

## **5G PPP PROGRESS MONITORING REPORT – 2022**

*This document has been prepared by the 6G Smart Networks and Services Industry Association (6G-IA) and it reflects the views only of its authors*

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## 1. Introduction

This document reports the progress achieved by the 5G Public-Private Partnership (5G PPP)<sup>1</sup> during 2022. For reasons of completeness, the document briefly presents the overall 5G PPP framework (Annexes 1 & 2). It also analyses the activities that were performed under this framework either by the 5G Initiative (i.e., 5G PPP Projects, 5G PPP working groups, Steering and Technology Boards) or the 6G Smart Networks and Services Industry Association (6G-IA)<sup>2</sup>, i.e., Verticals Engagement Task Force, 6G-IA working groups and specific activities. Detailed information can be found in Annexes 3 through 6.

Furthermore, it presents the results for several Key Performance Indicators (KPIs) for a) a common set of KPIs (i.e., mobilised private investments, new skills/job profiles, impact on the SMEs, Significant innovations), b) specific KPIs for the 5G PPP in terms of network performance, business and societal aspects and c) the contribution to 5G PPP Programme-level KPIs. Detailed information about this topic can also be found in Annexes 7 through 9.

Finally, the document provides a qualitative analysis about the outlook and the lessons learnt and provides some recommendations about the workplan for the following years.

Please note, that some of the reported information relates to data collected through specific Questionnaires. The current report contains some information taken from questionnaires released and processed during 2022.

## 2. Main activities and achievements

5G became commercially available during 2019, ahead of schedule. 5G network deployments are taking place all over the world. Deployments are on-going throughout Europe with thousands of 5G base stations becoming operational in many European cities. The 5G rollout in Europe is progressing and is comparable to most of the other global regions<sup>3</sup>. More specifically Europe has the second largest number of deployed BS in the world. Moreover, in Europe a 72% population coverage has been achieved by the end of 2022 in EU27<sup>4</sup>.

**The underlying technology developed in the context of the 5G PPP Initiative has been a key enabler for these success stories.** The 5G PPP Initiative has provided several scientific solutions that have been contributed to standardization activities and the global academic and research community through publications. More importantly, solutions that emerged through 5G PPP projects have been integrated into final products. In addition, the 5G PPP projects have been driving test and validation activities in Europe, collecting significant experience for all stakeholders, and raising public awareness on the capabilities of 5G networks.

Also, an analysis of the data in the latest publicly available reports such as IPlytics<sup>5</sup> (June 2022), indicates that **European headquarter companies share a 15,59% of active and granted 5G US or EP granted patent families**. As the report indicates “However, not all self-

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<sup>1</sup> <https://5g-ppp.eu/>

<sup>2</sup> <https://6g-ia.eu/>

<sup>3</sup> <https://5gobservatory.eu/observatory-overview/international-5g-scoreboard/>

<sup>4</sup> <https://5gobservatory.eu/observatory-overview/eu-scoreboard/>

<sup>5</sup> IPlytics, Who is leading the 5G Patent race?, A patent landscape analysis on declared SEPs and standards contributions, June 2022 <https://www.iplytics.com/>

declared patents are essential and valid, also SEPs vary by value – with some covering core technologies of the standard and others only claiming inventions on minor improvements to the standard”. Therefore, the same report also examines the **number of approved technical 5G contributions of European companies**. Their share is **37.04%** and brings European companies in the first place. **Moreover, publicly available results suggests that the EU HQ companies combined share the majority of 5G commercial deals<sup>6</sup>, whereas other reports suggest that the European HW companies hold 30% of the Telecom equipment market<sup>7</sup>.**

Related to IPR production, 5G PPP projects kept on being active in providing standardization contributions for 5G advanced networks. These contributions are being tracked regularly via an online tool, the Standards Tracker. The information provided in Figure 1 and Figure 2 below show the 5G PPP inputs up to Q3 2022.

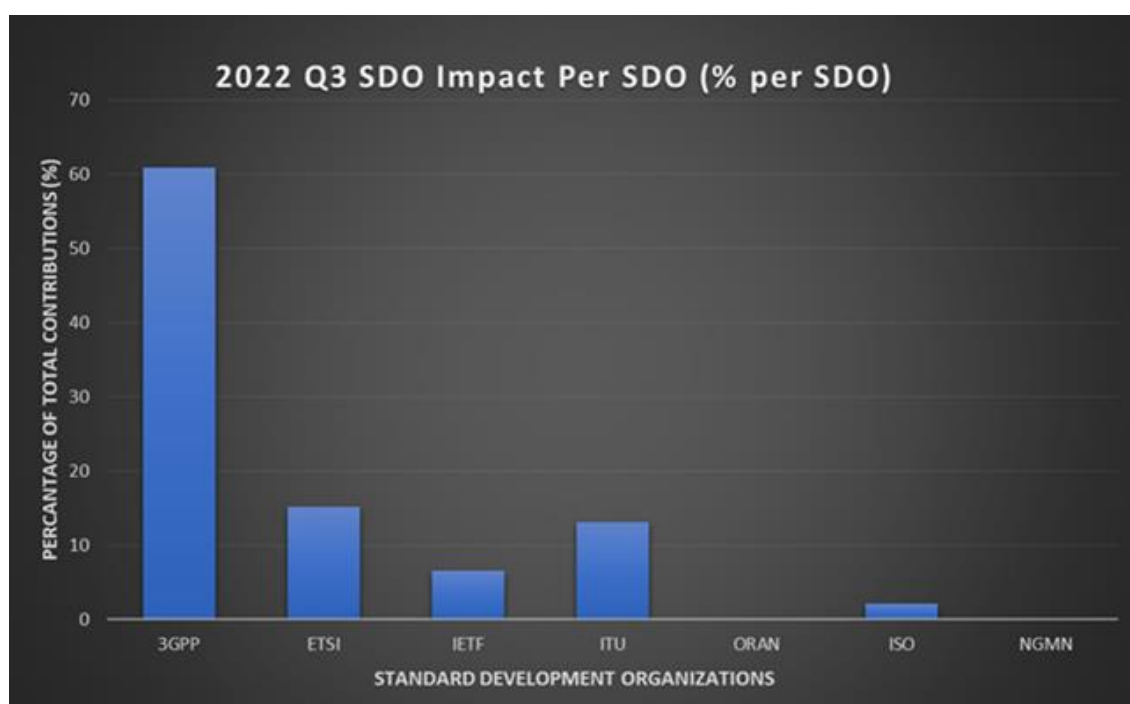


Figure 1. Impact breakdown by SDO.

Looking more specifically at the most targeted standards organisations, 3GPP and ETSI, it is possible to zoom in on specific targeted working groups and technical committees. The focus of 3GPP inputs is SA1 (Services), SA3 (Security and Privacy), SA5 (Management, Orchestration and Charging), SA6 (Application Enablement and Critical Communication Applications), RAN (Radio Access Network) 1 and 3. Most of the inputs to ETSI have been to the Industry Specification Group on NFV (Network Functions Virtualisation, 15%), MEC (Multi-Access Edge Computing, 40%), on Terahertz (THZ, 30%) Satellite Earth Stations and Systems (SES, 15%).

<sup>6</sup> <https://www.spglobal.com/marketintelligence/en/news-insights/research/5g-tracker-79-markets-worldwide-have-commercial-services>

<sup>7</sup> <https://www.delloro.com/key-takeaways-2021-total-telecom-equipment-market/>

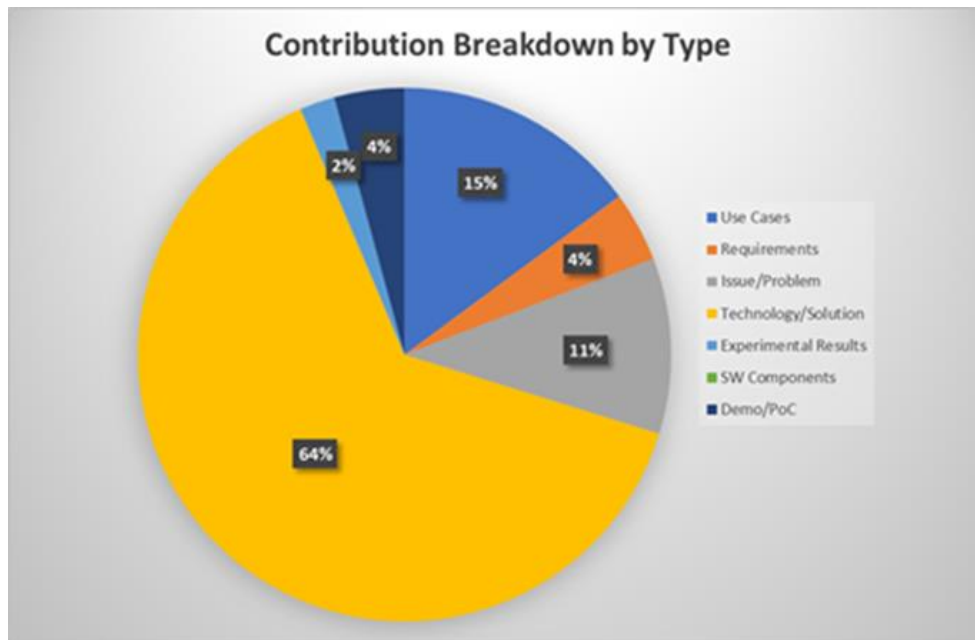


Figure 2. Impact breakdown by Typology

Moreover, Phase 3 projects have been very active in producing new knowledge. More specifically the projects from this phase alone have produced **1988 publications so far (34% of which was published in scientific journals)**.

In the following sections, it will be explained how the 5G PPP Initiative was organized in different Phases (Figure 3). The first phase (Phase 1) focused on basic research to provide the key concepts and solutions for 5G networks. The second phase (Phase 2) concentrated on system development and bringing this new 5G technology to the vertical industries and finally Phase 3 where large-scale trials and innovation infrastructures have been created. Phase 3 also contains basic research activities to consider evolution beyond 5G.

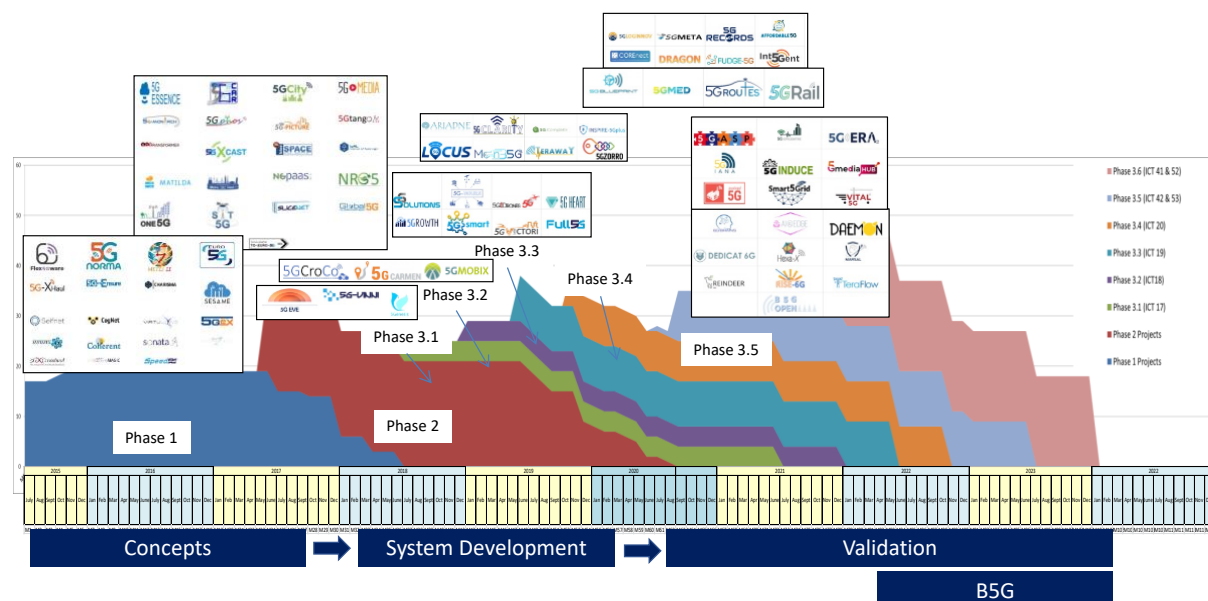


Figure 3: 5G PPP Phases

The last two Phases of 5G PPP have managed to cover around 12 vertical industries. This is an important achievement because one of the main aims of 5G is the digitization of the so call “verticals”.

The importance of EU funded projects to build a world-wide consensus in a pre-standardization level, the visionary specification of futuristic use cases and the raising of public awareness about the capabilities of 5G networks is undeniable. **The 5G Infrastructure PPP Initiative and 6G-IA achieved significant progress and impact during 2022.** The next subsections provide more detailed information.

## 2.1 Implementation of the calls for proposals evaluated during the reporting period

In 2022, there was no new call for projects in the 5G PPP Initiative as the Programme has already entered its final phase. Figure 4 illustrates the reference figure for the selected projects from the last calls. This figure presents their primary (main box colour) and secondary (colour of addendums) areas of technological focus.

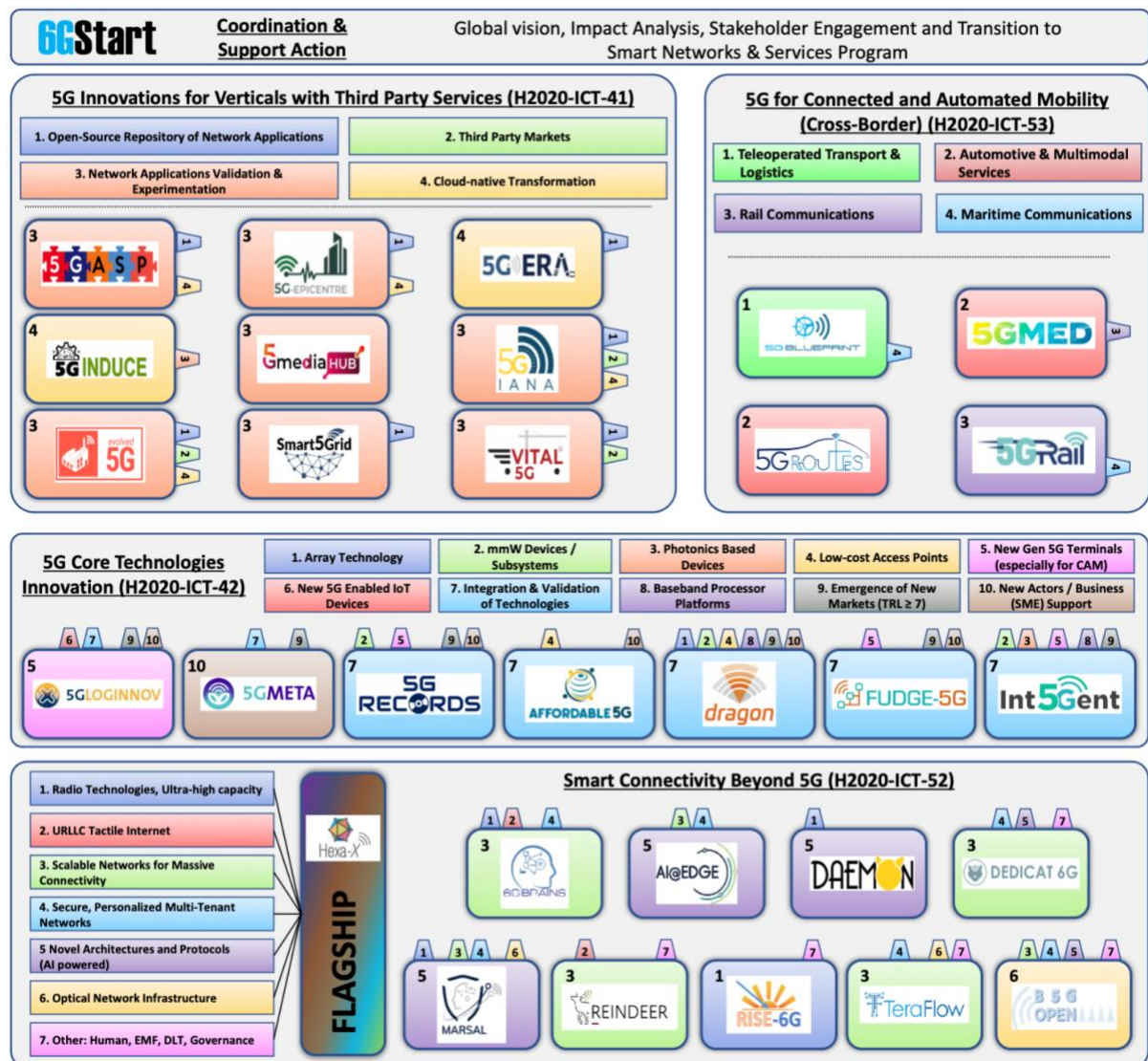


Figure 4: Phase 3 reference figure



Since Phase 1, **93 projects** in total have been contractually active in the 5G PPP Programme, ensuring **outstanding results and dynamism**. The Programme has managed to mobilise during its lifetime 166 unique beneficiaries in Phase 1, adding 144 new beneficiaries in Phase 2, and another 384 new beneficiaries in phase 3. By the completion of Phase 3.6 there were more than **700 organisations who are parties to the 5G PPP collaboration agreement**.

Also, note that **Phase 1 projects have produced 57 key achievements<sup>8</sup>, where Phase 2 key achievements<sup>9</sup> include 60 highlighted results** categorised under 14 program level achievements whereas the **latest counting of Key Achievements v3.2<sup>10</sup>**, from Phase 3 projects, **amounted to more than 100 innovations under multiple categories** (Annex 3).

As mentioned above, 5G PPP is an active contributor to 5G standardization globally and technological results have been disseminated in several scientific journals and conferences (Annex 9).

A key part of the 5G PPP structure is a set of cross-projects and cross-initiative **working groups** (Annex 4). The outcome of the work from these groups is presented in white papers. During 2022, the 5G PPP Initiative has released another **seven white papers** disseminating key findings<sup>11</sup>. The complete 5G PPP program **so far has produced more than 50 white papers**.

**Beyond the Phase 2 and Phase 3 projects achievements, a lot of joint (cross-projects) and programmatic achievements have been further developed**, thanks to the overall operation and efficiency of the working groups, Steering Board and Technology Board, in full synchronization with the 6G-IA, and with the strong support of the CSA projects. On the 10<sup>th</sup> of April 2018, the European Commission launched the Innovation Radar: a data-driven online tool which provides easy access to innovations supported by EU funding and the innovators behind them. **By searching “5G” on the Innovation Radar 595 innovations were found recorded from 381 innovators**, shown a continuous growth in numbers compared to the numbers recorded in the previous 5G PPP PMRs.

Section 3 provides **detailed information about common and specific sets of KPIs** for the 5G PPP program. Most notably, it has been evaluated that the **mobilization of private investment for 2022** has achieved a **leverage factor of 10,46** times the public EC investment in the 5G PPP for large industries and SMEs. (**7,64 for all types of stakeholders**).

## 2.2 Mobilization of stakeholders, outreach, success stories

As mentioned in the previous section, **783 organisations** have been identified who are parties to the **5G PPP collaboration agreement**. This clearly demonstrates a successful mobilization of the European stakeholders that are involved in various forms with 5G technologies. Moreover, this demonstrates an open initiative where competition is open for all.

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<sup>8</sup> <https://5g-ppp.eu/phase-1-key-achievements/#1507204993795-3eec9c4c-5911>

<sup>9</sup> <https://5g-ppp.eu/phase-2-key-achievements/>

<sup>10</sup> <https://5g-ppp.eu/key-achievements-v3-2/>

<sup>11</sup> <https://5g-ppp.eu/white-papers/>

Table 1 provides information about the number of projects, the number of unique beneficiaries and the funding per call for all three phases of 5G PPP<sup>12</sup>.

*Table 1: 5G PPP Beneficiaries*

Phase	Projects	Calls	Unique Beneficiaries	EU Funding
Phase 1	19	H2020-ICT-14-2014	170	129.8 M €
Phase 2	16	H2020-ICT-7-2016		104.6
	8	H2020-ICT-8-2016		43.9
Phase 2 Total	24		257	148.5 M €
Phase 3.1	3	H2020-ICT-17-2017		51.5
Phase 3.2	3	H2020-ICT-18-2018		49.2
Phase 3.3	9	H2020-ICT-19-2019		96.3
Phase 3.4	8	H2020-ICT-20-2019		46.2
Phase 3.5	8	H2020-ICT-42-2020		39.2
	4	H2020-ICT-53-2020		41.1
Phase 3.6	9	H2020-ICT-41-2020		50.7
	10	H2020-ICT-52-2020		65.6
Phase 3 Total	54		618	440 M €
Total	97		783	718.3 M €

In relation to the **SME engagement** the 5G PPP initiative has successfully met the Programme KPI of 20% SME participation by reaching a **21,95% SME participation in funding**. This represents 156.3 M€ EC funding for SMEs in the initiative overall. SMEs have contributed to 24.5% of the total participation in 5G PPP projects. 65% SMEs participated in one project, 35% in two or more projects. Their level of participation in RIAs and IAs was the same.

During 2022, several technical workshops, information days and research and innovation events took place to harmonize the activities of projects and promote their results. Some of the workshops were organized in the context of the 5G PPP Initiative. In other events, the funded projects had a strong presence. A detailed list of events is available at the 5G PPP web site<sup>13</sup>, where **more than 100 events have been recorded for 2022**.

In terms of international collaboration 6G-IA has been very active building up international cooperation for 5G networks (Annex 6). Currently, **25 MoUs** and **3 LoIs** with major 5G organizations from around the globe have been signed. 5G PPP activities and 6G-IA activities led to a significant number of participations in European and global events (i.e., more than 80 during 2022). The **9<sup>th</sup> Global 5G Event and Vertical Summit** took place in hybrid form in Seoul, Korea, on 1<sup>st</sup> and 2<sup>nd</sup> of November 2022. Colin Willcock, Chairman of the 6G-IA participated in the event and presented a keynote on 6G research in Europe focusing on the SNS-JU<sup>14</sup> and discussed international collaboration. Moreover, 5G PPP has been present in

<sup>12</sup> This Table also includes 4 complementary projects that we related with collaboration projects with other global regions. The number from these 4 projects do not really change the key points for the mobilization of stakeholders.

<sup>13</sup> [https://5g-ppp.eu/event-calendar/list/?tribe\\_paged=1&tribe\\_event\\_display=list&tribe-bar-date=2022-01-01](https://5g-ppp.eu/event-calendar/list/?tribe_paged=1&tribe_event_display=list&tribe-bar-date=2022-01-01)

<sup>14</sup> <https://smart-networks.europa.eu/>

major international conferences disseminating the results from the projects, creating a positive image for European stakeholders.

### 2.3 Governance

In the context of 5G PPP, the 6G Smart Networks and Services Industry Association (6G-IA) (formerly known as the 5G Infrastructure Association - 5G IA) represents the private side, and the European Commission, the public side. The 6G-IA is “*The voice of the European Industry and Research for Next Generation Networks and Services*”. To this aim, the 6G-IA brings together a global industry community of telecoms & digital actors, such as operators, manufacturers, research institutes, universities, verticals, and SMEs. *Figure 5*, presents the overall governance of the 5G PPP.

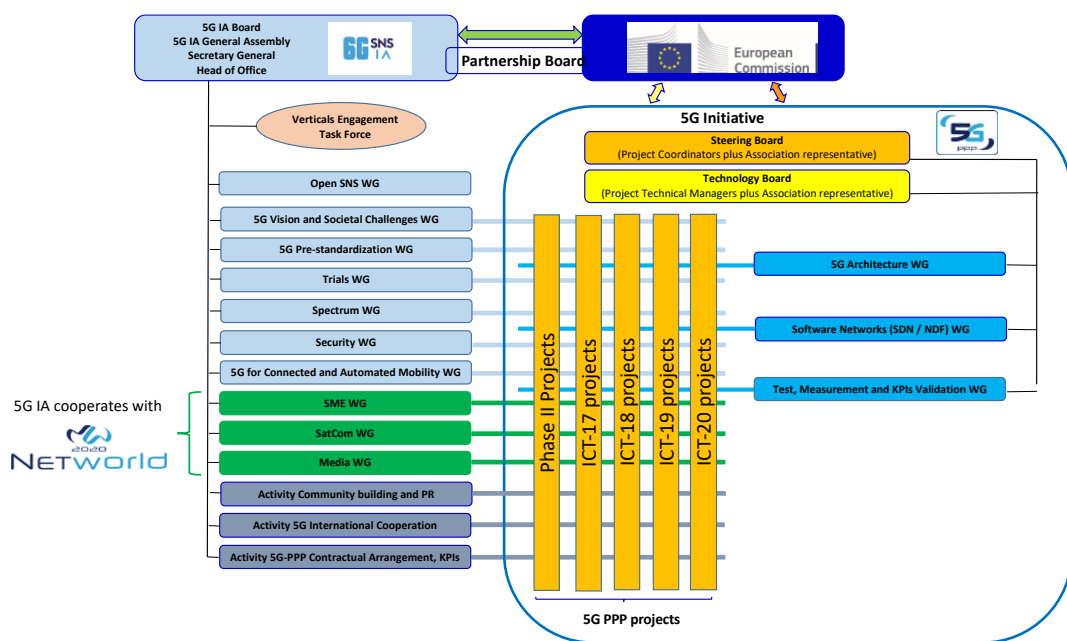


Figure 5: 5G PPP Governance

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

This section, accompanied with detailed information presented in the annexes, presents the overall progress that has been recorded since the launch of the 5G PPP.

### 3.1 Achievement of the goals of the cPPP

2022 was another successful year for the 5G PPP Initiative. Significant results were achieved in the following key areas for the implementation of the 5G PPP Contractual Arrangement:

- **An efficient and effective 5G PPP Programme:** The *5G PPP Programme* has been operating smoothly having now contracts for 93 projects over all 5G PPP phases (Section 2.1 and Annex 3). Phase 3 projects proceeded at full speed.

- **Optimum profile for the European 5G initiative in a global context:** As described in detail in Annex 6, the 6G-IA has in place 25 MoUs and 3 LoI with international peer Associations, Verticals' Associations, SDOs etc.
- **Widespread dissemination of European achievements:** During the past period, the *5G PPP Initiative* was actively engaged in organizing and disseminating results the European achievements through *more than 100 events*<sup>15</sup>. In several important events 5G PPP had the possibility to present its achievements, raise awareness on opportunities offered by 5G and have exchanges with major EU and international organizations. Additionally, 6G-IA organized or participated in multiple global events, promoting the European results.
- **Significant technical input to the standardization bodies:** In terms of standardization activities, 5G PPP is an active contributor to 5G standardization globally. Overall, the 5G-IA Pre-Standardization WG has tracked, until Q3 2022, more than 100 inputs based on specific and tangible inputs (e.g., technical reports, study/work item, PoC, new commercial requirements). Most inputs have been submitted to 3GPP and ETSI (38), with a growing number of inputs to IEEE, and inputs to sector associations working groups like 5GAA. Twenty-two projects (all Phase 3, except SliceNet) have contributed to two rounds of inputs. 14 projects have provided such information, from which 13 reported notable impact in SDOs (c.f., Annex 9).
- **Impact through scientific publications:** Moreover, data collected from the public sites of the funded projects, show that they have provided a significant impact on the scientific community. **Phase 3 projects have produced 1988 publications so far** (34% of which was published in scientific journals) (c.f., Annex 9).
- **Measurable Programme progress and KPIs:** In section 3.2.1 follows an analytical discussion about the measurable progress through a set of KPIs. More details are included also in the annexes. Summarizing some of the key findings, the analysis of the data has shown *a leverage factor of 10,46 times the public EC investment for large industry and SMEs*. The SME participation in 5G PPP projects has increased in 2020 to reach and even exceed the original objective of 20% (i.e., **21,95%**) participation defined as a KPI of the programme. Finally, specific 5G PPP KPIs (performance, business and societal) are also addressed in the following section.
- **Maintaining the holistic view of implementing 5G by 2020 and planning for Horizon Europe:** The governance model of 5G PPP was the key enabler to achieve the expected results. As planned, the *Programme has successfully shifted from research activities to large trials and eventually the market*. Moreover, the EU ICT community working closely together with the EC has successfully contributed to the launch of the Smart Networks and Services Joint Undertaking and the successful first Horizon Europe call for proposals.

### 3.2 Progress achieved on KPIs

In the following subsections common and specific sets of KPIs are presented. More detailed information on their progress is available in the annexes. The current report contains some information taken from questionnaires released to the active 5G PPP projects and their results have been processed during 2022.

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<sup>15</sup> <https://5g-ppp.eu/event-calendar/>

### 3.2.1 Common set of KPIs

#### 3.2.1.1 Mobilize private investments

As performed for 2018's PMR these calculations took place with the use of dedicated Questionnaires and collection of publicly available information. The complete methodology is presented in Annex 7.

The result from this calculation procedures show already excellent leverage factors:

- Large Industry and SMEs in 2022 mobilized private investments that sum up to an amount **10,46** times the public EC investment in the 5G PPP in the same period.
- All the types of stakeholders/beneficiaries invested in 2022 a total amount of money that is **7,64** times the public investment in the same period.

#### 3.2.1.2 New skills and/or job profiles

As in the previous section, data for new jobs/skills created were collected through the 2022 Questionnaire from 5G PPP project beneficiaries.

These are defined as progressive values, referring to the period 2014-2022. A finer scale (e.g., per year) is very difficult to implement, since the creation of jobs/skills can be hardly calculated on a per-year basis and attributed to specific periods. More information can be found in Annex 7.

Table 2: New skills and/or job profiles

2014-2022	New jobs/skills	
	Average	Total projected
Overall	3,15	3.399
Large Industry	7,33	1.833
SME	4,15	1.014
Academic Institution	2,00	150
Research Center	6,29	402

#### 3.2.1.3 Impact on SMEs

The business performance of an SME can depend on many factors, and not only on the participation in a given R&D Programme. It is up to the individual SME to quantify how the participation in 5G PPP projects had an influence on parameters like turnover, job profiles and staff headcount variations, etc. In most cases, they should manage to provide this information, with some degree of precision.

To capture the impact on SMEs, the following parameters were considered:

- The increase in yearly turnover
- The increase in yearly revenues
- The increase in staff headcount
- The number of new elements of foreground IP

Data for these parameters were collected through the 2022 Questionnaire mentioned in the previous subsection. This Questionnaire has had a specific table to collect this data (depicted in Table 3 below) from the SMEs. More information can be found in Annex 7.

Table 3: Impact on SMEs

	increase in yearly turnover	increase in yearly revenues	increase in staff headcount	number of new elements of foreground IP
Reference period	2022	2022	2014 - 2022	2014 - 2022
Average values	43,0%	44,0%	2,53	1,25
Total projected	n/a	n/a	618	305

#### 3.2.1.4 Significant innovations

The 5G PPP projects have produced several significant technological innovations. As described in Annex 3, during the reporting period the Key achievements v3.2<sup>16</sup>. The achievements were grouped in 9 technical areas, one for business standardization and regulation and 9 vertical sectors. In total, 129 achievements were reported in 2022 by 5G PPP projects.

In terms of standardization activities, 5G PPP is an active contributor to 5G standardization globally. Overall, the 5G-IA Pre-Standardization WG has tracked until Q3 2022, more than **100 inputs based on specific and tangible inputs** (e.g. technical reports, study/work item, PoC, new commercial requirements). Most inputs have been submitted to 3GPP and ETSI (38), with a growing number of inputs to IEEE, and inputs to sector associations working groups like 5GAA. Twenty-two projects (all Phase 3, except SliceNet) have contributed to two rounds of inputs. 14 projects have provided such information, from which 13 reported notable impact in SDOs).

Moreover, **Phase 3 projects have produced 1988 publications so far** (34% of which was published in scientific journals).

Also, an analysis of the data in the latest publicly available reports such as IPlytics<sup>17</sup> (June 2022), indicates that **European headquarter companies share a 15,59% of active and granted 5G US or EP granted patent families**. As the report indicates “However, not all self-declared patents are essential and valid, also SEPs vary by value – with some covering core technologies of the standard and others only claiming inventions on minor improvements to the standard”. Therefore, the same report also examines the **number of approved technical 5G contributions of European companies**. Their share is **37.04%** and brings European companies in the first place.

#### White papers produced by the 5G PPP WGs

<sup>16</sup> <https://5g-ppp.eu/key-achievements-v3-2/>

<sup>17</sup> IPlytics, Who is leading the 5G Patent race?, A patent landscape analysis on declared SEPs and standards contributions, June 2022 <https://www.iplytics.com/>



Since the creation of the 5G PPP and the 6G-IA WGs more than 50 white papers<sup>18</sup> have been produced overall until today. Seven of these white papers have been produced during 2022. These are:

- Non-Public-Networks – State of the art and way forward (November 2022)
- Intelligent Security Architecture for 5G and Beyond Networks (October 2022)
- Network Applications: Opening up 5G and beyond networks (September 2022)
- From 5G to 6G Vision – A Connected and Automated Mobility (CAM) perspective (June 2022)
- Beyond 5G/6G KPIs and Target Values ( June 2022)
- 6G IA – What societal values will 6G address? (May 2022)
- 5G PPP – Basic Testing Guide: A Starter Kit for 5G KPIs Verification (January 2022)

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

#### 3.2.2.1 Performance KPIs

The technical Annex to the 5G PPP contractual arrangement defines the following performance KPIs:

- 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.

These KPIs have been refined during the execution of the 5G PPP Programme in various white papers (see below). A more detailed and partly formal definition of the KPIs that are relevant for the performance of the 5G system have been defined by standards bodies such as ITU-T and 3GPP. Some of the most relevant standards work for the assessment of performance KPIs within the 5GPPP framework are:

- Report **ITU-R M.2410-0** (11/2017) defines KPIs specific to the radio interface. These include *Peak data rate*, *User experienced data rate*, *Mobility*, *Latency* – separately for user plane and control plane, *Connection density*, *Reliability*, *Area traffic capacity*, *Peak spectral efficiency*, *5<sup>th</sup> percentile user spectral efficiency*, *Average spectral efficiency*, *Energy efficiency*, *Mobility interruption time* and *Bandwidth*.
- In 3GPP Technical Specification **TS 28.554**, 3GPP specifies end-to-end Key Performance Indicators (KPIs) for the 5G network and network slicing. 3GPP introduces KPI categories; *Accessibility*, *Integrity*, *Utilization*, *Retainability* and for future updates also *Availability* and *Mobility*. The categories are defined with reference to ITU-T Rec.E.800

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<sup>18</sup> <https://5g-ppp.eu/white-papers/>

- *Accessibility* refers to Registered Subscribers of Network and Network Slice Instance through AMF and UDM, Registration success rate of one single network slice instance, as well as Data Radio Bearer (DRB) Accessibility for UE services. *Integrity* refers to End-to-end Latency of the 5G Network, Upstream/Downstream Throughput for network and network slice instance, Upstream/Downstream throughput at N3 Interface (between RAN and UPF) as well as throughput between RAN and UE. *Utilization* refers to the Mean number of PDU sessions of network and network Slice Instance and the Virtualised Resource Utilization of Network Slice Instance. Finally, *Retainability* refers to QoS flow Retainability.
- NGMN published a Testing Framework for the NGMN 5G pre-commercial network trials. Among others this paper specifies general requirements for testing, deployment scenarios, trial setup requirements, trial test requirements and service or technology specific requirements for several identified KPIs, such as *Latency*, *User throughput*, *Cell Capacity*, *Spectral Efficiency*, *Coverage*, *Mobility*, *Reliability* and *Retainability*, *User Experience*, *Energy Efficiency*, *Inter-RAT procedures*, *RAN architecture split*, as well as *Location/Positioning service* and *Fixed Wireless Access*.

As can be derived from the main references above, there exists several KPIs with partly diverging definitions, although these definitions are being consolidated by the standards bodies and the industry.

The Test, Measurement and KPIs Validation (TMV) Working Group (WG) of the 5G PPP has made a successful attempt to provide a consolidated view of the KPIs that are being addressed by the various projects of the 5G PPP Programme. As explained in the PMR 2017, there cannot and will not be one single overall system analysis per Performance KPI across all 5G Infrastructure PPP projects. Moreover, the progress of 5G PPP through its phases has identified a specific need to study and develop a mapping of vertical KPIs to network KPIs so that a better understanding is achieved in relation to the actual needs of the verticals from the network infrastructure.

Since October 2019, the work in relation to technological (performance) KPIs is under the umbrella of the TMV WG, including the active participation and stimulation from Full5G and 6G START CSA projects. In 2022 (and early 2023) the TMV WG has produced several white papers reflecting the knowledge and insights gained by the 5G PPP community regarding appropriate KPI measurements frameworks, suitable measurement tools and their configuration as well as 5G network and vertical KPI performance measured in the field. This work, summarized in the following white papers, encapsulates the attempts of the 5G PPP community to address the discussed performance KPIs. The relevant white papers are:

- **“Beyond 5G/6G KPIs and Target Values”** (June 2022). The main objective of this document is to present the current view of the available B5G and 6G KPIs from 5G PPP phase III projects with a focus on projects of the ICT-52 call. This view includes mapping to KPIs previously defined for 5G and evaluating how they might evolve to fit the B5G and 6G visions. We are presently at the start of the 6G research era, where visionaries and researchers are interplaying to define a vision for 6G. To ensure the direction of innovations towards realizing 6G it is critical that KPIs are defined at an early stage to help steer the process. The KPIs are either evolved from previous generation KPIs or are new and being defined in coordination with definition of new features and use cases. It is at this stage that this white paper makes its contribution, in collecting KPIs from active research projects based on work on new features and use



cases. The paper consists of two main technical parts. The first part gives an overview of standard network KPIs with defined target values for 5G system. These are well known KPIs that will be evolved to 6G by changing target values. The second part presents KPIs collected from ICT-52 research projects aimed at B5G and 6G system. These KPIs are processed in terms of being grouped according to KPI type or context, and they are presented with references to standards and target values where possible and available. The white paper is intended to be updated and re-published every year to track the B5G and 6G KPIs evolutions. The evolutions will occur as projects, use cases and functionalities mature. KPI definitions from new B5G and 6G projects from projects participating in the 6G SNS R&I Work Programme will be taken into account when available (2023). Future version of this report will also integrate more information on KPIs target values and definition of methodology for how to measure them.

- **“Basic Testing Guide: A Starter Kit for 5G KPIs Verification”** (January 2022). This Basic Testing Guide document is a practical guide describing the starter kit developed in the context of the 5G PPP Test, Measurement and KPI Validation work group. The guide enables the interested developer to understand how this can be applied to measure and verify basic 5G KPIs. The document starts from describing the idea intention to measure up to the actual realization of the test. To enable the test, a description of the environment, how to install it, the test tools and the methodology is provided. It goes from idea to run the actual test, step by step. The proposed framework with the support of the described android agents can in principle support the validation of application level KPIs running at the android UEs, while for other application-specific KPIs running at other systems, the development of specialized plugins is necessary.
- **“KPIs Measurement Tools – From KPI definition to KPI validation”** (May 2023). This white paper summarizes the 5G Key Performance Indicators (KPIs) and the tools that have been identified and utilized in several ICT-17, ICT-19, and ICT-52 projects. In particular, the document lists the identified 5G KPIs, with a brief and unified description, mapping them also to the measurement operations. Then, the tools recognized in the different projects are presented, including open-source, ad-hoc developed and proprietary tools. Each tool is presented, highlighting the main functionalities and the list of KPIs that can be measured. Finally, the platforms for data collection and the tools for visualization are reported, highlighting their features and the availability of plugins/APIs to connect other tools/frameworks.
- **“5G PPP Trials Results 2022 – Key Performance Indicators, measured in advanced 5G Trial Sites”** (June 2023). This white paper presents the aggregated field measurement and relevant KPIs from multiple 5G Trial sites. The results presented in this white paper are based on the work carried out by 15 Phase 3 5GPPP R&I projects that engaged in 5G-enabled trials in 2022 and early 2023. These fifteen projects performed field measurement in 36 distinct 5G Trial Sites, constructed across 14 European countries, during which a total of 50 vertical use cases were tested and validated via the implementation of about 80 distinct trial scenarios. A large variety of diversified 5G technologies, features and settings were used across the different projects, covering outdoor and indoor scenarios as well as stationary and mobile, different operational frequency bands and 5G system releases, architecture and configurations, as well as complementary technologies. The extensive set of parameters and configuration used during the 5GPPP Phase 3 trials proves the versatility of 5G networks and offers cumulative insights with regards to the expected 5G performance in diversified scenarios. The analysis provided, validates the performance of 5G networks in the field (in terms of data rates and latency) while also confirming the

enhanced performance delivered by Stand Alone (SA) 5G networks and providing insights regarding the delivered field performance per vertical application.

- **“Beyond 5G/6G KPI measurements”** (June 2023). This white paper is the continuation of the 5G-PPP TMV Working Group white paper entitled «Beyond 5G/6G KPIs and Target Values». The latter provided an early analysis of possible Beyond 5G/6G KPIs based on current work and perspectives from ICT-52 projects, seeking to understand the level to which existing definitions in standard documents will apply to 6G and to identify, at early stages, gaps and new candidate KPIs for being standardized for 6G systems. The intention of this white paper is to provide an analysis of the nature of the beyond 5G/6G KPIs identified in the previous white paper, by further elaborating on the feasibility of these KPIs to be measured, on the methods and tools to be used for their evaluation, and on identifying challenges encountered, gaps identified and research steps to be followed on the measurement and evaluation methodologies to be used in the 6G era.

### *3.2.2.2 Business KPIs*

#### **B1. 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**

In section 3.2.1.1 a detailed methodology for estimating the leverage factor has been presented. As mentioned before, the results from this calculation procedures show already excellent leverage factors:

- Large Industry and SMEs in 2022 mobilized private investments that sum up to an amount **10,46** times the public EC investment in the 5G PPP in the same period.
- All the types of stakeholders/beneficiaries invested in 2020 a total amount of money that is **7,64** times the public investment in the same period.

#### **B2. Target SME participation under this initiative commensurate with an allocation of 20% of the total public funding**

The SME participation in 5G PPP projects was increased and in 2020 (last calls for the 5G PPP Initiative) they reached and even exceeded the original objective of 20% participation defined as a KPI of the programme<sup>19</sup>. According to the H2020 dashboard<sup>20</sup>, **the participation of SMEs in the 5G PPP has reached 21.95% of EU funding**, representing a total of €156.3 M.

#### **B3. 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**

The race for the deployment of 5G networks is still ongoing and data are constantly changing. European HQ companies have provided information that shows that European solutions are still on the forefront at a global level.

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<sup>19</sup> All 5G PPP calls have been included, now that the latest 5G PPP calls have been completed.

<sup>20</sup> <https://webgate.ec.europa.eu/dashboard/>

Ericsson itself has announced 170 commercial 5G agreements or contracts with unique operators<sup>21</sup>. NOKIA itself has reported 228 commercial 5G deals as well as 75 live 5G operator networks<sup>22</sup>.

Moreover, analysis from independent sources demonstrates for 2021<sup>23</sup> the EU HQ key 5G vendors enjoyed together roughly 1/3 of the total worldwide telecom equipment revenues.

*At this point, we need to note however that the abovementioned data have been simply collected from public reports over the Internet and cannot be considered necessary as hard evidence, since these reports admit that not all companies have disclosed their total 5G contract wins.*

### 3.2.2.3 Societal KPIs

In this section we analyse the KPIs related to business aspects. These are the following:

#### **S1. Enabling advanced user-controlled privacy**

As there have been no explicit calls in this area there are no data to be reported. It is planned that this societal KPI will be further addressed in the scope of the Smart Networks and Services Partnership. However, the Architecture WG has been working during 2022 to produce a white paper entitled “Towards Sustainable and Trustworthy 6G – Challenges, Enablers and Architectural Design”.

#### **S2. Reduction of energy consumption per service up to 90% (as compared to 2010)**

As there have been no explicit calls in this area there are no data to be reported. As planned, this societal KPI is further addressed in the scope of the Smart Networks and Services Partnership targeting both the decrease of energy consumption by networks as well as by vertical industries.

#### **S3. European availability of a competitive industrial offer for 5G systems and technologies**

Also, an analysis of the data in the latest publicly available reports such as IPlytics<sup>24</sup> (June 2022), indicates that **European headquarter companies share a 15,59% of active and granted 5G US or EP granted patent families**. As the report indicates “However, not all self-declared patents are essential and valid, also SEPs vary by value – with some covering core technologies of the standard and others only claiming inventions on minor improvements to the standard”. Therefore, the same report also examines the **number of approved technical 5G contributions of European companies**. Their share is **37.04%** and brings European companies in the first place. **Moreover, publicly available results suggests that the EU HQ companies combined share the majority of 5G commercial deals<sup>25</sup>, whereas other reports suggest that the European HW companies holder 30% of the Telecom equipment market<sup>26</sup>.**

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<sup>21</sup> <https://www.ericsson.com/en/5g/contracts>

<sup>22</sup> <https://www.nokia.com/networks/5g/5g-contracts/>

<sup>23</sup> <https://www.delloro.com/key-takeaways-2021-total-telecom-equipment-market/>

<sup>24</sup> IPlytics, Who is leading the 5G Patent race?, A patent landscape analysis on declared SEPs and standards contributions, June 2022 <https://www.iplytics.com/>

<sup>25</sup> <https://www.spglobal.com/marketintelligence/en/news-insights/research/5g-tracker-79-markets-worldwide-have-commercial-services>

<sup>26</sup> <https://www.delloro.com/key-takeaways-2021-total-telecom-equipment-market/>

#### **S4. Stimulation of new economically viable services of high societal value like U-HDTV and M2M applications**

Although 5G networks have been operational in several countries their full rollout has not taken place yet. Also, the uptake of 5G devices by consumers has still to pick up pace. Thus, it is still not clear which new services with high societal value will emerge. Note that the economic viability of such services requires some careful analysis and design. Under the context of the Vision and Societal Challenges WG the “Business Validation, Modelling and Ecosystem SG” (BVME SG). During 2022 the WG has issued a white paper entitled “5G and Beyond 5G Ecosystem Business Modelling) offering some useful insight.

Also, as presented by 6G START Deliverable 1.1 “Impact Analysis Report 1.0” several application from verticals have been developed and tried. All these are captured in the Vertical Cartography<sup>27</sup>.

The Verticals Cartography visually shows the progress of 5G and early 6G use-case experiments within 5G PPP phase 2 projects, in the latter part of Global5G.org, phase 2 and phase 3 projects (ICT-17-18-19-20-41-42-52-53). The Verticals Cartography was developed thanks to the support of the Technical Board (TB) to collect data points that would help classify and analyse use-case experiments targeting industry verticals in the 5G PPP. This work was started under the Full5G project, where the focus was initially mainly on phase 2 projects, while 6G START has inherited this legacy working more towards enriching contributions and integrating phase 3 projects.

Until today, a total of 177 use cases have been added to the vertical cartography<sup>28</sup>. Of these use cases, 92 were mapped in the already-mentioned *D3.5 Verticals Cartography Version 2 of Full5G - Fulfilling the 5G Promise* project, while the rest was subsequently added after the deliverable’s publication. In the context of 6G START, a group of 52 5G projects need to be monitored to collect information about their relevant use cases. For this purpose, a survey was sent to the projects with the support of the Technical Board. As a result, the cartography is now updated with information provided by 28 projects and 83 related use cases. The remaining 24 projects still have not provided information. Therefore, they will be monitored closely in the second part of the project so that their updated use cases can be included in the cartography and analysed in the second iteration of the present deliverable due in July 2024 (M27).

Below is a summary of the use cases linked to the projects who replied to the survey:

- *5G-IANA: 5G Intelligent Automotive Network Applications*, **ICT-41-2020** (June 2021-May 2024): 7 use cases.
- *5GMediaHUB: 5G experimentation environment for 3rd party media services*, **ICT-41-2020** (January 2021-December 2024): 3 use cases.
- *B5G-OPEN: Beyond 5G – OPtical nEtwork coNtinuum*, **ICT-52-2022** (November 2021-October 2024): 1 use case.
- *DEDICAT 6G: Dynamic coverage Extension and Distributed Intelligence for human Centric Applications with assured security, privacy, and Trust: from 5G to 6G*, **ICT-52-2020** (January 2021-December 2024): 4 use cases.
- *MARSAL: Machine learning-based, networking and computing infrastructure resource*

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<sup>27</sup> <https://verticals-cartography.5g-ppp.eu>

<sup>28</sup> <https://global5g.5g-ppp.eu>

*management of 5G and beyond intelligent networks, ICT-52-2020* (January 2021-December 2024): 4 use cases.

- *SMART5GRID: Demonstration of 5G solutions for SMART energy GRIDs of the future, ICT-41-2020* (January 2021-December 2024): 2 use cases.
- *TERAWAY: Terahertz technology for ultra-broadband and ultra-wideband operation of backhaul and fronthaul links in systems with SDN management of network and radio resources, ICT-20-2019* (November 2019-October 2022): 1 use case.

During 2022 the 6G-IA Societal Needs and Values Creation sub-group of the 6G-IA Vision and Societal Challenges WG has provided a white paper entitled “What Societal Values will 6G address”. The White Paper outlines how a technology development driven from the perspective of societal values can complement the usual performance-driven perspective. A set of use case areas, representing new possibilities in 6G, are identified from published sources mainly from EU funded ICT-52 research projects. These use case areas are then analysed with respect to societal key values that can be impacted by future technology developments. This entails defining Key Value Indicators (KVIs) that can be used for monitoring and validating the impact on key societal values, and vice versa, for studying how societal Key Values can be enabled by impacting the technology development in certain directions. We find that the studied use case areas can indeed be connected to societal key values that can be enabled by future 6G networks, and that it is possible to define KVIs to estimate this value impact.

## **S5. Establishment and availability of 5G skills development curricula (in partnership with the EIT)**

Data for new curricula/qualifications created were collected through a questionnaire<sup>29</sup> from 5G PPP project beneficiaries. These are progressive values, referring to the period 2014-2022. A finer scale (e.g., per year) is very difficult to implement, since the creation of jobs/skills and of curricula/qualifications can be hardly attributed on a per-year basis.

The following procedure was applied to calculate this KPI:

- Data for New 5G curricula and/or educational qualifications were collected through a questionnaire from 5G PPP project beneficiaries.
- Calculated average values of per legal entity type (Large Industry, SME, Academic Institution, Research Center)
- On the H2020 Qlik Sense dashboard, the following information has been extracted:
  - (per legal entity type) # of beneficiaries for the following Phase 3 Call Topics: ICT-18-2018, ICT-19-2019, ICT-20-2019-2020, ICT-42-2020, ICT-53-2020, ICT-41-2020, ICT-52-2020.
- The average values of the parameter have been multiplied by the total number of beneficiaries.

*Table 4: 5G curricula and/or educational qualifications*

2014-2022	New 5G curricula and/or educational qualifications	
	Average	Total projected

<sup>29</sup> <https://5g-ppp.eu/5g-ppp-progress-monitoring-report-data-collection-2019/>

Overall	4,32	4.654
Large Industry	8,33	3.661
SME	2,00	686
Academic Institution	1,40	209
Research Center	0,67	98

### 3.3 Evolution over the years

The 5G PPP consists of three phases of collaborative research. Thousands of researchers and developers across Europe have been working on innovative solutions for the definition of 5G. The activities for 5G networks started in the context of FP7 producing the first research concepts and directions and continued through Horizon 2020. This approach has served the goal of placing Europe in the leading position. As explained in Section 2.1, The 5G PPP has been designed in a structured way to start with innovative concepts (Phase 1), move through the development of key technical breakthroughs (Phase 2), and follow up with trials and pilots (Phase 3).

During 2022 the last 30 5G PPP projects were active and are working to build on the momentum of the previous phases and produce results that will not only safeguard EU's position for 5G networks but also provide the initial pillars for 6G networks.

**Note that the 5G PPP Programme has successfully managed to capitalize the results produced by past phases and use them in latest projects as shown in Figure 6.**

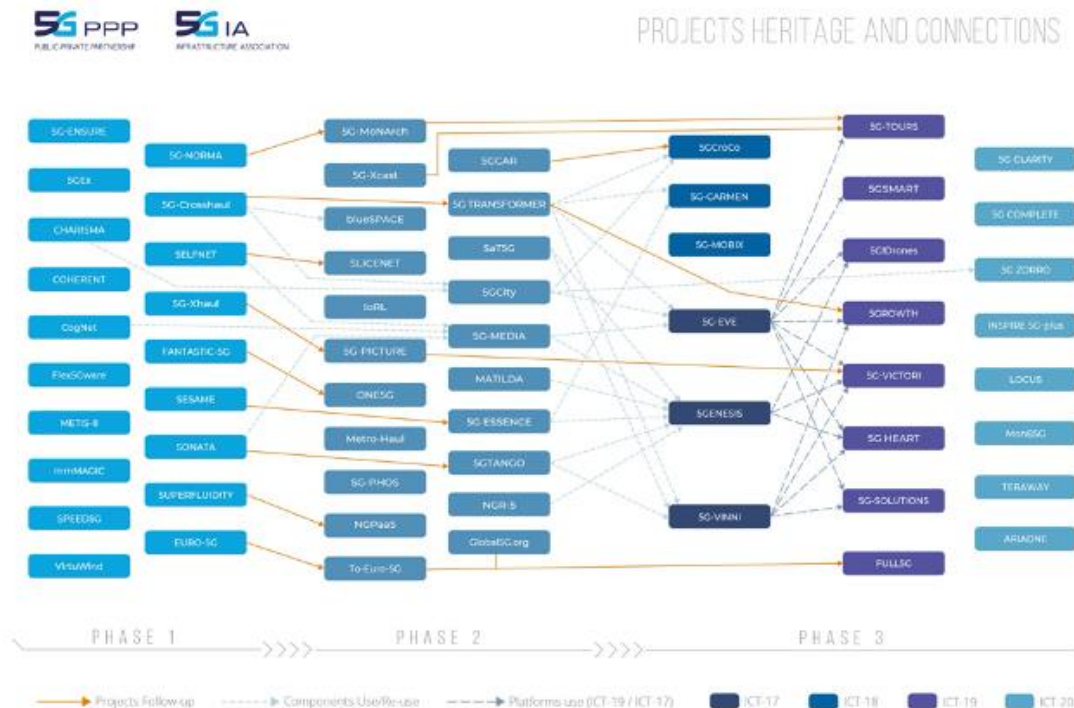


Figure 6: 5G PPP Projects - Heritage Figure



As we will discuss in the following section, the 5G PPP Programme has achieved several important and tangible results. Moreover, the overall results of the 5G PPP have been taken into consideration for the Smart Networks and Services Programme proposal as discussed in Annex 6.

#### 4. Outlook and lessons learnt

The 5G PPP Programme has continued to provide valuable results during 2022. The quantification of the success has been recorded in this PMR with data and information on Programme KPIs.

The 5G PPP global impact achievements already include:

- A major impact on 5G standards with continuous efforts with contributions to SDOs
- Beyond standards, proving the 5G system is working for more than 10 verticals' categories in multiple test/experiment sites
- Phase 3 projects have produced 1988 publications so far (34% of which was published in scientific journals).
- Successful pan-European mobilization in the activities with 783 stakeholders participating in the 5G PPP calls.
- Successful engagement of all types of organizations where notably 21,95% of the stakeholders were SMEs
- 25 MoUs and 3 LoI signed between 6G-IA and peer industry associations around the globe and industry organizations in priority vertical sectors

5G PPP has:

- Created 5G technology leadership for European industry
- Successfully achieved most of the challenging business and technical key performance indicators (KPIs) and is well on track for the societal ones
- Stimulated a high level of SME participation
- Had a positive impact on the innovation capacity of SMEs
- Mobilized huge private investments in 5G

Finally, the work in 5G PPP is enabling citizens and public authorities by:

- Supporting Europe's leadership in the digitization of industry and society
- Facilitating the creation of new societally beneficial services in 10 different vertical areas (e.g., smart cities, e-health, intelligent transport, power, environmental protection, education, entertainment & media)
- Enabling European e-inclusion through the rollout of high performant networks with pervasive access to all services

The above-mentioned achievements have been realized through hard work by many people. The 5G PPP is running smoothly under the current governance scheme. As 5G PPP has entered its final stage, the number of recorded achievements, the input to standardization organizations, the number of scientific publications, the significant number of trials are all proofs of the success of the Programme. The coordinated scientific work in the context of the working groups and the task forces is ensuring the dissemination of 5G PPP results at a global level. The organization of meaningful trials all over Europe is assisting European companies to test

in real life scenarios the 5G technology. Also, the European ICT community, through the close collaboration between the 6G-IA and the EC has managed to plan and successfully launch the follow up Programme, as Joint Undertaking. This certifies the strategic role of the ICT sector for Europe where is now in a unique position to create a live ecosystem that will bring together multinational industries, SMEs, research Centres, universities, and vertical industries.



## Annex 1 - 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 (i.e., the European Union Program for Research and Innovation). Its aim is to foster 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. It is one of the biggest 5G research programs 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.

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<sup>30</sup>.

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 completed their work around mid-2017, while some ended their tasks during mid-2018. They provided important results on core 5G technologies and managed to develop solutions that can 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.

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<sup>30</sup> [www.5GPPP.eu](http://www.5GPPP.eu)

- **Phase 3** addresses the development and rollout of 5G innovation and validation platforms across Europe. It started during the summer of 2018, with further calls preformed in 2019 and the final calls in 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 to strengthen Europe's influence on the 5G development.

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.

A key part of the 5G PPP structure is a set of cross-projects and cross-initiative working groups. Such 5G PPP working groups are the means to establish and publish program level opinions and positions on issues that impact all the projects and/or may be the basis for liaison or interaction with external bodies such as other regions or standards bodies. They are a) 5G Architecture WG, b) Software Networks WG, and c) Test Measurement and KPIs Validation WG.

## Annex 2 - The 6G Smart Networks and Services Industry Association (6G-IA)

During 2022, approximately 203 organizations were active full or associated 6G-IA members. Additionally, 6G-IA is collaborating with other partner organisations (e.g., 19 European and International organizations and industry associations) and it has signed 10 MoUs with international cooperation partners. Figure 7 shows the composition of the members. We need to note that since May 2022 and until June 2023, the number of 6G-IA members is over 300.

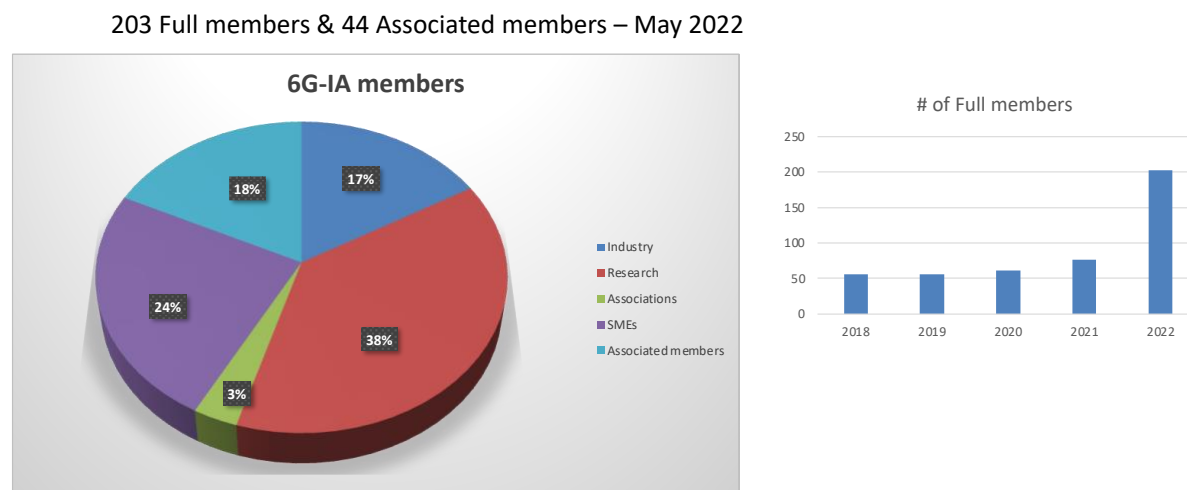


Figure 7: 6G-IA members as of May 2022

The 6G-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 6G-IA are to promote R&D in the networks industry 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, 6G-IA is working to mobilise the community and in particular the SMEs in the European collaborative research projects. As required by the 5G PPP Contractual Arrangement, the EU Commission and the Association have established the “**5G PPP Partnership Board**” comprising representatives from the European Commission (EC) and from the private side (i.e., from the 5G IA and Networld2020). This is the main body for dialogue and cooperation between the European Commission and the 6G-IA.

Moreover, under the responsibility of 6G-IA lie several WGs (c.f. **Figure 5**). These are: a) Open Smart Networks and Services WG, b) the Pre-standardization WG, b) the Spectrum WG (the operation of this WG were on pause during 2022 as not many 5G PPP projects are currently active in spectrum issues), c) the Vision and Societal Challenges WG, d) the Security WG, e) the Trials WG and f) 5G for Connected and Automated Mobility WG

Finally, 6G-IA carries out three additional key activities:

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

## Annex 3 – 5G PPP Projects

The 5G Infrastructure PPP Programme and its related projects continued their impressive work during 2022, providing key results and significant achievements for 5G networks and their evolution.

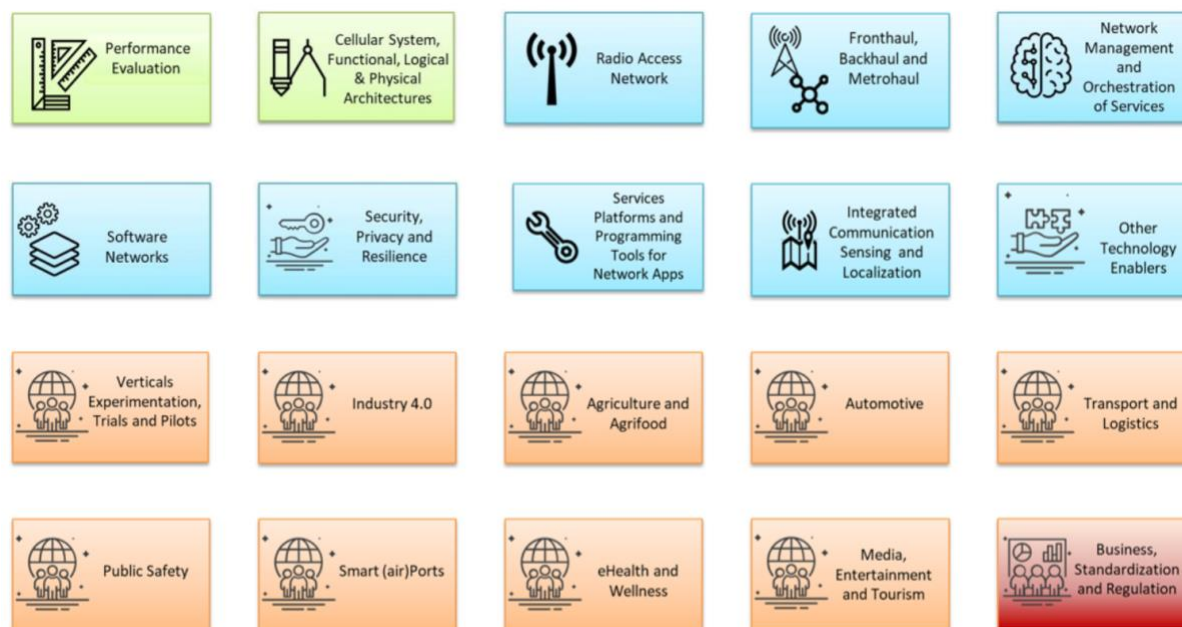


Figure 8: 5G PPP Key Achievements v 3.2

Following up on the previous years a compiled list of key achievements (version 3.1<sup>31</sup>) was produced on December 2022. As shown in Figure 8 the achievements were grouped in 9 technical areas, one for business standardization and regulation and 9 vertical sectors. In total, 129 achievements were reported in 2022 by 5G PPP projects.

Moreover, several 5G PPP projects have been working on technological areas that are closely related to B5G/6G technologies as identified by NetworldEurope SRIA. These areas are shown in Figure 9, and provide an excellent bridge of activities from the 5G PPP to the SNS JU era.

<sup>31</sup> <https://5g-ppp.eu/phase-3-key-achievements-3-2/>

# 5GPPP ACTIVITIES TO THE SRIA



Figure 9: Mapping 5G PPP activities in the SRIA pillars

Overall, during the last phase of 5G PPP, the community has placed significant effort on verticals sectors. As illustrated in Figure 10, 5G PPP projects have been active in 12 vertical sectors.

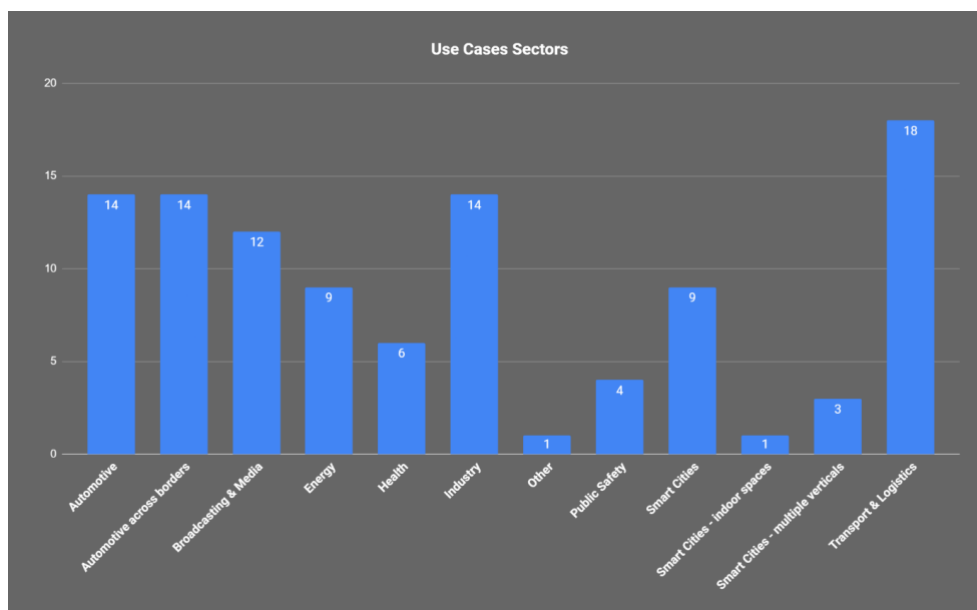


Figure 10: Vertical Sectors covered by 5G PPP projects

In geographical terms, top testbed locations include Spain (17 use cases), followed by Germany (16), Italy and Greece (15) and Norway (13), as depicted in Figure 11. Other EU countries have less than ten testbeds each.

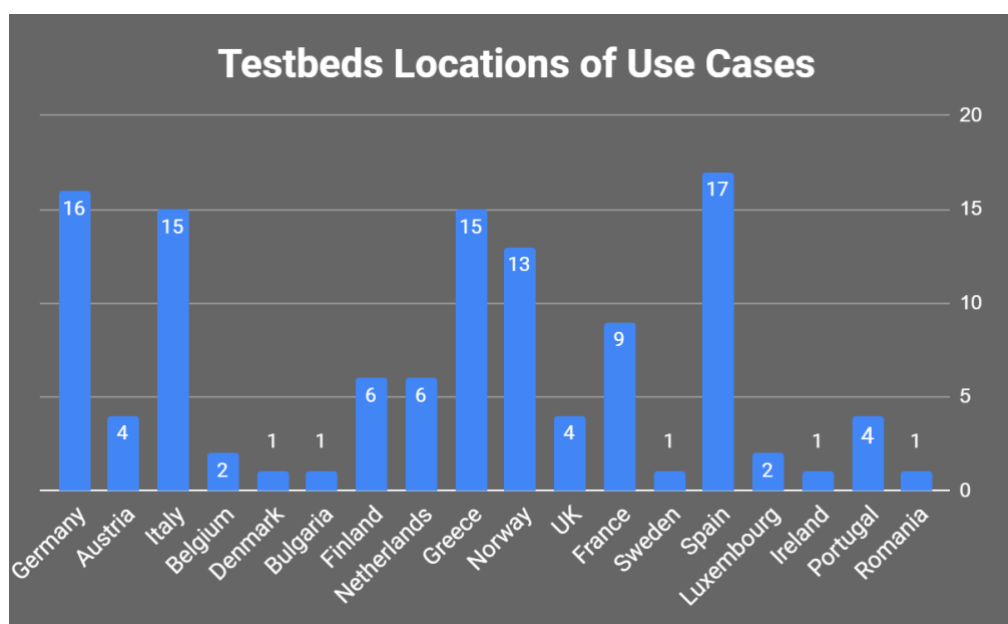


Figure 11: Use cases testbeds locations

Finally, as recorded in the 5G PPP site<sup>32</sup>, during 2022 the 5G PPP community has organized or participated in approximately 100 events.

<sup>32</sup> <https://5g-ppp.eu/event-calendar/>



## Annex 4 - 5G PPP working groups and their activities

As mentioned in section 2, a key part of the 5G PPP structure is a set of cross-projects and cross-initiative working groups. The outcome of the work from these groups is presented in white papers<sup>33</sup>. The first white paper was produced in October 2015. Below follows a description for the activities of each WG and their achievements during the reporting period.

### Architecture WG

The overall goal of the Architecture Working Group (WG) within the 5GPPP Initiative is to consolidate the main technology enablers and the bleeding-edge design trends for 5G and Beyond (5G/B5G) networks and bridging the gaps towards the future 6G networks. As a result, it aims to build a consolidated view of the architectural efforts developed in the framework of the 5G PPP initiative and other research efforts, including standardization. This effort serves not only to review the current state of the art, but also to identify architecture enabler technologies and solutions, promising trends towards the next generation of mobile and wireless communication networks.

The Architecture WG invites all 5G PPP projects together to attain a European View on the Overall Architecture of Mobile and Wireless Communications Networks across different Network Domains, such as Radio Access, Transport, Mobile Core, Cloud or Edge. The outcome is then published in a series of white papers and presented during various technical workshops in the international conferences and webinars. As shown in Figure 12, the latest white paper of the WG is “*The 6G Architecture Landscape - European Perspective*”, which is recently published on 06 February 2023, which is the Version 6.0. The first version of the architecture white paper from the Architecture WG was back to July 2016, since then, this effort continuously captured the technology trends as developed by the different phases of 5GPPP projects: the first phase (Phase I), that lied the foundation of the network slicing-aware operation we are seeing these days; the second one (Phase II) which provided the first proof of concepts; and the third one (Phase III) that has targeted the first large scale platforms. All these efforts were captured in the subsequent releases of the white paper (version 2 in January 2018 version 3 in February 2020, and version 4 in November 2021).



Figure 12: White Papers released by the Architecture WG

The latest Version 6.0 of the white paper<sup>34</sup>, was released in December 2022 for Public Consultation and final version is released in February 2023. This white paper summarizes the main findings from the European research landscape on the vision of the 6G architecture. Such a design vision is derived from around 45 projects (including ICT 17-20 Projects, ICT 41-42 projects, ICT 52-53 projects) starting from October 2020 in all relevant areas of 5G while paving the way towards 6G. The list of contributing projects can be obtained from the 5G PPP website at <https://5g-ppp.eu/5g-ppp-phase-3-projects/>. This white paper highlights the related

<sup>33</sup> <https://5g-ppp.eu/white-papers/>

<sup>34</sup> 5G PPP Architecture WG “*The 6G Architecture Landscape - European Perspective*,” February. 2023. Available at: <https://5g-ppp.eu/wp-content/uploads/2023/02/Whitepaper-final-version-rev1.pdf>

research work and presents all the key elements and key architecture enablers and solutions of future 6G network design; a design that is deeply rooted in real needs and can profoundly benefit humanity in the mid-to-long term. Specifically, a high-level view of the 6G End-to-End architecture as well as a functional view of the 6G reference architecture are introduced in this white paper, taking into consideration of new stakeholders in the mobile network ecosystem and how the architectural work is taking into account their requirements in all the domains of the network. The key architecture enablers, that will form the backbone of future 6G network architecture, includes all the related technological solutions for building intelligent, flexible, sustainable, secure, programmable networks and enabling versatile radio technologies, localization and sensing in the 6G networks.

The work in the latest version (version 6.0) of the white paper has been presented in the 2nd Workshop on Architectural Evolution toward 6G Networks – 6GArch in IEEE GlobeCom 2022. The workshop was organized by the Architecture WG together with projects Hexa-X, 6G BRAINS, DAEMON and others. The workshop included technical paper sessions where papers accepted by the workshop were presented, a keynote on “6G architecture driven design to enhance collaborative advantage” from Industry and also a panel focusing on the white paper presented by the main editors of the white paper.

In parallel, the Architecture WG is dedicating on the work of the Open Access book on B5G/6G, in joint efforts with Hexa-X and Hexa-X-II project and along with the support from EC and 6G-IA. The main chapters include: Strategy outlook, Efficient Access, Precise Positioning, Intelligent Networks, Sustainable Networks, Programmable Networks, and Secure, Trustworthy, Privacy-preserving Networks. The target completion and publication of the book is planned for June 2023, e.g., EuCNC 2023.

The key milestones of the WG for 2023 is planned as follows and illustrated in Figure 13.

- **M1:** Various inputs have been received based on the Public Consultation version from Dec 2022 and being processed, and included in the final version of the white paper. Noted that we obtained the most inputs received in the history of the WG.
- **M2:** Final version has been released on 06 Feb 2023. This is a concise version of the white paper with focus on overall architecture for 6G landscape, including the current technology and society trends, and key architecture enablers
- **M3:** Detailed version of the white paper is now preparing to be published as an open access book in 2023, which will cover overall architecture as well as the detailed chapters and sets architectural foundation.
- **M4:** Transition the WG to the SNS JU framework, e.g., update the Terms of Reference (ToR), change the focus to SNS projects, and align the WG scope accordingly. Potential completion date is targeted for Sept 2023.

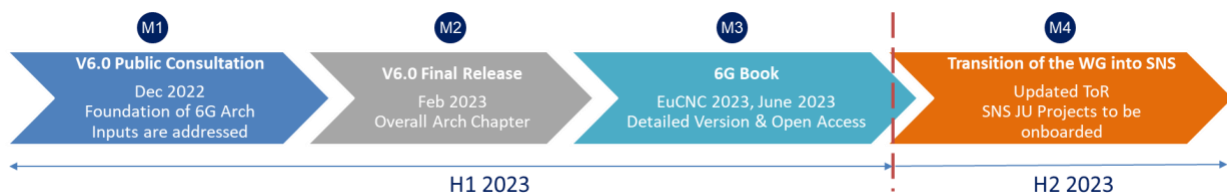


Figure 13: White Papers released by the Architecture WG



## Software Networks WG

In 2022, the Software Network Working Group worked on the interaction between network and applications. How to make the applications aware of the network and vis versa. This interaction led to the research topic named Network Applications. In fact, the Network Application ecosystem is more than the introduction of new vertical applications that have interaction capabilities. It refers to the need for a separate middleware layer to simplify the implementation and deployment of vertical systems on a large scale. Specifically, third parties or network operators can contribute to Network Applications, depending on the level of interaction and trust.

With a joint work among projects from ICT52, ICT41, ICT53, the WG released in September 2022 the white paper intitled: “*Network Applications: Opening up 5G and beyond networks 5G-PPP projects analysis*”. This version V1 summarizes the different implementations conducted by the different projects considering different API types and different level of trust between the verticals and the owner of the network platforms 5G and Beyond 5G.

Three models have been proposed:

- aaS Model: it is the model where the vertical application consumes the Network Applications as a service. The vertical application deployed in the vertical service provider domain. It connects with the 3GPP network systems (EPS, 5GS) in one or more PLMN operator domain.
- Hybrid: it is the model where the vertical instantiates a part of its Vertical App in the operator domain like the EDGE. The other part remains in the vertical domain. A similar approach has been followed in TS 23.286 related to the deployment of V2X server.
- Coupled/Delegated: it is the model where the vertical delegates its app to the operator. The Network Applications will be composed and managed by the operator. This approach is the one followed in the platforms like 5G-EVE.

The V1 paper also brings an analysis of the different API type deployed. It appears that the abstraction from network APIs to service APIs is necessary to hide the telco complexity making APIs easy to consume for verticals with no telco expertise and to address data privacy requirements.

### Key Activities and Achievements-

- Weekly call during it the different involved projects share their technical findings and collaborate on the joint white papers.
- Organize technical workshops focusing on new technologies/topics, new industry trend, etc. For example, one can cite Nephio, serverless, service exposure etc.
- Continuous participation in 5G PPP Steering Board (SB) and Technical Board (TB) meetings: working towards whitepapers of concerns and providing WG updates.
- Continue to cross-fertilise with other WGs of interest e.g. Architecture WG, and others.
- **Release** of version V1 of the white paper “[Network Applications: Opening up 5G and beyond networks 5G-PPP projects analysis](#)”, in September 2022.
- **Organize a Special Session in EUCNC 2022.**  
<https://www.eucnc.eu/programme/special-sessions/special-session-10/> . The following projects shared their views on Network Applications design: 5GIANA, 5GASP, 5G-

INDUCE, 5G-SOLUTIONS, EVOLVED-5G, 5G-EPICENTRE, 5G-ERA, Smart5Grid, VITAL-5G, 5G-MediaHub.

- Organize a **workshop in IEEE MEDITCOM 2022** (<https://meditcom2022.ieee-meditcom.org/>). The following projects are involved:
  - 5GIANA, 5GINDUCE, 5GASP, EVOLVED-5G, VITAL-5G, Smart5Grid, 5G-INDUCE, 5GMediaHub, 5GERA, 5G-EPICENTRE, 5G-SOLUTIONS, TERAFLW.
- Organize a **Special Issue for IEEE IoT magazine**, published in Dec 2022: <https://ieeexplore.ieee.org/document/10012471>.
  - 6 papers have been accepted and published, namely:
    1. M. Khadmaoui-Bichouna, G. Golcarenenrenji, I. Martinez-Alpiste and J. M. A. Calero, "Edge Computational Offloading for Corrosion Inspection in Industry 4.0," in IEEE Internet of Things Magazine, vol. 5, no. 4, pp. 116-120, December 2022, doi: 10.1109/IOTM.001.2200203.
    2. K. V. Katsaros et al., "Enabling Far-Edge Intelligent Services with Network Applications: The Automotive Case," in IEEE Internet of Things Magazine, vol. 5, no. 4, pp. 122-128, December 2022, doi: 10.1109/IOTM.001.2200215.
    3. E. Pateromichelakis, D. Dimopoulos and A. Salkintzis, "NetApps Enabling Application-Layer Analytics for Vertical IoT Industry," in IEEE Internet of Things Magazine, vol. 5, no. 4, pp. 130-135, December 2022, doi: 10.1109/IOTM.001.2200212.
    4. M. Barletta, M. Cinque and C. Di Martino, "SLA-Driven Software Orchestration in Industry 4.0," in IEEE Internet of Things Magazine, vol. 5, no. 4, pp. 136-141, December 2022, doi: 10.1109/IOTM.001.2200216.
    5. G. Miranda et al., "The Quality-Aware and Vertical-Tailored Management of Wireless Time-Sensitive Networks," in IEEE Internet of Things Magazine, vol. 5, no. 4, pp. 142-148, December 2022, doi: 10.1109/IOTM.001.2200214.
    6. S. Arora, K. Boutiba, M. Mekki and A. Ksentini, "A 5G Facility for Trialing and Testing Vertical Services and Applications," in IEEE Internet of Things Magazine, vol. 5, no. 4, pp. 150-155, December 2022, doi: 10.1109/IOTM.001.2200206.

#### Test, Measurement and KPIs Validation WG

The Test, Measurement, and KPIs Validation (TMV) Working Group was founded as part of the 5G PPP effort to promote commonalities across projects that have strong interest in the T&M methodologies needed to provide support to the vertical use cases in the 5G Trial Networks. Such efforts include the development of Test and Measurement methods, test cases, procedures and KPI formalization and validation to the greatest possible extent, ensuring a unique European vision on how to support the entire lifecycle of the 5G network, from R&D to actual deployed environments.

The Group is comprised by several Phase II and Phase III 5G PPP projects, and it considers the following research areas and technology domains:

- Testing KPI definition, KPI sources, collection procedures and analysis
- Testing frameworks (requirements, environment, scenarios, expectations, limitation) and tools
- Testing methodologies and procedures
- KPI validation methodologies
- Testing lifecycle (i.e. testing execution, monitoring, evaluation and reporting)

- Common information models for 5G T&M

Another important topic is the use of and contribution towards open-source projects such as OSM, OPNFV or ONAP and identification of relevant exploitation and dissemination targets to promote the European vision on T&M towards a more global adoption.

### Key Activities and Achievements

During 2022, TMV WG: a) organized 20 conference calls to discuss the WG current activities, progress and identify next steps; b) organized one workshop on B5G/6G KPIs for presenting and disseminating its outcomes; c) published two whitepapers on the topics of B5G/6G KPIs and 5G testing; d) provided contributions to ITU Working Party 5D (WP5D).

#### Whitepaper on Beyond 5G/6G KPIs and target values

This whitepaper, released in June 2022, is presenting the current view of the available B5G and 6G KPIs from the 5G PPP phase III projects with an emphasis on the views of the ICT-52 Smart Connectivity Beyond 5G projects. This overview view includes mapping the KPIs previously defined for 5G and evaluating how they might evolve to fit the B5G and 6G visions. The analysis of the KPIs from the projects seeks to understand if the KPIs are defined in existing standards documents (implying an evolution of the KPI from 5G) or if they are new and thereby are candidates for being standardised (true 6G KPIs).

Depending on the scope of the projects, the nature of the services and applications, and the focus of the experts' groups, the reference level and the definition of KPIs can be different. Standard definitions in previous generation networks are usually inherited, while at the same time new KPIs are defined addressing 6G-specific aspects. In order to provide a harmonized and formalised view of beyond 5G and 6G KPIs, a three-step KPI clustering and definition methodology (Figure 14) was followed in the whitepaper:

- Define the information to be collected by the research projects, related to KPI definitions, target values, and information relevant to the context of these definitions.
- Aggregate and streamline the information and cluster the KPIs in KPI families representing the ICT-52 projects vision on key beyond 5G and 6G qualities.
- Review standard KPI definitions and target values from International and European Standards Developing Organisations (ITU-R, 3GPP and ETSI) and use as reference for the relevant KPI families.

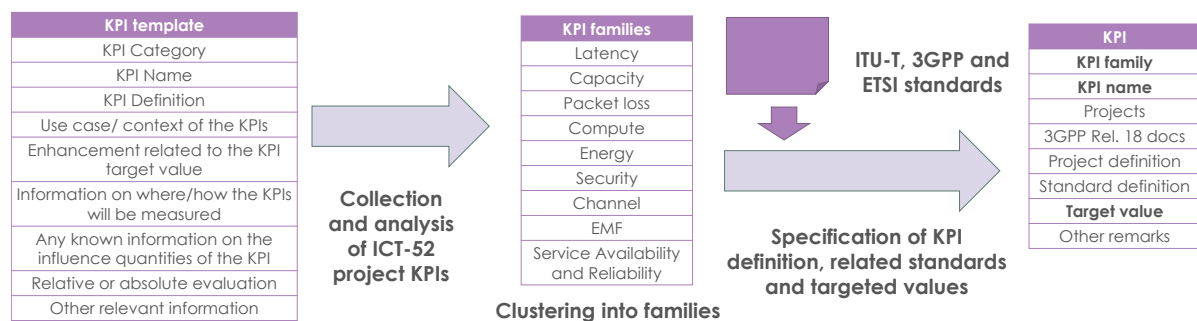


Figure 14: KPI clustering and definition methodology followed in the whitepaper

The white paper is available from the 5G PPP website<sup>35</sup> or directly on Zenodo<sup>36</sup>.

<sup>35</sup> <https://5g-ppp.eu/5g-ppp-white-paper-beyond-5g-6g-kpis-and-target-values/>

<sup>36</sup> <https://zenodo.org/record/6577506>

### Whitepaper on basic testing bundle for 5G testing

This document (Basic Testing Guide) is a practical guide describing the starter kit developed in the context of the 5G PPP TMV WG. The guide enables the interested developer to understand how this can be applied to measure and verify basic 5G KPIs. The document starts from describing the idea intention to measure up to the actual realization of the test. To enable the test, a description of the environment, how to install it, the test tools and the methodology is provided. It goes from idea to run the actual test, step by step. The proposed framework with the support of the described android agents can in principle support the validation of application level KPIs running at the android UEs, while for other application-specific KPIs running at other systems, the development of specialized plugins is necessary.

The white paper is available from the 5G PPP website<sup>37</sup> or directly on zenodo<sup>38</sup>. In addition, the starter kit software is available in Gitlab<sup>39</sup>.

### Contribution to ITU Working Party 5D (WP5D)

The initial motivation was to disseminate the whitepaper “Beyond 5G/6G KPIs and Target Values” into ITU. In this direction, the ITU Working Party 5D (WP5D) was selected as perfect candidate and its ongoing work on IMT-2030 Vision. The TMV WG partners contacted the WP5D members and presented to them the findings of the whitepaper. The proposal was accepted, and the whitepaper was submitted to ITU-R WP5D according to the existing procedure. The document was considered in the ongoing work of WP5D on IMT-2030 Vision.

### Workshop

TMV WG organized a workshop on “6G KPIs and how to measure them” on 28 Sept 2022 09:00 – 12:00.

This workshop targeted to discuss the KPI definitions and which measurement techniques exists to monitor them. The workshops also intended to identify potential support for the ICT-52 projects. The workshop was also the kick-off of the next iteration of the white paper on “Beyond 5G/6G KPIs and Target Values” where the aim is to further refine target values and the measurement techniques, again based on input from the ICT-52 projects and the 5GPPP TMV working group.

The workshop content can be found here<sup>40</sup>.

### **Future plans**

The TMV WG is planning to publish three whitepapers during 2023 (by end of June 2023) to report the progress and findings of TMV WG

- A whitepaper focused on B5G/6G KPI measurements. The main targets of the paper are: a) mapping of B5G/6G KPIs with measurement Tools; b) review standards on measurement capturing, collection and processing; c) identify KPIs that cannot be measured and study on concepts of how we can evaluate/assess the performance with respect to these KPIs.
- A whitepaper as an updated version of the 2021 trial-based results/KPIs whitepaper. This time, the targeted white paper should provide measurements/results and insights from the majority of the 5G PPP projects, and the respective trials/pilots they have

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<sup>37</sup> [https://5g-ppp.eu/wp-content/uploads/2022/01/TMV-Basic-Testing-rev005-17112021\\_clean.pdf](https://5g-ppp.eu/wp-content/uploads/2022/01/TMV-Basic-Testing-rev005-17112021_clean.pdf)

<sup>38</sup> <https://zenodo.org/record/5704519>

<sup>39</sup> <https://gitlab.com/OpenTAP/Plugins/5g-ppp-test-measurement-and-kpis-validation-wg/5gppp-tmv-basic-testing-bundle>

<sup>40</sup> <https://5g-ppp.eu/event/workshop-on-6g-kpis-and-how-to-measure-them/>

executed over the past years. The clear goal of this white paper will be to provide an answer to the question “What were the main KPI values that were measured across the 5G PPP 5G networks used in trials/pilots under different conditions and what were the key insights gained from the 5G PPP programme?”.

- A whitepaper on “KPIs Measurement Tools - From KPI definition to KPI validation”. The whitepaper will provide a comprehensive presentation of the 5G KPI measurement available tools / available infrastructures / available frameworks and platforms / available data infrastructures used in Phase II and Phase III 5G PPP projects. In addition, it will provide best practices on how to perform 5G measurements.

## Annex 5- 5G Initiative: Boards' activities and achievements

The 5G PPP Initiative is a complex structure engaging a significant number of stakeholders. The Steering and Technology Boards play a crucial role in the overall synchronization of the involved entities and the success of the Initiative. **These Boards** in full synchronization and cooperation with the 6G-IA Board, the 6G-IA Verticals Task Force and WGs as well as the 5G PPP WGs, with the strong support of the CSA project **have produced some significant results** (e.g., white papers from the WGs, workshops organized by WGs or projects, etc.). The Technology Board organized **regular conference calls** and **one virtual meetings (due to the pandemic)** and **one face-to-face meeting**.

The list below highlights some of the major achievements at Programme and Technology Board level.

- The ICT-41, -42, -52, -53 projects' Reference Figure was constructed jointly with the 6GStart project and made public towards the end of the year (2022-12-21). First, during the spring of 2022, the projects of each call agreed on categories to select from, and then each project selected the appropriate categories to reflect its project targets and overall focus. As a last step, during the autumn of 2022, the material was brought together into a joint reference figure of the respective calls that finally was made public on a 5G PPP website.
- The Key Achievements v3.2 (2022-12-21) has been produced from project inputs (where 46 out of 52 targeted projects have provided input) and where a 6GStart consolidation of the collected material illustrating the impact 5G PPP projects and their evolution of 5G networks and 6G research.
- Cartography work for Phase 3 projects continued, and now also includes technical position in relation to SNS that was used to create graphical illustrations of different focus areas on the 6G-mapping and new Strategic Research and Innovation Agenda (SRIA).
- Overall, the TB has continued to serve as a platform for projects in their technical interactions, and where established collaborations for instance have led to co-organized events at EuCNC. Different presentations were held in TB meetings during the year to inform projects on different topics, such as a Horizon Result Booster (HRB) presentation was given (7<sup>th</sup> of April), and the 28<sup>th</sup> of April 2022 TB meeting was dedicated to a Security session where six different projects held one 15 minutes presentation each on security related topics.
- The beginning of the year took off on the 18<sup>th</sup> and 19<sup>th</sup> of January 2022 with a virtual TB workshop with the first day focusing on ICT-17 and ICT-19 project presentations and learnings, while the second day was focused on 6G topics from ongoing projects to share learnings and trigger further collaborations.
- Early October (5<sup>th</sup> and 6<sup>th</sup>), A two-day SB and TB face-to-face meeting was hosted by Institute of Communication & Computer Systems (ICCS) in Athens. The TB-day was attended by around 30 people and was dedicated to reflections on our ways-of-working, on our way forward, and a technical workshop on Network Applications that contained presentations and in-depth discussions.
- The white paper Non-Public-Networks – State of the art and way forward was finalized and made public in November 2022.
- The collaboration with WGs continued. Some examples of TB and WGs interactions are for instance project inputs collection for the quarterly Standards Developing

Organization (SDO) Impact Report by the Pre-Standardization WG, collaboration with the Test, Measurements and Validation (TMV) WG to simplify for projects to make contributions, reviews and feedback on e.g. project KPIs, and Network Applications work run from the Software Network WG.

- Regarding the term NetApp, the following was agreed on the 8<sup>th</sup> of December 2022 TB meeting: “It has been brought to our attention that the term NetApp is trademarked by the company NetApp as described in <https://www.netapp.com/company/legal/trademarks/>. The term NetApp should therefore not be used within 5G PPP, e.g., from 5G-I TB, 5G-I SB, a 5G PPP WG or a 5G PPP project perspective, unless one is referring to the NetApp company. To avoid confusion, the term NetApps should also not be used. Instead, the recommendation is either to use the formulation Network Applications (alternatively network applications), or to use Network App or Network Apps as a shorter version.”
- Some other topics are still ongoing work that bridges over into 2023. For instance, the creation of a new 5G Infrastructure PPP – Trials & Pilots Brochure version has been initiated to highlight key results of Phase 3 Trials & Pilot activities. Another topic is to construct an updated version of the Heritage Figure, and also some ongoing on white papers.



## Annex 6 - 6G-IA Activities and Achievements

6G-IA is actively involved in the realization of 5G in Europe through several groups and actions, including: the ‘partnership board’, one task force, 7 WGs and three key activities. The following subsections record their outcomes and key achievements of all 6G-IA activities.

### Verticals Engagement Task Force

The Vertical Engagement Task force has pursued its strategic goals. Companies representing different industrial sectors joined 6GIA as new members, while the existing vertical community engagement was more involved in traditional activities such working group participation (e.g., Trial WG), whitepaper editing and industry events attendance.

**Events** were selected to disseminate 6GIA activities. **PSCE**, a vertical association in the Public Safety domain elected 6GIA Board Member, organized a session on 5G evolution within the PSCE Conference. A **Vertical User Workshop** was organized as online event with the **6GStart Project**. MoU partners were invited as speakers to provide requirements from their vertical sector to feed the standardization process.



The **6G Health Institute** joined as a new 6GIA member which will allow to gather inputs from a heavy adopter such as the **Health** public and private sector. The MoU with **5GAA** was renewed for other 3 years which will continue collaboration on strategic issues such as CEF program through the 5G CAM WG. Talks with new vertical associations (e.g., **EUTC** in the **utility** space) were undertaken.

Vertical related activities will be pursued in 2023 also within the 6GIA **SNS ICE** project. This CSA project includes **WP3** which will focus on vertical activities, bringing the VTF activities to the next level. Activities will focus on gathering requirements from vertical sectors to enrich 6G. Special sessions will be organized for key events such as EUCNC and 5G Techritory.

### 5G Vision and Societal Challenges WG

The mandate of the Vision and Societal Challenges WG (VSC WG) is to work out a comprehensive vision and high-level technology roadmap for the 5GPPP, SNS JU and the 6G-



IA by involving the 6GIA community and its experts. This roadmap should capture the most relevant, promising technological trends and analyse them in terms of:

- Technological excellence, suitability and relevance,
- Economic impact of both upcoming and recently introduced technologies,
- Regulatory and political impact,
- Societal impact and value,
- 

Beyond this, the VSC WG constantly and continuously analyses the project portfolio of the running 5GPPP and SNS JU projects and tries to distil the difference between its own findings and the accomplished research project work in the form of contributions to the future SNS JU calls.

To do all this, VSC WG has been running several subgroups (SG), dedicated to the impact analysis of the different technological developments in the sense of the above. As a reaction to the expected changes in the 6G research era and with the now initiated SNS JU, in 2021 and 2022, the Working Group has been reorganized and slightly restructured to include the following subgroups:

- Smart Networks and Services Vision SG – SNSV SG  
Responsible for the identification and analysis of the most promising technological trends.
- Business Validation, Models, and Ecosystem SG – BVME SG  
Responsible for the field of economic validation of novel and emerging use cases in the sense of the required ecosystem adaptations and suitable business models.
- Member State Initiatives in 5G/6G SG – MSI SG  
Responsible for the identification of and liaison with the local member state research and other initiatives
- Societal Needs and Value Creation SG – SNVC SG  
Responsible for the identification of methods to include a societal value-thinking into technology development.
- Portfolio Structuring and Analysis SG – PS&A SG  
Responsible for the structuring (e.g. PPP Pre-Structuring Model (PSM)) and analysis of the research and innovation portfolio, considering as well SNS JU.

To follow up on the ongoing integration of the SNS JU activities, in 2022, the Group Chairs have produced the new Terms of Reference (ToR) document and sent it for approval to the 6GIA GB. Also, with the help of the 6GIA exec office, the mailing lists were transferred from the previous 5GPPP to the 6GIA realm. Although both email addresses stay operational for the moment, this change strives for a more correct attribution of the WG's origins.

We now present the major results on per subgroup basis.

In 2022, through the liaison of 6G-IA with Network Europe, the SNSV SG has strongly contributed to Network Europe's Strategic Research and Innovation Agenda (SRIA). One of

the chairs of the SG was appointed chapter editor for the System Architecture (SA) chapter and also served as one of the few authors for the SRIA Whitepaper. The end-result of this expert community work reconfirmed and refined the European Industry 6G Vision published in 2021 and improved on the previous SRIA work from 2020 in terms of technology updates and additions, target descriptions and expected timeline definitions. Published as a comprehensive technical annex document and a more concise higher-level description document, this work has served as an exclusive technical base for the definition of the SNS Phase 2 Technical Call objectives (for the SA part, in particular for SNS JU Phase 2 Strand Call B-01-01).

Throughout 2022, the BVME SG has worked on a white paper on 5G and Beyond Ecosystem Business Modelling. The work rested, while the group opted for several workshop suggestions on the topic. One of our workshop proposals was accepted at IEEE GLOBECOM 2022<sup>41</sup>. Alas, the SG had to accept a cancellation of this workshop due to the lack of submissions. The BVME work on 5G ecosystems and business modelling was, on invitation, presented at a workshop at IEEE Future Networks World forum by the BVME chair<sup>42</sup>.

As in previous years, the Member State Initiatives in 5G/6G SG prepared and compiled the yearly edition of the Member State Initiatives report, which was published in early 2023.

During the year, SNVC SG has published and presented a first whitepaper on Key Value Indicators, arranged an ICT-52 workshop gathering inputs from running 5GPPP projects on that matter and submitted an ITU-R IMT-2030 contribution on this topic.

The Portfolio Structuring and Analysis (PS&A) SG has continued work on portfolio analysis of the 5GPPP and SNS JU as a whole. In connection with the Technology Board (TB) the PPP and 6GSTART, the PS&A SG further updated Projects Heritage table. Besides, also in 2022, the group contributed its vast experience (including key lessons learnt) during the compilation of the SNS JU Phase 2 Work Programme.

### Pre-standardization WG

The main activities of the Pre-Standardization WG have been:

- Tracking and analysing inputs to standards organizations from 5G PPP projects.
- Encouraging projects to showcase these inputs during monthly calls as part of the drive to collect success stories and support impact reporting.
- Strengthening the collaboration with ETSI, in particular ETSI NET:
  - Sending Liaison Statement including feedback on ETSI Technologies Radar;
  - Organising a Special Session at EUCNC'22, titled “Research results impacting B5G and 6G through Standardization”;
  - Contributing to the organisation of a Convened Session at EUCNC'23, organised by the EC, titled “The path to 6G standardisation”;
  - Periodic updates and discussion on upcoming and running ISGs (e.g. SubThz/Thz modelling, RIS);
  - Contributing to the organisation of ETSI Research Conference: “Maximizing the Impact of European 6G Research through Standardization”, held in Sophia Antipolis on Feb. 6-8, 2023;
- Hosted standard related educational activities, in particular the lecture “3GPP Standardization: A tutorial for Researchers”;

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<sup>41</sup> <https://globecom2022.ieee-globecom.org/>

<sup>42</sup> <https://fnwf.ieee.org/workshops/workshop-5g-trials-across-multiple-vertical-industries/>

- Continuing close collaboration with 3GPP on the 5G User Event series:
  - organising in November the 5G Vertical User WS “REQUIREMENTS & GAPS OF VERTICAL INDUSTRIES FOR THE FUTURE OF 3GPP RELEASES” held on 24.11.2022;
  - Series of online events/workshop in the pipeline for 2023, on Vertical Industries such as e-health, Satellite and Space, Automated farming, Education etc.
- Liaising with ETSI, 3GPP and other specialists to keep the WG members up to speed on standardization work, including dedicated 3GPP debriefs from Plenary Meetings.
- Liaising with StandICT, disseminating info e.g. on “EUOS” – online observatory - an helpful tool for all research projects involved in standardization;
- Liaising with ISO ITS, in particular disseminating info on Big Data and Artificial Intelligence supporting ITS activity.

The tracking of 5G PPP project inputs to EU and global standards organizations has covered contributions to 3GPP, ETSI, IETF, IEEE among others. Tracking such inputs has also been an effective way to identify successful projects with distinguishing and notable impact towards relevant standard bodies, such as past projects 5G-VINNI and 5G-Croco (presenting the EUCNC Special Session), and current ones such as 5G-Clarity and Teraflow.

The strengthened collaboration with ETSI enables the WG to give its members practical guidance on transferring their results through standardization. The collaboration is also an opportunity to highlight relevant ETSI activities members can join and potentially lead, such as forming an Industry Specification Group (ISG) for B5G/6G. One example is SubThz/Thz modelling as a cross-industry initiative.

The 5G User Event series has enabled the WG and MRPs to impart new knowledge on requirements and gaps of vertical industries for future 3GPP releases e.g. in the fields of Media Apps and ICT, Critical Communications Technologies (TCCA), Connected and Automated Industries (5G-ACIA) and Automotive.

The 5G IA Pre-Standardized WG tracks and analyses the inputs of 5G PPP projects to standards organisations. Many projects have contributed to three rounds of inputs in Q1-2022, Q2-2022 and Q3-2022. **In this activity over 200 contributions to Standards Developing Organisations have been tracked**, great proportion relating to **3GPP (40%+) and ETSI (25%+)**.

### 5G for Connected and Automated Mobility WG

The “5G for CAM Working Group” is a 6G-IA Working Group. It has been established as a means of supporting 5G for CAM activities funded under EU Programmes covering both R&I and deployment activities in two work streams:

- (i) R&I: Establish a knowledge base and facilitate the exchange of information on ongoing R&I activities in the field. Relevant findings should be disseminated e.g. in the form of white papers. This activity should also develop suggestions for Strategic Research and Innovation Agendas for SNS and the new PPP on Cooperative Connected and Automated Mobility (CCAM).
- (ii) Deployment: Prepare elements of strategic guidance in view of European deployment programmes on the field, in particular, 5G Corridors for CAM under the CEF2 Digital Programme. Such activities should be the basis for the

establishment and update of Strategic Deployment Agendas adopted by the Governing Board of the SNS JU as foreseen in the Council Regulation establishing the JU. The group should also facilitate broader stakeholder cooperation and building of project pipelines through workshops and networking activities. This activity will get major input from the planned programme support action on the 5G corridor SDA under CEF2 Digital, which is planned to be launched early 2022.

### **Key achievements**

From January to July 2022, the group had been chaired by Jesus Alonso-Zarate (i2CAT), along with Apostolos Kousaridas (Huawei Technologies) as the vice-chair for the R&I Stream, and Edwin Fischer (Deutsche Telekom) is the vice-chair for the deployment stream. In June 2022, Markus Dillinger, also from Huawei Technologies, replaced Apostolos as vice-chair for the R&I Stream. This decision was approved by the 6G-IA Governing Board as per request from Apostolos Kousaridas, since he was leaving Huawei Technologies.

The WG has had regular bi-weekly meetings along the year, with the exception of the summer period, when only a monthly meeting was celebrated. The meetings account with an average of 20-25 attendees regularly, including participation from both representatives from the 6G-IA Board and the European Commission.

The meetings have been alternating between R&I stream and deployment stream:

- The meetings for the R&I stream have been used, in addition to producing documents – described below – to host presentations from active 5GPPP projects, but also other invited speakers from sister initiatives; for example: the CCAM association, with whom it is planned to establish a long-term collaboration.
- The deployment stream has been focusing on becoming a common ground for ICT-18 and iCT-53 projects developing both cooperation models and deployment studies to assess how 5G coverage could be deployed and offered across European 5G Corridors. This stream has also been used to discuss the upcoming CEF Digital projects planned to start in January 2023.

Along the year 2022, the WG has elaborated and published a visionary paper on the transition from 5G to 6G from the CAM perspective:

- “From 5G to 6G Vision – A Connected and Automated Mobility perspective”, June 2022. Document available at: <https://5g-ppp.eu/white-papers/>

This document was released at the time of the EuCNC, and it is essentially an executive and easy-reading short document answering to 5 key questions to pave the way towards the future:

1. How is mobility going to change?
2. Why and how 5G will change road mobility?
3. Which 5GPPP Projects have been working on CAM and which are the key contributions and the main lessons learnt?
4. What has been identified that is missing and beyond 5G will need to be addressed?
5. Which candidate 6G technologies will enhance CCAM services?

In addition to this key milestone for 2022, the WG has been organizing a series of presentations during the regular telcos where 5G-PPP projects, but also other related associations to the 5G FOR CAM WG, have presented their progress and lessons learned. The WG has been used as a platform for knowledge exchange and for sharing expertise gained in the projects.

Furthermore, the regular telcos have been used for Information exchange on the SNS programme and calls, discussion of opportunities to have “beyond 5G for CAM aspects” included as part of a focus on 6G verticals.

As usual, the WG has been used as a platform to exchange information related to relevant pieces of news as well as the dissemination of events in the intersection of both connectivity and CAM.

Finally, the WG has been a platform to exchange information related to the CEF Digital programme, in particular, with focus on the 5G Corridors deployment plans. Cross-border corridor calls and opportunities for follow-up from R&I cross-border projects with related deployment activities have been announced and discussed, including the CSAs on deployment and the SDA, plus edge / cloud integration. This activity is planned to be intensified along 2023 with the leadership of the 5G4CAM WG towards the elaboration of an updated version of the 5G Strategic Deployment Agenda.

### **Trials WG**

The Trials Working Group was launched by 5G Infrastructure Association in September 2016 after the publication of the 5G Manifesto of industry in Europe and in the context of the 5G Action Plan of the EU Commission.

In the March-November’22 period, the Chair and the Stream Champion for 5G Private Trials / Observatory were deeply involved in the elaboration of the SNS Workprogramme 23-24, this including their participation in the corresponding editorial team (4 people). For this reason, the working group had to adapt its initial workplan and focus mostly on the organization of plenary meetings. The ultimate goal was to safeguard networking and information dissemination activities. In total, four meetings were organized:

- Trials WG Plenary Meeting #1 (36 attendees): February 16
- Trials WG Plenary Meeting #2 (31 attendees): March 14
- Trials WG Plenary Meeting #3 (40 attendees): October 24
- Trials WG Plenary Meeting #4 (28 attendees): December 16

The corresponding agendas included detailed overviews of the various activities organized at the stream level; information on the elaboration of the SNS Workprogramme and related consultations; short presentations on new projects/recent Trials and Pilots; plans for the new White Paper of the WG, report and brochure; introduction of new members joining the WG, etc. Three Stream Champion meeting were held for internal coordination and planning, as well (07.02.22, 10.03.22, and 17.10.22). Besides, the WG Chair participated in several 5G-I-SB meetings (24.01.22, 14.03.22, 09.05.22, 23.11.22), and publicized the activities of the WG in the CCAM Webinar (19.12.22) where a presentation was given.

The activity of the WG revolved around the following tasks:

- Elaboration of the PPP Trials and Pilots (T&Ps) Brochure n°4 (lead: D. Bourse): The PPP T&Ps Brochure n°4 has been further developed, jointly between both Trials WG and TB. The Brochure n°4 leverages the experience from the previous Brochures (including call for inputs and selection by a panel of experts) and will bring to the readers' attention 10 additional Phase 2 and Phase 3 Trials & Pilots that were recently completed. The initial March deadline was extended and in total 24 flyers were received. The Editorial Team (including D. Bourse, C. Antón-Haro, A. Kaloxylos, M.

Alarcón and C. Manero) is tasked with the evaluation and selection of flyers based on several pre-defined criteria (e.g., impact of 5G networks, achieved KPI, Technology and Market Readiness Levels, societal impact, 5G empowerment...). The plan is to release Brochure no. 4 in Q1/2023.

- Preparation of the report entitled “Smart city vertical trials and experimentations in 5GPPP Phase 3 projects” (lead: J. Huusko). Several calls for rapporteurs were launched in 2022. Their contributions will be supplemented with information extracted from smart city-related trials in the latest version of the T&P brochure. The plan is to release this report in Q1/2023.
- Drafting of the White Paper “5G and towards 6G Verticals” (lead: V. Frascolla). A Table of Content of the White Paper was discussed and agreed upon. The scope is to identify relevant use cases that have the potential to go well beyond 5G/5G-Advanced requirements, the ones that most probably will compose the first set of 6G use cases. An editorial team has been assembled. The plan is to release this whitepaper in Q1-Q2/2023.
- Contributions to the definition of Stream D in the SNS Workprogramme 2023-24: The WG chair has actively contributed to the definition of the Stream D (‘SNS Large Scale Trials and Pilots (LST&Ps) with Verticals, including the required Infrastructure’) which is of critical importance for WG participants. This includes contributions to drafting/scope, budget definition, etc.

Besides, in 2022 two Stream Champions stepped down: F. Pujol (iDATE) and B. Altman (LiveU). The former has been replaced by C. Manero from the same company. For the latter, a formal election was organized with candidates from the WG. M. Ghorraishi was elected as a new Stream Champion of the International Cooperation stream.

The Stream Champion meeting organized on 17.10.22 was devoted to synch up, touch base on all those tasks, and resume normal activity. Further progress details will be provided in subsequent bi-monthly reports.

## Security WG

During Year 2022 the 6G-IA Security WG did renew one of its co-chairs. Following election process put in place by 6G IA, Jean-Philippe WARY from ORANGE (FR) who had resigned was replaced as co-chair of 5G IA Security WG by Antonio SKARMETA from University of Murcia (SP). Following this election, the Work Plan of 6G IA Security WG for 2022 which had been prepared and proposed by co-chair (P. Bisson) to project’s representatives and members was endorsed by all. As such it came to force and all actions were performed leading to the main following achievements for Y’22:

- A number of new members have been enrolled starting first with the ones having joined the 6G IA but also from the newly awarded projects. Overall and through discussions held it opened to some new security topics to be considered.
- Both TB & SB meetings were monitored and/or attended by co-chair(s) to follow the discussion, inform sec-wg members accordingly and work on actions items of concerns. Some of the meetings were also used in 2022 to have dedicated sessions to highlight some of the results (i.e., security session at TB where some of the results coming from join work had been highlighted).
- On the front of conferences, 6G IA SEC WG participated to three major events namely with: 1) the 5<sup>th</sup> International Workshop on Emerging Network Security (ENS 2022) held at the 17<sup>th</sup> International Conference on Availability, Reliability and Security



(ARES), 2) the IEEE Future Networks World Forum 2022 with a Symposium on Security for 5G and Future Networks and 3) the 2<sup>nd</sup> Workshop on Accountability, Liability, and Trust for 5G and Beyond (WALT5G+) held at the 1<sup>st</sup> International Conference on 6G Networking.

- Activities led but other WGs of interest (i.e., Architecture WG, Vision WG, Pre-Standardization WG) were monitored with focus on security concerns this with objective to support also team.
- Activities performed by ENISA on the field of 5G/6G Cybersecurity were continued to be monitored this as direct follow-up of work done in support of ENISA for what concerns “5G Threat Landscape” and its update. This with objective to further develop liaison with ENISA in 2023.
- Liaison with ECSO was maintained and couple of directions to have it further developed have been devised. They would need to be further explored and worked out with full support of appointed representative. Something on which to work on 2023.
- A number of technical presentations from projects’ representatives or members were called for and made at our regular sec-wg meetings. This was appreciated to share topics of interest and/or achievements but also helpful to structure and organize activities of the wg. Something that would be continued and amplified in the coming year.
- Work was done once again to materialize joint outcomes of sec-wg on the field of 5G&B/6G security. This was especially true when it comes to security enablers developed and reported.
- On the front of Whitepapers, having faced difficulties with couple of short whitepapers we had initiated we decided to change/adapt our strategy and go for only whitepapers with enough commitments from members to make them produced in due time and good/enough. This without neglecting in the meantime the possibility to contribute to other WG Whitepapers for what concerns security.
- Following solicitation received from NetworldEurope ETP, the co-chairs of 6G IA security WG did contribute security topics proposals regarding revision of Security Chapter of NetworldEurope Strategic Research and Innovation Agenda (SRIA). Proposals made were also chaired with sec wg members who were also invited to join and contribute / support the process.
- Apart from security research topics a number of complementary actions were also initiated in 2022 to share and progress (e.g., security KPIs, security Standardization just to quote a few). Objective being to leverage on it and foster this work.
- Agenda and minutes of meetings conducted in 2022 have been uploaded on BSCW together with material presented.

#### Open Smart Networks and Services WG

The working group was created in July 2021 and start its activities during 2022 with 28 members, ending 2022 with 33 Members, as depicted in Figure 15, where 12 Industry, 12 research and 9 SME.





Figure 15: Open Smart Networks and Services WG members

- 5 Invited participants (Figure 16)

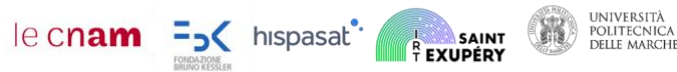


Figure 16: Invited WG participants

- The activities of the WG are divided in different domains as depicted in Figure 17. The active domains include: Radio Access Network (15 members, leading Qualcomm and Vodafone), Non-Terrestrial-Networks (5 members, leading CTTC), Platforms (14 members, leading Huawei and IRT Exupéry)

	Sub-domains		Contributors	Leaders
ACTIVE	Radio Access Network	15	imec, UNIVERSIDAD DE MÁLAGA, NEC, orange, TIM, SAMSUNG, Deutsche Telekom, VTT, i2cat, ERICSSON, technarts, Telefonica, Vodafone, Qualcomm, TNO	Qualcomm, Vodafone
	Non Terrestrial Network	5	imec, CTTC, technarts, hispasat, SAINT EXUPÉRY	CTTC
	Platforms	14	imec, UNIVERSIDAD DE MÁLAGA, NEC, i2cat, TNO, VTT, ERICSSON, technarts, Huawei, le cnam, UNIVERSITÀ POLITECNICA DELLE MARCHE, SAINT EXUPÉRY	Huawei, SAINT EXUPÉRY

Figure 17: Active domains of the WG

There are also some inactive domains due to lack of participants or currently no leading entity. These domains are: transport, core, and services, and are depicted in Figure 18.

INACTIVE	Transport	4	TIM, UNIVERSITÀ POLITECNICA DE CATALUNYA BARCELONATECH, technarts, HUAWEI, orange	N/A
	Core	7	UNIVERSITÀ POLITECNICA DE CATALUNYA BARCELONATECH, TNO, VTT, ERICSSON, technarts, HUAWEI	N/A
	Services	4	UNIVERSIDAD DE MÁLAGA, INSTITUTO DE telecomunicações, technarts, HUAWEI, RedZinc	N/A

Figure 18: Inactive domains of the WG

The plan for 2022 was to develop the following 2 whitepapers which were delayed to 2023

- Open SNS status and future development whitepaper:
  - Benefits and challenges of Open Networks
  - The role of Industry Organizations
  - Labs and testing infrastructure
  - Open networks' evolution to beyond 5G and 6G

- Action proposal for the future of the open SNS:
  - EU ecosystem status
  - Common European roadmap for network innovation

On November 3rd, 2022 there was a session with the Telecom Infra Project (TIP) to introduce the WG. Several collaboration areas were shared, to be considered once the 1st whitepaper is available as draft for comments:

- Discuss how open smart network and services will have an evolution on the overall open ecosystem through the development of a common set of requirements to evolve the current open smart network and services in TIP for 5G and beyond 5G/6G networks
- Exchange of open related R&D projects for TIP ecosystem assessment
- Create a framework of open R&D projects to access to TIP labs
- Access to forums and panels for the discussion of the open smart network and services between organisations

Similarly, the WG has agreed to engage the O-RAN New Generation Research Group (nGRG) for early 2023.

### SME Community

The year 2022 marked the completion project calls of the 5G PPP initiative<sup>43</sup>, and the first calls of the SNS JU<sup>44</sup>. SMEs had already contributed in building up the SNS Partnership, in particular via a dedicated position paper published end of 2020<sup>45</sup>. The evolution from 5G PPP to SNS is an important step for SMEs (as well as for other project participants), as the SNS ecosystem involves more and more stakeholders from vertical sectors as well as from complementary domains such as AI, IoT, HPC and others. Every effort was deployed by the NetworkEurope SME Working Group to promote once again the skills and expertise of European SMEs within the newly formed (and evolving) SNS ecosystem. The interest of SMEs in this new initiative was demonstrated by the huge increase of SMEs becoming members of 6G-IA, from a dozen in 2021, to 63 in 2022<sup>46</sup>. The number of members in the SME WG also continued to increase throughout 2022, reaching 241 members by the end of the year, including 214 SMEs. This represents an increase of 11% in one year. The overall number of SMEs that are members of NetworkEurope reached 361 by the end of 2022.

The SNS JU recommends a minimum 20% participation from SMEs in the upcoming projects, replicating one of the KPIs of the 5G PPP initiative. Unfortunately, SNS Call 1 did not manage to reach this objective, culminating at 18% participation from SMEs. More SMEs should be involved at a later stage in several SNS Call 1 projects that include open calls, hopefully increasing eventually the SME participation.

To promote further the participation of SMEs in the upcoming SNS call 2 planned in 2023, a new update of the SME-related web pages<sup>47</sup> was finalised at the end of 2022, along with a new

<sup>43</sup> <https://5g-ppp.eu/>

<sup>44</sup> <https://smart-networks.europa.eu/>






<sup>45</sup> “SME WG SNS Position Paper”, 4 November 2020, <https://www.networkeurope.eu/wp-content/uploads/2020/12/sme-wg-sns-position-paper-final.pdf?x70854>

<sup>46</sup> The list of SME members of 6G-IA may be found at <https://6g-ia.eu/sme/>. A few SMEs are also associate members of 6G-IA (cf. <https://6g-ia.eu/associates-members/>).

<sup>47</sup> <https://www.networkeurope.eu/sme-wg/>, <https://www.networkeurope.eu/find-the-sme-you-need-new-page/>

edition of the “European SME Expertise in 5G and Beyond” brochure<sup>48</sup>. 81 SMEs are now present both on the web and in the brochure, representing a progression of 17% since the previous edition. In addition, 12 new SME success stories were published, demonstrating the results obtained by SMEs from their participation in collaborative projects, mostly 5G PPP. A screen copy of some examples of such success stories is shown in *Figure 19*.

#### NEW! NOVEMBER 2022 SUCCESS STORIES

 <p>ACTA LTD Advanced Communications Testing Applications</p>	<p>ACTA has been very successful in providing telecoms solutions, such as “zero-touch provisioning” xDSL CPE management platforms, in three Greek Telecom Operators. In addition, ACTA has developed an innovative Web Application which collects EMF (ElectroMagnetic Field) measurement results from compatible Narda EMF Stations, stores and presents these results through an intuitive web interface. The solution is currently deployed at the Greek EMF Authority as well as Romania, Paraguay Authorities.</p> <p><a href="#">Download the success story</a></p>
 <p>CyberEthicsLab Responsible Research and Innovation</p>	<p>CyberEthics Labs has developed an innovative research and assessment methodology for the Social Acceptance of Technologies, the “SAT”, which includes the engagement of all the stakeholders, from developers to users, and aims to support them in integrating psychological, economic, legal, ethical and political values from the very beginning of the design process of new products and systems.</p> <p><a href="#">Download the success story</a></p>
 <p>Fivecomm</p>	<p>Thanks to 5G-PPP projects such as FUDGE-5G, Fivecomm has developed the 5G BROAD router designed for connecting user devices to 5G networks through Ethernet or USB. It comes with an open operative system based on OpenWRT that permits any user to configure it and make changes in an easy manner.</p> <p><a href="#">Download the success story</a></p>
 <p>Incelligent Machine learning – powered Networks</p>	<p>Incelligent’s core IP is a platform that has been developed out of years of R&amp;D in the areas of Big Data, Machine Learning (ML) and Artificial Intelligence (AI). By following best practices in data-driven development (DataOps), Incelligent has managed to incorporate the latest advances in Big Data systematically, ML/AI-related technologies in its product research and development processes, resulting in a diverse product portfolio that includes out-of-the-box and production-ready, AI/ML-based solutions, tailor-made for the Telecommunications, Banking and Public sectors.</p> <p><a href="#">Download the success story</a></p>
 <p>Internet INSTITUTE</p>	<p>Internet Institute Ltd. (ININ) has successfully developed and verified Industrial IoT Gateway. This appliance assures secure, resilient and QoS guaranteed 5G connectivity for IoT devices such as various environmental, industrial, and cameras. The appliance has been developed within 5G-LOGINNOV project.</p> <p><a href="#">Download the success story</a></p>

*Figure 19: “Find the SME you need” web page: latest SME success stories*

The “Find the SME you need” web page was viewed almost 3,500 times in 2022, making it once again the most viewed page on the NetworldEurope web site, after the home page. The “SME WG” page ranks #10 with 330 views. The relevant statistics are depicted in Figure 20. This demonstrates the continuing interest of the visitors of the NetworldEurope web site in SME-related information, and the corresponding impact on the ecosystem stakeholders.

<sup>48</sup> <https://bscw.5g-ppp.eu/pub/bscw.cgi/d518320/2022-sme-brochure-final.pdf>

Page ?	Pageviews ?	Unique Pageviews ?	Avg. Time on Page ?	Entrances ?	Bounce Rate ?	% Exit ?	Page Value ?
	17,056 % of Total: 100.00% (17,056)	14,112 % of Total: 100.00% (14,112)	00:02:03 Avg for View: 00:02:03 (0.00%)	9,888 % of Total: 100.00% (9,888)	68.93% Avg for View: 68.93% (0.00%)	57.97% Avg for View: 57.97% (0.00%)	\$0.00 % of Total: 0.00% (\$0.00)
1. /	3,471 (20.35%)	2,905 (20.59%)	00:01:19	2,628 (26.58%)	56.82%	51.69%	\$0.00 (0.00%)
2. /find-the-sme-you-need-new-page/	3,468 (20.33%)	2,507 (17.77%)	00:03:10	2,404 (24.31%)	72.18%	69.43%	\$0.00 (0.00%)
3. /sria-and-whitepapers/	1,123 (6.58%)	991 (7.02%)	00:03:10	743 (7.51%)	60.53%	71.06%	\$0.00 (0.00%)
4. /workshop-on-green-telecom-hybrid-on-march-02nd-2022-cet-900-1220-beijing-1600-1920/	1,090 (6.39%)	904 (6.41%)	00:03:40	838 (8.47%)	82.14%	78.90%	\$0.00 (0.00%)
5. /webinar-on-smart-ports-16-september-2022/	772 (4.53%)	649 (4.60%)	00:03:28	571 (5.77%)	84.79%	79.27%	\$0.00 (0.00%)
6. /overview/	671 (3.93%)	548 (3.88%)	00:01:31	52 (0.53%)	61.54%	32.94%	\$0.00 (0.00%)
7. /our-members/	532 (3.12%)	440 (3.12%)	00:01:51	81 (0.82%)	65.43%	37.03%	\$0.00 (0.00%)
8. /satcom-wg/	494 (2.90%)	459 (3.25%)	00:02:10	394 (3.98%)	91.62%	83.00%	\$0.00 (0.00%)
9. /relationship-to-5g-ppp/	402 (2.36%)	359 (2.54%)	00:03:06	188 (1.90%)	88.83%	63.43%	\$0.00 (0.00%)
10. /sme-wg/	402 (2.36%)	330 (2.34%)	00:02:05	170 (1.72%)	61.05%	43.03%	\$0.00 (0.00%)

Figure 20: Statistics re. the NetworkdEurope web page visits – January to December 2022

The two editions of the SME brochure were downloaded about 100 times during the year. The relevant statistics are depicted in Figure 21. This is a lower figure than in 2021; however, it is still an interesting figure, especially if we consider that there was no new edition of the brochure in 2022<sup>49</sup>, and that the related “Find the SME you need” was viewed 500 times more than in 2021<sup>50</sup>.

Event Label ?	Total Events ?	Unique Events ?	Event Value ?	Avg. Value ?
	938 % of Total: 49.45% (1,897)	874 % of Total: 49.60% (1,762)	0 % of Total: 0.00% (0)	0.00 Avg for View: 0.00 (0.00%)
1. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d367342/networkd2020%20sria%202020%20final%20version%202.2%20.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d367342/networkd2020%20sria%202020%20final%20version%202.2%20.pdf</a>	195 (20.79%)	186 (21.28%)	0 (0.00%)	0.00
2. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d392313/annex%20v2.3%20-%20public.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d392313/annex%20v2.3%20-%20public.pdf</a>	183 (19.51%)	169 (19.34%)	0 (0.00%)	0.00
3. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d511515/sria%202022%20-%20white%20paper%20-%20for%20public%20consultation.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d511515/sria%202022%20-%20white%20paper%20-%20for%20public%20consultation.pdf</a>	129 (13.75%)	119 (13.62%)	0 (0.00%)	0.00
4. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d511521/sria%202022%20-%20technical%20annex%20-%20for%20public%20consultation.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d511521/sria%202022%20-%20technical%20annex%20-%20for%20public%20consultation.pdf</a>	92 (9.81%)	86 (9.84%)	0 (0.00%)	0.00
5. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d437286/2021-07%20sme%20brochure.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d437286/2021-07%20sme%20brochure.pdf</a>	73 (7.78%)	64 (7.32%)	0 (0.00%)	0.00
6. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d516608/sria-2022-wp-published.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d516608/sria-2022-wp-published.pdf</a>	45 (4.80%)	41 (4.69%)	0 (0.00%)	0.00
7. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d516614/sria%202022%20technical%20annex%20published.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d516614/sria%202022%20technical%20annex%20published.pdf</a>	27 (2.88%)	25 (2.86%)	0 (0.00%)	0.00
8. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d391067/2021-01_5g_sme_brochure.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d391067/2021-01_5g_sme_brochure.pdf</a>	25 (2.67%)	25 (2.86%)	0 (0.00%)	0.00
9. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d484308/greentelecomworkshoppoeventreport.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d484308/greentelecomworkshoppoeventreport.pdf</a>	20 (2.13%)	18 (2.06%)	0 (0.00%)	0.00
10. <a href="https://bscw.5g-ppp.eu/pub/bscw.cgi/d322688/nem%20networkd2020%205g%20media%20slice%20v1-2_24092019.pdf">https://bscw.5g-ppp.eu/pub/bscw.cgi/d322688/nem%20networkd2020%205g%20media%20slice%20v1-2_24092019.pdf</a>	15 (1.60%)	15 (1.72%)	0 (0.00%)	0.00

Figure 21: The “European SME Expertise in 5G and Beyond” brochure views in 2021

Information of the SME WG was also shared regularly on the 5G PPP web site, and disseminated via the NetworkdEurope, 5G PPP, and 6G-IA mailing lists.

In 2022, the SME WG continued its cooperation with the European DIGITAL SME Alliance, an association dedicated to strengthening SME presence at policy level in Europe<sup>51</sup>. A joint workshop entitled “Microelectronics and connectivity: Europe going forward” was co-organised with the COREnect project on February 1<sup>st</sup>, 2022<sup>52</sup>.

<sup>49</sup> The latest edition of the brochure was publicly released on the web site in January 2023.

<sup>50</sup> ≈3,500 in 2022, vs. ≈3,000 in 2021.

<sup>51</sup> <https://www.digitalsme.eu/>

<sup>52</sup> <https://www.corenect.eu/workshops/microelectronics-and-connectivity-europe-going-forward-workshop>

Speakers from other initiatives such as WiTaR (Women in Telecommunications and Research)<sup>53</sup> were invited to present their activities in SME WG online meetings, to support discussions among WG members about new potentially relevant activities to be addressed by the SME WG.

### International Cooperation Activity on 5G, 5G and beyond, 6G

The 6G-IA has been very active building up international cooperation for 5G networks. This is obviously of the utmost importance for keeping Europe in the frontline of key players at a global level.

The 6G-IA has signed the following MoUs.

#### International Multilateral MoU

Signatories Organizations	Status
5G IA, IMT-2020 (5G) Promotion Group, 5G Forum, 5GMF, 5G Americas, 5G Brazil	Signed
TSDSI (India) joined and signed the Multilateral MoU on 8 September 2020 (announcement was made at the IEEE 5G WF– Worldwide 5G Industry Fora Session on 10 September 2020).	

#### International Bilateral MoUs

Organization	Status
5G MF (Japan)	Signed
IMT-2020 (5G) Promotion Group - China	Signed
5G Forum (Korea)	Signed and renewed on 1 <sup>st</sup> November 2022
4G Americas <sup>54</sup> (Americas)	Signed
Telebrasil – Projeto “5G Brasil”	Signed
ENCQOR (Canada)	Signed
TSDSI (India)	Signed
Beyond 5G Promotion Consortium - Japan	Signed on 2 May 2022
IMT-2030 (6G) Promotion Group - China	Signed on 2 June 2022
Next G Alliance – North America	Signed on 18 July 2022

<sup>53</sup> <https://hexa-x.eu/witar/>

<sup>54</sup> Now “5G Americas”

## Agreements with Organizations representing Vertical Sectors

Organization	Status
5GAA (Automotive)	MoU Signed and RENEWED on 28 July 2022
ERTICO (Transport systems and services)	MoU Signed
ECSO (Security)	MoU Signed
PSCE (Security)	LoI Signed
NEM (Media)	MoU Signed
EBU (Media)	MoU Not Signed
5G-ACIA (Manufacturing)	MoU Signed
Other possible agreements could be signed with: - UIC (Railways) - EUTC (Utilities) - ECHalliance (Health) and/or 5G Health Association	

## Other Agreements

Organization	Status
NetworldEurope ETP	Collaboration Agreement Signed
AIOTI (IoT)	MoU Signed
ESA (SatCom)	LoI Signed
ECC (Regulation)	LoU Signed
ETSI (Standards)	MoU with 6G-IA renewed on 1 <sup>st</sup> December 2022
TransContinuum Initiative (signatories: ETP4HPC, ECSO, BDVA, 5G IA, EU-MATHS-IN, CLAIRE, HiPEAC, AIOTI)	Collaboration agreement signed on 17.09.2020
NGMN Alliance (Mobile broadband technologies)	Liaison Statement on the “ <i>Definition of the Testing Framework for the NGMN 5G Pre-Commercial Network Trials</i> ”. + MoU signed on 8 <sup>th</sup> February 2022.
CELTIC-NEXT	MoU signed on 7 <sup>th</sup> April 2022
AENEAS	MoU signed on 17 <sup>th</sup> May 2022



GSMA (Regulation, Events)	Cooperation Agreement on hold. Contacts could be resumed after the renewal of the association for the SN&S partnership.
Small Cell Forum (Small Cells)	Draft MoU sent to Jean-Pierre in June 2018
MoU between SCoDIHNet and the ‘Sector Group Digital’ of the Enterprise Europe Network	MoU signed on 19 <sup>th</sup> October 2022

### Activity Community Building and Public Relations

6G-IA has played a central role in the abovementioned activities. The activities of the Verticals Engagement Task Force, the work of 6G-IA WGs, its close collaboration with NetworkEurope, have been the enabler for success. Moreover, as analysed in the following subsections has been quite active in the Digital Innovation Hub network and the Transcontinuum initiative.

### Smart Connectivity Digital Innovation Hub Network

The Smart Connectivity Digital Innovation Hub Network (*SCoDIHNet*) has the ambition to facilitate adoption of the 5G and IoT technologies and contribute to the Digitalisation of the European Industry which is part of the next Digital Europe Program (DEP).

For that purpose, during 2020, DIHs that are offering 5G services were identified in the S3 platform catalogue and *SCoDIHNet* began to work on a set of services that DIHs are expecting from a network. Following this, in 2021 it was decided to extend to a larger domain addressing Smart connectivity encompassing 5G, IoT, Cybersec and AI. Finally, the conclusion was to merge the 5G initiative with the AIOTI initiative to become stronger.

The *SCoDIHNet* initiative is co-supported by AIOTI<sup>55</sup> and the 6G-IA. In turn it supports Digital Innovation Hubs that are providing services on 5G, IoT, Cybersecurity and artificial intelligence. 5G and IoT are key technologies to develop digitalization of European industry together with AI and cybersecurity it will ensure flexibility, adaptability, and end-to-end security.

*SCoDIHNet* initiative is contributing to the European Industry Digitalisation helping companies to improve their processes, products and services through the use of Smart connectivity technologies.

The *SCoDIHNet* initiative is currently well-known from the community, and more than 90 members are participating regularly to the monthly meetings.

In 2022, the main activity conducted by *SCoDIHNet* was to establish cooperation among members and also with sister organisations. In this respect, *SCoDIHNet* has put in place the following liaisons:

- Enterprise Europe Network (<https://een.ec.europa.eu/>): European SMEs
- European Business and Innovation Centre Network (<https://ebn.eu/>)
- [Horizon Result Booster](#) & [Horizon Result Platform](#): Replicability and reusage of existing solutions
- DIH4Industry (<https://dih4industry.eu>): Manufacturing DIHs network

<sup>55</sup> [www.aioti.eu](http://www.aioti.eu)



- Liaison with the Digital Transformation Accelerator (<https://www.edihnetwork.eu/home>): The project in charge of the coordination of all EDIHs
- African DIH networks: Best practices exchange with African DIHs,
- Center for Innovation Management Research (<http://www7.bbk.ac.uk/cimr/>): IoT technology watch
- OpenDEI project (<https://www.opendei.eu/>): Contribution to the task force in charge of DATA-POWERED BUSINESS ECOSYSTEM BUILDING to Foster collaboration, business interoperability between stakeholders
- DIH4AI (<https://www.dih4ai.eu/>): Artificial intelligence DIHs network
- [Partnerships for Regional Innovation](#): 63 regions, seven cities and four Member States selected for Pilot Action
- Connecting European Facilities / [5G for Smart Communities](#): sharing 5G infrastructures with DIHs in order to accelerate development of innovations at local level
- European Startup Nation Alliance (<https://esnalliance.eu/>): including Startups in the DIHs local ecosystems
- EVOLVED-5G project (<https://evolved-5g.eu/>): 5G startup support

Following the selection of EDIHs (European DIHs funded under the Digital Europe Program by the European Commission and by the Member states), *SCoDIHNet* has stated to develop 2 platforms that will offer to DIHs the 18 services described by the group, as depicted in Figure 22.



Figure 22: SCoDIHNet platforms

Finally, *SCoDIHNet* and the 5G Trial working group are collaborating in order to identify the use cases and solutions developed and experimented by 5G PPP projects that are replicable. A replicability catalogue which contains 117 use cases from 28 projects is available for DIHs which want to reuse in a local context with end customers.

### The Transcontinuum Initiative

This activity is contributing to stimulate the overall digital ecosystem and mainly the future Horizon Europe missions. The objective is to concentrate all digital competencies in one initiative which is better able to bring solutions to the programs/projects and making 5G part of the story.

In 2020, Eight European associations and projects committed to the Transcontinuum Initiative to promote cross-domain collaboration for EU R&D programmes. The Transcontinuum Initiative, or TCI, is developing a vision of the characteristics of the infrastructure required for the convergence of data and compute capabilities in many leading edge industrial and scientific use scenarios.

The ambition of TCI is also to become a meeting place or a competence centre of experts representing various digital disciplines in both science and industry – an asset that Europe can apply in the resolution of its other challenges such as healthcare, climate change or smart cities.

In 2021, the group has set the scene and describe a set of use cases that has to be studied all together to cover all digital technologies needed. One of the most emblematic use cases is the Digital Twin which is needed all digital technologies, a paper has been developed to describe the contribution of each domain (HPC, big data, AI, Cybersec, IoT, Mathematics and Smart Connectivity)

In 2022, TCI group has elaborated a methodology to facilitate analysis of use cases in order to better understand the digital technology needs and requirements. This methodology has been built on 5 steps:

- Step 1: Presentation of the use case by the owner to the TCI expert group
- Step2: Decision to go ahead and decide to develop a 4 pager paper which has to provide further information on the purpose and operational aspect of the UC, Business drivers and societal impact, stakeholders types profiting from this UC, IT technologies requirements, high-level illustration of the workflow, R&D Challenges using TCI-“traffic light” wheel chart, authors and owners of the UC
- Step3: Deep dive discussions to understand the use case details
- Step4: Identification of the high priority challenges and write up R&I recommendations per domain
- Step5: TCI core team interlocks with funding agencies

With this methodology, the TCI has begun to identify large European projects that can have a need with such expertise; the 5 European missions have been contacted as well as the Destination Earth project (DestinE). Looking to their respective roadmaps, DestinE projects was ready to use first the TCI expertise to help the development of the use case. A contract has been signed and 15 experts from the 8 clusters are contributing to identify the most relevant technologies with regards to the project requirements.

DestinE project has the ambition to develop a digital twin of the atmosphere in order to better predict weather disasters. For that purpose, the system needs to collect large amount of data from satellites but also aircrafts, ships, buoys and in the future from drones, cars, mobile, IoT, etc. Smart connectivity and 5G is one of the key elements of the data collection but also of the end users which will have access remotely to the result of the weather prediction.

Work on the Smart Networks and Services

5G PPP has already provide plenty of results and is coming at an end. For its successor funding instrument (i.e., Smart Networks and Services - SNS JU<sup>56</sup>) to be successful, bridging activities between instruments are needed.

A key goal of the SNS Partnership is to define and implement the research, innovation and deployment roadmaps that will enable Europe to lead in the creation of the next generation of smart network technologies and services. These will be designed and implemented in such a way that European values like security and privacy are safeguarded, and European technological sovereignty is further strengthened. The Partnership also focuses on the full digitization of European society including vertical industries and public administration. Thereby, the SNS Partnership targets to have a positive impact on the quality of life for European citizens and boost the European data economy. The SNS drivers are depicted in Figure 23.

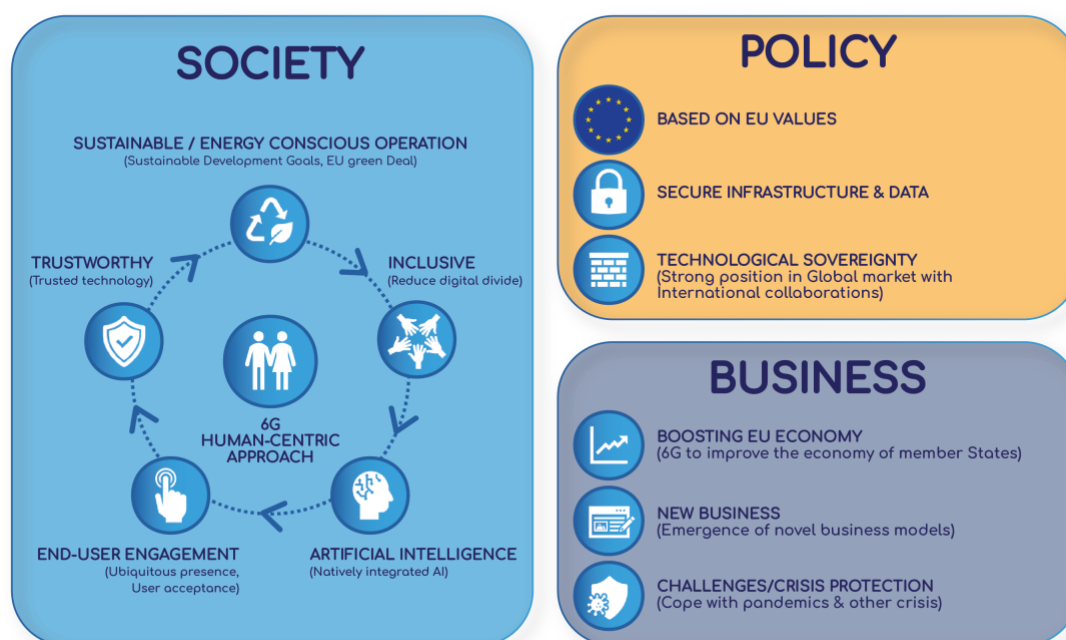


Figure 23: Smart Networks and Services JU drivers

The first wave of 35 SNS projects (including two Coordination and Support Action (CSA) projects) from Call 1 of 2022 (Phase 1 of SNS JU) kicked off their operations in January 2023. 6G-IA, through the 6GStart CSA project, has engaged in a series of activities to promote the SNS JU programme, to widely disseminate its main message and scope, to include as many European stakeholders as possible in the definition of the first and second waves of calls of the SNS and to adapt the R&I directions accordingly and finally to disseminate the “Call for proposals” to maximize the participation of stakeholders in the SNS JU activities.

Moreover, after the first 35 projects had been selected, an extensive dissemination and communication campaign took place to spread awareness about the selected projects and the focus area of their respective work and to disseminate further opportunities for the participation of additional stakeholders (i.e., information on open calls hosted by the Call 1 projects). In parallel, there have been direct engagement with the 35 selected projects to assist them with

<sup>56</sup> <https://smart-networks.europa.eu/>

preparatory activities that were necessary for the smooth operation of the SNS partnership, especially during the first months and until all foreseen bodies and Work Groups are in place. The results of the first call are presented in Figure 24

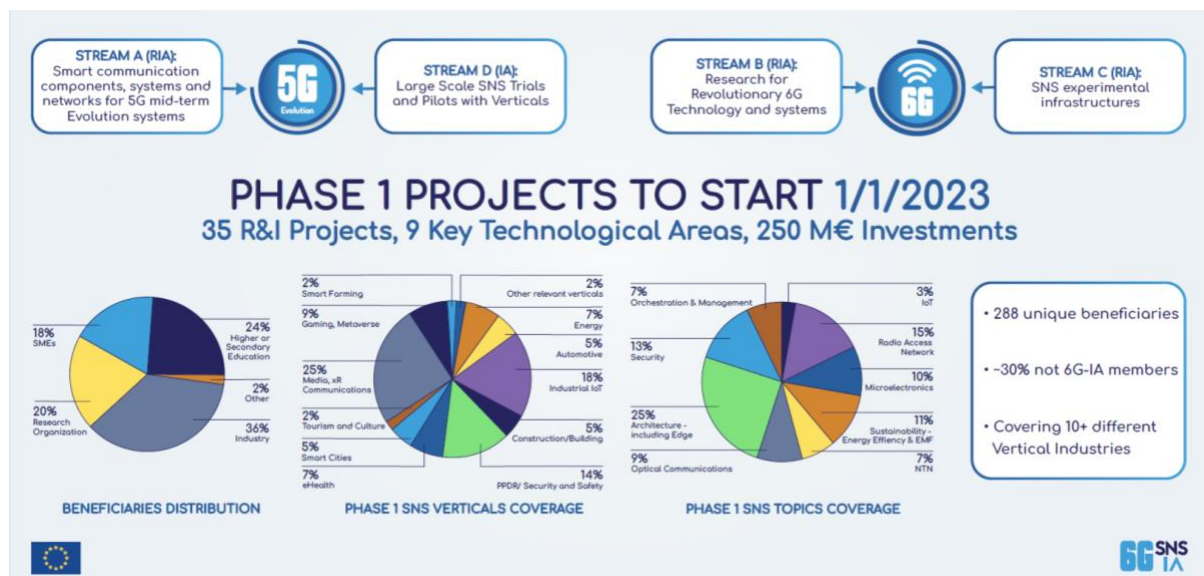


Figure 24: SNS JU results from the first call

## Annex 7 – Common Priority Key Performance Indicators

	Key Performance Indicator (KPI)	Value in 2022	Baseline at the start of H2020 (latest available)	Target (for the cPPP) at the end of H2020	Comments
1	Mobilised Private Investments	<ul style="list-style-type: none"> <li>• <b>10,46</b> considering Large Industry and SMEs</li> <li>• <b>7,64</b> considering all types of beneficiaries</li> </ul>		Between 5 and 10.	<p>The following procedure was applied to calculate this KPI:</p> <ul style="list-style-type: none"> <li>• Data for A2.1, A2.2, B1.1 and B2.1 were collected through a questionnaire from 5G PPP project beneficiaries.</li> <li>• Calculated average values of A2.1, A2.2, B1.1, B2.1, per legal entity type (Large Industry, SME, Academic Institution, Research Center) <ul style="list-style-type: none"> <li>○ B2.1 is given for the period 2014-2022, so its quota for 2022 has been calculated by dividing the value by 7</li> </ul> </li> <li>• On the H2020 Qlik Sense dashboard, the following information has been extracted: <ul style="list-style-type: none"> <li>○ (per legal entity type) # of participants, # of beneficiaries, Total cost and Total Net EU contribution for the following Phase 3 Call Topics: ICT-18-2018, ICT-19-2019, ICT-20-2019-2020, ICT-42-2020, ICT-53-2020, ICT-41-2020, ICT-52-2020.</li> </ul> </li> <li>• The Total cost and Total Net EU contribution has been projected on 2022 only <ul style="list-style-type: none"> <li>○ assuming an average project duration of 36 months, and</li> <li>○ considering that the grants for ICT-18-2018 were signed in 2018, the grants for ICT-20-2019-2020 and ICT-42-2020 were signed in 2019, and the grants for ICT-42-2020, ICT-53-2020, ICT-41-2020, ICT-52-2020 in the late part of 2020.</li> </ul> </li> <li>• Then, the following calculations have been performed, for each legal entity type: <ul style="list-style-type: none"> <li>○ The average values of A2.2, B1.1 have been multiplied by the total number of participants, and B2.1 (2022) by the total number of beneficiaries.</li> </ul> </li> </ul>

					<ul style="list-style-type: none"><li>○ The average Overhead (A2.1) has been applied to the Total Direct costs (= Total cost / 125%), and the difference with the flat OH 25% has been calculated</li><li>○ Finally, A.1 has been calculated with the difference between the Total Net EU contribution 2022 and the Total costs 2022.</li><li>• The sum of total A.1, A2.1, A2.2, B1.1, B2.1 provides, for each legal entity type, the additional investment in 2022 w.r.t. the Total Net EU contribution received during the year.</li><li>• The total across a subset of legal entity types provides the overall additional investment in 2022 for that subset of beneficiaries, and leads to the related Leverage Factor during the year. Two (sub)sets have been considered:<ul style="list-style-type: none"><li>○ Large Industry and SMEs; i.e. the business-oriented (and by far largest) part of private investments.</li></ul></li></ul> <p>All kinds of beneficiaries.</p>																					
2	New skills and/or job profiles	<table><tr><th>2014-2022</th><th colspan="2">New jobs/skills</th></tr><tr><th></th><th>Average</th><th>Total projected</th></tr><tr><td>Overall</td><td>3,15</td><td>3.399</td></tr><tr><td>Large Industry</td><td>7,33</td><td>1.833</td></tr><tr><td>SME</td><td>4,15</td><td>1.014</td></tr><tr><td>Academic Institution</td><td>2,00</td><td>150</td></tr><tr><td>Research Center</td><td>6,29</td><td>402</td></tr></table>	2014-2022	New jobs/skills			Average	Total projected	Overall	3,15	3.399	Large Industry	7,33	1.833	SME	4,15	1.014	Academic Institution	2,00	150	Research Center	6,29	402			<p>These are progressive values, referring to the period 2014-2022. A finer scale (e.g., per year) is very difficult to implement, since the creation of jobs/skills and of curricula/qualifications can be hardly attributed on a per-year basis.</p> <p>The following procedure was applied to calculate this KPI:</p> <ul style="list-style-type: none"><li>• Data for New jobs/skills created were collected through a questionnaire from 5G PPP project beneficiaries.</li><li>• Calculated average values of per legal entity type (Large Industry, SME, Academic Institution, Research Center)</li><li>• On the H2020 Qlik Sense dashboard, the following information has been extracted:<ul style="list-style-type: none"><li>○ (per legal entity type) # of beneficiaries for the following Phase 3 Call Topics: ICT-18-2018, ICT-19-2019, ICT-20-2019-2020, ICT-42-2020, ICT-53-2020, ICT-41-2020, ICT-52-2020.</li></ul></li><li>• The average values of the parameter have been multiplied by the total number of beneficiaries.</li></ul>
2014-2022	New jobs/skills																									
	Average	Total projected																								
Overall	3,15	3.399																								
Large Industry	7,33	1.833																								
SME	4,15	1.014																								
Academic Institution	2,00	150																								
Research Center	6,29	402																								

3	Impact of the 5G PPP on SMEs		increase in yearly turnover	increase in yearly revenues	increase in staff headcount	number of new elements of foreground IP	<p>An SME's business performance can depend on many factors, and not only on the participation in a given R&amp;D programme. It is up to the individual SME to quantify how the participation in 5G PPP projects had an influence on parameters like turnover, job profiles and staff headcount variations, etc... In most cases, they should manage to provide this information, with some degree of precision.</p> <p>These are progressive values, referring to the period 2014-2022, and 2 of them (variation in turnover and revenues) have a yearly focus. The following procedure was applied to calculate this KPI:</p> <ul style="list-style-type: none"> <li>• Data for the 4 parameters were collected through a questionnaire from 5G PPP project SME beneficiaries.</li> <li>• Calculated average value for each parameter.</li> <li>• On the H2020 Qlik Sense dashboard, the following information has been extracted: <ul style="list-style-type: none"> <li>○ (per legal entity type) # of SME beneficiaries for the following Phase 3 Call Topics: ICT-18-2018, ICT-19-2019, ICT-20-2019-2020, ICT-42-2020, ICT-53-2020, ICT-41-2020, ICT-52-2020.</li> </ul> </li> </ul> <p>The average values of 2 parameters have been multiplied by the total number of beneficiaries.</p>
		Reference period	2022	2022	2014 - 2022	2014 - 2022	
		Average values	43,0%	44,0%	2,53	1,25	
		Total projected	n/a	n/a	618	305	
4	Significant Innovations	The key achievements v3.2 is the latest version reporting more than 100 key achievements. <a href="https://5g-ppp.eu/phase-3-key-achievements-3-2/">https://5g-ppp.eu/phase-3-key-achievements-3-2/</a>					



## Annex 8 – Specific Key Performance Indicators for the 5G PPP


	KPI domain	Key Performance Indicator (KPI)	Value in 2022	Baseline at the start of H2020 (latest available)	Target (for the cPPP) at the end of H2020	Comments
1	Performance	P1. Providing 1000 times higher wireless area capacity and more varied service capabilities compared to 2010	Analysis about the KPis (network and verticals) can be found at white papers released in 2022			A detailed analysis for the Performance KPis can be found at section 3.2.2.1
2	Performance	P2. Reducing the average service creation time cycle from 90 hours to 90 minutes				
3	Performance	P3. Facilitating very dense deployments of wireless communication links to connect over 7 trillion wireless devices serving over 7 billion people				
4	Performance	P4. Creating a secure, reliable and dependable internet with a "zero perceived" downtime for services provision				
5	Business	B1. 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	<ul style="list-style-type: none"> <li>• <b>10,46</b> considering Large Industry and SMEs</li> <li>• <b>7,64</b> considering all types of beneficiaries</li> </ul>		Between 5 and 10	The methodology used for this assessment is described in Section 3.2.1.1.
6	Business	B2. Target SME participation under this initiative commensurate with an allocation of 20% of the total public funding	The SME participation in 5G PPP projects has been increasing in 2020 to reach and even exceed the original objective of 20% (i.e., <b>21,95%</b> ) participation		20%	An analysis of the impact of the 5G PPP on the SME community, including information on the reported KPI can be found in Annex 6.

			defined as a KPI of the programme.																								
7	Business	B3. 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	<u>Publicly available reports suggest that EU HQ companies currently have more 30% of total worldwide telecom equipment market.</u>			This KPI is further discussed in section 3.2.2.2																					
8	Societal	S1. Enabling advanced user -controlled privacy				This KPI is presented in Section 3.2.2.3																					
9	Societal	S2. Reduction of energy consumption per service up to 90% (as compared to 2010)				This KPI is presented in Section 3.2.2.3																					
10	Societal	S3. European availability of a competitive industrial offer for 5G systems and technologies				This KPI is presented in Section 3.2.2.3																					
11	Societal	S4. Stimulation of new economically-viable services of high societal value like U-HDTV and M2M applications				For this KPI please refer to section 3.2.2.3																					
12	Societal	S5. Establishment and availability of 5G skills development curricula (in partnership with the EIT)	<table><tr><td>2014-2022</td><td colspan="2">New 5G curricula and/or educational qualifications</td></tr><tr><td></td><td>Average</td><td>Total projected</td></tr><tr><td>Overall</td><td>4,32</td><td>4.654</td></tr><tr><td>Large Industry</td><td>8,33</td><td>3.661</td></tr><tr><td>SME</td><td>2,00</td><td>686</td></tr><tr><td>Academic Institution</td><td>1,40</td><td>209</td></tr><tr><td>Research Center</td><td>0,67</td><td>98</td></tr></table>	2014-2022	New 5G curricula and/or educational qualifications			Average	Total projected	Overall	4,32	4.654	Large Industry	8,33	3.661	SME	2,00	686	Academic Institution	1,40	209	Research Center	0,67	98			The methodology used for this assessment is described in section 3.2.2.3
2014-2022	New 5G curricula and/or educational qualifications																										
	Average	Total projected																									
Overall	4,32	4.654																									
Large Industry	8,33	3.661																									
SME	2,00	686																									
Academic Institution	1,40	209																									
Research Center	0,67	98																									

## Annex 9 – Contribution to Programme-Level KPI's

	Key Performance Indicator	Definition/Responding to question	Type of data required	Data [Commission]	Baseline at the start of H2020 (latest available)	Target (for the cPPP) at the end of H2020	Comments
1	Patents	Also, an analysis of the data in the latest publicly available reports such as IPlytics (June 2022), indicates that <b>European headquarter companies share a 15,59% of active and granted 5G US or EP granted patent families.</b> As the report indicates “However, not all self-declared patents are essential and valid, also SEPs vary by value – with some covering core technologies of the standard and others only claiming inventions on minor improvements to the standard”. This is why the same report also examines the <b>number of approved technical 5G contributions of European companies.</b> Their share is <b>37.04%</b> and brings European	Number of patent applications.  Number of patents awarded				Information on IPRs is always difficult to assess as certain time-periods are required from the IPR request submission to the grant of the patent.

		companies in the first place.					
2	<p>Standardisation activities (project level)</p> <p>Contributions to new standards (PPP level)</p>	<p>Online Standards Tracker</p> <p>Tracking activities in the Pre-standardization WG</p>	<p>Number of activities leading to standardisation</p>	<p>In terms of standardization activities, 5G PPP is an active contributor to 5G standardization globally. Overall, the 5G-IA Pre-Standardization WG has tracked until Q3 2022, more than <b>100 inputs</b> based on specific and tangible inputs (e.g. technical reports, study/work item, PoC, new commercial requirements). Most inputs have been submitted to 3GPP and ETSI (38), with a growing number of inputs to IEEE, and inputs to sector associations working groups like 5GAA. Twenty-two projects (all Phase 3, except SliceNet) have contributed to two rounds of inputs in Q4-2020 and Q2-2021.</p> <p>14 projects have provided such information, from which 13 reported notable impact in SDOs)</p>			

3	Operational performance	<ul style="list-style-type: none"> <li>• ICT-42</li> <li>• ICT-53</li> <li>• ICT-41</li> <li>• ICT-52</li> </ul>					All operational performance information is available at section 2.1
5	<b>H2020 - LEIT</b> - Number of joint public-private publications	<p>The document hereunder contains available information collected from the public sites Phase 3 projects.</p> <div>  <p>Publications- PMR_2021_update</p> </div>	Information collected from cordis.europe.eu and project's sites	<b>Phase 3 projects have produced 1988 publications so far</b> (34% of which was published in scientific journals).			