

## 5G PPP PROGRESS MONITORING REPORT – 2017

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*This document has been prepared by the 5G Infrastructure Association (5G IA) and it reflects the views only of its authors.*

## **Executive Summary**

This Annual Progress Monitoring report provides an overview of the main activities and achievements of the 5G Infrastructure Public-Private Partnership in 2017.

In 2017, the 5G PPP has continued to provide great benefits for Europe and in particular:

### **5G PPP places Europe ahead in the global 5G race**

The 5G PPP Programme provides the leading global forum for developing the ideas, concepts and solutions for what 5G will be and which technical solutions will be chosen.

The 5G PPP global impact achievements already include:

- A major impact on 5G standards with more than 300 technical contributions to IEEE802, 3GPP, ETSI, etc
- Beyond standards, proving the 5G system will work in more than 100 test/experiment sites
- Beyond Europe, a global impact with 6 memorandum of understandings signed between the European 5G IA and peer industry associations around the globe (North America, China, Japan, South-Korea, Brazil and India)
- Creation of a unique ecosystem bringing together multinational industries, SMEs, research centres and universities

### **5G PPP drives European economy**

Europe is focusing on truly disruptive vertical use-cases for 5G - including URLLC (Ultra-reliable, low-latency communications) and critical communications - within 2020-22 timeframe, enabling new players entering the market with new services. For this purpose, 5G PPP has already:

- Created 5G technology leadership for European industry
- Successfully achieved most of the challenging business and technical key performance indicators (KPIs) as well as on track for the societal ones
- Stimulated a high level of SME participation in Phase 1 and Phase 2
- Had a positive Impact on the innovation capacity of SMEs
- Mobilised a huge additional private investment in 5G on top of the allocated public funding (700 million €) by 2020

### **5G PPP supports citizens and public authorities**

- Supporting Europe's leadership in the digitisation of industry and society

- Facilitating the creation of new societally beneficial services such as smart cities, e-health, intelligent transport, power, environmental protection, education or entertainment & media
- Enabling European e-inclusion through the rollout of high performant networks with pervasive access to all services

In this report, special attention is devoted to present the progress made on **Key Performance Indicators (KPIs)**.

The performance-related KPIs show substantial development. The 5G-XHaul project, for example, achieved a data rate of 4Gbps under operational conditions with backhaul devices, while user throughput at the cell edge jumped from 15Mbps to 170Mbps in the mmMAGIC project, representing an 11-fold increase on baseline LTE.

Significant advancement has also been made on business KPIs. **The European ICT sector is significantly exceeding the investment leverage factor envisioned in the 5G PPP Contractual Arrangement**, based on the industry methodology we have been using for 3 years. Such a high leverage ratio is due on the one hand to the fact that we used a top-down approach based on information from the overall industry, rather than exclusively from R&D activities related to 5G PPP. Another reason of the high leverage ratio is due to the timing factor, with a gradually increasing role of private investment in the 5G Partnership: phase 1 (fundamental research) required less private funding than phase 2 (integration of vertical industries), and above all less than phase 3 (5G validation platforms, trials and pre-commercial phase), where direct and indirect investments will result in a much higher part of private funding.

In parallel, **SMEs represent an average of nearly 20%** of the participants in budget in the 5G PPP Phase 1 and Phase 2 projects, just a fraction away from the objective of 20% that was the minimum share originally set as a KPI.

The progress towards societal KPIs remains challenging to determine as the 5G infrastructure, services and applications are not yet in commercial service. However, reductions in energy consumption are receiving considerable attention. Furthermore, positive progress has been made on activities related to the **availability of 5G skills development curricula** (in partnership with the EIT).

Also **Vertical Industries (automotive, industry 4.0, healthcare, energy,...) will be instrumental in delivering the societal benefits of 5G**. Therefore the projects selection in 5G PPP Phase 2 has strongly included vertical stakeholders representing various types of applications (autonomous vehicles, immersive media, virtualised transport platforms with network slicing, smart energy as a service, smart manufacturing, public safety, emergency real time intervention, 5G rail service, test-beds in sea-port and touristic city,...), as shown in this report.

Furthermore, **other cPPPs can also benefit** significantly from the presence of 5G infrastructure.

## 1. Introduction: The 5G Infrastructure Public-Private Partnership

The 5G Infrastructure Public-Private Partnership (5G PPP) is the 5G collaborative research program that is organized as part of the European Commission's Horizon 2020 program – The European Union Program for Research and Innovation. It is aimed at fostering industry-driven research, monitored by business-related, technological performance and societal KPIs. The 5G PPP will deliver solutions, architectures, technologies and standards for ubiquitous next-generation communication infrastructure over the coming decades.

5G PPP is a 7 year partnership leading to the introduction of 5G infrastructure and the roll out of 5G services in Europe from 2020. It is the biggest 5G research program in the world. Research in the 5G PPP has a very wide scope far beyond classical telecommunications.

5G PPP is a joint initiative between the European Commission and the European ICT industry. The Commission is investing 700 million € and the industry will leverage this investment by at least a factor of 5, bringing the total investment in the 5G PPP to **more than 4 billion €**. This will allow to rethink the infrastructure and to create the next generation of communication networks and services. The 5G PPP is therefore a good example of Europe's commitment to invest in ICT research at the right time to lead the world in capturing the benefits of 5G for both European Industry and Society.

Moreover 5G PPP is aiming at securing Europe's leadership in the areas where Europe is strong and where there is potential for providing novel 5G application capabilities in "vertical" sectors, such as automotive, healthcare, smart factories, smart cities, education, media & entertainment, thus creating a new ecosystem. 5G PPP will therefore reinforce the European industry to successfully compete on global markets opening innovation opportunities.

5G PPP's goal is to maintain and enhance the competitiveness of the European ICT industry and to ensure that Europe can enjoy the economic and societal benefits these future networks will bring.

In the 5G PPP, the 5G Infrastructure Association (5G IA) represents the private side, and the European Commission, the public side. The 5G IA is *"The voice of the European industry for the development and evolution of 5G"*. To this aim, the Association brings together a global industry community of telecoms & digital actors, such as operators, manufacturers, research institutes, universities, verticals and SMEs.

The 5G IA carries out a wide range of activities in strategic areas including standardization, frequency spectrum, R&D projects, technology skills, collaboration with key vertical industry sectors, notably for the development of trials, and international cooperation.

The overall objectives of the 5G IA are to promote R&D in the networks industry in order to strengthen it in the European Union, to foster technology skills in Europe, and to increase the competitiveness of the European industry by providing new tools and capabilities for manufacturing in Europe. In addition, the 5G IA is working to mobilise the community, in particular the SMEs in the European collaborative research projects.

5G PPP was launched in December 2013. Since then, it has constantly grown and successfully implemented its program plan. 5G PPP's governing documents are available on its website [www.5GPPP.eu](http://www.5GPPP.eu).

The 5G PPP consists of three phases of collaborative research:

- **Phase 1** performed fundamental research for the 5<sup>th</sup> generation of network communications: 19 Projects were retained, many of them completing their work around mid-2017, while some continue until mid-2018. They provided important results on core 5G technologies and managed to develop solutions that are able to meet nearly all the performance KPIs for 5G.
- **Phase 2** uses these technologies for the digitisation and integration of vertical industries in Europe. It started in June 2017, with 21 new 5G PPP selected projects. In addition, there are 2 complementary projects dealing with international collaboration with Taiwan. Most Phase 2 projects will be completed in 2019, while some will continue in 2020. This phase is more focused on demonstrating and validating the developed technology and explicitly trying to integrate use cases from vertical industries beyond classical telecommunications.
- **Phase 3** will address the development and rollout of 5G innovation and validation platforms across Europe. It began early 2018, the first projects beginning this summer, and future calls are planned later in 2018, 2019 and 2020.

Thousands of researchers and developers across Europe have been working on innovative solutions for the definition of 5G.

5G PPP projects are building pre-standards consensus and provide contributions to global standardization in order to strengthen Europe's influence on the 5G development.

A key part of the 5G PPP structure is a set of cross-projects and cross-initiative working groups. The working groups are the means to establish and publish program level opinions and positions on issues that impact all of the projects and/or may be the basis for liaison or interaction with external bodies such as other regions or standards bodies.

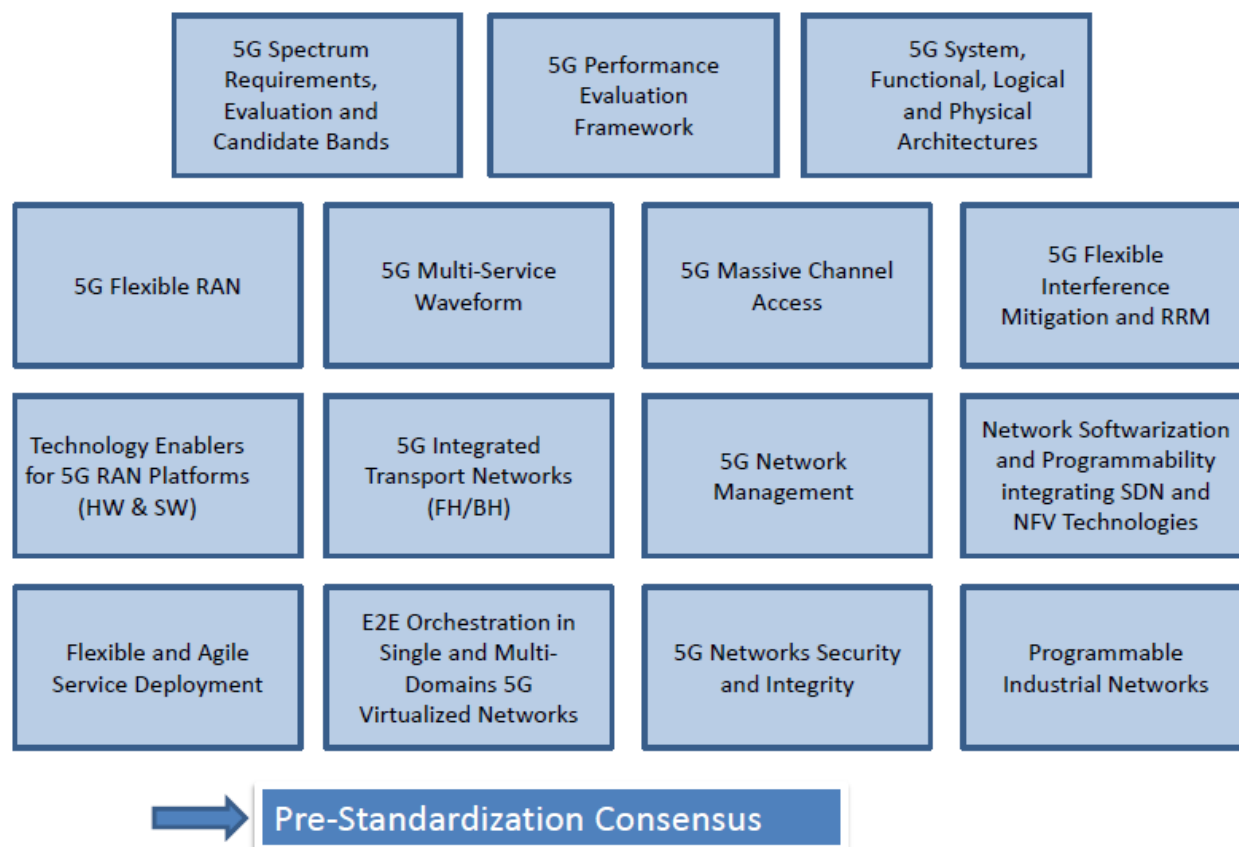
Besides the Board of the 5G IA, main bodies of the 5G PPP are the "Steering Board" (composed of the 5G PPP projects coordinators) and the Technology Board (composed of the 5G PPP projects technical managers), ensuring efficient collaboration and coordination among projects and working groups. Furthermore, the Partnership Board comprises representatives from the European Commission and from the private side and is the main body for the dialogue and cooperation between the European Commission and the 5G IA.

## 2. Main activities and achievements during 2017

Key activities and successes include:

- Presentation of Phase 1 projects key achievements

The Technology Board defined 15 technical achievements of Phase 1 projects<sup>1</sup>. Such key results were also communicated in the White Paper “5G innovations for new business opportunities”<sup>2</sup>. A video illustrating some of the achievements reached by Phase 1 projects is available on the 5G PPP YouTube channel<sup>3</sup>.



*Figure 1- Key Achievements of 5G PPP Phase 1 Projects in 2017*

- Successful launch of 5G PPP Phase 2 projects

All retained Phase 2 projects were launched with no delays on the planned timing. These projects are integrated in 5G PPP activities like the 5G PPP Steering and Technology Boards as well as working groups. Phase 2 projects are addressing key strategic areas as illustrated in Figure 6.

- Presentation and development of the “5G Pan-European Trials Roadmap”<sup>4</sup>

The Trials WG, created in September 2016 as an open WG, has been elaborating a solid and comprehensive strategy to develop the Pan-EU coordinated trials, as well as international trials

<sup>1</sup> <https://5G PPP.eu/phase-1-key-achievements/>

<sup>2</sup> <https://5G PPP.eu/wp-content/uploads/2017/03/5GPPP-brochure-final-web-MWC.pdf>

<sup>3</sup> <https://www.youtube.com/watch?v=pvmyWD3KLyw>

<sup>4</sup> <https://5G PPP.eu/5g-trials-roadmap/>

with non-EU partner countries. The “5G Pan-EU Trials Roadmap” is addressing several key elements of the European Commission’s 5G Action Plan, issued in September 2016, and targets to develop the necessary synergies between these elements.

Following the first version released in May 2017, version 2.0 of the Roadmap was presented and discussed at the [4th Global 5G event<sup>5</sup>](https://5gppp.eu/4th-global-5g-seoul/) in Seoul, Korea on 22-23 November 2017. It addressed the latest up-dates of the strategy, 5G Private Trials, 5G Platforms, 5G Vertical Pilots, 5G Pan-EU Flagship event for UEFA EURO 2020, 5G Trials Cities and International EU-X trials.

The work on the “5G Pan-EU Trials Roadmap” is intense and is successfully attracting an ever-increasing interest and participation from various stakeholders, including vertical industries.

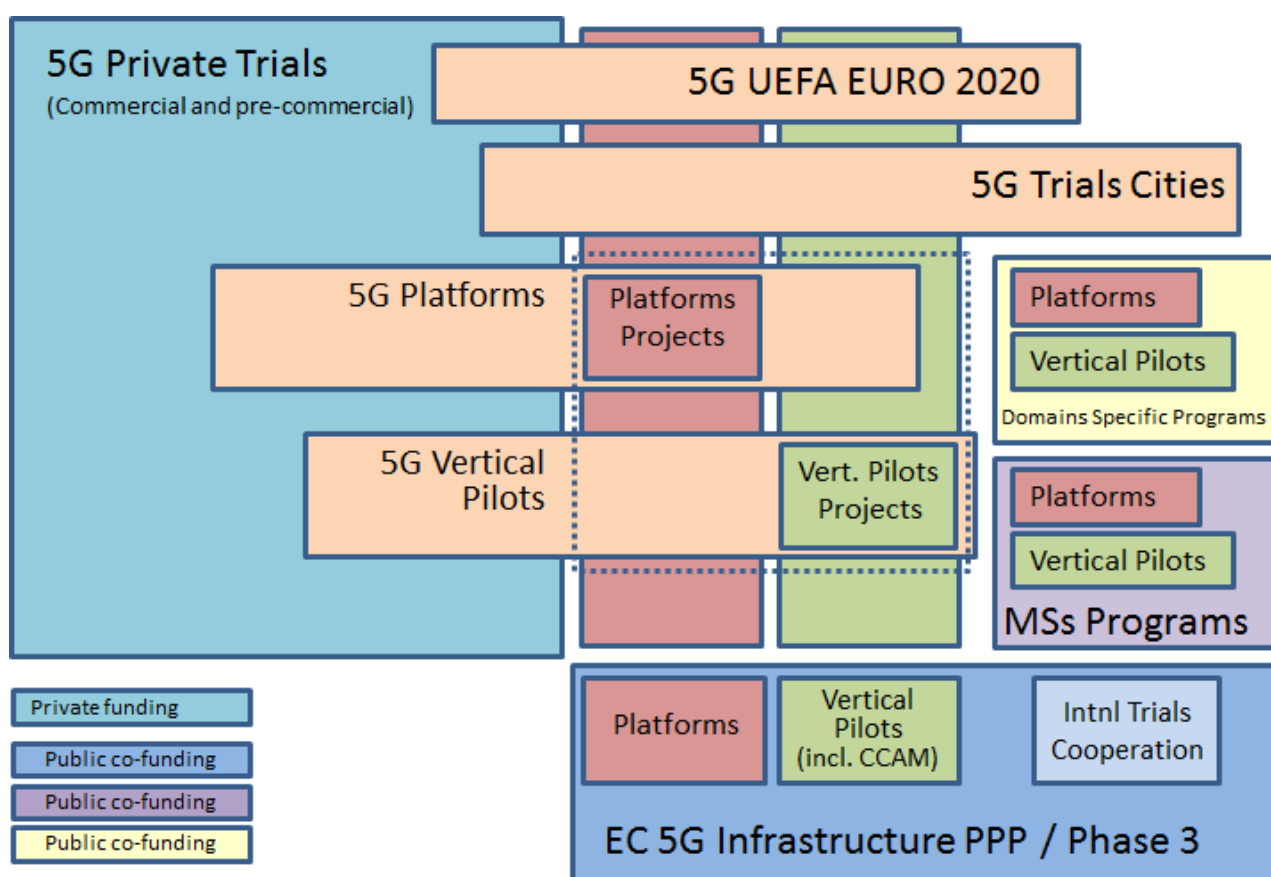


Figure 2 - 5G Pan-EU Trials Roadmap 2017- 2020

<sup>5</sup> <https://5gppp.eu/4th-global-5g-seoul/>

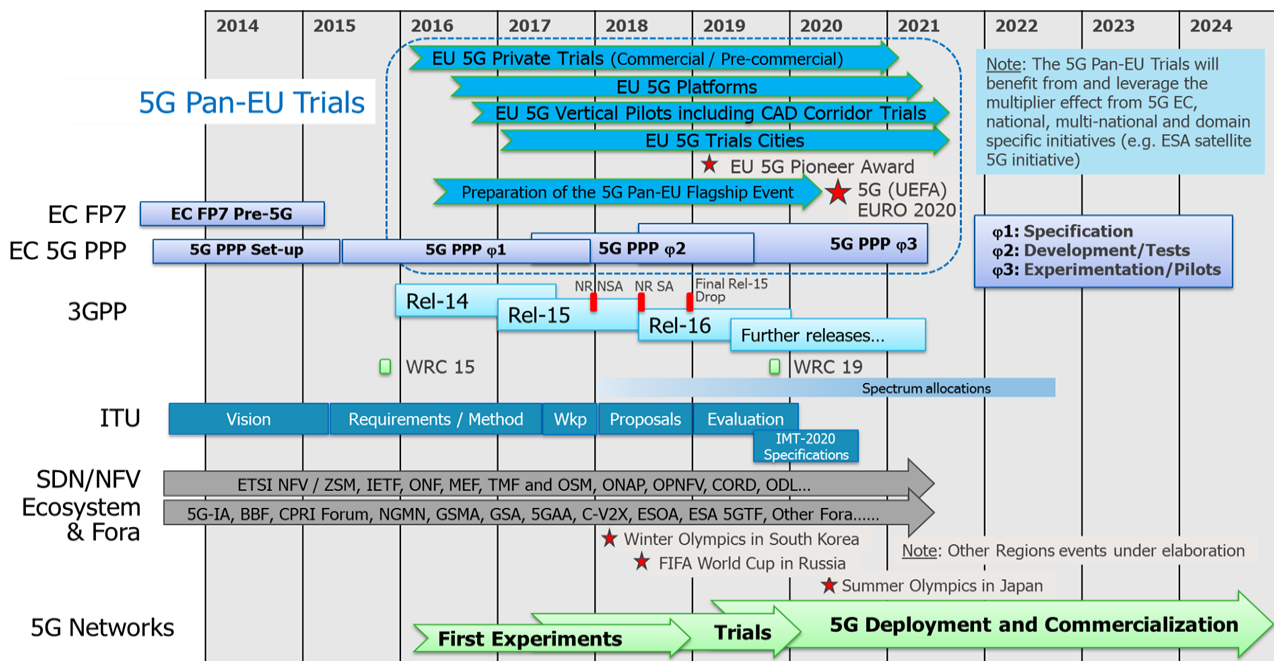


Figure 3 - 5G Pan-EU Trials Roadmap Time Plan

- Reach out to vertical industry sectors

5G will be instrumental in digitising the traditional industry as it races for digitalisation, productivity and competitiveness. Creating synergies across verticals, lowering costs via network slicing, and cost sharing on infrastructure deployment and service operations is possible with 5G. Leading vertical industries are involved in the 5G standardisation process. Phase 2 projects are either dedicated to an industrial sector or target applications for various verticals.

Organisations and companies in key vertical sectors (e.g. eHealth, Factories of the Future, Energy, Automotive, Media & Entertainment) have been mainly involved in 5G PPP's activities via the 5G IA Trials WG (e.g. to facilitate their participation in the activities related to the trials roadmap), and through numerous events and workshops organized by 5G PPP projects and working groups.

At the end of 2017, the Board of the 5G IA established a **"Verticals Engagement Task Force"** that defined a strategy for supporting verticals engagement, including some priority vertical sectors. Its first objectives to be fulfilled in 2018 include:

- Verticals Industry fora to be addressed for cooperation agreements
- Relevant B2B industry events to speak in, and network,
- Bottom up activities on verticals recorded in a 'Tracker document' to trigger future top down actions – "one stop shop" document on all vertical related activities in 5G PPP

- 5G spectrum: pioneer bands identified

For trials and early commercial deployment, it is necessary to get access to spectrum early. It is essential to have a sufficient number of bands identified for both industries and spectrum



authorities to gain experience with 5G systems. For Europe, the following pioneer bands have been suggested by the EU's RSPG Opinion as response to the 5G Action Plan of the EU Commission: Low band 700 MHz, Middle band 3.4 - 3.8 GHz, and High band 24.25 - 27.5 GHz (26 GHz). These bands are now debated in the ITU-R preparatory process for WRC 2019.

The 5G IA Spectrum WG underlined the importance of this approach, and suggested suitable bands along these lines in response to the RSPG public consultation that was held prior to issuing the opinion.

The pioneer bands seem good candidates for global harmonization, particularly the middle band. The high band could benefit from specific radio technology for the use of adjacent spectrum bands notably in the US and some countries in Asia.

- International Cooperation

Following the Joint Declaration between the European Commission and the Brazilian government in 2016, **5G IA and “Telebrasil – Projeto 5G Brasil”**, the Brazilian 5G Industry body, signed a Memorandum of Understanding in March 2017 at the Mobile World Congress to foster industrial collaboration on 5G development.

After this important bilateral agreement, “Telebrasil – Projeto 5G Brasil” joined the Multilateral MoU for the organisation of “Global 5G Events” in May 2017. The original signatories of the Multilateral MoU are leading 5G organizations from various world's regions: 5G Forum (Korea), 5G Americas (Americas), IMT-2020 Promotion Group (China), the 5G Infrastructure Association (5G IA, Europe) and the Fifth-Generation Mobile Communications Promotion Forum (5GMF, Japan).

At last, in order to cover the 7 most important regions in the world, a dialogue began in Spring 2017 with India, which led to the signature of an MoU between the **5G IA and TSDSI, Telecommunications Standards Development Society, India**, in April 2018.

## 2.1 Implementation of the calls for proposals evaluated in 2016

In May 2017, 21 Phase 2 projects were retained (13 RIA, 6 IA and 2 CSA). A presentation of all projects is available in the “5G PPP Phase 2 brochure”<sup>6</sup> and on the website <https://5G PPP.eu/5G PPP-phase-2-projects/>.

There were around 40 5G PPP active projects during the time-wise overlap between the ending of Phase 1 and the start of Phase 2.

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<sup>6</sup> <https://5G PPP.eu/wp-content/uploads/2017/11/5GPPP-brochure-phase2-final-web.pdf>



Figure 4 - Overview of the 5G PPP program (Phase 1, 2 and 3)

The governance model of 5G PPP and the 5G PPP Contractual Arrangement foresee that R&I actions resulting from relevant calls of the Horizon 2020 LEIT ICT actions (and beyond where appropriate) should be implemented as a programme to reach high industrial impact. A particular requirement for new projects was to leverage work and results of Phase 1 projects, and to accelerate on proof of concepts and demonstrators. Access for Phase 2 projects to Phase 1 results is ensured by the Collaboration Agreement, which is signed by all project participants.

Based on this background, the 5G IA and the European Commission organised a full day meeting on 1 June 2017 at DG CONNECT in Brussels to kick off the collaborative process between Phase 1 and Phase 2 projects. This covered identification of issues of common interest, identification of project Working Groups per theme, update of current structures and roadmap of the collaboration process.

Immediate actions engaged at Technology Board level to develop rapid awareness and interactions between projects included:

- Release of a document summarizing Phase 2 projects deliverables, including the cross-projects interests on these deliverables
- Release of the Phase 2 projects / WGs “champions” document, summarizing the projects experts participating in the different WGs.

Furthermore, to better analyse the project portfolio, facilitate coordination and timely fill-in possible gaps, the following tables providing a strategic overview of Phase 2 projects were prepared:

- Phase 2 projects time plan
- Relevance and expected contribution to 5G PPP Performance KPIs
- Relevance and interest in 5G PPP Working Groups.

All Phase 2 projects were successfully launched. All of them joined the “5G PPP collaboration agreement” as required by Article 41.4 of the grant agreements.

## 2.2 Mobilisation of stakeholders, outreach, success stories

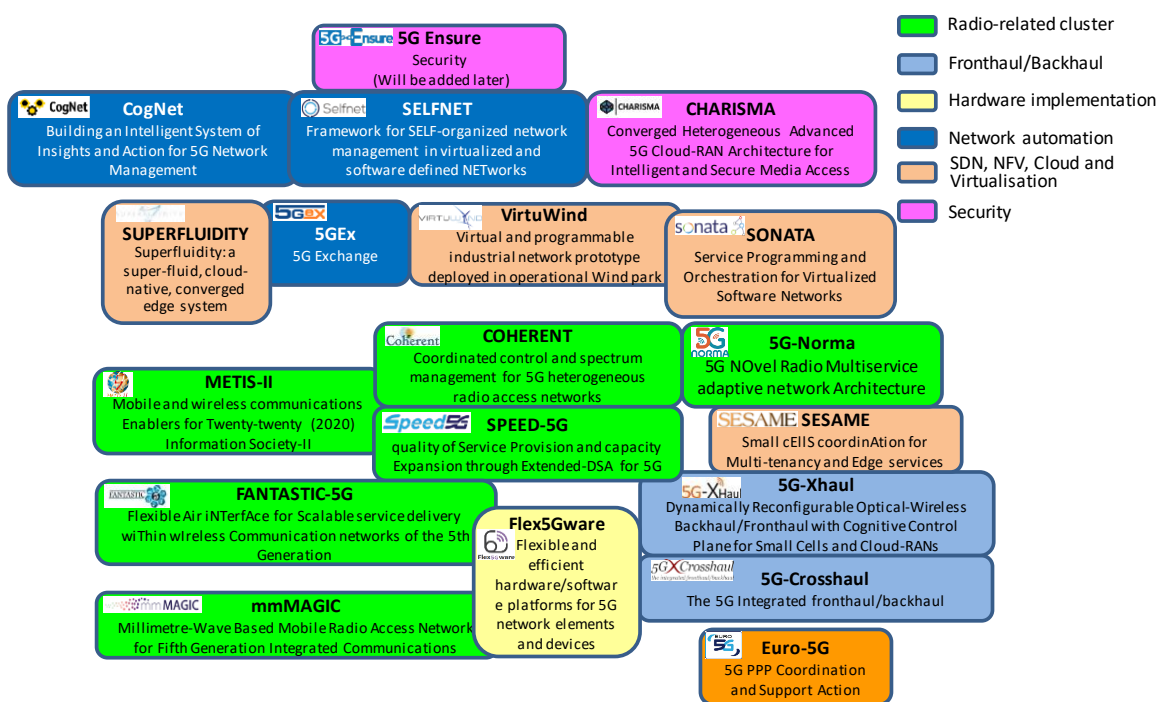


Figure 5 - 19 5G PPP Phase 1 Projects

167 partners in Phase 1 projects

224 partners in Phase 2 projects – 62% of which not involved in Phase 1

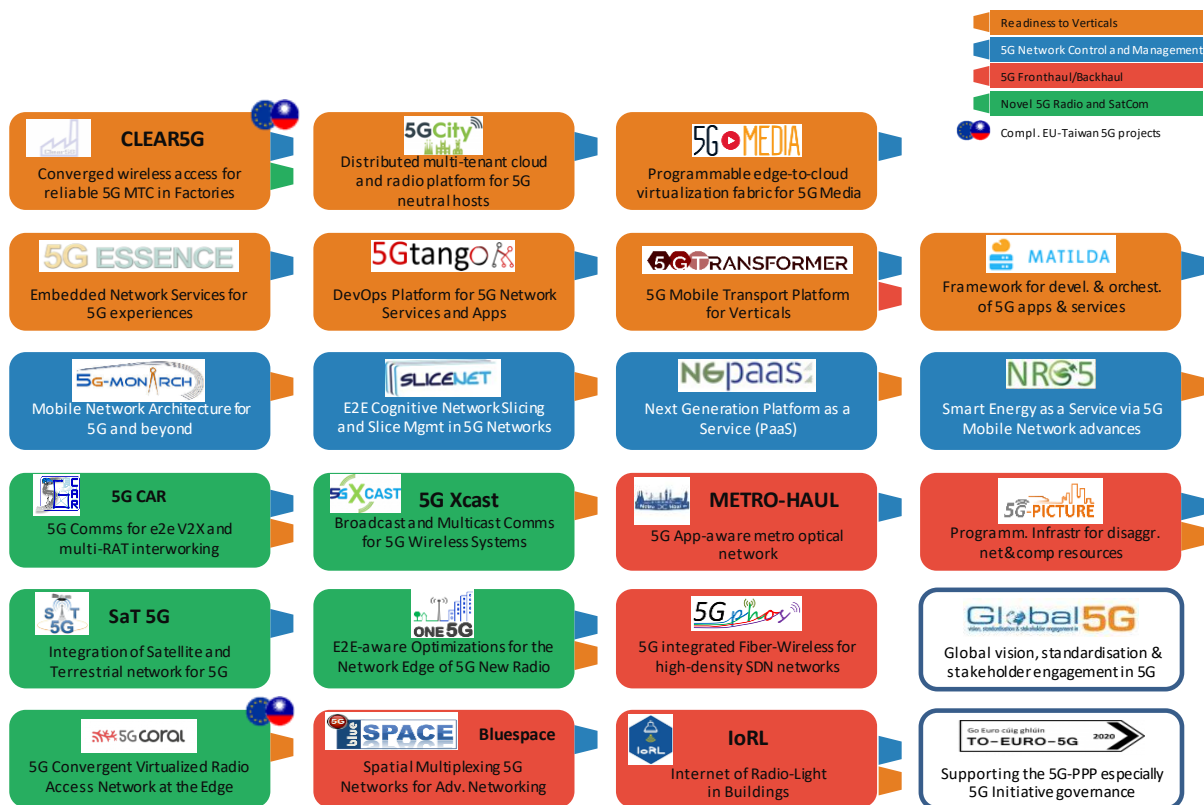


Figure 6 - 21 5G PPP Phase 2 projects

- 5G Pan-EU Trials Roadmap

As stated above, the wider community was mainly involved via the ‘Trials Working Group’, created by the 5G IA in September 2016. Besides the 5G IA Members, this WG is also open to organisations from the European ICT domain, and vertical sector organisations that are not members of the Association.

- “5G PPP Phase 3 Infodays” in 2017:

- On 17th October 2017 in Ljubljana, Slovenia<sup>7</sup>
- On 9/10 November (held as part of the ICT Proposers’ Day 2017) in Budapest, Hungary<sup>8</sup>.

The Infodays provided stakeholders in the 5G domain with information on Phase 3 calls in 2018. They also gave prospective proposers the opportunity to present their ideas to potential partners for the preparation of proposals.

- Phase 3 (Part.I) Pre-structuring Model<sup>9</sup>

Version 2.0 of the Pre-structuring Model was released by the 5G IA on 7<sup>th</sup> November 2017. It focused on the 5G PPP Strategic Objectives related to experimentation and trials.

<sup>7</sup> <https://5G PPP.eu/5G PPP-phase-3-infoday-ljubljana/>

<sup>8</sup> <https://ec.europa.eu/digital-single-market/en/events/ict-proposers-day-2017>

<sup>9</sup> <https://5G PPP.eu/phase-3-pre-structuring-model/>

The model presented recommendations to potential proponents to support the smooth integration of new projects in the existing programme, to achieve the best possible coverage of call topics and to develop future efficient cross-projects cooperation. It also highlighted the tight connections between the Phase 3 (Part.I) and the “5G Pan-EU Trials Roadmap”.

- SME Community

The SME Working Group, supported by Euro-5G and then To-Euro-5G Coordination and Support Action, involved 100 SMEs, as well as 12 industrial companies and 18 research organisations by the end of 2017. It succeeded in increasing the visibility and exposure of SME’s expertise and skills to the point that SME represent an average of 20% of the participants in budget in the 5G PPP Phase 1 and Phase 2 projects, which was the minimum share originally set as a KPI. The next challenge is to reach 20% or more for the upcoming Phase 3.



*Figure 7 – Interactions with 5G stakeholders*

- Pre-Standardization

Standards create benefits for industries by reducing complexity and increasing interoperability. This creates larger markets for products following a global standard and also provides stability in the marketplace by reducing dependence on a single vendor. Providing European companies with a larger market is one of the main benefits of standardisation, but it is also a way to increase the speed of innovation since some of the necessary components are already available “off -the-shelf”.

The Pre-Standardization WG maintains a tracking document of 5G PPP projects contributions to standards bodies. A complete tracking is available for phase 1 and can already support the DSM objectives for ICT standardization and Rolling Plan. Phase 1 projects have established a pre-standardisation consensus on areas ranging from physical layer to overall architecture, network management and software networks. Tracking is underway for phase 2 and is designed to reflect the focus on vertical industries.

Demonstrated impacts: 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.

Potential impacts: Some evidence has already been collected on contributions of vertical industries to standardization work, expanding the number of standards bodies and influential associations relevant to 5G.

A standardisation Roadmap has been produced to guide the 5G PPP projects on timely contributions to standards bodies aligned with the industry time line for 5G functionalities (eMBB, mMTC and URLLC) moving towards those functionalities that have significant added value for Europe.

The Pre-standardisation WG has also kept track of the ongoing work in the standards bodies, e.g. the open work items and the informal discussions that take place at standards meetings. This provides an easier way to obtain information about what is ongoing in the standards domain and helps projects to better plan for engaging with standards activities.

- **IMT-2020 Evaluation Group**

ITU-R WP5D launched an evaluation process for Radio Interface Technologies (RITs), which are submitted by SDOs (Standards Developing Organisations) to ITU-R to be recognised as member of the IMT family of systems for mobile and wireless communications. In that process ITU-R is looking for independent second opinions by independent Evaluation Groups. The 5G Infrastructure Association was registered at ITU-R as one of the 11 globally recognized groups. It is organised under the umbrella of the Association and supported by several 5G PPP projects and Association members. It was set up at the end of 2017 and activities started in 2018. The main objective is to perform an independent evaluation and to provide a complete evaluation report to ITU-R by February 2020.

- **5G IA's cooperation agreement with ETSI and with CEPT/ECC**

Following the acceptance of the 5G IA as a Market Representative Partner (MRP) in 3GPP in October 2016, a cooperation agreement was signed between ETSI and 5G IA in April 2017.

In the field of spectrum, a cooperation agreement was signed between 5G IA and CEPT/ECC in June 2017, to be put in action by the 5G IA WG Spectrum.

- **Selection of main events in 2017** (either organised by 5G IA/5G PPP or with their active participation):

- 5G IA Press, Media and Analyst Event “5G Action Plan: from Research to Trials” at Mobile World Congress 2017 in Barcelona, Spain (27 February-2 March).

The event was opened by Roberto Viola, Director General of DG CONNECT at the European Commission. A CTO panel attended by leading 5G global players, discussed the progress achieved through European 5G research and the emergence of 5G standards.

In a second panel, representatives of vertical industries and the public sector outlined their plans to accelerate the deployment of 5G in Europe. Version 1 of the 5G trials roadmap strategy was discussed for the implementation of advanced pre-commercial and pan-European trials to be launched in key sectors in 2018, in view of ensuring Europe’s leadership.

Around 160 people from the media, business and research sectors attended the event.

- 3<sup>rd</sup> and 4<sup>th</sup> Global 5G Events (organised in the framework of the Multilateral MoU)

Participation of several 5G IA/5G PPP speakers in the 3<sup>rd</sup> Global 5G Event “Creating the Crossover Collaboration for 5G Eco-Society” in Tokyo, Japan (24-25 May) and in the 4<sup>th</sup> Global 5G Event “5G, Accelerating the 4th Industrial Revolution” in Seoul, South Korea (22-24 November), with 5G demos organised by KT and the 5G Forum in the PyongCheang Winter Olympics 2018 site.

- “Spectrum for 5G” workshop

This workshop was held in Brussels, Belgium on 7 June 2017. It presented recent research results covering the need for 5G spectrum and the suitability of the frequency bands under consideration (sub-GHz to millimetre) for 5G to provide ambitious services and adequate coverage, especially leveraging the 5G PPP projects advancements.

- EuCNC 2017 (12-15 June, Oulu, Finland)

Many Phase 1 5G PPP projects’ demos and achievements were showcased. They organised seven joint workshops and participated in various briefings. 8 innovative companies from the SME WG presented demos in a dedicated booth.

Two informative sessions on 14<sup>th</sup> and 15<sup>th</sup> June were organised to present Phase 1 projects’ achievements and introduce 5G PPP Phase 2 projects.

- Helsinki 5G week (18-21 September, Helsinki, Finland)

5G PPP projects were very active at this event. In particular, METIS-II co-chaired the session on 5G Radio and Wireless Communications while Flex5Gware co-chaired the sessions on Softwarisation and Virtualisation and on Verticals, Services and Applications.

- Wireless World Research Forum (WWRF) Meeting (18-20 October, Castelldefels, Spain)

Several 5G PPP Projects participated in the event. Furthermore, Colin Willcock, 5G IA Chair, presented the key features and latest updates on the “5G Pan-EU Trials Roadmap”.

- Berlin 5G Week 2017 (6-9 November, Berlin, Germany)

This was a great opportunity for 5G PPP projects (both from phase 1 and 2) to promote their activities and achievements. MATILDA and 5GTANGO organised the Workshop on Network Function Virtualization and Programmable Networks (NFVPN) in conjunction with the IEEE NFV-SDN conference. SONATA, 5GEx and 5G-TRANSFORMER jointly organised the IEEE Workshop on Orchestration for Software-Defined Infrastructures (O4SDI). In addition, Jean-Pierre Bienaimé, 5G IA Secretary General, gave a presentation on 5G testbeds and trials at the FFF17 Forum.

- Joint workshops organized by 5G PPP projects<sup>10</sup>

5G PPP projects organised several joint workshops fostering collaboration and creating positive synergies.

- Significant number of White Papers on:

- [5G PPP 5G Architecture White Paper Revision 2.0](#) (December 2017)<sup>11</sup>  
Highlighting the key 5G architecture design recommendations from 5G PPP Phase 1 and providing a baseline architecture for Phases 2 and 3.
- [5G PPP Security Landscape](#) (June 2017)<sup>12</sup>  
Providing insights into how 5G security should be addressed in terms of “what” and “why”.
- [5G Innovations for new Business Opportunities](#) (March 2017)<sup>13</sup>  
Showing how the 5G PPP innovations go beyond what is announced for early 5G deployments for the eMBB service class, and how all 5G service classes are delivered over a scalable and cost-efficient network. It then explains how 5G technological innovations transform the network into a secure, reliable and flexible orchestration platform across multiple technology and administrative domains.
- [5G PPP Cognitive Network Management for 5G](#) (March 2017)<sup>14</sup>  
Presenting the novelties for network management in 5G.
- [5G PPP Vision on Software Networks](#) (January 2017)<sup>15</sup>  
Providing a first conceptual architecture seamlessly and flexibly combining SDN and NFV technologies for 5G.

<sup>10</sup> For information on the many joint projects’ workshops in 2017, please refer to pg. 17 and 77 of the “The European 5G Annual Journal 2017” <https://bscw.5GPPP.eu/pub/bscw.cgi/d204796/Euro%205G%20Annual%20Journal%202017-web.pdf> and to the ‘Past events’ section of the 5G PPP website [https://5GPPP.eu/event-calendar/list/?tribe\\_paged=1&tribe\\_event\\_display=past](https://5GPPP.eu/event-calendar/list/?tribe_paged=1&tribe_event_display=past)

<sup>11</sup> <https://5GPPP.eu/wp-content/uploads/2018/01/5G-PPP-5G-Architecture-White-Paper-Jan-2018-v2.0.pdf>

<sup>12</sup> <https://5GPPP.eu/wp-content/uploads/2014/02/5G-PPP-White-Paper-Phase-1-Security-Landscape-June-2017.pdf>

<sup>13</sup> <https://5GPPP.eu/wp-content/uploads/2017/03/5GPPP-brochure-final-web-MWC.pdf>

<sup>14</sup> <https://5GPPP.eu/wp-content/uploads/2017/03/NetworkManagement-WhitePaper-1.pdf>

<sup>15</sup> [https://5GPPP.eu/wp-content/uploads/2014/02/5G-PPP-SoftNets-WG-whitepaper\\_v20.pdf](https://5GPPP.eu/wp-content/uploads/2014/02/5G-PPP-SoftNets-WG-whitepaper_v20.pdf)



- [The European 5G Annual Journal 2017<sup>16</sup>](#) (September 2017)  
Presented an analysis of the 5G ecosystem evolution over the past year, of the achievements of 5G PPP phase 1 projects almost two years after their launch, and of 5G IA activities. It was widely distributed in printed copies at several events and greatly contributed to raise awareness on the work of the 5G PPP.

## 2.3 Governance

As required by Article 4 of the 5G PPP Contractual Arrangement, the EU Commission and the Association have established the “5G PPP Partnership Board” comprising representatives from the European Commission and from the private side (i.e. from the 5G IA and Network2020). This is the main body for dialogue and cooperation between the European Commission and the 5G IA.

Among others, main issues dealt with by the Partnership Board (PB) in 2017 were:

- Work Program 2018/20
- Relation and cooperation with vertical sectors
- International cooperation
- Preparation of major events (e.g. “Global 5G Events”, Mobile World Congress)
- Status of 5G PPP
- Review of 5G PPP Contractual Arrangement.

In 2017, three Partnership Board meetings were organised in January, May and September.

The Board of the 5G IA is composed by 11 members, elected from the membership<sup>17</sup>, who, in turn, elect the Chair and Vice-Chair of the Association Board. The Board and the Association are supported by the 5G IA Office, including the Secretary General and the Head of Office.

The Secretary General is in charge of the overall visibility and management of the 5G IA and is also the Ambassador/Spokesperson of the Association and of the 5G PPP.

The Head of Office is responsible to ensure the daily operational well-functioning of the Association.

5G PPP projects are organised in the “5G PPP Initiative” (see Figure 8).

The “5G PPP Initiative Steering Board” reviews the activities and mandates of the 5G PPP projects and working groups at regular intervals. It is composed by the Project Coordinators and representatives of the 5G IA.

The “5G PPP Initiative Technology Board”, as the body responsible for technical consistency across the projects, monitors the ongoing activities of the cross-projects working groups and identifies actions that need to be taken. It is composed by the Project Technical Managers and representatives of the 5G IA.

<sup>16</sup> <https://bscw.5G PPP.eu/pub/bscw.cgi/d204796/Euro%205G%20Annual%20Journal%202017-web.pdf>

<sup>17</sup> <https://5G PPP.eu/our-members/>

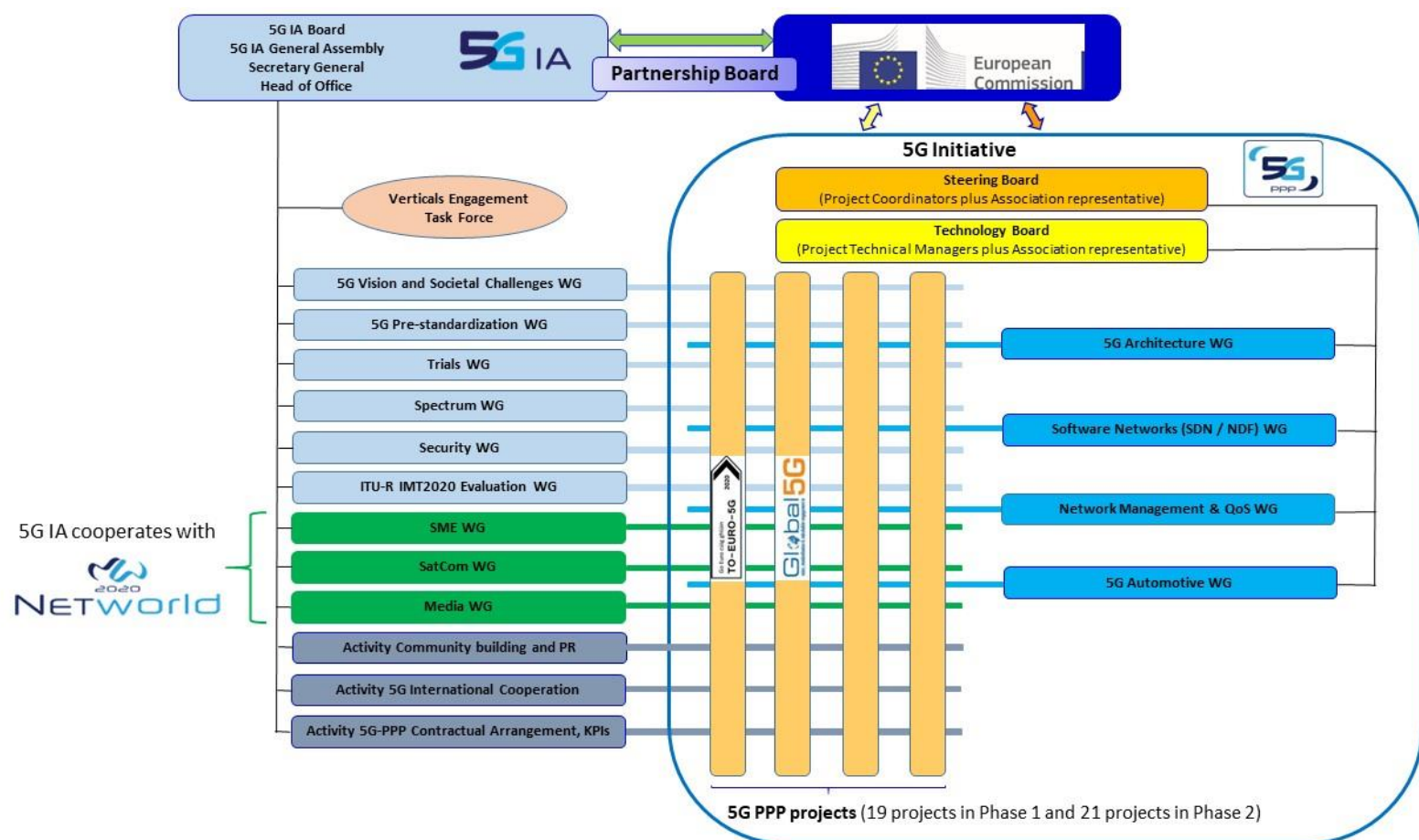


Figure 8 – 5G PPP Governance

Technical working groups (“5G PPP projects WGs”) are organised by projects to facilitate cooperation among them.

More policy-oriented working groups (“5G IA WGs”) are under the responsibility of the Association.

A short presentation of “5G IA WGs” and “5G PPP Projects WGs” is available at <https://5g-ppp.eu/5g-ppp-work-groups/>

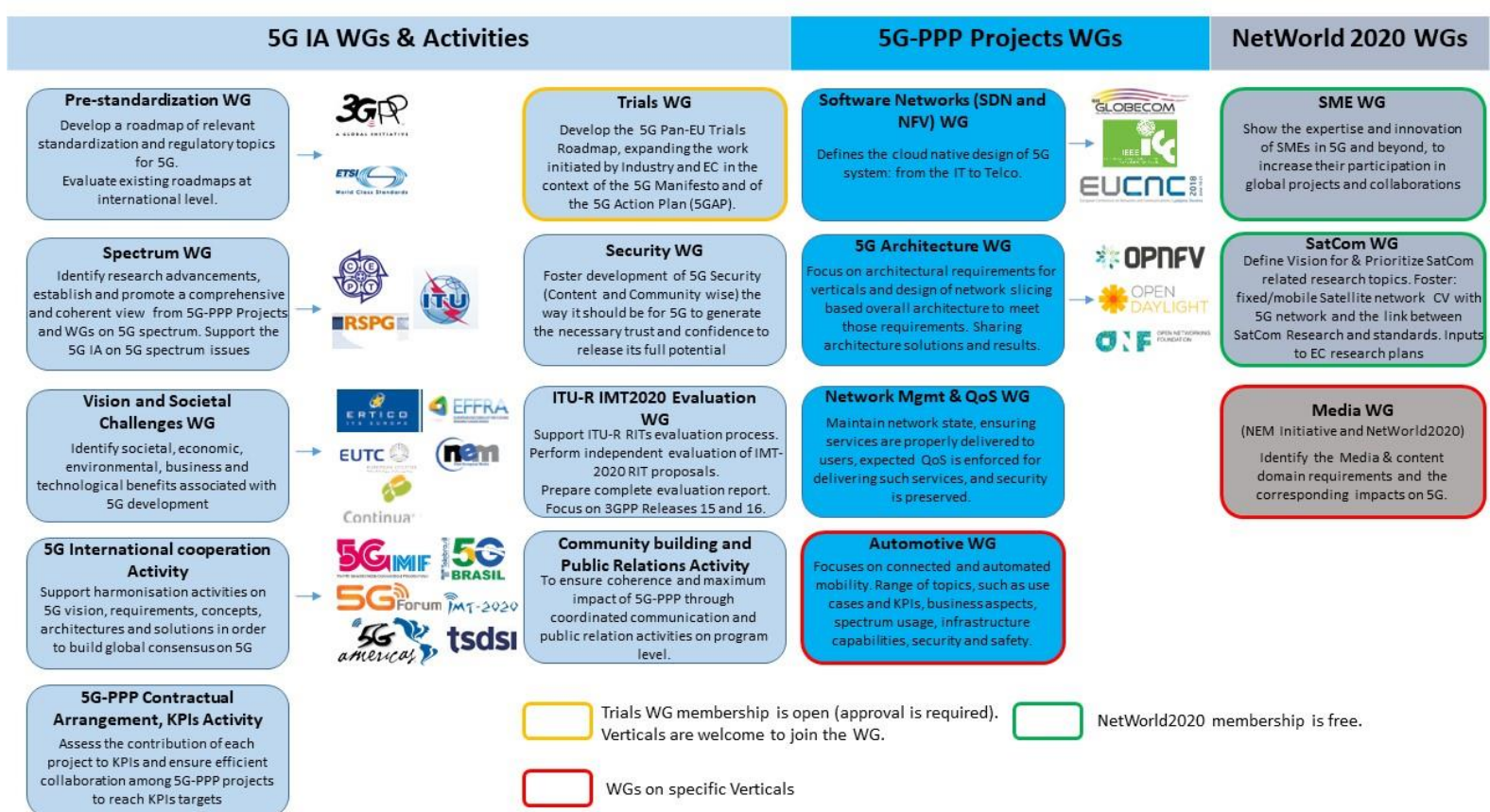


Figure 9 – 5G IA and 5G PPP Working Groups

The 5G IA also carries out the following three Activities:

- International Cooperation Activity on 5G
- Activity Community building and Public Relations
- Activities based on the 5G PPP Contractual Arrangement & KPIs.

### 3. Monitoring of the overall progress since the launch of the 5G PPP

#### 3.1 Achievement of the goals of the cPPP

2017 was an important and successful year for 5G development. Many strategic initiatives, initiated in 2017, are currently being progressed and implemented in 2018.

In 2017, significant results were achieved with regard to the following key areas for the implementation of the 5G PPP Contractual Arrangement:

- An efficient and effective 5G PPP programme
- Optimum profile for the European 5G initiative in a global context
- Widespread dissemination of European achievements

- Launch of necessary 5G standards work
- Measurable programme progress and KPIs
- Maintaining the holistic view of implementing 5G by 2020
- Enhancement of 5G roadmaps and visions
- Growth of the 5G constituency.

## 3.2 Progress achieved on KPIs

Detailed information on the progress on KPIs common to all cPPPs and specific 5G PPP KPIs are available in the annexes.

### 3.2.1 Common set of KPIs

#### a) Mobilise private investments

**Our methodology (see details in Annex 2 Specific KPIs) is based upon gathering the published public figures from annual reports for worldwide R&D expenses.** The main challenge is then to assess the declared R&D figures of a representative set of key ICT players and deduce which proportion of their R&D spend is 5G related.

We made conservative assumptions on what the 5G activities share of their worldwide R&D was – usually in the order of 10% and then we further reduced that to reflect what European share of the 5G activities as part of the total R&D expenses could be – typically we ended up with a figure of about 5% of global R&D. To further eliminate over-assessment risks and to give us a very conservative figure we also considered the European 5G as 2% of Global R&D. These proportions of 5G research of total research expenses will increase as 5G moves into full standardization, development and production over the next few years and future iterations of these assessments will take account of this.

For direct evaluation purposes, we took into account a representative set of players active in the 5G PPP. For a second reference figure we have considered a wider set of players in different aspects of the ICT sector including: equipment manufacturers, mobile network operators, test equipment manufacturers, device manufacturers, and chipset manufacturers.

From the above exercise, it results that the most conservative assessment of 2% of the Global R&D spend being invested in 5G would increase in a **leverage factor of 21** considering the whole 5G PPP 2017 investment (Phase 1 third year and Phase 2 first year).

Even allowing for the assumptions and generalisations, we can confidently state that the European ICT sector is exceeding the planned level of investment leverage expected in the 5G PPP Contractual Arrangement.

**Such a high leverage ratio is mainly due to the fact that we used a wider top-down approach based on information from the overall industry, rather than exclusively from projects R&D activities participating in 5G PPP.** We will endeavour next year to combine the two approaches, with both the entities directly participating in the 5G PPP Projects on the one hand, and with the wider industry committed in 5G on the other hand.

**Another reason of the high leverage ratio is due to the timing factor, with a gradually increasing role of private investment in the 5G Partnership: phase 1 (fundamental research) required less private funding than phase 2 (integration of vertical industries), and above all less than phase 3 (5G validation platforms, trials and pre-commercial phase), where direct and indirect investments will result in a much higher part of private funding.**

Therefore the very high leverage factor associated with the 5G PPP at this point in time, should not be seen as putting in question public funding in this area but rather as an incredible successful example of applying public money to create vital technology and leadership for Europe through seed funding. Public funding has enabled this huge industrial investment by creating technology leadership. In general, the public money has, and is, being used to create new markets and opportunities where the risk and uncertainty make purely industrial funding not possible or at least not in a time frame to enable European leadership. For example in the first phase of the 5G PPP fundamental 5G research was the key focus, this was before standardisation and set the corner stones for what 5G is. Now that the first standards are available the 5G PPP has moved on in phase 2 to focus on enabling 5G in the vertical markets. It is also worth noting that simply leaving the funding of such research to industry would cause a radically different eco-system of research partners. The large vendors would still invest in future technology at some level, but SMEs (20% of partners in 5G PPP projects) who are critical in terms of competence and growth in the future would be effectively frozen out. Likewise the funding from the large vendors would be at a much lower level because without the publicly funded projects the technology would not have been validated and therefore the risks much higher.

**In summary we believe the high leverage factor associated with the 5G PPP is an example for all of how public research money should be used** to create and stimulate European industry through technology leadership.

## **b) New skills and/or job profiles**

From a technical perspective , 5G research and development skills are available. However, know how on 5G needs to be built-up. We will need new skills for cross-functional activities for the use of 5G in different vertical sectors. Mutual understanding with vertical sectors and on what 5G offers will be needed. 5G creates new opportunities and business in verticals industries, which will create new types of jobs.

5G IA invited EIT Digital to a 5G IA Board meeting for an open discussion on how the two organisations could mutually benefit from a close cooperation in particular in relation to the establishment and availability of 5G skill development curricula. Further collaboration in this area and implementation of actions are planned in H2 2018.

On April 28, 2016, 5G Infrastructure Association requested the NetWorld2020 Members active in the Academic and Research domains to provide information on the 5G skills development curricula they established and/or that they plan to establish. Feedback was received from: University of Florence, Italy ; University of Padova, Italy ; Aalto University, Finland ; University Carlos III, Madrid, Spain ; Tampere University of Technology, Finland ; Chalmers University of Technology, Gothenburg, Sweden; Institut Mines-Telecoms, France. **A similar survey on 5G related curricula, new skills and job profiles was relaunched in July 2018 among the 70 5G IA Members and the 19 5G PPP Phase 2 Projects. The "Initial feedback from 5G-IA Members and 5G-PPP Projects on 5G Related Curricula, New Skills and Job**



**Profiles" is available in the Annex.** Due to the very short notice over the summer period, only 4 Universities and one Project responded by providing relevant qualitative information. A new survey will be launched next year in a more timely manner to collect information on:

- **Expectation of jobs creations and new jobs profiles**
- **5G-related curricula/courses established or planned**

5G deployment will allow a large number of sectors (e.g. industry verticals) to offer a huge variety of new services, solutions and products, which, in turn, will require the creation of many new job profiles to fully exploit the potential of 5G.

### **c) Impact on SMEs**

When 5G PPP Phase 3 starts and Phase 1 and Phase 2 projects will have ended, i.e. in the course of 1H 2019, information on impact of the 5G PPP on SMEs could be collected by the SME WG. **A survey to collect such information (e.g. turnover, job profiles and staff headcount variations) among the SMEs participating in the 5G PPP will be made by end Q1 2019.** A change in the turnover of an SME cannot come only from participation in a given R&D programme but depends on many other factors. Therefore, it is up to the individual SME to quantify how the participation in 5G PPP projects had an influence on those parameters; in most of the cases, they should manage to provide this information, with some degree of precision. We consider this an effective way to quantitatively measure the impact of 5G PPP on SMEs.

A **catalogue** providing a preliminary mapping of the SME community to the 5G PPP already exists, along with a tool to search SMEs and connect them to the broader community of 5G stakeholders (both big industry and academia). So far, 34 SMEs have advertised their expertise and interest in the 5G PPP topics and business verticals for Phase 3 (cf. <https://www.networld2020.eu/find-the-sme-you-need/>). This same exercise had already been done for Phase 1 and Phase 2. Information is also available in the SME brochure (cf. [https://bscw.5G\\_PPP.eu/pub/bscw.cgi/d119698/SME-A5-brochure-final-web.pdf](https://bscw.5G_PPP.eu/pub/bscw.cgi/d119698/SME-A5-brochure-final-web.pdf)) that was released for Phase 2. **A fully revised and updated brochure was published in June 2018 for Phase 3, under the name "SME Expertise and Skills in the 5G Domain"** (cf. <https://5g-ppp.eu/wp-content/uploads/2018/06/A4-sme-brochure-final-web5G-PPP.pdf>). The brochure highlights the expertise and skills from 34 selected European SMEs in 5G and related domains, and this time focuses more on the expertise that might be useful in various industry vertical sectors (automotive & transport, media & content, manufacturing & logistics, energy, health,...). **The success stories described in the brochure show that the impact of 5G PPP on SMEs is significant, and that SMEs bring great added value to the 5G value chain by providing innovative concepts and solutions.**

Information for a broader mapping of the SME community could be extracted from the EC projects database and provided to the SME WG in an aggregated form for further analysis and dissemination.

### **d) Significant innovations**

As seen in chapter 2, 5G PPP Phase 1 produced key achievements in four main domains:

- 5G System design & Evaluation aspects
- 5G Air interface innovations
- Network management & Security innovations
- Virtualization & Service deployment innovations

In terms of **IPRs**, the document “**5G IP Landscape Analysis**” (updated version July 2018) enclosed in the Annex, prepared by 5G IA Member Thales in the context of the preparation of this Progress Monitoring Report, aims at determining early trends for 5G mobile network underlying technologies and may represent a contribution to the definition of IP KPIs for the 5G PPP. It analysed how stakeholders are gearing up towards the next 5G through the angle of patent filed since 10 years. It is a starting point that could be enriched within the 5G PPP community.

In terms of **Standardisation**, one of the largest impacts of EU projects is setting the scope of this standardisation effort; the triad of eMBB, mMTC and URLLC was originally promoted by the first phase of large 5G projects. As the standardisation process digs more into the details, the domains where 5G PPP Phase 1 projects had greater impact are:

- Support of the Architecture for splitting of user plane and control plane.
- Support for slicing.
- Channel models used for evaluations.
- Scenarios and requirements.

Subscriber Privacy protection, which has also received extensive press coverage including WIRED, FORBES and Sky News.

#### Current contribution count

KPI: Contribution Count	Qualitative Metric
Phase 1: 317 contributions towards 19 standards groups	Most contributions took place in the second half of the project lifecycles.
Phase 2: 40 contributions towards 19 standards groups	Contributions currently identified including contributions from vertical industries. Monitoring is on-going through the Pre-Standardization WG. Based on current evidence, the total number of relevant standards organisations is expected to increase with the involvement of vertical industries.

### 3.2.2 Specific KPIs for 5G PPP

Overall, the 5G PPP is performing well on 5G PPP specific KPIs as far as they can be assessed at this point in time and is even over-performing on the private investments leveraging factor.

There are 4 performance KPIs, 3 KPIs related to business aspects 5 KPIs related to societal aspects:

#### a) Performance KPIs

The 5G Infrastructure PPP Position Paper “5G Empowering Vertical Industries”<sup>18</sup> – published at Mobile World Congress 2016 – refined and detailed the Performance KPIs in alignment with international standards bodies such as International Telecommunication Union-Radiocommunication Sector (ITU-R), 3<sup>rd</sup> Generation Partnership Project (3GPP) and Next Generation Mobile Networks (NGMN) Alliance as follows:

- 1 000 X in mobile data volume per geographical area reaching a target of 0.75 Tb/s for a stadium.
- 1 000 X in number of connected devices reaching a density  $\geq 1\text{M terminals/km}^2$ .
- 100 X in user data rate reaching a peak terminal data rate  $\geq 1\text{ Gb/s}$  for cloud applications inside offices.
- 1/10 X in energy consumption compared to 2010 while traffic is increasing dramatically at the same time.
- 1/5 X in end-to-end latency reaching delays  $\leq 5\text{ ms}$ .
- 1/5 X in network management Operational Expenditure (OPEX).
- 1/1 000 X in service deployment time reaching a complete deployment in  $\leq 90\text{ minutes}$ .
- Guaranteed user data rate  $\geq 50\text{ Mb/s}$ .
- Capable of IoT terminals  $\geq 1\text{ trillion}$ .
- Service reliability  $\geq 99.999\%$  for specific mission critical services.
- Mobility support at speed  $\geq 500\text{ km/h}$  for ground transportation.
- Accuracy of outdoor terminal location  $\leq 1\text{ m}$ .

The 5G evolution will require a re-assessment of the performance metrics that can be used for a meaningful assessment of new use cases. The KPIs and corresponding evaluation procedures proposed in the collaborative work so far can be used to harmonize evaluation results coming from different sources and, therefore, facilitate a fair assessment and comparability of the different technical concepts considered for 5G.

**The METIS-II Project assessed the performance KPIs results in February 2017.** The analytical evaluation of the radio KPIs concluded the ability that 5G RAN can deliver peak data rates at the order of 21 Gbps in DL and 12 Gbps in UL. Compared to 4G operations, 5G will also enable a significant reduction of UP and CP latencies, down to 0.763 ms and 7.125 ms, respectively. In UP, the reduction of the sub-frame length to 0.125 ms is of paramount importance. It was also proven that for mMTC operations a single battery life time exceeding 10 years is possible for devices that sporadically upload data to the network.

Simulation-based evaluations carried out in 5G PPP prove that proposed 5G solutions can cater for >100 Mbps experienced user data rates in rural deployments. In dense urban deployments the HetNet deployments are capable of > 300 Mbps data rates and enable high energy efficient RAN operations. Reliability of 99.999% is achievable for URLLC services.

Conducted simulations proved also that dual connectivity deployments of 5G and LTE-A provide superior performance over standalone operations. This improvement is clearly noticeable for users (higher data rates) and network operators (lower energy consumption of infrastructure).

**Point of Concern:** The METIS-II follow-up proposal for Phase 2 was not successful and, at the moment, no other project has continued METIS-II’s work on the evaluation of Performance KPIs,

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<sup>18</sup> [https://5G PPP.eu/wp-content/uploads/2016/02/BROCHURE\\_5PPP\\_BAT2\\_PL.pdf](https://5G PPP.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf)



e.g., for the ITU-R independent evaluation process of RIT proposals by SDOs (Standards Developing Organisations). The To-Euro-5G project and the Technology Board are considering how this work can be continued in Phase 2 and Phase 3. The activities of the 5G PPP IMT-2020 Evaluation Group are addressing these missing planned activities.

The 5G Infrastructure PPP focused in 2015-2016 on the following main Performance KPIs: (1) Data Rate, (2) Mobility (Speed), (3) (Low) Latency, (4) Density, (5) Reliability, (6) Positioning Accuracy and (7) Coverage.

The analysis of PPP Phase 1 projects contribution to the Performance KPIs has been further elaborated in 2016-2017 through the following clustering detailed in chapter 7 of the 5G PPP Architecture White Paper Version 2.0<sup>19</sup>: (1) Extremely high data rates, (2) Significant energy reduction at the radio access, (3) Reducing service creation time, (4) Very low E2E latency for time-critical services, (5) Massive connectivity of devices, (6) High performance in high mobility scenarios and (7) Positioning accuracy.

The 5G Infrastructure PPP work on Performance KPIs is considering:

- Phase 1 projects contributions to 5G Performance KPIs as reported in Chapter 7 of the 5G PPP Architecture White Paper.
- Additional contributions provided by 5G PPP Phase 1 projects concluding on 30.06.18.
- New contributions from 5G PPP Phase 2 projects started on 01.06.17.

It should be noted that there cannot and will not be one single overall system analysis per Performance KPI across all 5G Infrastructure PPP projects. The on-going study will lead to a summary of clustered projects contributions to the Performance KPIs in a structured programmatic approach.

The up-to-date clustering and the main PPP Projects contributions/achievements (40 PPP Phase 1 and Phase 2 projects) will consider the Vertical Sectors related KPIs. One of the currently key discussions points is related to the synchronization on terminology between projects and on methods of measurement/assessment for the KPIs.

## **b) Business KPIs**

While it is too early in the program to accurately assess the financial return on the work of phase 1, it is clear that the industrial investment figures are substantially ahead of the projections made in the 5G PPP contract (see Annex 2).

The evaluation of economic aspects of future network suggests that centralized RAN deployments reduce the total costs of running 5G networks. Especially in edge cloud operations, when edge cloud provisioning of base station processing is beyond 30 macro sites, its optimal price point is reached.

## **c) Societal KPIs**

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<sup>19</sup> <https://5G PPP.eu/wp-content/uploads/2018/01/5G PPP-5G-Architecture-White-Paper-Jan-2018-v2.0.pdf>

Since 5G services have not yet been introduced to the market, it is a bit early to report on the full societal impact. However, reductions in energy consumption are receiving considerable attention (e.g. > 10 years battery lifetime on a single 5 Wh battery were achieved; for the capacityX1000, network energy efficiency improvements of 350-7500 were reported).

Furthermore, positive collaboration with EIT Digital has been initiated to cooperate on the availability of 5G skills development curricula for higher education.

**Also Vertical Industries (automotive, industry 4.0, healthcare, energy,...) will be instrumental in delivering the societal benefits of 5G. Therefore the projects selection in 5G PPP Phase 2 has strongly included vertical stakeholders representing various types of applications (autonomous vehicles, immersive media, virtualised transport platforms with network slicing, smart energy as a service, smart manufacturing, public safety, emergency real time intervention, 5G rail service, test-beds in sea-port and touristic city,...), as shown in Figure 10 hereunder:**














































Project	Vertical Stakeholders	ITU Service Type	Location	Project	Vertical Stakeholders	ITU Service Type	Location
	  	eMBB, URLLC	Montlhéry (FR)		 	mMTC	Hamburg (DE) Turin (IT)
	City councils of Barcelona, Bristol and Lucca	eMBB, URLLC (mMTC)	Barcelona (ES) Bristol (UK) Lucca (IT)		   	mMTC, URLLC, (eMBB)	Terni (IT)
	  	eMBB	Watford (UK) Paris (FR) Madrid (ES)			mMTC (URLLC)	Detmold (DE)
	  	eMBB	Surrey (UK) Munich (DE) Turku (FI)	 (Phase 1)		URLLC	Brandenburg (DK)
		eMBB	Egaleo (EL)		 	mMTC, URLLC, eMBB	Barcelona (ES) Bristol (UK)
	 	eMBB	Athens (EL) Thessaloniki (EL) Madrid (ES) Rome (IT)		 	mMTC, URLLC	Paris, Grenoble (FR)
		eMBB, URLLC	Aveiro (PT) Athens (EL)			URLLC, eMBB	Coventry (UK)
	 	URLLC	Turin (IT), Pisa (IT) Madrid (ES) Nice (FR)			URLLC (eMBB)	Genoa (IT) Ljubljana (SL)

Figure 10 – 5G PPP Phase 2 Projects – Vertical Trials & Pilots (Highlights)

**Furthermore, other cPPPs can benefit significantly from the presence of 5G infrastructure, and cooperation agreements and actions will be explored in the coming months.**

On a more general level, the NetWorld2020 and 5G IA document “*Economic considerations on Smart Networks as key enabler of the Human Centric Internet and the digital transformation research in FP9*” (available in the Annexes) provides an excellent description of the essential link between 5G and Smart Networks and their strong positive impact on economy and society in Europe and globally. Hereunder some considerations and findings extracted from the document are reported:

“The United Nations agreed in 2015 sustainable development goals until 2030, many of which require suitable communication technology, which provides high throughput, high reliability and availability and allows cost-efficient deployment.

The digitalisation of society and economy in developing and developed countries is supporting these goals and is a key enabler for solutions. All means of digitalisation are based on communication systems and networks and their relation to vertical sectors.

Communication systems and networks and the economic impact in terms of GDP contribution across various domains and industry show the strong relevance of this domain for secure, highly available and reliable networks.

5G is just the beginning of a new paradigm after the successful development of digital communication systems such as 2G/GSM, 3G/UMTS and 4G/LTE. The further development is leading towards new challenges and requirements from many different sectors in society and industry.

The communication infrastructure will form the nervous system of the future Internet. It will amalgamate distributed network, compute and storage resources to facilitate an agile composition of new services in a variety of markets and industry sectors.

The UN 2030 goals are a good starting point to identify needs on future systems and where and how communication technology can support such goals by the digitalisation of society and economy in developing and developed countries. Several studies have shown that economic growth can be increased by the availability of broadband access. This has also positive impacts on employment in the overall economy. The ICT domain is rather diverse with different sectors, which are closely related to each other. In the domain of communication systems and networks employment is slightly decreasing in the last years due to technology changes and the impact of globalisation, where in the service sector employment is increasing. However, the infrastructure side represents a strong contribution to the European economy with

- about 28 % of ICT employment,
- 40 % of ICT market size and
- 49 % of R&D expenditure in Europe.

The service sector is based on the availability of a high-performance communication infrastructure – the future Smart Networks. Therefore, the different sectors should be seen together. The existing employment in the communications sector is of strategic importance to enable the huge number of services and applications, to ensure the development of secure systems, a stable and secure operation of all critical infrastructures and to maintain and increase the know-how base in Europe.”

### **3.3 Evolution over the years**

Europe is entering into a critical phase in the global race to 5G and so is the 5G PPP. The first technology building blocks are there - they led to the adoption of the early-drop 5G standard. Standardisation work - based on the latest R&D results - needs to continue and proof of concept has started. 5G PPP Phase II will be important to master 5G technologies and to look into their application with relevant users in particular vertical industries. Let us keep in mind the European 5G targets set in the 5G Action Plan: commercial launch in at least one city per Member State by 2020 and comprehensive roll-out in all cities and along major transport paths by 2025. We have also set the wider ambition to have mobile connectivity wherever people live, work, gather, or travel. These targets will be an important basis for sustainable growth and jobs in Europe, for the digital society as well as the digital transformation of our economy. They will only be reached in partnerships - between public authorities and market players and between digital and vertical industries. Europe has vast opportunities with its strong industry and service sectors. Such partnerships will be the

centre of Phase II and Phase III of the 5G PPP. We will soon see major 5G validation platforms up and running with all 5G players on board. They will be used for trialling and piloting 5G with verticals. One promising example is a number of 5G corridors that have been agreed among Member States for testing of Connected and Automated Mobility. First 5G PPP projects running on these corridors will be launched in 2018. The 5G PPP trial roadmap and the vertical engagement strategy will be key to facilitate ambitious partnerships driving deployment and swift market introduction. We need to watch the progress closely in an international context. That is why the European Commission has set up the European 5G Observatory for monitoring and reporting major market developments and preparatory actions by the private sector and public authorities.

It is an exciting time for 5G, with the first versions of the 3GPP specification completed and many 5G trials planned or happening across Europe. In addition to this, it is a decisive time for the form and scope of next framework programme 'Horizon Europe', which will define the future research agenda for Europe. The existing 5G PPP programme has been a clear success for Europe with thousands of researchers and developers across Europe successfully working on innovative solutions for the definition of 5G. These efforts have had a significant effect on the initial 5G standards we have today, especially in the areas of system design, evaluation aspects, air interface innovations network management, security innovation, virtualization and service deployment innovations. In addition to the hundreds of standardization submissions the 5G PPP projects were the key place for building global pre-standardization consensus. As well as key input to the current 5G version, 5G PPP is closely involved in the development of further releases of the 5G standard, which will address vertical industries. However, 2020 is not the end of the story. Communication infrastructure will continue to evolve driven by cutting-edge research and the 5G IA would like to see a continuation of research partnerships between the EU Commission and the private side to ensure that Europe stays in the forefront of this important area, that we name **"Smart networks & Connectivity"**, which is a key enabling technology for all sectors of society and economy and which provides the basis for all Internet services and critical infrastructures.

## 4. Outlook and lessons learnt

5G PPP is the embodiment of Europe as we face the world in the drive for the fifth generation of network communications. It represents all Europe stands for: society, growth, sustainability, openness, and leadership.

The **phase 2 projects selection process**, finalised in May 2017, brings some first learnings:

- Very good coverage of the work programme, as defined by the 5G-IA pre-structuring model (Targeted Actions)
- Leveraging on Phase 1 results and clear move towards software and cloud networks (RAN & CN)
- Effective inclusion of Verticals: automotive, healthcare, energy, media...
- New stakeholders and domains (satellite, optical)
- Strong potential to drive Europe towards 5G trials and demo paving the way towards implementation

- SME presence now above the 20% target

In addition to strongly enhanced technical performance compared with 4G, the true differentiator for 5G is the vertical markets.

**As for the next Progress Monitoring Report exercise (PMR 2018), and as stated above, we are committed to improve the results in the common set of KPIs with the implementation of 3 surveys:**

- **Investment leverage: include the direct projects stakeholders and beneficiaries, to be combined with the current wider approach,**
- **Skills and jobs profiles: send much earlier the questionnaire to all 5G-IA members and 5G PPP Projects,**
- **Impact on SMEs: send a survey on turnover and jobs on Q1 2019.**

The heterogeneity of Europe provides many challenges, but also opportunities. We need to grasp these opportunities. The key issues are:

- Create scale on the European level (spectrum, cross border support, test licenses, ...)
- Create a dynamic European 5G ecosystem as platform for future innovation
- Coordinate efforts at national and European level to create consistent narrative and more impact
- Communication networks provide the life blood to realize the digital society
- Connectivity has gone from a luxury to a critical human right
- Research, development and deployment of communication networks will be a key future economic differentiator
- Europe should establish a new key area in FP9 on **Smart Networks (communication infrastructure, digital security and connectivity)** with a significant budget allocation
- This activity should be implemented in a (PPP-type) partnership instrument in close cooperation with other areas in FP9, which can contribute to Smart Networks.

## Annexes

### Separate document

- **Part 1 - Common Priority Key Performance Indicators**
- **Part 2 - Specific Key Performance Indicators for the 5G PPP**
- **Part 3 - Contribution to Programme-Level KPI**
- *Table A - Performance KPIs evaluated by phase 1 project METIS-II*
- *Table B - 5G R&D expenses – Investment Leverage Effect*