and governments (Member States and Associated Countries). The involvement of foundations and NGOs as well as other societal stakeholders are also still found to be (very) relevant for more than 50% of the respondents.

Similarly as described for the question on setting joint long-term agendas, most stakeholder categories valued their own involvement higher than other respondents – although also here differences between stakeholder categories were minor. As such, academic/research institutions see the relevance of academia higher, while large companies, SMEs and business association indicated a lower relevance of academia than other respondents. Similarly, these private sector stakeholders valued the relevance of industry higher than others while valuing the relevance of NGOs and other societal stakeholders less. NGOs value themselves and other societal stakeholders however higher than other respondents, and also public authorities indicated a higher relevance for Member States and Associated Countries then other respondents. Citizens mainly put more emphasis on the role of NGOs and other societal stakeholders then other respondents.

Figure 30: Relevance of actors for pooling and leveraging resources



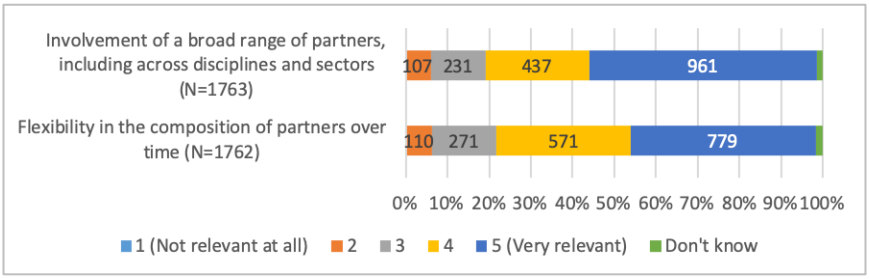
Notes: Question: "In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives – Pooling and leveraging resources (financial, infrastructure, in-kind expertise, etc.) through coordination, alignment and integration with:"; Non-campaign replies; Aggregation of responses of all candidate initiatives

Composition of the partnerships

Regarding the composition of the partnership most respondents indicated that for the proposed European Partnership to meet its objectives the composition of partners needs to be flexible over time and that a broad range of partners, including across disciplines and sectors, should be involved (see Figure 31).

When comparing stakeholder groups only minor differences were found. Academic/research institutions and public authorities found the involvement of a broad range of partners and flexibility in the composition of partners over time slightly more relevant than other respondents, while large companies found both less relevant. SMEs mainly found the flexibility in the composition of partners over time less relevant than other respondents, while no significant differences were found regarding the involvement of a broad range of partners. Citizens provided a similar response to non-citizens. Respondents that are/were directly involved in a current/preceding partnership, when compared to respondents not involved in a current/preceding partnership, indicated a slightly lower relevance of the involvement of a broad range of partners and flexibility in the composition of partners over time.

Figure 31: Assessment of the partnership composition



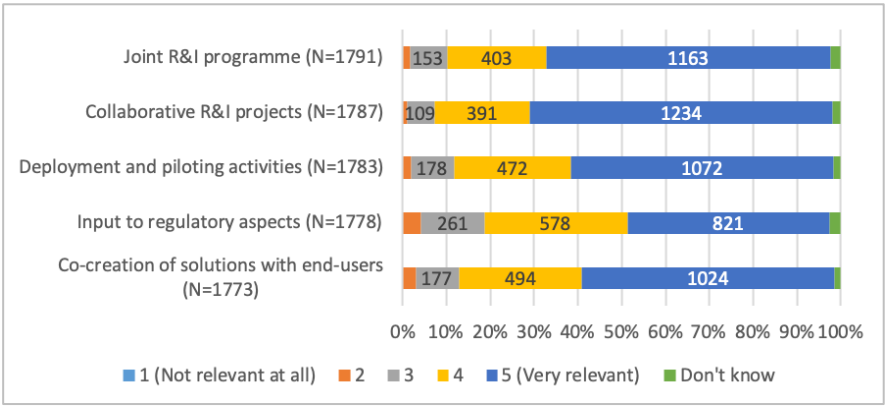
Notes: Question: "In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives – Partnership composition"; Non-campaign replies; Aggregation of responses of all candidate initiatives

Implementation of activities

Most respondents indicated that implementing activities like a joint R&I programme, collaborative R&I projects, deployment and piloting activities, providing input to regulatory aspects and the co-creation of solutions with end-users are all (very) relevant for the partnerships to be able to meet its objectives (see Figure 32).

Minor differences were found between the main stakeholder categories, the differences found were in line with their profile. As such, academic/research institutions found joint R&I programme & collaborative R&I projects slightly more relevant and deployment and piloting activities, input to regulatory aspects and co-creation with end-users slightly less relevant than other respondents. For SMEs an opposite pattern is shown. Large companies, however, also found collaborative R&I projects slightly more relevant than other respondents, as well as input to regulatory aspects. The views of citizens are similar to non-citizens. Respondents that are/were directly involved in a current/preceding partnership, when compared to respondents not involved in a current/preceding partnership, show a slightly higher relevance across all activities shown in Figure 32.

Figure 32: Relevance of activities to implement



Notes: Question: "In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives – Implementing the following activities"; Non-campaign replies; Aggregation of responses of all candidate initiatives

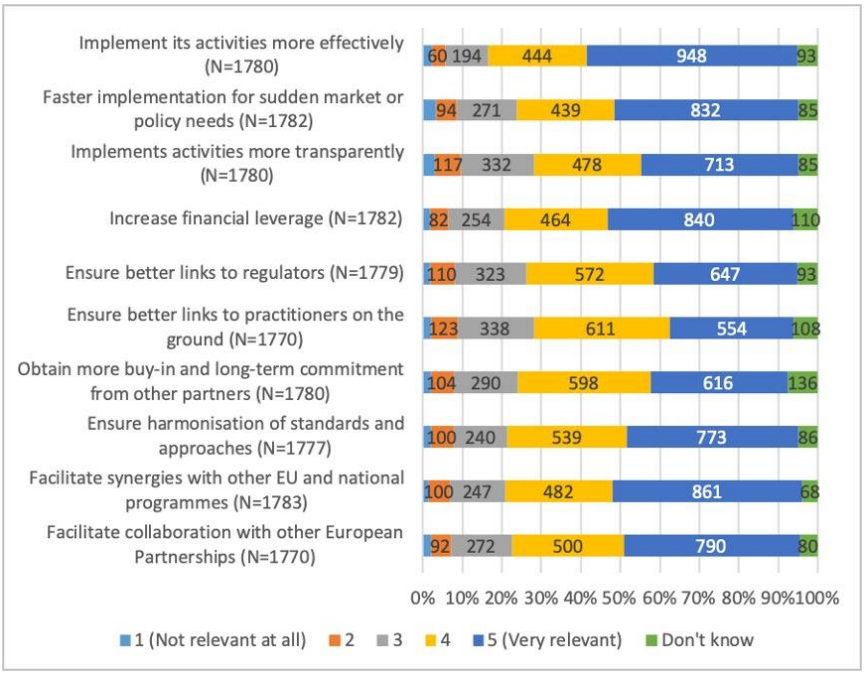
Relevance of setting up a legal structure (funding body) for the candidate European Partnerships to achieve improvements

Respondents were then asked to reflect on the relevance of setting up a legal structure (funding body) for achieving a set of improvements, as presented in Figure 33. In general, 70%-80% of respondents find a legal structure (very) relevant for these activities. The legal structure was found most relevant for implementing activities in a more effective way and least relevant for ensuring a better link to practitioners on the ground, however differences are small.

When comparing the main stakeholder categories we found minor differences. Academic/research institutions indicated a slightly lower relevance for transparency, better links to regulators as well as obtaining the buy-in and long-term commitment of other partners. SMEs also indicated a lower relevance regarding obtaining the buy-in and long-term commitment of other partners. Large companies showed a slightly higher relevance for implementing activities effectively, ensure better links to regulators, obtaining the buy-in and long-term commitment of other partners, synergies with other EU/MS programmes and collaboration with other EU partnerships than other open consultation respondents. NGOs find it slightly more relevant to implement activities faster for sudden market or policy needs. Public authorities, however, find it slightly less relevant to facilitate collaboration with other European Partnerships than other respondents.

The views of citizens show a slightly lower relevance for a legal structure in relation to implementing activities in an effective way. Quite different results are shown for respondents that are/were directly involved in a current/preceding partnership when compared to respondents not involved in a current/preceding partnership, they indicated a higher relevance across all elements presented in Figure 33.

Figure 33: Relevance of setting up a legal structure (funding body)



Notes: Question: "In your view, how relevant is to set up a specific legal structure (funding body) for the candidate European Partnership to achieve the following?"; Non-campaign replies; Aggregation of responses of all candidate initiatives

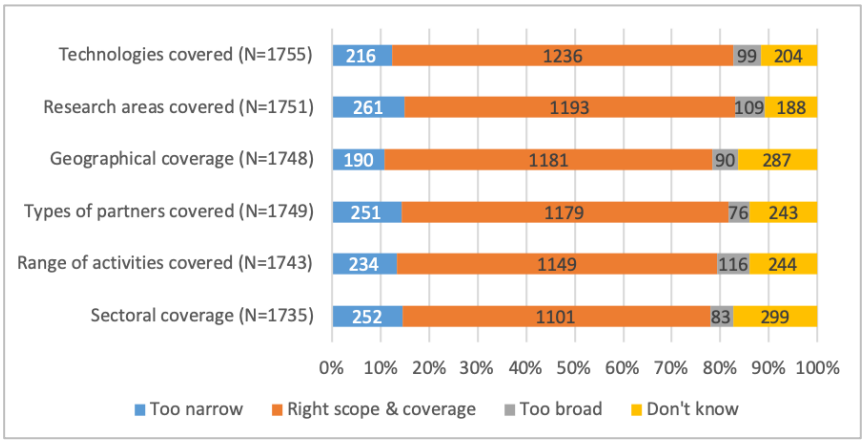
Scope and coverage of the candidate European Partnerships based on their inception impact assessments

The response regarding the scope and coverage for the partnerships, based on inception impact assessments, shows that the large majority feels like the scope and coverage initially proposed in the inception impact assessments is correct. Figure 34 shows the results. However, about 11% to 15% of the respondents indicated the scope and coverage to be too narrow. About 11%-17% of respondents answered "Don't know". In the open answers respondents mostly reflected on specific aspects of the geographical and sectoral scope and coverage of the specific candidate European Partnerships, no overall lessons could be extracted.

Overall, differences between the main stakeholder categories were found to be minor. Academic/research institutions indicated slightly more often that the research area was "too narrow" then other respondents. SMEs on the other hand indicated slightly more often that the research area and the geographical coverage were "too broad". NGOs and public authorities, however, found the geographical coverage slightly more often "too narrow" when compared to other respondents. Large companies found the range of activities slightly more often "too broad" and the sectoral focus slightly more often "too narrow" when compared to other respondents.

The views of citizens are the same as for other respondents. Most notably, respondents that are/were directly involved in a current/preceding partnership, when compared to respondents not involved in a current/preceding partnership, more often indicated that the candidate institutionalised European Partnership have the "right scope & coverage".

Figure 34: Assessment of the proposed scope and coverage of the candidate European Partnerships



Notes: Question: "What is your view on the scope and coverage proposed for this candidate institutionalised European Partnership, based on its inception impact assessment?"; Non-campaign replies; Aggregation of responses of all candidate initiatives

Scope for rationalisation and alignment of candidate European Partnerships with other initiatives

When asked whether it would be possible to rationalise a specific candidate European Institutionalised Partnership and its activities, and/or to better link with other comparable initiatives, nearly two thirds of respondents answered "Yes" (1000, or 62.15%), while over one third answered "No" (609, or 37.85%). Nearly no differences were found between the main stakeholder categories, only large companies and SMEs indicated slightly more often "Yes" in comparison to other respondents.

The views of citizens are the same as for other respondents. Respondents that are/were directly involved in a current/preceding partnership, indicated "No" more often, the balance is about 50/50 between "Yes" and "No" for this group.

In the open responses respondents often referred to specific similar/comparable and complementary initiatives discussing the link with a specific candidate European Partnership, no overall lessons could be extracted, but more detailed results can be found in the partnership specific result sections.

Relevance of European Partnerships to deliver targeted scientific, economic/technological and societal impacts

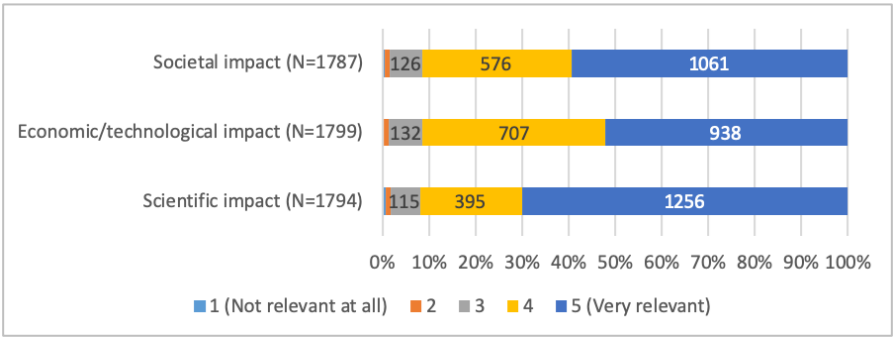
Finally, respondents were asked to rate the relevance of partnership specific impacts in three main areas: Societal impacts, Economic/technological impacts and Scientific impacts. To aggregate results the average of the responses on partnership specific impacts were calculated.

As presented in Figure 35, overall, all three areas were deemed (very) relevant across the candidate partnerships. Scientific impact was indicated as the most relevant impact, more than 90% of respondents indicated that these impacts were (very) relevant.

Only minor difference between stakeholder groups were found. Academic/research institutions found scientific impacts slightly more relevant, while large companies found economic and technological impacts slightly more relevant than other respondents. NGOs found societal impact slightly more relevant, while SMEs found this slightly less important.

Citizens, both EU and non-EU citizens, did not a significantly different view when compared to other respondents. Respondents that are/were directly involved in a current/preceding partnership find all impacts slightly more relevant than other respondents.

Figure 35: Relevant impacts of future European Partnerships



Notes: Question: "In your view, how relevant is it for the candidate European Institutionalised Partnership to deliver on the following impacts?"; Non-campaign replies; Aggregation of responses of all candidate initiatives

B.6 Responses to the open public consultation for the candidate partnership "Smart Networks And Services"

B.6.1 Introduction

This section outlines the results of the Open Public Consultation for the candidate European Partnership for Smart Networks and Services. The section outlines the following:

- Results on general questions, segregated for this candidate European Partnership:
  - Views on the needs of the future European Partnerships under Horizon Europe
  - Views on the advantages and disadvantages of participation in an Institutionalised European Partnership
- Results on specific questions for this candidate European Partnership:
  - Relevance of research and innovation efforts at the EU level to address problems
  - Views on Horizon Europe interventions to address these problems
  - Views on the relevance of elements and activities in:
    - setting a joint long-term agenda;
    - pooling and leveraging resources;
    - partnership composition;
    - implementation of activities.
  - Views on setting up a specific legal structure (funding body)
  - Views on the proposed scope and coverage of this candidate European Partnership
  - Views on the alignment of the European Partnership with other initiatives
  - Relevance of this candidate European Partnership to deliver impacts

B.6.2 Characteristics of respondents

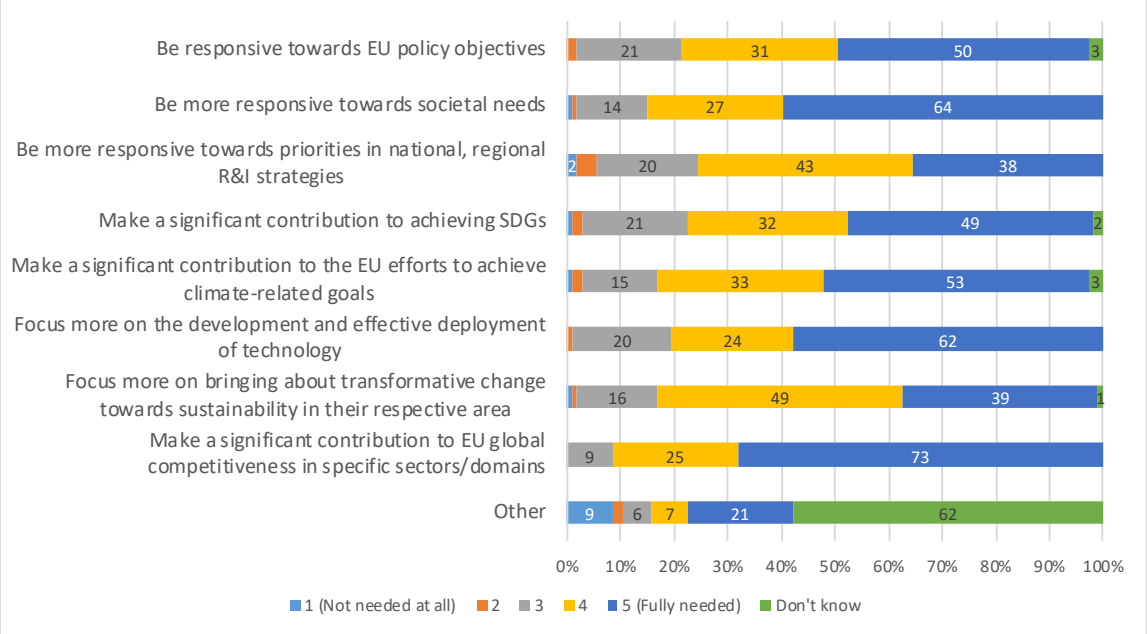
For the Smart Networks and Services Partnership, 107 respondents provided their views. Among them, 21 respondents (19.63%) are citizens. The group is dominated by respondents from academic and research institutions (34 respondents or 31.78%), citizens and company/business organisations (29 respondents or 27.19%). The majority of respondents, namely 84 (78.50%), have been involved in the on-going research and innovation framework programme, while 62 respondents (73.81%) were directly involved in a partnership under Horizon 2020 or its predecessor Framework Programme 7.

B.6.3 Characteristics of future candidate European Partnerships – as viewed by respondents to the Smart Networks and Services initiative

At the beginning of the consultation, all 107 of the respondents for this partnership indicated their views of the needs of the future European Partnerships under Horizon Europe. Overall, respondents indicated that many of the options presented were fully needed (score 5) or gave them a score of 4. The needs where most respondents indicated that it was fully needed was , was making a significant contribution to EU global competitiveness in specific sectors and/or domains (73, 68.22%). Aside from 'other', the needs where the least respondents indicated that improvements were fully needed, was being more responsive towards priorities in national and/or regional R&I strategies (38, 35.51%) and focusing more on bringing about transformative change towards sustainability in their respective area (39, 36.45%). However, these options have a large number of respondents who have given the option a 4 out of 5 on the scale.

No statistical differences were found between the views of citizens and other respondents for most needs. However, citizens found the need of making a significant contribution to EU global competitiveness slightly less relevant.

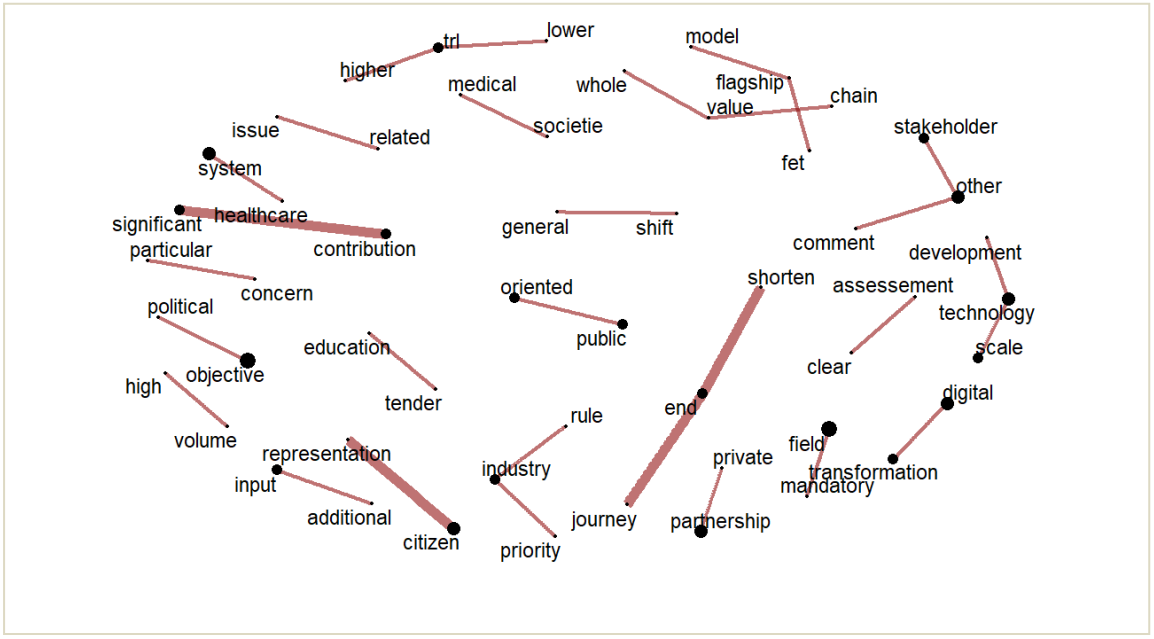
Figure 36: Needs assessment (N=107)



Notes: Question: " To what extent do you think that the future European Partnerships under Horizon Europe need to …"

The respondents also had the option to indicate other needs. The results of the analysis resulted in the chart shown in Figure 37 showing the co-occurrences of keywords. The results show that respondents have indicated needs around citizen representation and significant healthcare contribution.

Figure 37: Needs assessment, open answers to "Other" field (N=28)

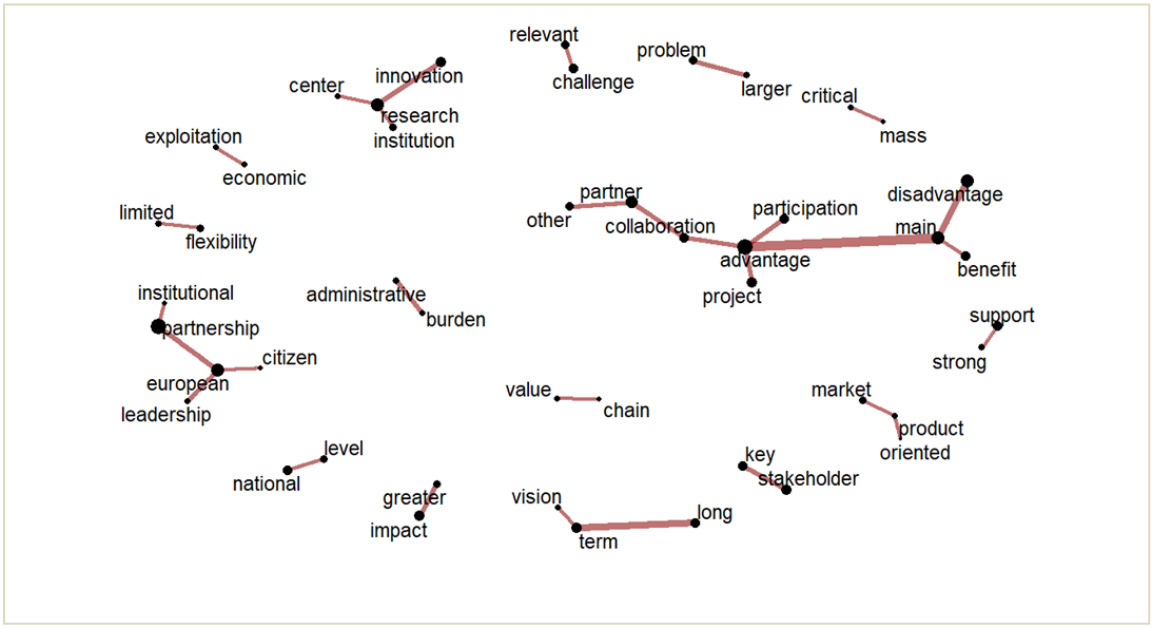


Notes: Question: " To what extent do you think that the future European Partnerships under Horizon Europe need to …"; 50 most common co-occurring keywords

B.6.4 Main advantages and disadvantages of Institutionalised European Partnerships

The respondents were asked what they perceived to be the main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) under Horizon Europe. The keyword analysis used for open questions resulted in the graph shown in Figure 38. This analysis showed the respondents viewed collaboration as the main advantage, while also mentioning European leadership and long-term vision.

Figure 38: Main advantages and disadvantages of participation in an Institutionalised European Partnership (N=87)

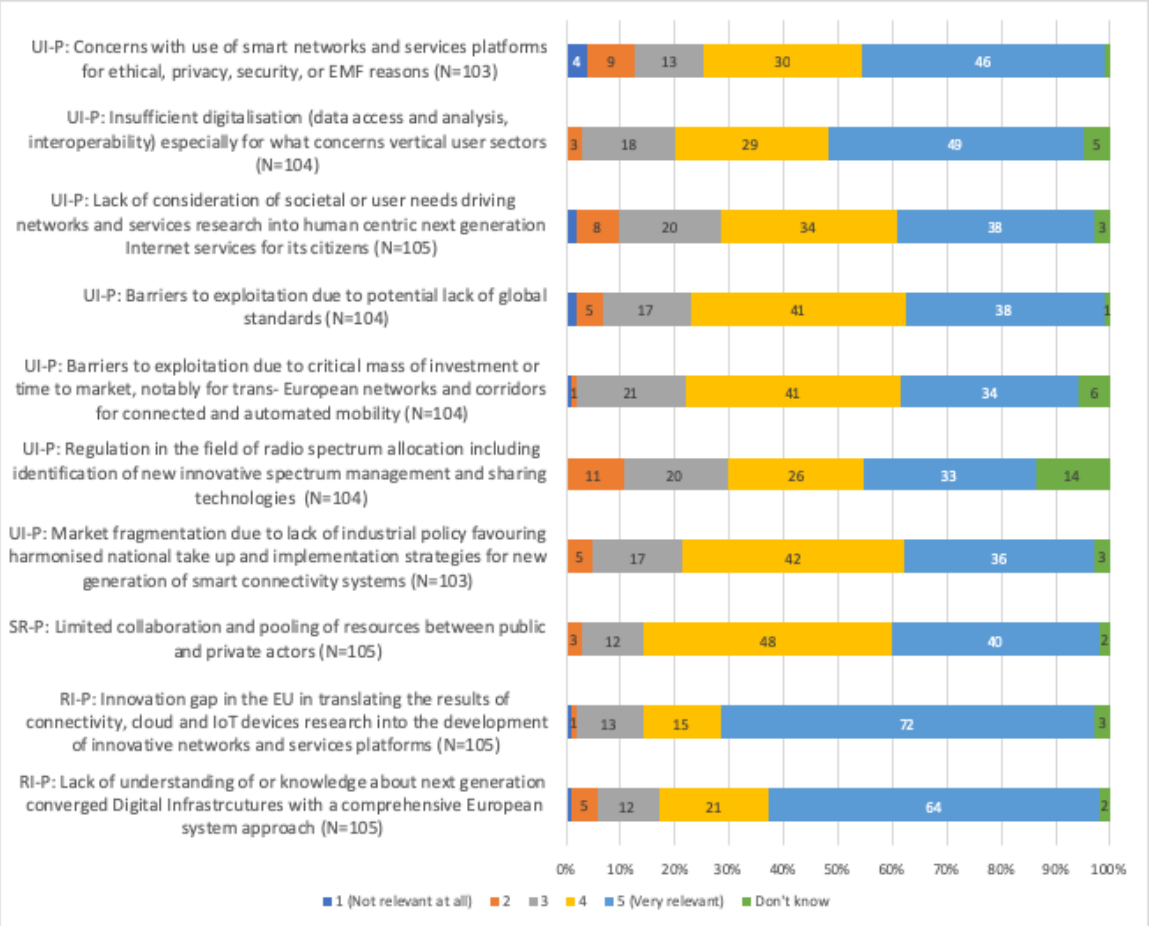


Notes: Question: " What would you see as main advantages and disadvantages of participation in an Institutionalised European Partnership (as a partner) under Horizon Europe?"; 30 most common co-occurring keywords

B.6.5 Relevance of EU level efforts to address problems in relation to the Smart Networks and Services initiative

In the consultation, respondents were asked to provide their view on the relevancy of research and innovation efforts at EU level to address the following problems in relation to key digital technologies, specifically on three types of problems: problems in uptake of smart networks and services (UI-P), structural and resource problems (SR-P) and research and innovations problems (RI-P). In Figure 39, the responses to these answers are presented.

Figure 39: Relevant problems to address



Notes: Question: "To what extent do you think it is relevant for research and innovation efforts at EU level to address the following problems in relation to the candidate partnership in question?"

With regard to the uptake in innovation problems, the majority of respondents have picked either a 4 or a 5 on the 5-point relevancy scale. Respondents indicated that insufficient digitalisation (data access and analysis, interoperability) especially for what concerns vertical user sectors is a very relevant problem, with 49 respondents giving this answer (47.57%). The option that has received the least 5 (very relevant) answers, out of all the problems presented, is regulation in the field of radio spectrum allocation including identification of new innovative spectrum management and sharing technologies (33, 31.73%). This lower relevancy might also be related to the higher number of respondents who have indicated that they 'don't know'. 14 respondents have selected this answer (13.46%), the highest number for any of the options.

There was only one structural and resource problem that the respondents were asked to reflect on, namely, limited collaboration and pooling of resources between public and private actors. With 40 respondents indicating that this is very relevant (38.10%) the

relevancy for research and innovation efforts at EU level to address the problem is similar to the problems presented under the uptake of innovations category.

Finally, respondents have indicated that research and innovation problems are considered the most relevant, as both of the problems presented in this category have received more 5 (very relevant) answers than any of the other problems. The innovation gap in the EU in translating the results of connectivity, cloud and Internet of Things devices research into the development of innovative networks and service platforms is considered the most relevant with 72 respondents indicating it is very relevant (68.57%).

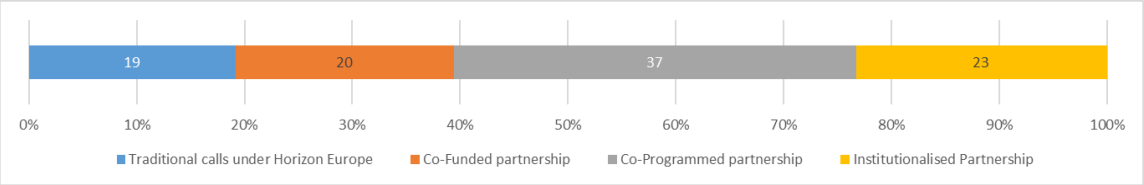
No statistical differences were found between the views of citizens and other respondents.

B.6.6 Horizon Europe mode of intervention to address problems

After providing their views on the relevance of problems, respondents were asked to indicate how these challenges could be addressed through Horizon Europe intervention. As shown in Figure 40, just over 20% of respondents indicated that institutionalised partnerships were the best fitting intervention.

No statistical differences were found between the views of citizens and other respondents.

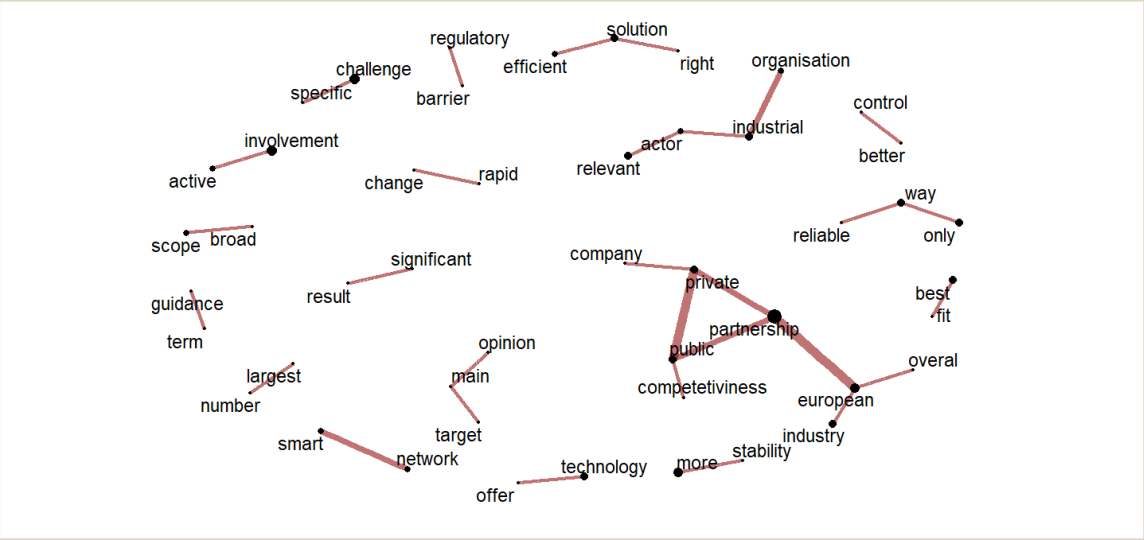
Figure 40: Options to address the challenges



Notes: Question: "In your view, how should the specific challenges described above be addressed through Horizon Europe intervention?"

The respondents were asked to briefly explain their answers to the question above. People who stated that an institutionalised partnerships was the best fitting answer mentioned public private European partnerships, significant results and specific challenges (Figure 41). Respondents who did not select institutionalised partnership as their preferred intervention (N=58) mentioned a wide range of stakeholders, higher degree of freedom, traditional calls and the development of new innovations (not pictured).

Figure 41: Open answers to explain the choice institutionalised partnership in the assessment of the Horizon Europe intervention (N=21)



Notes: Question: "In your view, how should the specific challenges described above be addressed through Horizon Europe intervention?"

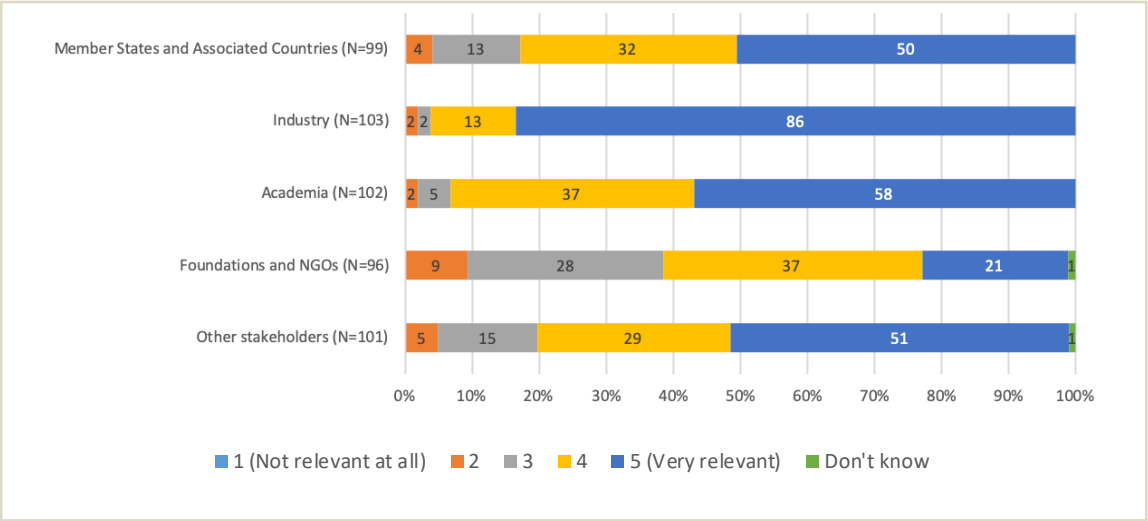
B.6.7 Relevance of a set of elements and activities to ensure that the proposed European Partnership would meet its objectives

Setting joint long-term agendas

Respondents were asked how relevant the involvement of actors is in setting a joint long-term agenda to ensure that the proposed European Partnership would meet its objectives. The higher share of respondents (86 respondents or 83.50%) indicated that industry is most relevant for setting joint long-term agenda. In contrast, the least number of respondents stated that foundations and NGOs are very relevant for this purpose.

A slight statistical difference was found between the views of citizens and other respondents, citizens found other stakeholders (like Connectivity vendors, Telecom operators, regulators, user groups) slightly more relevant.

Figure 42: Stakeholders to involve in setting joint long-term agenda's



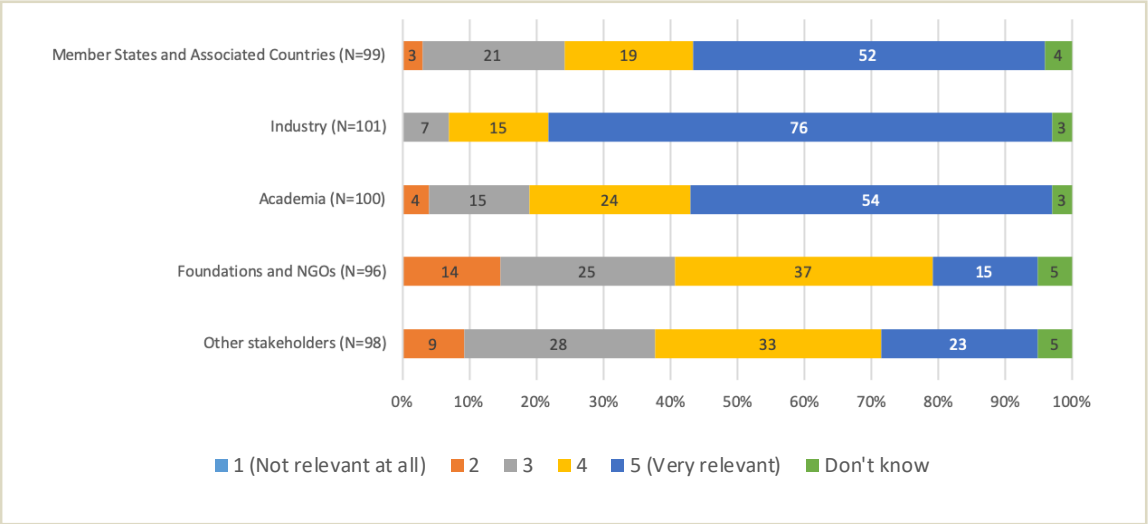
Notes: Question: "In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives - Setting joint long-term agenda with strong involvement of:"

Relevance of elements and activities in pooling and leveraging resources

The pattern of responses about the relevance of actors in pooling and leveraging resources, such as financial, infrastructure, in-kind expertise, to meet Partnership objectives is similar. Industry is considered the most relevant actor for this purpose, based on views of 76 out of 101 respondents (75.25%). The importance of academia and Member States, Associated Countries and other stakeholders is also perceived relatively high for pooling and leveraging resources to reach objectives of the Smart Networks and Services. The least number of respondents (15 respondents or 15.63%) assessed the relevance of foundations and NGOs as "very high" for pooling and leveraging resources. See Figure 43.

A slight statistical difference was found between the views of citizens and other respondents, citizens found government slightly more relevant.

Figure 43: Relevance of actors for pooling and leveraging resources



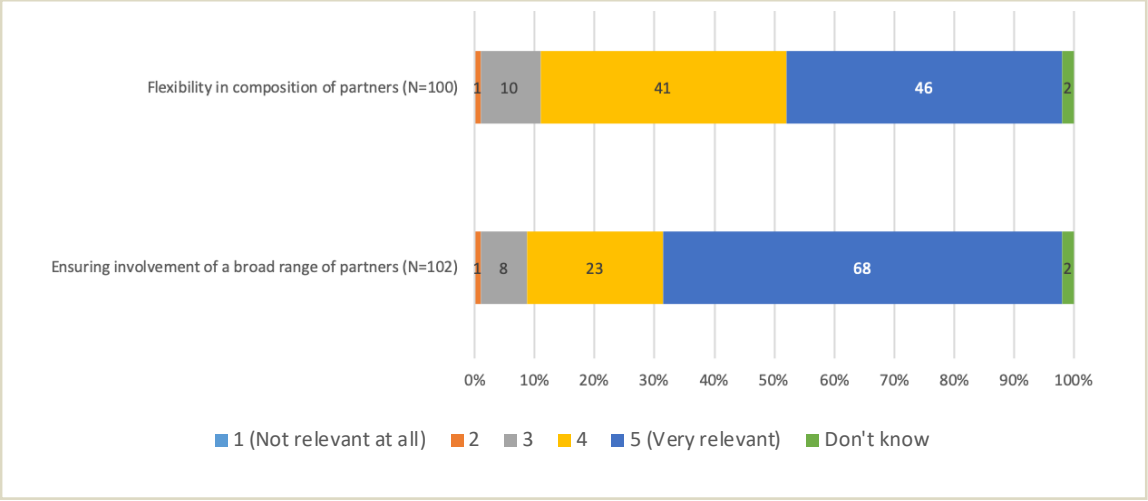
Notes: Question: "In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives – Pooling and leveraging resources (financial, infrastructure, in-kind expertise, etc.) through coordination, alignment and integration with:"

Relevance of elements and activities for the partnership composition

Respondents were asked about the relevance of Partnership composition, such as flexibility in the composition of partners over time and involvement of a broad range of partners (including across disciplines and sectors), to reach Partnership objectives. Based on Figure 44, between the two composition options a higher share of respondents (68 respondents or 66.66%) consider the involvement of a broader range of partners very relevant for meeting objectives of the Smart Networks and Services.

No statistical differences were found between the views of citizens and other respondents. Respondents that are/were involved in a current/preceding partnership (Horizon 2020 or Framework Programme 7) indicated a slightly lower relevance of the flexibility in composition of partners.

Figure 44: Relevant principles for the partnership composition



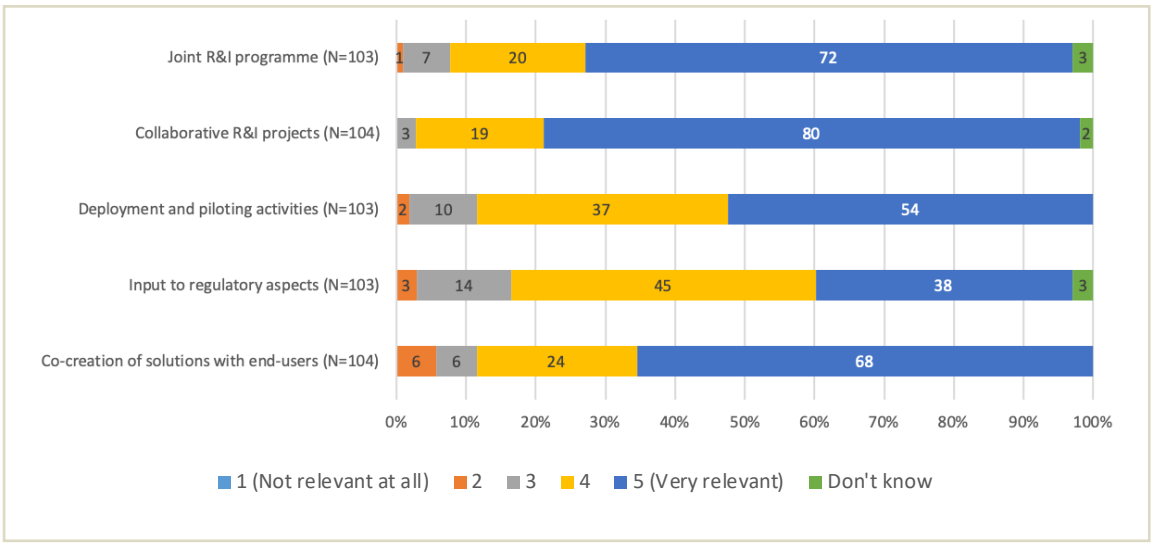
Relevance of implementation of activities

Respondents were asked to provide opinions on relevance of implementation of several activities for meeting objectives of the Partnership. Among activities were listed – join R&D programme, collaborative R&D projects, deployment and piloting activities, input to regulatory aspects and co-creation of solutions with end-users. As it is visible in Figure 45,

a higher number of respondents view that collaborative, joint R&I projects, as well as, co-creation of solutions with end-users is very relevant for meeting the objectives. In comparison, only 38 respondents out of 103 (36.89%) consider that the input to regulatory aspects is very relevant for this purpose, and 54 respondents (52.43%) view that deployment and piloting activities are very relevant for meeting objectives of the Smart Networks and Services Partnership.

No statistical differences were found between the views of citizens and other respondents.

Figure 45: Relevance of activities to implement



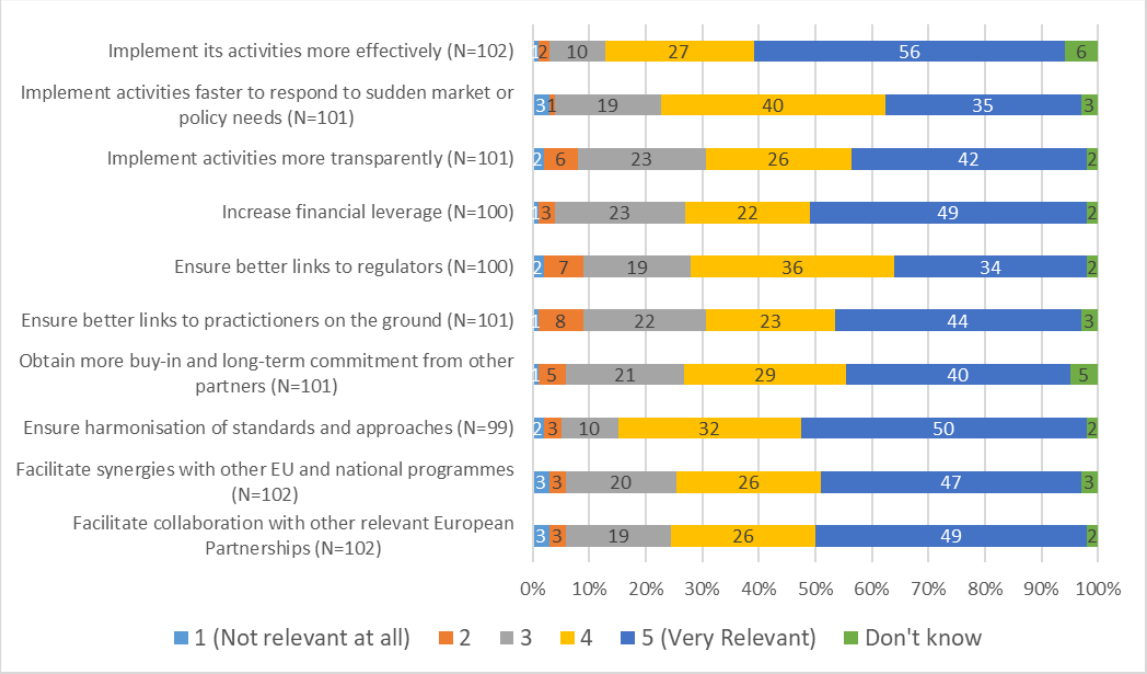
Notes: Question: "In your view, how relevant are the following elements and activities to ensure that the proposed European Partnership would meet its objectives – Implementing the following activities"

B.6.8 Relevance of setting up a legal structure (funding body) for the candidate European Partnerships to achieve improvements

Respondents were asked to assess the relevance of a specific legal structure (funding body) for the candidate European Partnership to achieve several objectives. According to Figure46, a greater number of respondents indicated that the legal structure would be helpful/relevant to implement activities more effectively (83 respondents gave a score of 4 and 5, or 81.37%), to ensure harmonization of standards and approaches (82 respondents gave a score of 4 and 5, or 82.83%). The least number of respondents suggest that the legal structure would assist in ensuring better links to regulators, as only 34 respondents (34%) indicated that it would be very relevant for this purpose.

No statistical differences were found between the views of citizens and other respondents for most objectives. The relevance of a legal structure was, however, found less relevant by citizens for the effective implementation of activities. Respondents that are/were involved in a current/preceding partnership found a legal structure more relevant for the objectives regarding harmonising standards and facilitative synergies with other programmes.

Figure 46: Relevance of setting up a legal structure (funding body)



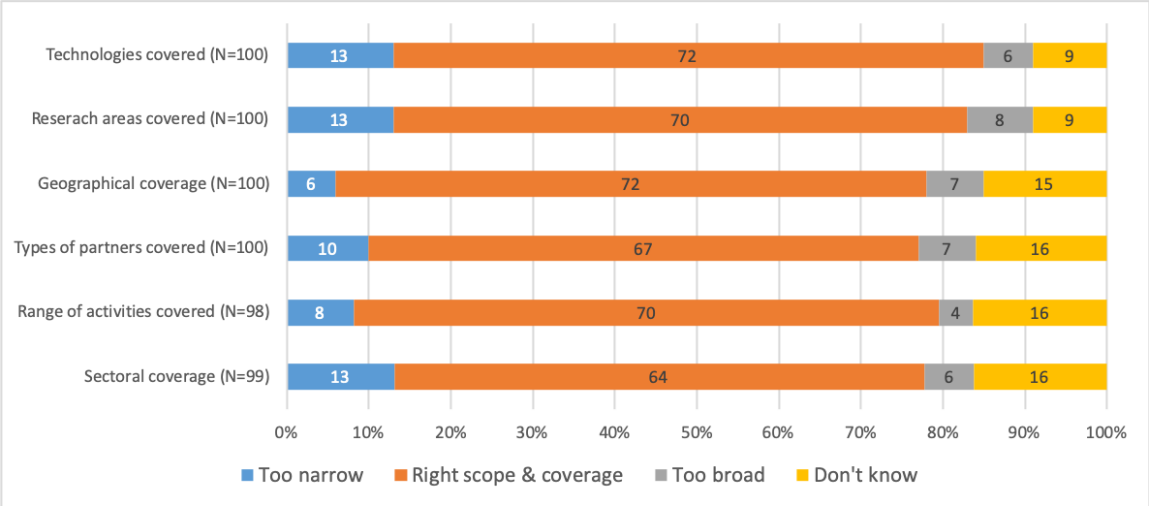
Notes: Question: "In your view, how relevant is to set up a specific legal structure (funding body) for the candidate European Partnership to achieve the following?"

B.6.9 Scope and coverage of the candidate European Partnerships based on their inception impact assessments

Respondents were asked to assess the scope and coverage of the proposed Partnership, based on its inception impact assessment. According to Figure 47 below, the majority of them consider that the Partnership has a right scope and coverage in all aspects. However, among listed areas, a slightly smaller share of respondents (64 respondents or 64.65%) indicated that the sectoral coverage is right and has an appropriate scope, and 13 respondents (13.13%) suggested that the sectoral coverage is too narrow.

No statistical differences were found between the views of citizens and other respondents.

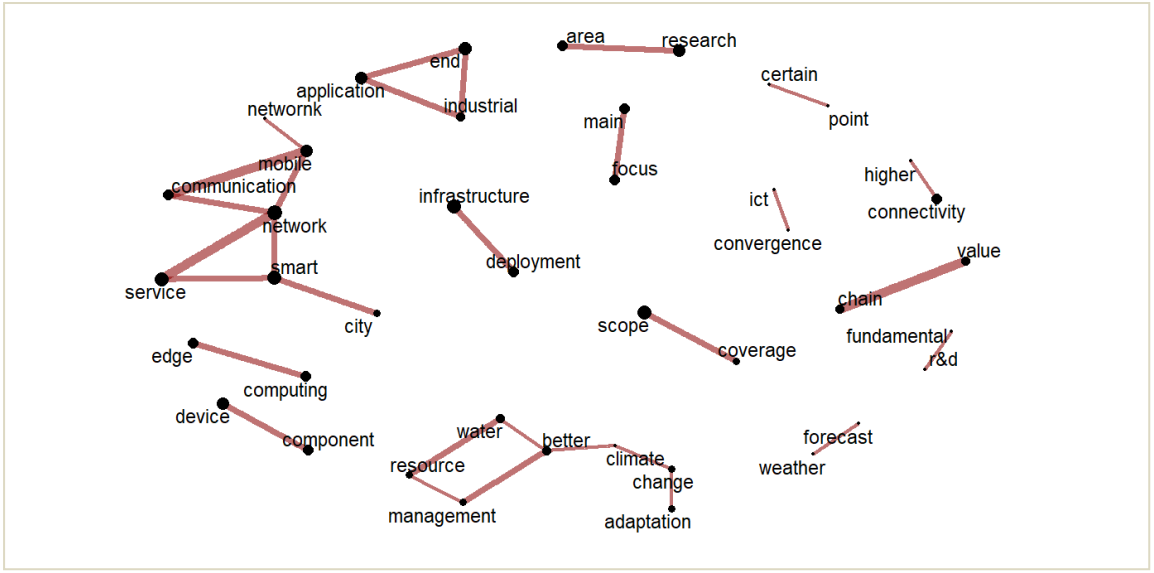
Figure 47: Scope and coverage proposed for the institutionalised Partnership



Notes: Question: "What is your view on the scope and coverage proposed for this candidate institutionalised European Partnership, based on its inception impact assessment?"

Aside from this multiple choice question, the respondents were also asked to provide any comment that they may have on the proposed scope and coverage for this candidate Institutionalised Partnership. The keyword analysis used for open questions resulted in the graph shown in Figure 48. This analysis showed the respondents used this question to talk about mobile communication smart service networks in cities, value chains and better resource management in relation to climate change as well as infrastructure deployment.

Figure 48: Scope and coverage proposed for the institutionalised Partnership – open question (N=23)



Notes: 30 most common co-occurring keywords

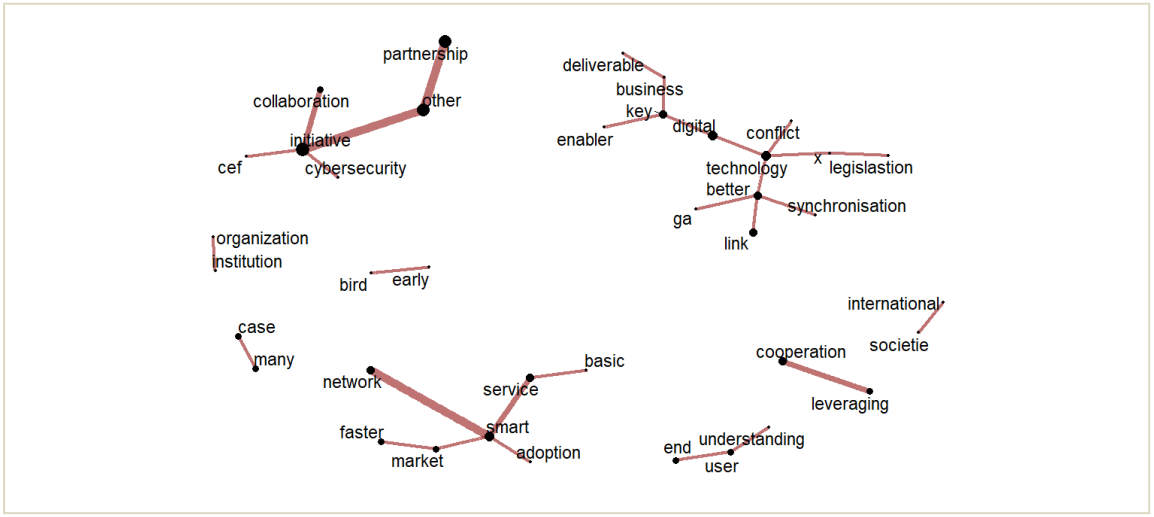
B.6.10 Scope for rationalisation and alignment of candidate European Partnerships with other initiatives

Among 39 respondents, 62 (66.67%) consider that it would be possible to rationalise the candidate European Institutionalised Partnership and its activities, and/or to better link it with other comparable initiatives.

No statistical differences were found between the views of citizens and other respondents.

The respondents who answered affirmative, where asked which other comparable initiatives it could be linked with. The results of the analysis resulted in the chart shown in Figure 49 showing the co-occurrences of keywords. The results show that respondents mention other initiatives regarding cybersecurity, the faster adoption by the market of smart network services and understanding the end user.

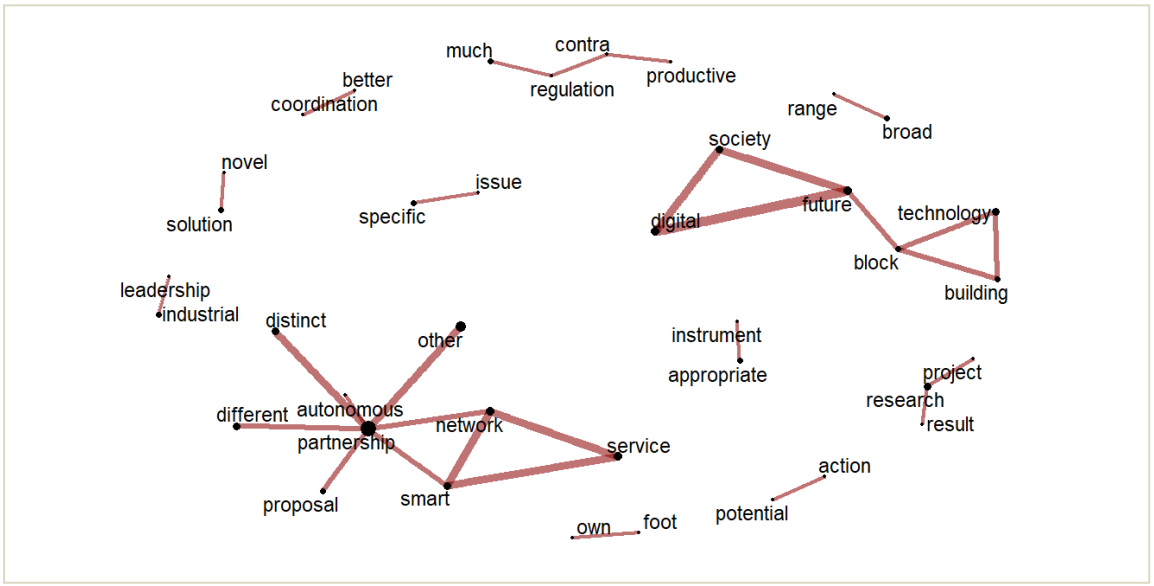
Figure 49: Comparable initiatives to link with the partnership (N=30)



Notes: Open question: "Which other comparable initiatives could the partnership be linked with?"; 30 most common co-occurring keywords

For the respondents who answered negatively on the previous question, the results of the analysis resulted in the chart shown in Figure 50 showing the co-occurrences of keywords. The results show that respondents mention future digital society and other autonomous partnerships related to smart network services.

Figure 50: Other comparable initiatives – open question (N=14)



Notes: Open question: "why other comparable initiatives are not suitable to be linked"; 30 most common co-occurring keywords

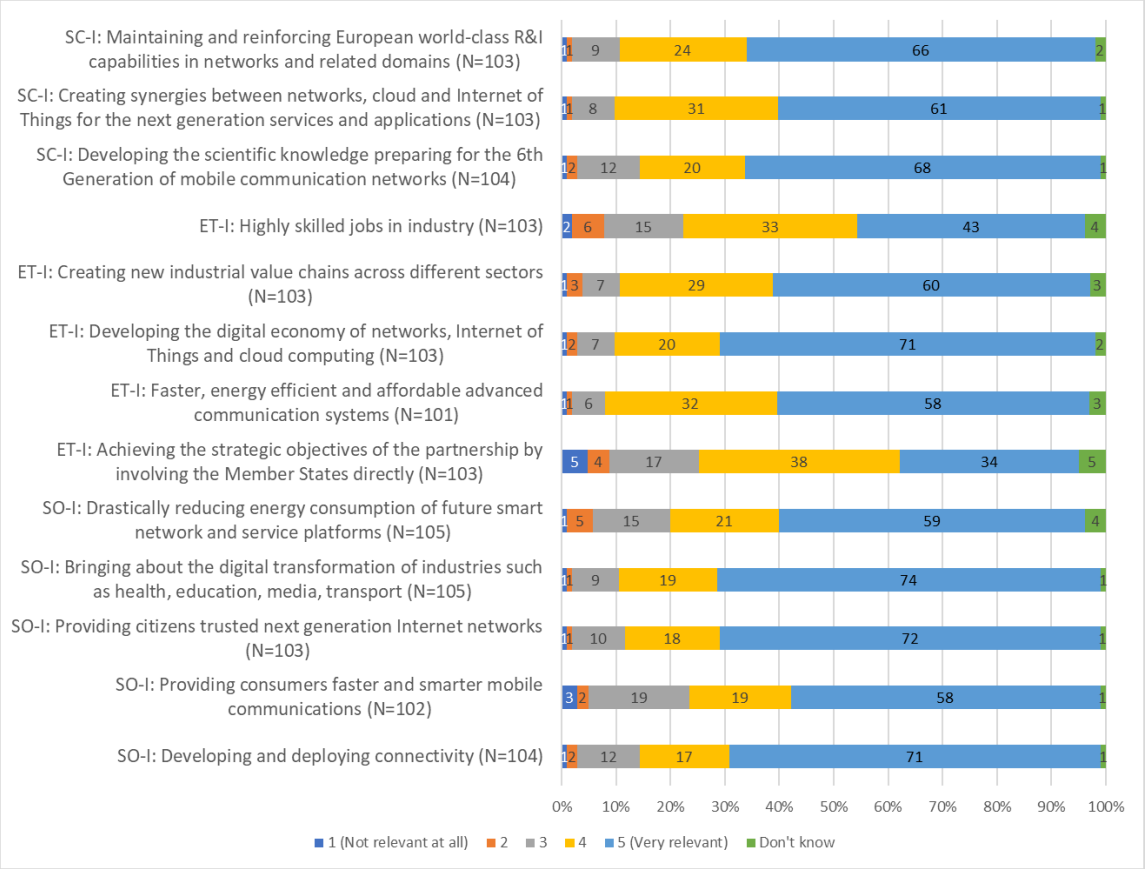
B.6.11 Relevance of European Partnerships to deliver targeted scientific, economic/technological and societal impacts

Respondents were asked to assess the relevance of the candidate European Institutionalised Partnership to deliver on listed impacts. According to Figure 51, a similar number of respondents indicated that the Partnership would be 'very relevant' for delivering on the following societal impacts: developing and deploying connectivity, providing citizens trusted next generation Internet networks and bringing about the digital transformation of industries such as health, education, media and transport. Such results reflect high expectations of the effects of the candidate Partnership on society. Among

economic/technological impacts that were suggested, a higher number of respondents, namely 71 out of 103 (68.93%), indicated that the Partnership would be 'very relevant' for developing the digital economy of networks, Internet of Things and cloud computing. The least number of respondents think that the Partnership would have a significant impact on achieving the strategic objectives of the partnership by involving the Member States directly. The pattern of responses of open consultation participants about the presented scientific impacts depicts many similarities – over 60% of respondents believe that the Partnership would be 'very relevant' for achieving all listed impacts.

No statistical differences were found between the views of citizens and other respondents.

Figure 51: Relevance of the candidate European Institutionalised Partnership to various impacts



B.6.12 Summary of campaigns results for this specific initiative

The following points sums up the key takeaways from the Open Public Consultation:

- For a high proportion of SMEs, there is an agreement on the **necessity to enlarge the technological scope of the research programme beyond 5G**. Typically, in order to address critical applications, security should be addressed as well as a wide array of technologies including network intelligence, network automation, network softwarisation, network slicing, edge computing, cybersecurity, machine learning, Artificial Intelligence, IoT, robotics, high performance computing…
- A very large majority of respondents from the categories of academia, business association, SMEs, large organisations and EU citizens agree on the high relevance to address the **innovation gap in Europe** in translating the results of **connectivity, cloud and Internet of Things devices research.**
- The Open Public Consultation shows that the stakeholders identify **an insufficient level of digitalization of Europe and its industries**. The majority of almost all categories of stakeholders including academics, SMEs, large organisations, European citizens and

NGOs find relevant or very relevant **the important role of innovation** in order to tackle this insufficient level of digitalisation.

- **The market fragmentation** due to **lack of industrial policy and implementation strategi**es is seen as very relevant for R&I efforts at European level especially clearly expressed by the majority of SMEs. For the other categories including academics, business association, large organisation and EU citizen, the topic remains relevant but at a lesser level.
- The potential **lack of global standards** has been seen as very relevant as a barrier to exploitation according to the majority of stakeholders in the categories of business association, large organisation, EU citizen, NGO and public authority.
- The Open Public Consultation results emphasizes **the necessity to bring a variety of stakeholders together in the Smart Networks and Services initiative**. This relates to an increasing cross-sectoral dimension of digitalisation programmes with industries including automotive, IIoT and energy.
- According to the Open Public Consultation, the **relevance of considerations of societal or user needs varies according to the stakeholders**. For most of the citizens, NGOs and academia, the issue is very relevant while for other categories of stakeholders, the majority of respondents indicated an average level of relevance.
- Business associations, SMEs and large organisations find very relevant **the regulation in the field of radio spectrum allocation.**
- For a majority of respondents in several categories including academia, SMEs, large organisations, EU citizen, **the concerns with using Smart Networks and Services platforms for ethical, privacy, security, or EMF reasons** is evaluated as very relevant. For business association and public authority, the topic is seen as relevant but at a lower degree (which can be taken as a hint that this issue is unlikely to resolve only through market dynamics).
- **Drastically reducing energy consumption of future smart network and service** platforms is seen as very relevant for a couple of categories including academia, SMEs, large organisations, EU citizen and public authority; only the category of business association finds the issue at a lesser level of relevance.

Appendix C Methodological Annex

The Impact Assessment studies for all 13 candidate institutionalised European Partnerships mobilised a mix of qualitative and quantitative data collection and analysis methods. These methods range from desk research and interviews to the analysis of the responses to the Open Consultation, stakeholder analysis and composition/portfolio analysis, bibliometrics/patent analysis and social network analysis, and a cost-effectiveness analysis.

The first step in the impact assessment studies consisted in the definition of the context and the problems that the candidate partnerships are expected to solve in the medium term or long run. The main data source in this respect was desk research. The Impact Assessment Study Teams went through grey and academic literature to identify the main challenges in the scientific and technologic fields and in the economic sectors relevant for their candidate partnerships. The review of official documentations, especially from the European Commission, additionally helped understand the main EU policy proprieties that the initiatives under assessment could contribute to achieve.

Almost no candidate institutionalised European Partnership is intended to emerge ex nihilo. Partnerships already existed under Horizon 2020 and will precede those proposed by the European Commission. In the assessment of the problems to address, the Impact Assessment Study Teams therefore considered the achievements of these ongoing partnerships, their challenges and the lessons that should be drawn for the future ones. For that purpose, they reviewed carefully the documents in relation to the preceding partnerships, especially their (midterm) evaluations conducted. The bibliography in Appendix A gives a comprehensive overview of the documents and literature reviewed for the present impact assessment study.

Finally, the description of the context of the candidate institutionalised European Partnerships required a good understanding of the corresponding research and innovation systems and their outputs already measured. The European Commission services and, where needed the ongoing Joint Undertakings or implementation bodies of the partnerships under Article 185 of the TFEU, provided data on the projects that they funded and their participants. These data served as basis for descriptive statistic of the numbers of projects and their respective levels of funding, the type of organisations participating (e.g. universities, RTOs, large enterprises, SMEs, public administrations, NGOs, etc.) and how the funding was distributed across them. Special attention was given to the countries (and groups of countries, such as EU, Associated Countries, EU13 or EU15) and to the industrial sectors, where relevant. The sectoral analysis required enriching the eCORDA data received from the European Commission services with sector information extracted from ORBIS. We used the NACE codification up to level 2. These data enabled identified the main and, where possible, emerging actors in the relevant systems, i.e. the organisations, countries and sectors that will need to be involved (further) in the future partnerships.

The horizontal teams also conducted a Social Network Analysis using the same data. It consisted in mapping the collaboration between the participants in the projects funded under the ongoing European partnerships. This analysis revealed which actors – broken down per type of stakeholders or per industrial sector – collaborate the most often together, and those that are therefore the most central to the relevant research and innovation systems.

The data provided by the European Commission finally served a bibliometric analysis aimed at measuring the outputs (patents and scientific publications) of the currently EU-funded research and innovation projects. A complementary analysis of the Scopus data enabled to determine the position and excellence of the European Union on the international scene, and identify who its main competitors are, and whether the European research and innovation is leading, following or lagging behind.

All together, these statistical analyses will complement the desk research for a comprehensive definition of the context in which the candidate institutionalised European Partnerships are intended to be implemented. The conclusions drawn on their basis will be confronted to the views of experts and stakeholders collected via three means:

- The comments to the inception impact assessments of the individual candidate institutionalised European partnerships received in August 2019
- The open public consultation organised by the European Commission from September to November 2019
- The interviews (up to 50) conducted by each impact assessment study team conducted between August 2019 and January 2020.

For instance, in all three exercises, the respondents were asked to reflect on the main challenges that the candidate institutionalised European Partnerships should address. In the open public consultations, they mainly reacted to proposals from the European Commission like when they were given to opportunity to give feedback to the inception impact assessment.

The views of stakeholders (and experts) were particularly important for determining the basic functionalities that the future partnerships need to demonstrate to achieve their objectives as well as their most anticipated scientific, economic and technological, and societal impacts. The interviews allowed more flexibility to ask the respondents to reflect about the different types of European Partnerships. Furthermore, as a method for targeted consultation, it was used to get insights from the actors that both the Study Teams and the European Commission were deemed the most relevant. For the comparative assessment of impacts, the Study Teams confronted the outcomes of the different stakeholder consultation exercises to each other with a view of increasing the validity of their conclusions, in line with the principles of triangulation. Appendix B includes also the main outcomes of these three stakeholder consultation exercises.

The comparison of different options for European partnerships additionally relied on a cost-effectiveness analysis. When it comes to research and innovation programmes, the identification of costs and benefits should primarily be aimed at identifying the "value for money" of devoting resources from the EU (and Member States) budget to specific initiatives. Based on desk research and consultation with the European Commission services, the horizontal study team produced financial estimates for different types of costs (preparation and setup costs, running costs and winding down costs) and per partnership option. The costs were common to all candidate European Partnerships. The results of the cost model were displayed in a table, where each cost was translated on a scale using "+" in order to ease the comparison between the partnership options.

A scorecard analysis, which allocated each option a score between 1 and 3 against selected variables, was used to highlight those options that stand out as not being dominated by any of the other options in the group: such options are then retained as the preferential ones in the remainder of our analysis. It also allowed for easy visualisation of the pros and cons of alternative options.

Appendix D Additional information on the policy context

D.1 Emerging challenges in the field

D.1.1 Social challenges

5G networks will enable the provision of fully digitised/automated services in all verticals sectors of the industry in Europe: industry, smart city, transports, e-health, etc. As such, 5G will be the basis infrastructure on which several important social trend will build up: digitalisation of industries, automation of transport, real-time health and environment monitoring, etc. Future networks is seen as a key enabler to bring high value to the society. Also, new jobs will be created in new areas of research like artificial intelligence and high performance computing that will counterbalance with the increasing automation operations. More than 1.7 billion vertical IoT objects will be connected by 2030 through 5G (of which more than half in the automotive industry).[53] The IHS study[54] conducted for Qualcomm states that "In 2035**, 5G will enable $13.2 trillion of global economic output**". It also forecasts that "The global 5G value chain will generate $3.6 trillion in economic output and support 22.3 million jobs in 2035". Ericsson[55] estimates that the 5G-enabled BLISK (manufacture of bladed disks) case study alone could create annual savings of approximately €27 million for one single factory, and up to €360 million globally. Telecom operators could benefit from a $619 billion opportunity by 2026 from the digitalisation of industries[56] that would be welcome by MNOs to counterbalance the stagnation of revenues expected around broadband. Capturing these opportunities for both vendors/operators and vertical end-users will not be possible without strong network performances and strong technology integration (beyond connectivity, like Industrial IoT) especially in the case of critical services and strong collaboration of vertical and 5G stakeholders to ensure the technology will meet the business requirements. Today, 5G performances are often insufficient for B2B services and some of the use cases will even need performances going beyond 5G.

EMF (Electro Magnetic Field) concerns perceived by certain citizens due to the higher number of base stations and higher frequencies used in 5G networks are a **concern in some Member States and are addressed by regulatory authorities, Ministries and spectrum agencies**. EMF limits set by cities might also delay deployment by network operators. This is an important factor as 5G networks will need a **huge number of small cells** in order to provide the expected capacity and data rates (the target is around 10 times more cells than with 5G). 15% of Internet US users are [57]expressing concerns about the health issues that could be related to 5G. Some Stop5G community movements have developed around the world, leading sometimes in delays in roll-outs like in Switzerland. Concerns around EMF could slow the roll out and later on the usage of 5G-based solutions, as there is no real public commitment/statement from technology vendors and operators today.

Smart networks and services development also face issues of trust. The future networked society will have high demands in terms of security. Cyber-security issues are very important as 5G will be used by many vertical sectors including e-health, industry and

[53] 5G IoT, IDATE Digiworld (2018). The cellular M2M market is estimated to reach close to 2 billion connected objects in 2020.

[54] The 5G Economy - How 5G will contribute to the global economy – November 2019

[55] A case study on real-time control in manufacturing – Ericsson – April 2018

[56] https://www.ericsson.com/en/networks/trending/insights-and-reports/5g-challenges-the-guide-to-capturing-5g-iot-business-potential

[57] https://decisiondata.org/news/report-the-publics-fear-of-5g-health-risks-is-spiking/

emergency services. Robustness and resilience will also become more important as all sectors in society will depend on the 5G networks.

Indeed, like for cloud,[58] there could be numerous concerns from B2B end-users if 5G (and beyond 5G network) is becoming a critical enabler for traditional industries. Trust is already low today regarding many online services, most of them being services that are critical (social networks), and will likely even decrease for more critical services around health or autonomous cars.[59] Key innovations around 5G are not expected to be around data security by consumers[60] and security and privacy are barely tackled in 5G R&D projects so far. Trust issues could slow down the development of 5G-enabled B2B services.

D.1.2 Technological challenges

5G will continue to integrate technological innovations and will evolve significantly. The continuous inclusion of smart connectivity platforms in industrial environments will call for new performance levels and the corresponding KPIs identified for **5G will have to evolve towards even lower latencies, better availability, higher capacity, bringing new R&I challenges, going far beyond evolutionary approaches …** Societal issues will also bring new technological requirements such as very low energy networks, full security, trust, privacy, EMF aware networks and low cost inclusive solutions.

Figure 52: Spectrum bands for 5G and 6G

FREQUENCY BAND	0.3-3 GHz	3-30 GHz	30-300 GHz	0.3-3 THz	3-30 THz
WAVELENGTH	100-10 cm	10-1 cm	10-1 mm	1000-100 µm	100-10 µm
DOMINANT PROPAGATION MECHANISM	LOS, Reflection, Diffraction, Scattering, Penetration	LOS, Reflection, Diffraction, Scattering	LOS, Reflection	LOS, Reflection	LOS, Reflection
DOMINANT ATTENUATION EFFECTS	Free Space Loss	Free Space Loss -Transmission Loss Through Materials High at Upper Band	Free Space Loss/ Molecular Absorption -O_2 @60 GHz -H_2O > 24 GHz	Free Space Loss/ Molecular Absorption -High H_2O Peaks	Free Space Loss/ Molecular Absorption -High H_2O Peaks
SUPPORTED LINK DISTANCES	10 km	1000 m	100 m	<10 m	<1 m
TX POWER LIMITING FACTOR	Regulation	Regulation	Technology	Technology	Technology
APPROXIMATE SYSTEM BANDWITH	up to 100 MHz	400 (or 800) MHz	Up to 30 GHz	Up to 300 GHz	> 100 GHz

Source: 6G Flagship [61]

In order to support higher data rates and capacities than those envisaged for 5G, **support of transmission at frequencies above 100 GHz has to be planned after** 2030 (i.e.

[58] https://newsroom.ibm.com/2018-04-15-New-Survey-Finds-Deep-Consumer-Anxiety-over-Data-Privacy-and-Security

[59] https://gizmodo.com/71-percent-of-americans-still-dont-trust-autonomous-car-1833284527

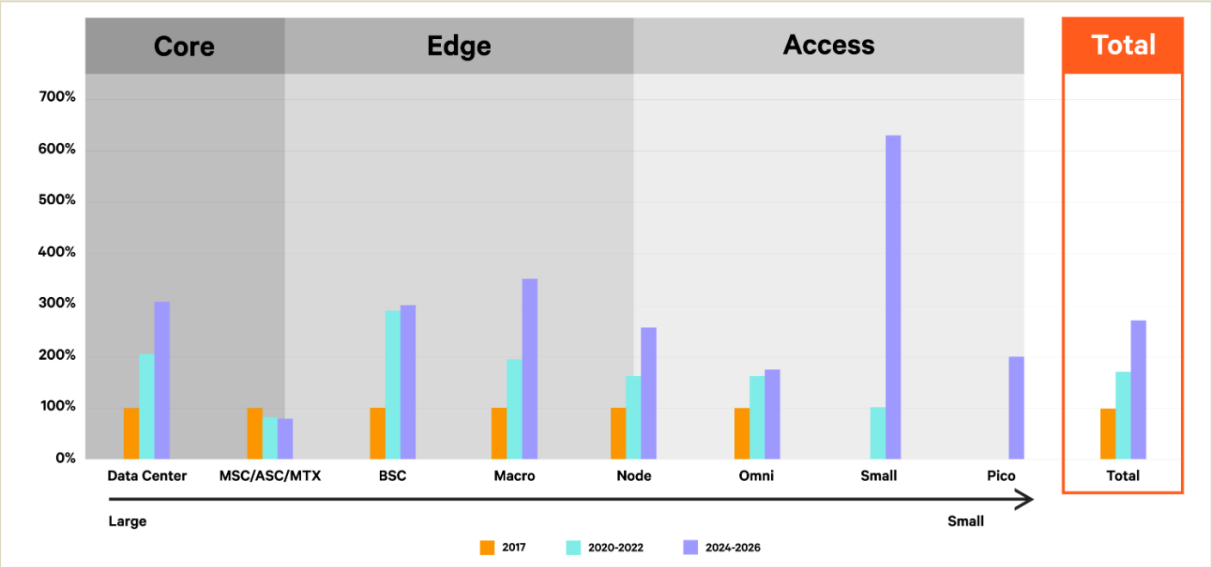
[60] https://www.ericsson.com/en/reports-and-papers/consumerlab/reports/six-calls-to-action

[61] https://www.oulu.fi/6gflagship/

spectrum bands not covered by 5G). This will enable the use of multi-GHz channel bandwidths and the provision of multi-Gbps throughputs. Beamforming with massive MIMO combined with a higher number of base stations and additional spectrum will certainly enable 5G networks to reach high speed connectivity in a context of large numbers of simultaneous real-time connections. This will require to address new types of chipsets to operate in those frequency bands and to coordinate allocation of the additional spectrum targeted for use.

There is significant pressure on energy consumption both at network and device level, especially in the case of increased usage due to more B2B devices using 5G and later networks as their critical enabling technologies. **Research is needed in this field as the energy per bit objective for beyond 5G systems would be 1 pJ/bit.** It is expected that transition to the edge could lead to massive energy consumption at the edge where solutions have to be found to improve energy efficiency.

Figure 53: Percentage energy consumption increase



Source: Vertiv

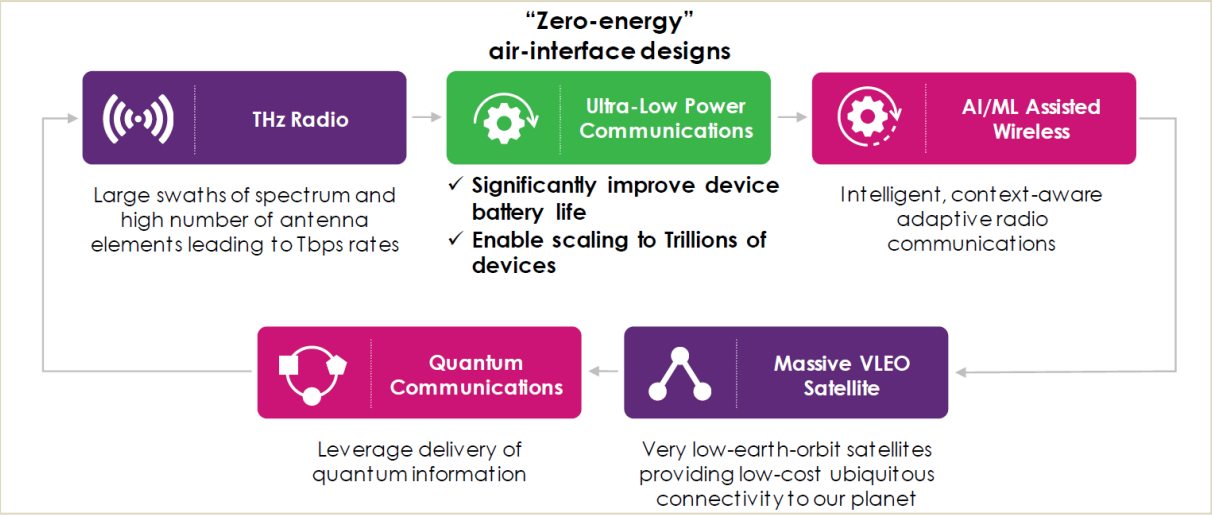
Solutions under development at 3GPP include an "advanced sleep mode" that would save energy when a smartphone is not communicating with a 5G base station. It is also expected that big data analytics and artificial intelligence could reduce energy consumption in 5G networks. China Telecom showed in 2018 that AI could help reducing by 30% consumption at data centres. In a context of rising concerns and regulations around climate change and carbon emissions, 5G and future network technologies will have to provide optimization of energy consumption. This will be a real challenge, as this was never really addressed before (no KPI was for instance really defined for 5G). The energy intensity of the ICT sector is globally growing by 4% per year[62] with close now to 4% of global emissions in OECD countries despite of global decrease of greenhouse gases emissions.

New technologies such as Artificial Intelligence/machine-learning, blockchain or edge computing are used for 5G and their usage will be extended for beyond 5G networks. They offer new perspectives to cover new applications or provide better performance and need to be integrated in the overall technology continuum, from device to service platforms. A better integration directly with networking technologies will also increase the overall performances. Other improvements compared to 5G could come from technologies not yet

[62] https://theshiftproject.org/en/article/lean-ict-our-new-report/

really combined with 5G like massive VLEO satellite (to increase coverage), quantum computing (and associated quantum communications)

Figure 54: Key innovations for 6G



Source: InterDigital

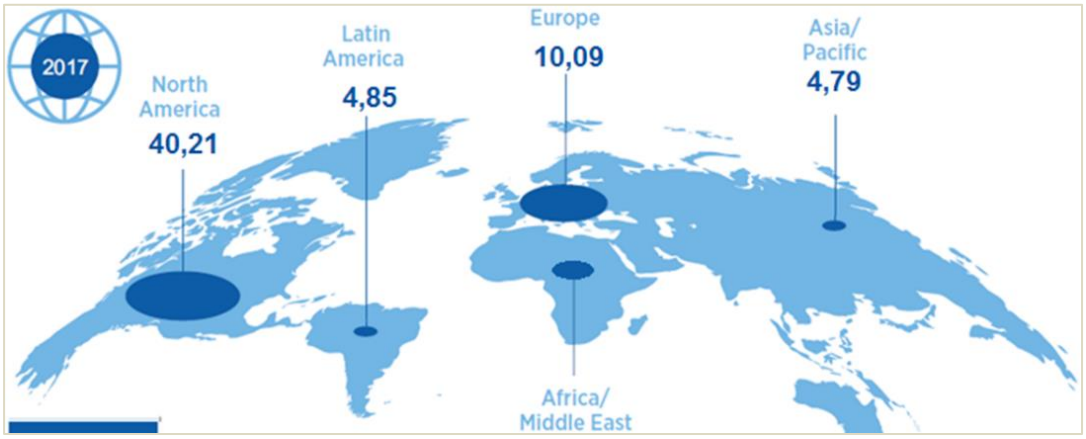
Overall, a wider technology and spectrum (mainly THz) approach than the one defined around 5G (whose focus is mostly around connectivity and virtualisation/cloud) by the 5GPPP is therefore necessary. Other regions of the world have already started 6G programs in that direction, whereas Europe has barely addressed it so far in H2020 programs (in addition to Finland 6G Flagship initiative). Combining all those technologies within 6G (or beyond 5G) will likely very complex, as technologies come from various domains.

D.1.3 Economic challenges

Deployment of 5G in Europe is very limited with a small number of base stations compared to front-runners such as South Korea (South Korean operators, which launched 5G service in early April, surpassed the 3 million 5G subscriber mark on 9 September), USA or China. Europe appears now unlikely to catch-up (even by 2025) and may reposition as a leader (like it was for 2G) with beyond 5G and 6G networks. Delay in Europe can be explained by multiple factors, including regulations and legislation and concerns to develop cross-border services (an issue that most other advanced 5G regions do not have to face).

Another important factor explaining the delay is the weak situation of telecom operators in Europe, with limited growth and limited revenues. As far as revenues from mobile services are concerned, mobile ARPU (average revenue per user) has been declining or being flat in all regions (-14.4% globally between 2012 and 2017) and is **much higher in North America than in Europe giving mobile operators more room for 5G investments**. The risk is really higher for EU players facing huge investments with 5G.

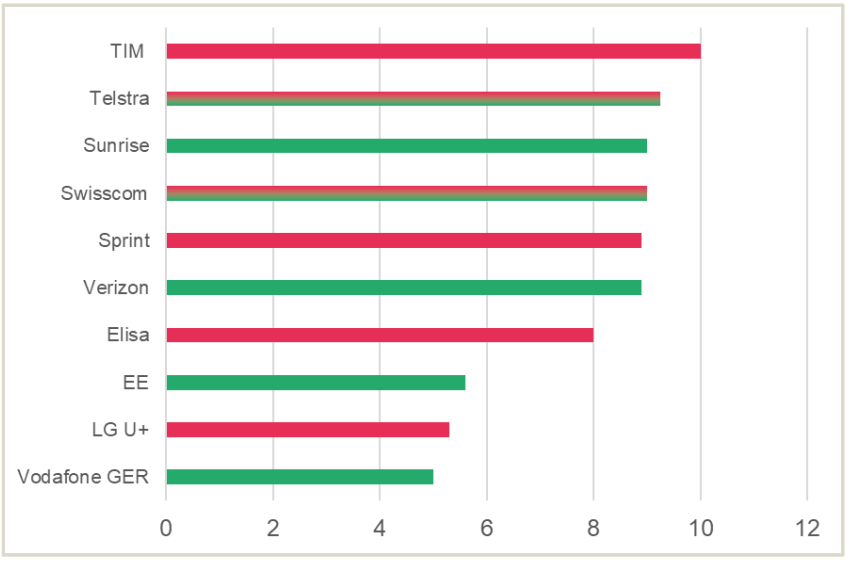
Figure 55: Mobile ARPU by region - ARPU (€/month)



Source: IDATE DigiWorld, State of Telecom Services & Players Worldwide, December 2018

Mobile operators still hope to generate additional revenues with 5G, even in the B2C market, and the first 5G commercial services show that the premium put on 5G compared to 4G is between €5 and €10 – or an average of €8. But it is rather unclear if such premium will remain in the future beyond early adopters.

Figure 56: 5G monetisation compared to 4G (EUR)-(price of the option or price difference between 4G and 5G plans)



Source: IDATE DigiWorld, 5G Monetisation, September 2019[63]

Research and development for 5G is a long process and includes very significant evolutions of the network with the implementation of virtualisation and the provision of slicing capabilities, and also Artificial intelligence/Machine learning and quantum computing for beyond 5G solutions. The R&D process and full deployment of 5G networks by operators lead to long time to market. Huge investments will be required in infrastructure as rural areas and indoor coverage will be very CAPEX intensive and should lead to more network sharing.

It is expected that demand from the enterprise and social sectors will impact the 5G coverage and QoS/reliability. This is reflected in B2B market by the fact that significant revenues are expected from the development of uRLLC solutions (offering specific coverage

[63] https://fr.idate.org/produit/monetisation-de-la-5g/

and/or QoS), mostly from 2025, with close to €22 billion of revenues for telecom operators.[64]

Overall, broadband revenues are at best steady in most regions (they have been declining from 2015 to 2019 in Europe and North America,[65] but also in Japan). Investing in 5G is therefore a real challenge, as global broadband revenues (mostly derived from the consumer market) are flat but 5G and future technologies require strong CAPEX, especially to ensure broad coverage, end-to-end solutions and densified coverage to address new B2B use cases. Most of the growth with 5G and future networks is therefore expected to come from the B2B market/vertical markets rather than the consumer. This comes with numerous uncertainties as the equivalent markets are mostly captured so far by IT/cloud providers.

Value chains will be transformed with different roles for the existing players and new players playing a role such as neutral hosts, micro operators, enhanced connectivity providers or partner service providers. Existing players might be under pressure and will have to adapt to the evolutions of the environment. New players may come from outside the traditional telecom industry, from vertical industries but also from the rest of the ICT industry (especially on cloud markets and more generally on Internet services, but also from device markets) where EU is a more a challenger than a contender. Indeed, Europe is lagging behind regarding devices and software industries in general (especially regarding cloud computing). There is therefore a high risk of loss of sovereignty for Europe, with a limited number of champions so far in the ICT domains and even lower number of stakeholders capable to provide the right combination of these technologies to provide end-to-end services. Additional elements are provided in section 1.2 on EU competitive positioning.

D.1.4 Environmental/societal challenges

Installation of additional network access nodes in cities will be a major effort for 5G operators as they will need to deploy a huge number of small cells. Better integration of access nodes in the cities (street furniture, utilities networks) will be needed in the long term and might be facilitated by R&D support and involvement of public sector stakeholders.

Energy efficiency will also be addressed through new technologies thanks to network optimisation approaches and virtualisation techniques reducing the number of hardware and related energy.

D.1.5 Regulatory framework

The development of future networks will require spectrum allocation. This process has already started for the 5G pioneer bands (see section 1.2.1) and will continue over the progress of technology beyond 5G and toward 6G. It raises significant challenges in term of coordination of policies at the European level, as spectrum auctions are conducted at the Member States level with little regards for a unified European approach. Collaboration should be promoted in order to facilitate harmonisation by helping to build consensus and consistency among MS. The Peer Review Forum for discussion of national spectrum assignment procedures introduced in the European Electronic Communications Code could help promote and facilitate harmonisation. The RSPG Peer Review Platform enables RSPG members to learn from each other's experiences and to seek support, as appropriate, from

[64] 5G IoT, IDATE Digiworld (2018)

[65] https://en.idate.org/product/world-telecom-services-players-dataset-report/

peers on issues of spectrum management, focusing on spectrum harmonised for Electronic Communication Services.

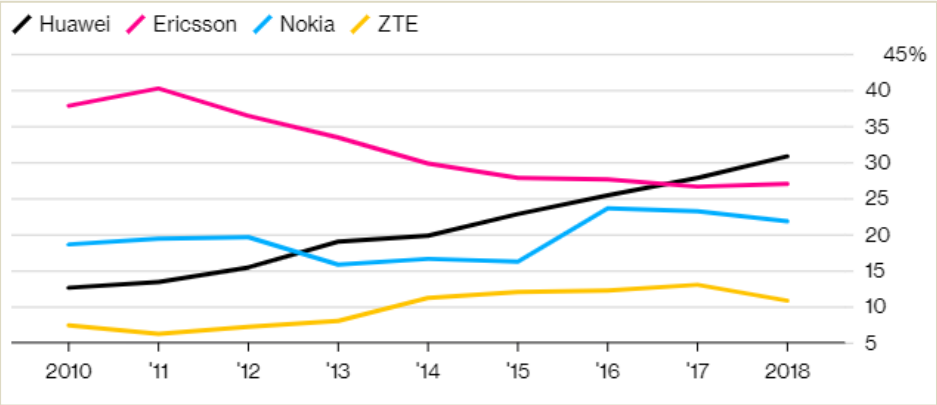
Furthermore, the increasing importance of the Smart Networks and Services in various vertical industries (automotive, transport, manufacturing, health, energy, etc.) will create additional challenges, as the various regulations of these application domains may also apply to future Smart Networks and Services.

D.1.6 Political framework

EU digital ecosystem is more and more being challenged by US and Asia. Its main strengths are around telecom industry (both operators and equipment vendors). But the telecom industry is experiencing a radical shift of paradigm to evolve towards value-added services and losing ground in the global digital market, with close to a loss of 1 point of market share per year. Europe is following the same evolution, with a loss of 1 point of market share. The digital ecosystem is essentially dominated by the USA (Internet, cloud, content, IT) and China (devices, equipment, Internet, progressively cloud), which replicated the commercial wars going beyond the digital markets (as China is more and more exporting its digital assets in Africa and now in the rest of the world) and emphasized for the digital markets by the debate around Huawei initiated by Trump. So far, only South Korea stands out with an original approach for 5G while other countries have more a follower approach. **Europe needs to build a differentiated approach to remain competitive while facing USA (clear leader on software-based services) and China (able to produce low-cost hardware).**

Standardisation is necessary to develop in network industries. In a context of trade wars, there is a need for strategic technological sovereignty in Europe in order to be able to implement and maintain end-to-end 5G networks. Even for the telecom industry, competition is fierce in the network equipment sector and market shares of European equipment manufacturers have been declining over the past ten years. As shown in the figure below and given that Alcatel-Lucent's share was close to 9% in 2010, **the combined market share of European network equipment manufacturers (Alcatel Lucent + Nokia + Ericsson) has decreased from 65.4% in 2010 to 48.9% in 2018. The challenge is therefore to remain competitive against especially Chinese OEMs to maintain the sovereignty, which will take even more importance as networks will be more and more enablers of critical services.**

Figure 57: the wireless equipment market shares



Source: IHS Markit

D.2 Positioning of Europe in the field

Table 27: Number of cell sites/base stations for 5G trials and networks

Country	Operator	Number of 5G cell sites	Announcement date
Austria	T-Mobile	Commercial launch with friendly customers. 25 base stations installed in rural areas.	May 2019
Australia	Optus	Signed a partnership with Ericsson to deploy 50 5G sites across the cities of Sydney and Melbourne	February 2019
China	China Mobile	China Mobile announced plans to deploy more than 50,000 5G base stations in 2019	June 2019
China	China Unicom	April 2019: 500 5G stations in Shanghai. Plans to construct 10,000 5G base stations by the end of 2019 and 30,000 by 2021.	
Europe	Vodafone	Setting up trial areas in seven cities and plans to expand to 1,000 sites by 2020	September 2018
France	Orange	Orange announced the installation of 80 5G antennas in Marseille, 40 of which should be installed by spring 2019, and the rest before the end of 2019.	January 2019
Germany	Deutsche Telekom	Deutsche Telekom currently maintains about 28,000 towers across Germany, but the operator has formerly suggested that figure could even double with the rollout of 5G technology in the 2020s	February 2018
Germany	Deutsche Telekom	Wants to build over 2,000 new mobile sites every year along with 10,000 smaller radio cells to improve coverage at high-demand locations or inside buildings	October 2018
Italy	Vodafone	The 5G network in Milan covers 80% of the city's population via 120 active sites	December 2018
Kuwait	Viva	Viva is rolling out a nationwide 5G network with over 1,000 5G NR-based radio sites in 2019	March 2019
South Korea	KT	Around 1500 5G base stations deployed in January 2019. 30,000 base stations by April 5, 2019 (including 15,000 in Seoul)	January 2019 March 2019
South Korea	LG Uplus	5,500 5G base stations deployed in January 2019 18,000 base stations deployed in March 2019. The operator plans to install 50,000 base stations within the first half of the year. 80,000 5G base stations planned for end 2019	January 2019 March 2019
South Korea	SK Telecom	Around 1500 5G base stations deployed in January 2019 34,000 5G base stations 54202 5G base stations	January 2019 April 2019 May 2019
UK	Vodafone	In 2018, tested 5G at more than 40 sites in Birmingham, Bristol, Cardiff, Glasgow, Liverpool, London and Manchester Extension to 1,000 sites by 2020	June 2018 December 2018

Country	Operator	Number of 5G cell sites	Announcement date
UK	EE/BT	Nine 5G trial sites are now live across East London. 1500 cell sites will be operating in 2019 covering 15% of the population (25% of total traffic)	November 2018

Source: IDATE Digiworld, 5G Observatory[66]
Europe is clearly lagging behind USA and Asia-Pacific for 5G roll-out and will likely not catch-up by 2025.

D.3 Support in the field in the previous work programme

D.3.1 Scope and objectives of the 5G-PPP

Through 5G-PPP, the goal of Europe is to put in place the right framework to tackle 5G challenges and bring the appropriate solutions, architectures, technologies and standards to the next generation of communication networks.

The main target objectives of the 5G-PPP are the technological development of 5G and the contribution to growth and jobs. Considered as EU flagship initiative, the **5G-PPP** comprises public and private partners. The latter also agreed on KPIs to leverage the 700 million EUR public investment by a factor of 5 bringing **total funding into 5G-PPP to 4.2 billion EUR**.

5G-PPP is organized in 3 phases, each comprising several call for projects with a variable duration of 24-36 months:

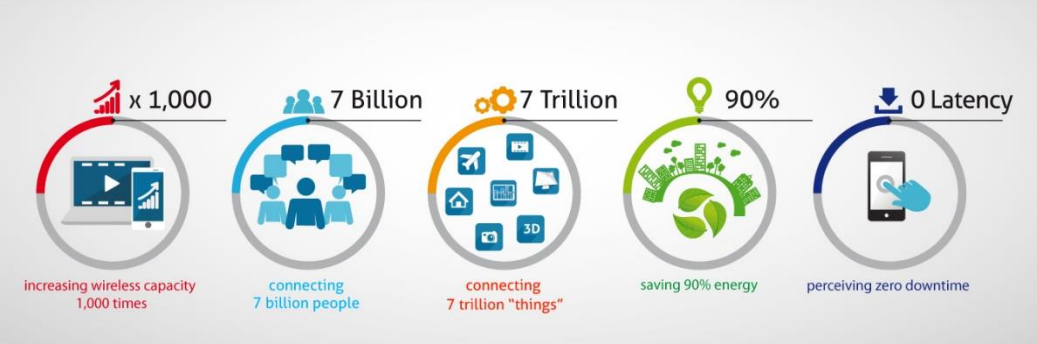
- Phase 1 with 19 projects (2014-2016) focusing on 5G infrastructure, automotive projects and 5G validation trials across multiple vertical industries
- Phase 2 (2017-2019) with 21 new projects targeting a move towards demonstrations and experimentations in order to establish closer links between 5G community and verticals industries. Many new stakeholders (more than 60% of phase 2 participants) joined the PPP
- 3rd and last phase ending in 2020 consolidating the results of the previous phases to support implementation and applicability of 5G and will be dedicated to a number of projects in vertical industries use cases.

The global objectives of the 5G programme is to build the next generation of wireless communication network technologies. This new generation is expected to improve the existing (4G) wireless network capabilities (in term of bandwidth, capacity, coverage, and reliability). But beyond this incremental progress, the 5G technologies also aim to provide new capabilities (ultra-low latencies, ability to connect very large numbers of devices, high dependability and quality of service, etc.) that would enable the wireless network to be used in scenarios that are essential for vertical industries.

Indeed, the vision behind 5G is that this new generation of communication network could serve as a critical infrastructure for numerous industries (automotive, transport, manufacturing, etc.)

[66] European 5G Observatory, *Quarterly Report up to June 2019, 2019,* http://5gobservatory.eu/wp-content/uploads/2019/07/80082-5G-Observatory-Quarterly-report-4-min.pdf

Figure 58: 5GPPP objectives



Source: 5GPPP.

D.3.2 Stakeholder analysis of the 5G-PPP

Stakeholders involved so far in the 5GPPP (note that the analysis is only based on projects funded from the 5GPPP during Phase I and Phase II, i.e. projects funded before 2018)[67] are mainly from the telecom industry or from the public research centres and universities with a strong background in telecommunications. **The majority of funding was directed towards private research** (56% of funding), and within that the vast majority for the telecom (operators, OEMs (Original Equipment Manufacturers) and IT industries. The involvement of verticals is still modest but growing. This is globally consistent with the analysis done for just Phase 1 project [68] (65% of private research)

Funding has been essentially allocated to EU 15[69] Member States (92% of funding, of which 70% for top 5 countries in Phase 1), **reflecting also the domination of telecom operators from bigger EU countries (and their associated partners),** which are generally controlling telecom operators from smaller EU countries.

Three main groups of players are mainly involved in the 5G-PPP, as designed by the European Commission and the 5G IA (5G Industry Association):

- **Current connectivity providers** (MNOs, MVNOs) are taking the opportunity of these new technologies to try to **diversify their offer and address new market segments** (in specific verticals, including manufacturing) as a way to compensate declining consumer revenues. They have engaged into many projects within the 5G-PPP and trials[70] targeting key vertical markets like automotive, healthcare, industry 4.0, energy and media, and additional vertical markets targeted in a second step like public safety and smart city[71]. In Europe, Orange, Telefonica, Telecom Italia and BT (plus to a lesser extent Altice, Deutsche Telekom and OTE) have been leading the efforts on 5G.

[67] Only a part of Phase 3 projects have really started

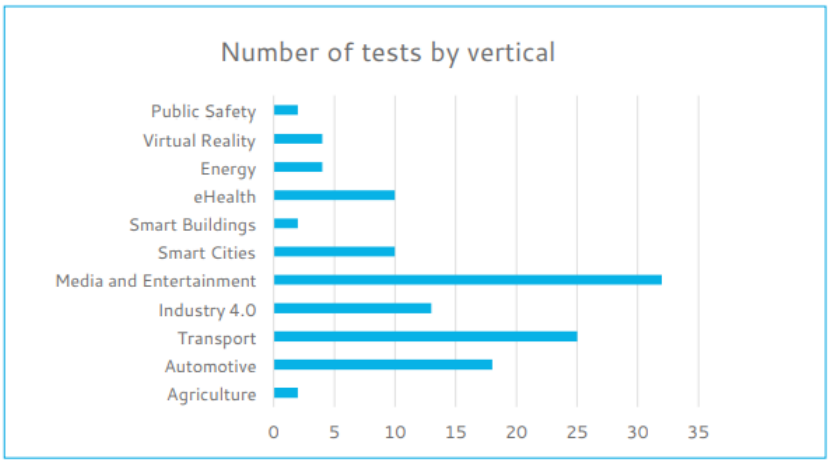
[68] Mid-term review of the contractual Public Private Partnerships under Horizon 2020 (2007), Report if the Independent Expert Group https://publications.europa.eu/en/publication-detail/-/publication/6de81abe-a71c-11e7-837e-01aa75ed71a1

[69] EU 15 being: Germany, Belgium, France, Italy, Luxembourg, Netherlands, Denmark, Ireland, UK, Greece, Spain, Portugal, Austria, Finland and Sweden.

[70] Vertical trials may not involve a vertical stakeholder

[71] 5G IA (2019) available at https://5g-ppp.eu/verticals/

Figure 59: Trials in Europe testing vertical markets



Source: Euro-5G Annual Journal[72]

- Providers of enabling technologies include software and hardware vendors. **Hardware equipment manufacturers** can also see 5G as an opportunity to **diversify their business modelling,** by bundling equipment with connectivity service provisioning in, for example, the small cell area. The need for an upgraded infrastructure, supported by virtualization and allowing for edge computing, is also an opportunity, partly challenged nonetheless by the development of pure software players. Traditional OEMs (especially Nokia and Ericsson, but also Huawei and NEC) and their counterpart software and/or electronics companies (Atos, Samsung, Intel) are well represented within the 5GPPP projects.
- Fundamental building blocks may also be developed by academic and public research institutes/centres also well represented in the 5GPPP. Close to 40% of participants in 5GPPP (and 36% of funding)[73] was allocated to either high education and research centres (with a slight bigger proportion for education).
- Some content providers (including OTT players) and **industrial solution providers, and potentially manufacturers (a.k.a. vertical stakeholders)**, will also play a role in the new communication value chains, not only as content and service providers, but also as **connectivity providers**, and infrastructure providers. This is reinforced by the integration of **direct, proximity communications** (such as public safety services or V2V (Vehicle to Vehicle communication), V2I (Vehicle to Infrastructure)) in the 5G standards, thereby **removing partially or even entirely in some cases the need for a mobile operator in the value chain.** Their engagement as participants in projects is still modest (5% overall for Phases 1 and 2) but increasing. Indeed, the NACE code analysis shows the following evolution. Most vertical stakeholders have participated to only 1 project.

[72] https://5g-ppp.eu/annual-journal/

[73] NACE code analysis

Table 28: Analysis of participants based on NACE codes[74]

	2014[75]	2016	2017
% of participants from "vertical" NACE codes [76]	2%	6.3%	16.4%
% of funding from "vertical" NACE codes	2%	5.4%	16.6%

Source: IDATE Digiworld

Vertical industries were not very active around 5G developments before 2018-2019. **Among the active vertical industries, a few already really stand out:** the automotive industry (thanks to the creation of the 5G AA (5G Automotive association)) and to a lesser extent manufacturing industries (5G ACIA - 5G Alliance for Connected Industries and Automation) and utilities. These vertical stakeholders are often not involved around business use cases but rather focus on specific technologies development. The question of the business sustainability of the proposed scenario thus often remain open.

Table 29: The main vertical stakeholders in projects of phases 1 and 2 and in other 5G initiatives involving vertical stakeholders.

Vertical industries	Vertical stakeholders
Utilities/Energy	ENGIE, ASM Terni, PowerOps, RomGaz, eMOTION, VerticalM2M, EFAFEC, Power Solutions Group, Siemens, World Sensing
Automotive	Volvo, PSA, Bosch, Fiat, ExpertSystems *5GAA (created late 2016) including also AUDI AG, BWM Group, Daimler AG, Ford, Denso, Continental, Honda, Hyundai, Nissan, Mitsubishi, Volkswagen*
Public Safety	Thales, ENGIE, WIND-3, RomGaz, ASM Temi *Public Safety Communication Europe (PSCE), the European public safety Association, and 5G IA, signed a Cooperation agreement in May 2018 to foster collaboration on 5G development.*
Healthcare	Servicio de Asistencia Municipal de Urgencia y Rescate (SAMUR), Irish National Ambulance Services facilitated by CIT; LifeSemantics, Camanio Care AB
Media	RAI, RTVE, BBC, EBU, IRT, Nurogames
Transport	Fiat, COMSA, FGC, Hamburg Port Authority, riaGnoSys GmbH (Zodiac Inflight Innovations), Ferrovial (through Seamless Air Alliance, Delta and Airbus) Ports of Thessaloniki, Patras and Pireus (in SMI initiative) Ahlers in 5G Manifesto[77]
Industry	Weidmüller, Airbus, Siemens, Royal Philips in 5G Manifesto

[74] NACE code analysis based on participant portal data made available by the European Commission.

[75] No calls for the 5GPPP in 2015

[76] Vertical NACE codes excludes all NACE codes related to ICT industry, support actions like marketing or administration and wholesale trade

[77] 5G Manifesto is an open letter from 17 telecom operators, equipment vendors and satellite operators that was sent to European Commissioner for Digital Economy and Society Günther Oettinger in July 2016. The 5G Manifesto covers a wide range of verticals. Five non-telecoms companies expressed their interest and willingness to participate in the next phase: Ahlers (logistics and maritime service provider), Airbus Defence & Space (defence and aerospace), Royal Philips (electronics, healthcare, and lighting), Siemens AG (engineering) and Thales Alenia Space (satellites, payloads).

Vertical industries	Vertical stakeholders
	5G-ACIA created early 2018
Smart Cities	City of Lucca, City of Bristol, City of Barcelona, Alba Iulia City Flash Lighting Services

Source: IDATE Digiworld[78]

This limited participation of actors from the vertical industries to the 5G-PPP can be explained mainly by the natural phasing of the 5G-PPP, with earlier phases dedicated to technology development and later phases to validation, testbeds and trials, especially around platforms. The increase overtime of the vertical stakeholders' presence in project and access to funding shows positive signs of uptake.

This is in addition confirmed by analysis of the Phase 3 projects started or about to start, reaching even at least 22% of vertical participants (some projects like 5G-TOURS and 5G-DRONES are even with more than a third of vertical participants), when excluding platforms. Verticals industries with the most contributors are by far automotive (with a specific call), transport and industry 4.0, with a mix of very large companies and smaller ones.

Table 30: Analysis of participants based on listing

	15 Phase 3 projects from calls in 2018	Same scope but excluding the CSA and the 3 platforms
% of participants from "vertical industries" (private only)	18.0%	22.4%

Source: IDATE Digiworld (from 5GPPP description of projects) [79]

Table 31: Non-exhaustive list of vertical participants in Phase 3 projects

Vertical	
Energy	Enel, EDF, Iren, Mirantis, Admie
Automotive	BMW, PSA, Renault, Bosch, Volvo, Volkswagen, Fiat, Swarco, Daimler, Ford, Dalian, Valeo, Alsa
Industry 4,0 *(including robotics and drones)*	ABB, Bombardier, Marposs, Bosch, Orbis, Cafa, Involi, Unmanned systems, Droneradar, Comau
Transport	Athens Airport, Deutsche Bahn, Vediafi, Sanef, Autostrada del Brennero, Aenl, Siemens Mobility, Trenitalia
Other	Procter&Gamble, City of Torino, City of Egaleo, Polar, Sealab, Epitomical, Nurogames, RAI, LiveU, Philips, CHU Rennes, AMA

Source: IDATE Digiworld

[78] ESA, Techno-Economic impacts of 5G for the European Satellite Industry, (2019), https://artes.esa.int/projects/techno-economic-impact-5g-standards-european-canadian-satellite-industry-ecosystem

[79] https://5g-ppp.eu/5g-ppp-phase-3-projects/

D.3.3 Outcomes and (expected) impacts

It is quite early to measure the outcomes of the 5G-PPP based on previous assessments or evaluations, as the 5G-PPP is still ongoing. Only Phase 1 projects are closed and Phase 2 projects ran until mid 2019 for most of them, while most Phase 3 projects have just started or will start in 2020.

The only evaluation conducted so far relates to the 19 Phase 1 projects[80] (but is not specific to 5G). The 5G-PPP showed some very good performances in shorter average time to grant than FP7 or Horizon 2020 and higher quality and success rates. This illustrates that the overall structuration has been well thought and organized in advance. Funding was mainly allocated to a limited number of beneficiaries (top 50 getting 65% against only 22% in other Horizon 2020 projects). In Phase 1, 5G-PPP was seen as performing well in general, with some improvements needed around inclusion of SMEs and of EU13 (only 2% of funding for Phase 1) and also in terms of links with other cPPPs (contractual Public Private Partnership).

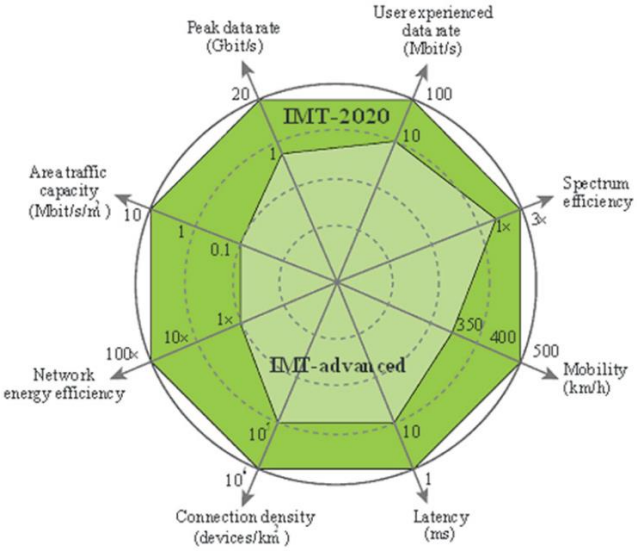
The contractual arrangement defines 12-13 (depending on documents) specific KPIs (Key Performance Indicators) for the 5G-PPP in addition the common set of KPIs defined by the EC for all cPPPs. These KPIs have been assessed in Euro-5G and To-Euro-5G.[81]

Scientific and technological results

ITU requirements

The targets set for IMT-2020, corresponding to the fifth generation of mobile systems, by ITU are described below. IMT-Advanced corresponds to 3GPP LTE.

Figure 60: Enhancement of key capabilities from IMT-Advanced to IMT-2020



Source: ITU[82]

[80] Mid-term review of the contractual Public Private Partnerships under Horizon 2020 (2007), Report if the Independent Expert Group https://publications.europa.eu/en/publication-detail/-/publication/6de81abe-a71c-11e7-837e-01aa75ed71a1

[81] D4.4 Final report on 5G PPP KPI progression of June 2019, To-Euro 5G

[82] ITU, *Setting the Scene for 5G: Opportunities and Challenges, 2018. Available at:* https://www.itu.int/en/ITU-D/Documents/ITU_5G_REPORT-2018.pdf

5G-PPP KPIs

The following Key Performance Indicators were set by the Public Private Partnership on 5G:[83]

- Providing 1000 times higher wireless area capacity and more varied service capabilities compared to 2010.
- Saving up to 90% of energy per service provided.
- Reducing the average service creation time cycle from 90 hours to 90 minutes.
- Creating a secure, reliable and dependable Internet with a "zero perceived" downtime for services provision.
- Facilitating very dense deployments of wireless communication links to connect over 7 trillion wireless devices serving over 7 billion people.

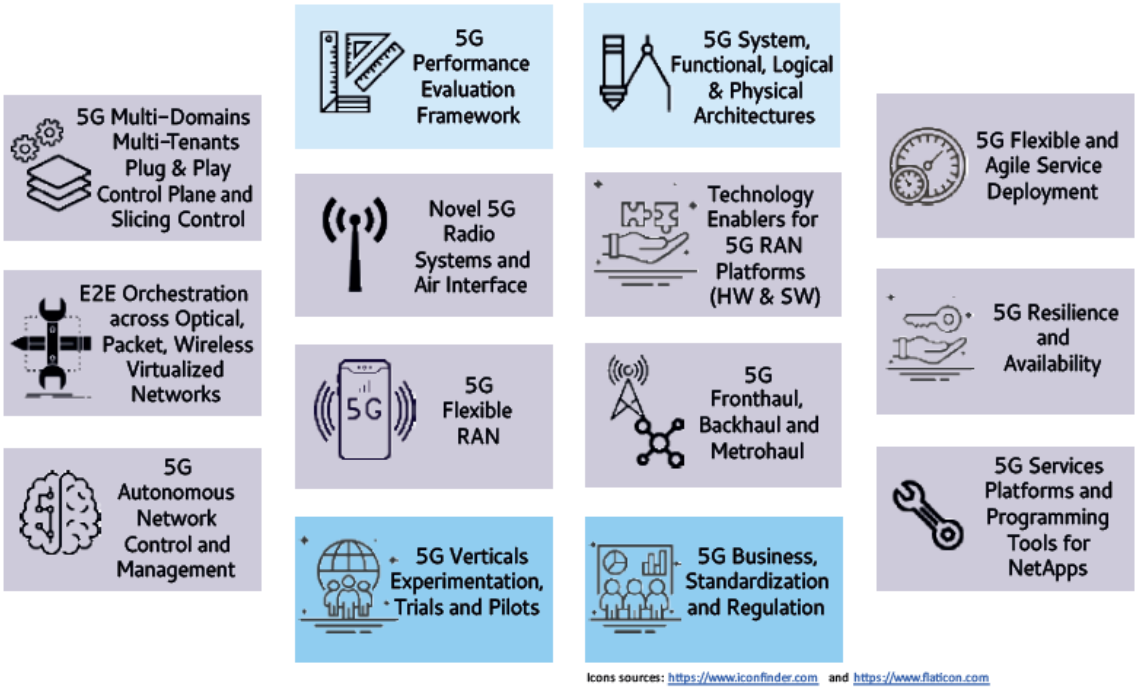
The 5G Initiative Technology Board produced a document on the definition, assessment and there cannot and will not be one single overall system analysis per Performance KPI across all 5G Infrastructure PPP projects. The running study leads to a summary of clustered projects contributions to the Performance KPIs in a structured programmatic approach. The PPP Performance KPIs definition, at Programme level, are based on the work of a Phase 1 project (Flex5GWare), the approach has been extended to the overall set of PPP Phase 2 Projects.

The PMR (Progress Monitoring Report) Annex consolidates the available KPIs from the different sources of the 5G Infrastructure PPP Programme Working Group activities and projects. It consolidates an agreed definition for each KPI and provides an agreed method of measurement. The PPP Performance KPIs work has also then been further developed on specific Performance KPIs, starting first with Latency and Service Creation Time. This information is included in the PMR Annex. It contains the up-to-date status on these KPIs / Projects contributions. **The work is in progress and the final reports will be released during the second half of 2019.** Potentially, additional White Papers could be developed on Peak Data Rate KPI, Summary of individual Projects Performance KPI and PPP KPIs Cartography development of '5G-PPP Phase II Projects Performance KPIs'.

The 5G-PPP Technical Board advanced the approach defined in Phase 1 with the definition of the Programme Golden Nuggets (GNs), elaborated on the basis of the key projects achievements. The PPP GNs Version 2.0 was released in February 2019, allowing all PPP projects to fully understand and match their individual contributions inside the overall programme achievements. **Key achievements from Phase 2 5G PPP projects include 60 highlighted results categorised under 14 program level achievements as shown in the figure below.**

[83] 5GPPP, *5G PPP progress monitoring report, 2017, available at:* https://5g-ppp.eu/wp-content/uploads/2018/10/5G-PPP-Progress-Monitoring-Report-2017.pdf

Figure 61: PPP Key Achievement Phase 2 Projects (Golden Nuggets Version 2.0)



Source: 5G-PPP[84]

Additional Programme-Level KPIs

- Patents

At the end of March 2019, Europe had filed for ~22% of standard essential patents (SEP) for 5G communication systems.

- Standardisation activities

5G-PPP has had significant influence in building pre-standardization consensus across key actors. Major impact on the 5G architecture ideas has also been achieved through 610 activities leading to standardization (Phase 1: 315; Phase 2: 295). The table below shows a breakdown of the inputs for the development of 5G standardization tracked between June 2018 and June 2019:

Table 32: Input to 5G standardisation

Number of contributions per category tracked	
Overall architecture: Mostly to 3GPP, with many inputs on the implementation of 5G V2X systems and multimedia broadcast or streaming services.	70
Core and transport architecture: Mostly to 3GPP, with most of the inputs related to terminals.	58
Management and orchestration architecture: Mostly to three ETSI groups, namely, the ZSM ISG, NFV ISG and OSM.	50
Radio and edge architecture: Mostly to 3GPP, with many inputs on 5G NR enhancements for V2X and multimedia broadcast.	41

[84] EURO 5G – The European 5G Annual Journal, 2019 https://bscw.5g-ppp.eu/pub/bscw.cgi/d302069/Euro%205G%20PPP%20Annual%20Journal%202019-web.pdf

Number of contributions per category tracked	
Other 3GPP WGs: RAN 3 (new radio); SA1 (service requirements); SA5 (network management, including energy efficiency and architecture); SA4 (codec); SA6 (northbound APIs); SA4-5-6 (media and broadcasting).	21
ETSI Multi-Access Edge Computing (e.g. Instantiating a Network Slice integrating MEC applications, using 3GPP elements).	6
Industry groups (e.g. DVB for media and broadcasting); other standards organisations (e.g. IETF for network virtualisation, fog computing and northbound interfaces); not specified	49
Total	295

Business outcomes and impacts

Three business KPIs were set and have been mostly achieved:

- Leverage effect of EU research and innovation funding in terms of private investment in R&D for 5G systems in the order of 5 to 10 times (B1). The expected KPI has been surpassed, with private investments from large industry and SMEs reaching 10,12 in 2018 (7.24 when taking into account all beneficiaries like education).
- Target SME participation under this initiative commensurate with an allocation of 20% of the total public funding (B2). This KPI has been almost reached over Phase 1 and Phase 2 (19%) and is expected to be reached thanks to the last phase (trials).
- Reach a global market share for 5G equipment & services delivered by European headquartered ICT companies at, or above, the reported 2011 level of 43% global market share in communication infrastructure (B3). With roll-out in progress, it is too early to assess this KPI, but there are some early signs showing the KPI can be reached (such as the good positioning of actors such as Ericsson and Nokia in the standardization and patent activity).

As part of the common set of KPIs, additional outcomes have been calculated or identified

- around 2,000 new jobs are expected from 5G-PPP participants over the period 2014-2018 (i.e. an increase of 5 jobs per participant, of which 2.3 for SMEs)
- an increase of turnover by 10% for SMEs in 2018
- the development of a brochure "European SME expertise in 5G and beyond" (June 2019)

Societal outcomes and impacts

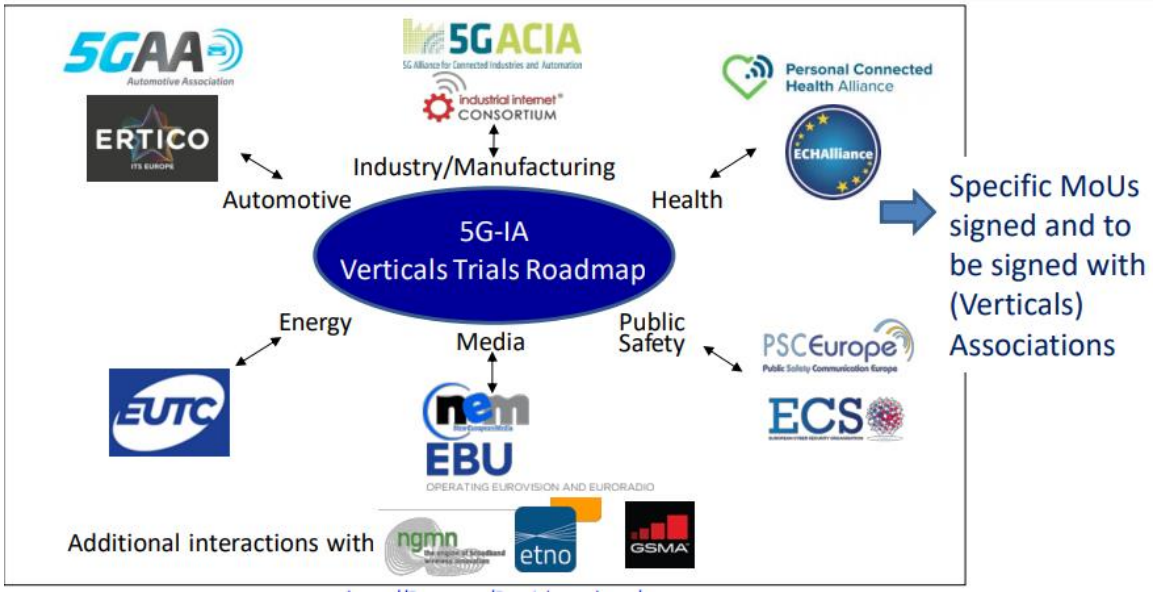
Five business KPIs were set, for which outcomes are not still limited for now (except KPI S3) but are still on track to be achieved for most of them in Phase 3:

- Enabling advanced user-controlled privacy (S1). Progress has been made around security (especially with MEC and slicing) more than privacy, expected to be tackled around with new projects, in Phase 3 and more likely in the candidate PPP.
- Reduction of energy consumption per service up to 90% (as compared to 2010) (S2). No results yet beyond some initial findings in METIS-II project. Data is indicated to be collected from projects to get better information.
- European availability of a competitive industrial offer for 5G systems and technologies (S3). In addition to B3, progress has been made by progressive integration of verticals during Phase 2 and then Phase3. Current forecasts for the share of patent by European

HQ vendors is of 45.6% for 5G RAN, 29.45% for 5G patents at a global level and a 25.32% for 5G declared standard essential patents in the automotive industry.[85]

- Stimulation of new economically-viable services of high societal value like U-HDTV and M2M applications (S4). Initial results are encouraging with the progressive integration of verticals and the definition of candidate pilots for media usage by NEM-Networld 2020 and of various pilots and use cases in other projects (with some live experience for a few of them). MoUs are signed or under negotiation with several stakeholder groups (see image below).
- Establishment and availability of 5G skills development curricula (in partnership with the EIT) (S5). Around 500 new curricula and educational qualifications among 5G PPP participants (around 1.25 per participant) were created over the period 2014-2018. 5G IA and EIT are also in discussions.

Figure 62: Highlights from 5G vertical strategy of 5GPPP



Source: 5G-PPP,[86] Roadmap Version 3.0

[85] To Euro 5G Project - Final Report on 5G PPP KPI progression, July 2019.

[86] Didier Bourse – 5G IA, 5G Pan-European Trials Roadmap, 7th Global 5G Event in Valencia (June 2019), available at https://static1.squarespace.com/static/5bf2b77d75f9eefcd937cb5c/t/5d1a23ea423b7e000142cc2e/1561994240968/6.+Didier+Bourse.pdf

Appendix E Additional information related to the problem definition

E.1 High risk R&D reinforces the risks for European actors

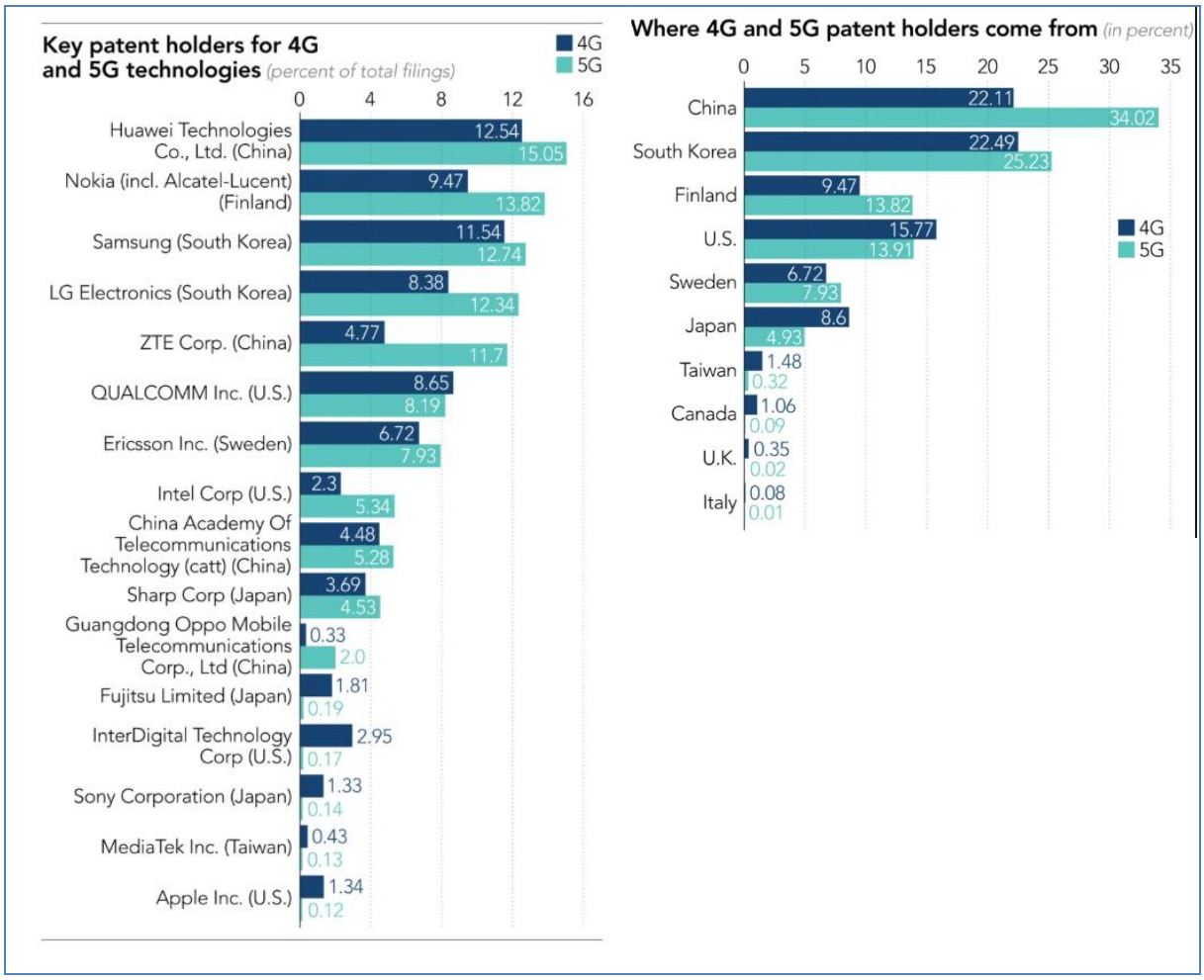
Table 33: R&D Intensity of Telecommunication Equipment providers.

Company	Country	R&D Expense (in USD billions)	Total Revenue (in USD billions)	R&D Intensity (%)
Huawei	China	12.53	85.54	14.6%
Cisco Systems. Inc.	United States	6.06	48.01	12.6%
Nokia Corporation	Finland	5.90	27.79	21.2%
Telefonaktiebolaget LM Ericsson	Sweden	4.63	24.59	18.8%
ZTE Corporation	China	1.99	16.72	11.9%
ARRIS International plc	United States	0.54	6.61	8.2%
Motorola Solutions. Inc.	United States	0.57	6.38	8.9%
Juniper Networks. Inc.	United States	0.98	5.03	19.5%
Fiberhome Telecommunication Technologies Co.. Ltd.	China	0.30	3.24	9.3%
Ciena Corporation	United States	0.48	2.80	17.0%
F5 Networks. Inc.	United States	0.35	2.09	16.8%
Palo Alto Networks. Inc.	United States	0.35	1.76	19.7%
Arista Networks. Inc.	United States	0.35	1.65	21.2%
Viasat. Inc.	United States	0.20	1.56	12.9%
Finisar Corporation	United States	0.24	1.45	16.5%
Fujian Star-net Communication Co.. Ltd.	China	0.14	1.18	11.9%
NetScout Systems. Inc.	United States	0.22	1.16	18.5%
Lumentum Holdings Inc.	United States	0.15	0.90	16.4%
Viavi Solutions Inc.	United States	0.14	0.81	16.8%
Infinera Corporation	United States	0.22	0.74	30.3%
Datang Telecom Technology Co.. Ltd.	China	0.16	0.67	23.9%
ADTRAN. Inc.	United States	0.13	0.67	19.6%
ADVA Optical Networking SE	Germany	0.12	0.62	19.1%
Calix. Inc.	United States	0.13	0.51	25.0%
Ribbon Communications Inc.	United States	0.12	0.33	36.3%

Source: Strategy& PwC, The 2018 Global Innovation 1000 study, analysis of the 1000 largest corporate R&D spenders.

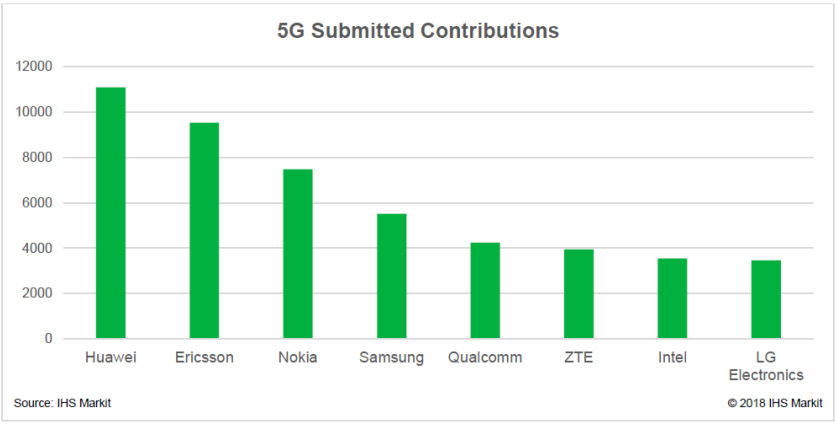
E.2 A need for critical mass in standardization

Figure 63: Patent holders for 4G and 5G technologies



Source: Nikkei Asian Review[87]

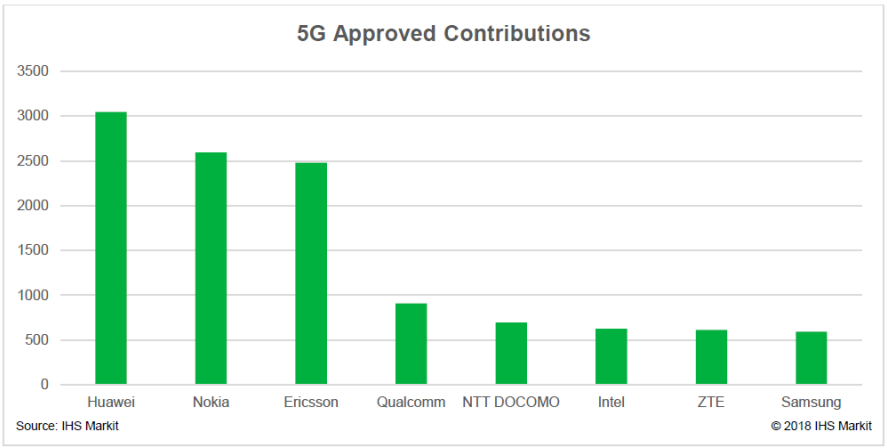
Figure 64: Number of submitted 5G contributions (3GPP) – 2015 to 2018 H1



Source: IHS Markit

[87] Akito Tanaka, Nikkei Asian Review, *China in pole position for 5G era with a third of key patents,* May 2019, available at: https://asia.nikkei.com/Spotlight/5G-networks/China-in-pole-position-for-5G-era-with-a-third-of-key-patents

Figure 65: Number of approved 5G contributions (3GPP) – 2015 to 2018 H1



Source: IHS Markit

Appendix F Additional information related to the policy options descriptions

F.1 Degree of coverage of the different functionalities by policy option

Table 34: Type and composition of actors (including openness and roles)

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is possible? *Any legal entity* in a consortiu**m** can apply to Horizon Europe calls in ad hoc combinations Calls are open to participation from across Europe and the world (not all entities from third countries are eligible for funding)	***What is possible?*** Partners can include *any national funding body or governmental research organisation*, Possible to include also *other type of actors*, including foundations.	***What is possible?*** Partners can include *MS and Associated Countries*.	***What is possible?*** Suitable for *all types of partners*: private and/or public partners, including MS, regions, foundations. By default open to AC/ 3rd countries, but subject to policy considerations. Can cover a *large and changing community.* HE rules apply by default to calls included in the FP Work Programme, so any legal entity can apply to these.	***What is possible?*** Suitable for *all types of partners*: private and/or public partners, including MS, foundations. By default open to legal entities from AC/ 3rd countries, but subject to policy considerations. In case of countries participating non-associated third countries can only be included as partners if foreseen in the basic act and subjected to conclusion of dedicated international agreements HE rules apply by default, so any legal entity can apply to partnership calls.

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is limited? Systematic/ structured engagement with public authorities, MS, regulators, standard making bodies, foundations and NGOs.	***What is limited?*** Requires substantial national R&I programmes (competitive or institutional) in the field. Usually only legal entities from countries that are part of the consortia can apply to calls launched by the partnership, under national rules.	***What is limited?*** Non-associated third countries can only be included as partners if foreseen in the basic act and subjected to conclusion of dedicated international agreements. Needs good geographical coverage – participation of at least 40% of Member States is required Requires substantial national R&I programmes (competitive or institutional) in the field. While by default the FP rules apply for eligibility for funding/participation, in practice (subject to derogation) often only legal entities from countries that are Participating States can apply to calls launched by the partnership, under national rules.	***What is limited?*** If MS launch calls under their responsibility, usually only legal entities from countries that are part of the consortia can apply to these, under national rules	***What is limited?*** Requires a *rather stable set of partners* (e.g. if a sector has small number of key companies). Basic act can foresee exceptions for participation in calls / eligibility for funding.
What is not possible? To have a joint programme of R&I activities between the EU and committed partners that is implemented based on a common vision.	***What is not possible?*** To have industry/ private sector as partners.	***What is not possible?*** To have industry/ private sector as partners.	***What is not possible?***	***What is not possible?***

Appendix G Additional information related to the problem definition

G.1 Taxonomy of failures requiring policy intervention

Market failures	
Market power	Limited interest from private sector parties to invest in R&D for the development of health technologies for PRNDs due to low potential for return on investment. Lack of universal health coverage means that individuals are often unable to cover the costs for treatments.
Externalities	There are weak and underfunded health systems in Africa. Capacity for conducting research in the region is similarly weak.
Information asymmetry	Pharmaceutical companies usually have a large extent of monopoly power, making it challenging for countries, in particular, LMICs, to negotiate affordable prices for health technologies.
Systemic failures	
Capability	Low capacity in Africa to conduct research and development locally
Network	Private sector parties have shown relatively limited interest in the development of suitable and affordable health technologies for PRNDs. Whereas public sector parties, including academic organisations, have shown greater interest in this, they usually lack the experience and resources to bring products through the clinical research and product development stages to bring a product to market. This calls for a partnership approach. Fragmentation in the research landscape should be reduced through stronger networking and a partnership approach.
Institutional	SSA countries require the development of a capacity to support the conduct of clinical trials in the region, including frameworks for regulatory oversight and medical ethics committees.
Infrastructural	Limited staff capacity for the conduct of clinical trials in the SSA region, as well as insufficient laboratory infrastructures (e.g. laboratory equipment, supply chain management systems, digital infrastructure to support data collection and analysis)
Transformational failures	

Directionality	Need for a strong partnership to agree on shared objectives and development of global R&D roadmaps e.g. for TB vaccine development
Demand articulation	Equal voice and representation of SSA countries helps to ensure that supported activities are aligned with the local needs and demands for products of greatest relevance to the region
Policy coordination	There are many different stakeholders and initiatives in the global health field. A partnership approach allows ensuring proper coordination and alignment.
Reflexivity	EDCTP has developed a strong results-based management approach which supports is the ability to monitor its impacts and make necessary adjustments along the way. A strong partnership is able to more rapidly respond to emerging needs, as in the case of the 2014 West Africa Ebola outbreak.

Source: Weber and Rohracher (2012) adapted by Technopolis Group (2018)

Appendix H Additional information related to the policy options descriptions

H.1 Degree of coverage of the different functionalities by policy option

Table 35: Type and composition of actors (including openness and roles)

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is possible? *Any legal entity* in a consortiu**m** can apply to Horizon Europe calls in ad hoc combinations Calls are open to participation from across Europe and the world (not all entities from third countries are eligible for funding)	***What is possible?*** Partners can include *any national funding body or governmental research organisation*, Possible to include also *other type of actors*, including foundations.	***What is possible?*** Partners can include *MS and Associated Countries*.	***What is possible?*** Suitable for *all types of partners*: private and/or public partners, including MS, regions, foundations. By default open to AC/ 3rd countries, but subject to policy considerations. Can cover a *large and changing community.* HE rules apply by default to calls included in the FP Work Programme, so any legal entity can apply to these.	***What is possible?*** Suitable for *all types of partners*: private and/or public partners, including MS, foundations. By default open to legal entities from AC/ 3rd countries, but subject to policy considerations. In case of countries participating non-associated third countries can only be included as partners if foreseen in the basic act and subjected to conclusion of dedicated international agreements HE rules apply by default, so any legal entity can apply to partnership calls.
What is limited? Systematic/ structured engagement with public authorities, MS, regulators, standard making bodies, foundations and NGOs.	***What is limited?*** Requires substantial national R&I programmes (competitive or institutional) in the field. Usually only legal entities from countries that are part of the consortia can apply to calls launched by the	***What is limited?*** Non-associated third countries can only be included as partners if foreseen in the basic act and subjected to conclusion of dedicated international agreements. Needs good geographical coverage – participation of at least 40% of Member States is required	***What is limited?*** If MS launch calls under their responsibility, usually only legal entities from countries that are part of the consortia can apply to these, under national rules	***What is limited?*** Requires a *rather stable set of partners* (e.g. if a sector has small number of key companies). Basic act can foresee exceptions for participation in calls / eligibility for funding.

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
	partnership, under national rules.	Requires substantial national R&I programmes (competitive or institutional) in the field. While by default the FP rules apply for eligibility for funding/participation, in practice (subject to derogation) often only legal entities from countries that are Participating States can apply to calls launched by the partnership, under national rules.		
What is not possible? To have a joint programme of R&I activities between the EU and committed partners that is implemented based on a common vision.	***What is not possible?*** To have industry/ private sector as partners.	***What is not possible?*** To have industry/ private sector as partners.		

Table 36: Type and range of activities (including flexibility and level of integration)

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is possible? Horizon Europe standard actions that allow *broad range of individual activities* from R&I to TRL 7 or sometimes higher. Calls for proposals published in the Work Programmes of Horizon Europe (adopted via comitology).	***What is possible?*** Activities may range from R&I, pilot, deployment actions to training and mobility, dissemination and exploitation, but according to national programmes and rules. Decision and implementation by "beneficiaries" (partners in the co-fund grant agreement) e.g. through institutional funding programmes, or by "third parties" receiving financial support, following calls for proposals launched by the consortium.	***What is possible?*** Horizon Europe standard actions that allow a broad range of coordinated activities from R&I to uptake. In case of implementation based on national rules (subject to derogation) Activities according to national programmes and rules. Allows integrating national funding and Union funding into the joint funding of projects	***What is possible?*** *Horizon Europe standard actions* that allow a broad range of coordinated activities from R&I to uptake. The association representing private partners allows to continuously build further on the results of previous projects, including activities related to regulations and standardisation and developing synergies with other funds Union contribution is implemented via calls for proposals published in the Work Programmes of Horizon Europe based on the input from partners (adopted via comitology). Open and flexible form that is simple and easy to manage.	***What is possible?*** *HE standard actions* that allow to build a portfolio with broad range of activities from research to market uptake. The back-office allows dedicated staff to implement integrated portfolio of projects, allowing to build a "system" (e.g. *hydrogen*) via pipeline of support to accelerate and scale up the take-up of results of the partnership, including those related to regulations and standardisation and developing synergies with other funds. E.g. setting up biorefinery plants and promoting their replication by additional investments from MS/ private sector. Procuring/purchasing jointly used equipment (e.g. HPC) Allows integrating national funding and Union funding into the joint funding of projects
What is limited?	***What is limited?*** Scale and scope of the programme the resulting funded R&I actions and depend on the participating programmes, typically		***What is limited?*** Limited control over precise call definition, resulting projects and outcomes, as they are implemented by EC agencies.	***What is limited?*** Limited flexibility because objectives, range of activities and partners are defined in the Regulation, and negotiated in the Council (EP).

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
	smaller in scale than FP projects			
What is not possible? To design and implement in a systemic approach a portfolio of actions. To leverage additional activities and investments beyond the direct scope of the funded actions				

Table 37:Directionality

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is possible? Strategic Plan (as implementing act), annual work programmes (via comitology). Possible also to base call topics on existing or to be developed SRIA/roadmap	***What is possible?*** Strategic R&I agenda/roadmap agreed between partners and EC Annual work programme drafted by partners, approved by EC Objectives and commitments are set in the Grant Agreement.	***What is possible?*** Strategic R&I agenda/roadmap agreed between partners and EC Objectives and commitments are set in the legal base. Annual work programme drafted by partners, approved by EC Commitments include obligation for financial contributions (e.g. to administrative costs, from national R&I programmes).	***What is possible?*** Strategic R&I agenda/roadmap agreed between partners and EC Objectives and commitments are set in the contractual arrangement. Input to FP annual work programme drafted by partners, finalised by EC (comitology) Commitments are political/best effort, but usually fulfilled	***What is possible?*** Strategic R&I agenda/roadmap agreed between partners and EC Objectives and commitments are set in the legal base. Annual work programme drafted by partners, approved by EC (veto-right in governance) Commitments include obligation for financial contributions (e.g. to administrative costs, from national R&I programmes).
What is limited? No continuity in support of priorities beyond the coverage of the strategic plan (4 years) and budget (2 years Annual work programme).				
What is not possible? Coordinated implementation and funding linked to the concrete objectives/ roadmap, since part of overall project portfolio managed by agency				

Table 38: Coherence (internal and external)

Option 0: Horizon Europe calls	Option 2: Co-funded	Option 3: Institutionalised Art 185	Option 1: Co-programmed	Option 3: Institutionalised Art 187
What is possible? Coherence between different parts of the Annual Work programme of the FP ensured by EC	***What is possible?*** Coherence among partnerships and with different parts of the Annual Work programme of the FP can be ensured by partners and EC Synergies with national/regional programmes and activities	***What is possible?*** Coherence among partnerships and with different parts of the Annual Work programme of the FP can be ensured by partners and EC Synergies with national/regional programmes and activities Synergies with other programmes	***What is possible?*** Coherence among partnerships and with different parts of the Annual Work programme of the FP can be ensured by partners and EC If MS participate: Synergies with national/regional programmes and activities Synergies with industrial strategies	***What is possible?*** Coherence among partnerships and with different parts of the Annual Work programme of the FP can be ensured by partners and EC Synergies with other programmes or industrial strategies If MS participate: Synergies with national/regional programmes and activities
What is limited? Synergies with other programmes or industrial strategies	***What is limited?*** Synergies with other programmes or industrial strategies	***What is limited?*** Synergies with industrial strategies	***What is limited?*** Synergies with other programmes	
What is not possible? Synergies with national/regional programmes and activities				

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