# 5G PAN-EUROPEAN TRIALS ROADMAP VERSION 2.0

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**The 5G Pan-European Trials Roadmap has been elaborated and reviewed by the Trials Working Group (WG) Members organizations as listed in Page 11.**

## 1. Introduction

This document addresses the high-level 5G Pan-European Trials Roadmap and the related actions towards implementation. This Roadmap Version 2.0, made available in view of public release at the 4th 5G Global Event taking place on 22-24.11.17 in Seoul, builds on the Roadmap Version 1.0 [1] publicly released at the 3rd 5G Global Event organized on 23-25.05.17 in Tokyo. The Trials Roadmap is worked out by the European Trials WG[2] coordinated by the 5G Infrastructure Association (5G-IA), expanding the work initiated by the Industry and EC in the context of respectively the 5G Manifesto [3] and the 5G Action Plan [4].

The main objectives of the Roadmap are to:
- Support global European leadership in 5G technology, 5G networks deployment and profitable 5G business.
- Validate benefits of 5G to vertical sectors, public sector, businesses and consumers.
- Initiate a clear path to successful and timely 5G deployment.
- Expand commercial trials and demonstrations as well as national initiatives.

Most of the Roadmap implementation is and will be covered by the Industry on a private basis, with part of this implementation supported by the EC through the 5GAP, EC 5G Infrastructure PPP Phase 3, EC 5G Investment Fund, by Member States (MSs) through specific National programmes as well as by Domains specific programmes (such as the one initiated by the European Space Agency (ESA)) that will provide a multiplier effect enhancing other public funding.

This Roadmap Version 2.0 addresses the latest up-dates of the Roadmap strategy, the 5G Private Trials, the 5G Platforms, the 5G Vertical Pilots, the 5G Pan-EU Flagship event 5G for UEFA EURO 2020 and the 5G Trials Cities.

The release of the Roadmap Version 3.0 is planned for May 2018 in view of public release at the 5th 5G Global Event in Austin.

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[1] https://5g-ppp.eu/wp-content/uploads/2017/05/5GInfraPPP_TrialsWG_Roadmap_Version1.0.pdf
[2] Open participation / membership.
[3] http://ec.europa.eu/newsroom/dae/document.cfm?action=display&doc_id=16579
[4] http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=17131

## 2. 5G Pan-EU Trials Strategy and Roadmap

In the context of 5G trials and pilots, some of the key questions which should be considered by all parties include (1) What are the benefits of 5G?, (2) How do I prove that 5G provides these benefits?, (3) Why cannot this be achieved already now?, (4) What is 5G bringing that makes this possible? and (5) How do I transition from 4G to 5G? Each of the ICT stakeholders, vertical sectors, participants, sponsors and contributors will have different objectives, expectations or KPIs and outcomes by which they will want to measure the success of the 5G trial(s)/pilot(s). These will be driven by the user requirements and will need to be measured (quantitative or qualitative) during the trial/pilot. In this document, the term pilot is used and differentiated from the term trial as follows: In a trial, activities are conducted (outside a laboratory environment) to verify the functionality of a system or parts of it, e.g. when the correct functionality is still the primary interest. Pilot is the execution of a trial including business relationship assumptions, exemplifying a contemplated added value for the end-user of a product or service.

The core part of the 5G trials and pilots will be achieved through private trials (commercial and pre-commercial) between network operators and manufacturers/vendors and will step by step involve vertical stakeholders. The acceleration of 5G in Europe is happening thanks to a specific joint strategy between Industry (hand in hand with Research Centers and Academics), EC and MSs and Domains specific initiatives. Expanding bilateral and trilateral private trials, the strategy relies on the development of specific projects addressing 5G vertical pilots and 5G platforms, 5G UEFA EURO 2020 as major 5G Pan-EU Flagship event and the 5G Trials Cities programme. The 5G Pan-EU roadmap leverages a multiplier effect of the cooperation between ecosystem partners over different European countries (allowing interoperability and defragmentation). The projects and actions are and will be partly supported by specific EC and MSs programmes and funded projects and also by Domains specific programme and projects (e.g. ESA satellite for 5G Initiative). An example to illustrate this are the 5G Corridors projects for which different network operators and manufactures/vendors will engage in dedicated projects at Pan-EU level (e.g. 2 or 3 MSs involved). Some of these projects will be supported by EC and MSs projects (e.g. the EC H2020 5G Infrastructure PPP Phase 3 ICT-18-2018 Call on Corridors).
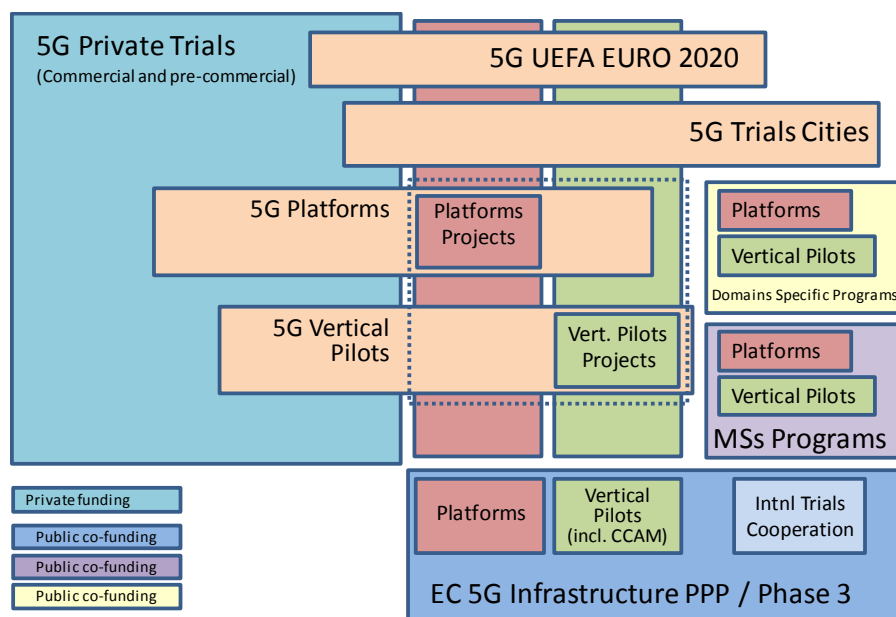


Figure 1: 5G Pan-EU Trials Roadmap Strategy

The 21 EC H2020 5G Infrastructure PPP Phase 2 projects (2017-2019) will actively contribute to the prototyping, experimentation and trialling of 5G technologies and components for specific use cases, including vertical uses cases developed with vertical stakeholders. There will be further momentum gained through PPP Phase 3 projects (2018-2020) with a set of 3-4 projects addressing end to end test facilities and platforms, 2-4 projects addressing vertical pilots for connected mobility (corridors) and 6-9 projects addressing vertical pilots. In particular, Phase 3 projects will target large scale trials and pilots including complete end to end 5G systems, demonstrating 5G KPIs and key distinguishing features (e.g. end to end network slicing, service based architecture, diverse access technologies integration…) and proving 5G technology capability to address and integrate requirements of a multitude of vertical industries. Concerning the Domain specific programmes, the recently announced "ESA Satellite for 5G Initiative" aims to expedite space sector integration in the 5G Pan-EU trials. The intention is to bring together relevant stakeholders to accelerate the integration of Satellite in 5G through relevant projects, in particular 5G Infrastructure PPP Phase 3 projects, with ESA funding typically providing a complementary "multiplier" effect to the satellite elements in those projects. [5]

The overall 5G Pan-EU Trials Roadmap is summarized in Figure 2, capturing the EC 5G Infrastructure PPP programme phases and the high-level standardization time plan.
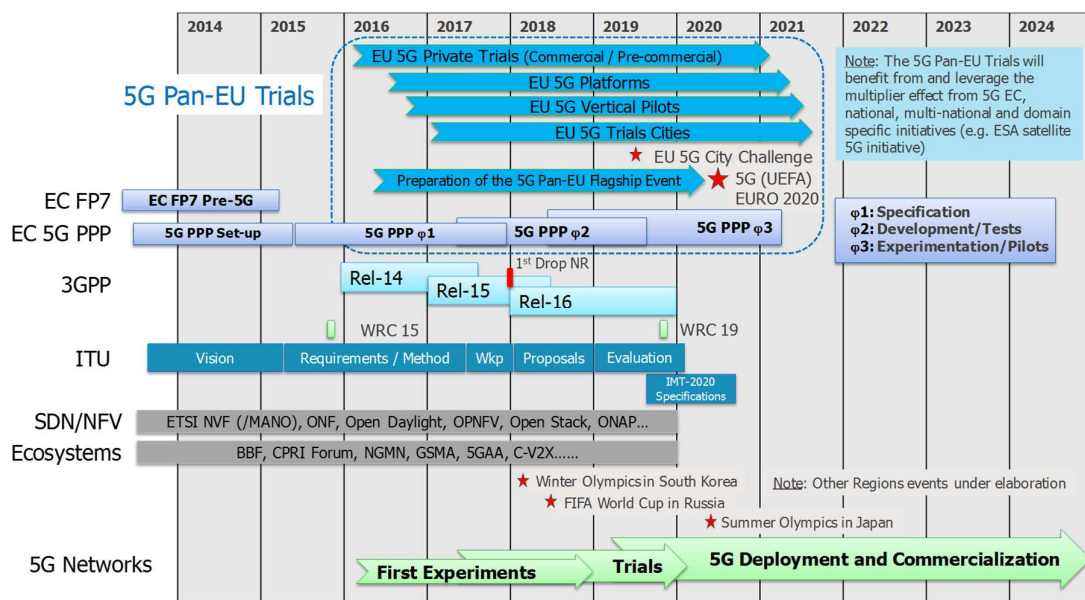


Figure 2: 5G Pan-EU Trials Roadmap

Finally, it is important to highlight that besides 5G Pan-EU Trials, similar activities and initiatives are planned or already taking place in other countries and regions across the globe. In that respect, it is very important to avoid premature "5G" launch announcements and the subsequent potential fragmentation among the different countries, which would hurt both industry and consumers. Instead, the aim should be towards a 5G globally harmonized standard, which can only be achieved via international cooperation. Accordingly, the roadmap of the 5G-IA does not only include Pan-

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[5] The primary objective is to incentivize collaborations within 5G Infrastructure PPP projects (for example the inclusion of a relevant satellite element) by providing the opportunity to further enlarge their scope. A secondary objective could be to implement individual complementary activities, in a coordinated manner, typically to extend the scope of selected 5G Infrastructure PPP projects in areas specific to satellite technology and use cases.

European 5G trials, but also international trials. In addition, the 5G-IA will boost the standardization process and will push collaborative international research as a means for consensus building. International research related to trials, in the 2018-2020 time frame, will take place with the following countries and topics: (1) Japan, with a focus on spectrum and interoperability at different bands, (2) South Korea, with special emphasis on mmWave and integration of 5G vertical testbeds in heterogeneous environments, (3) China, where the main use cases will be V2X communications and eMBB applications, (4) Taiwan, where trials will be conducted on end-to-end testbeds for specific applications and (5) Brazil, with a clear focus on spectrum and standards cooperation. Moreover, cooperation with a long-term scope with the US will also take place via coordination activities between existing EU projects and those of the PAWR (NSF) program. Efforts carried out by the 5G-IA to involve additional countries are expected to culminate in collaboration agreements with Canada and India, which will further strengthen the global consensus and cooperation on 5G.

### 3. Building Europe 5G readiness through 5G Private Trials

Europe is home of an increasing number of 5G private trials and pilots (pre-commercial and commercial) involving a multitude of stakeholders, notably network operators, manufacturers/vendors and some vertical industries. Several major network operators in Europe have already announced first results of experimentations and plans for further demonstrations of specific 5G features, either bilaterally with a single manufacturer/vendor or multilaterally with a number of manufacturers/vendors. Trials have been achieved or have been announced in most of the EU countries (50+ experimentation and trials publicly announced in the different EU countries).

The main target of the current trials is to demonstrate the high data rates and low latency communications, which are key features for 5G technology. In 2017 there were only a few 5G Private trials including vertical stakeholders. Trials in 2016-2017 have been focused on enabling technologies related to the radio interface (high throughput, millimetre-waves and other new large spectrum bands, antenna technologies…), the network architecture (virtualization, cloudification, network slicing, edge computing…) and the introduction of new technologies dedicated to specific use cases (technologies for IoT, for automotive…). It is foreseen, that when the maturity level of 5G features increases, more direct vertical stakeholders will be engaged in the trials. Some of the 5G trials announced include joint work on experimentation platforms that could become open to new ecosystems, in order to develop 5G applications and services in the context of the digital transformation of vertical industries.

Before 2018, when the first 5G standard release will be delivered by the 3rd Generation Partnership Project (3GPP), demonstrations and trials are done partly independently of the status of standardization (though network operators may prioritize features well advanced in standardization), to early demonstrate and validate the new 5G capabilities as well as to foster an ecosystem around these new 5G capabilities. Consequently, the running trials and demonstrations are already today building concrete know-how and readiness of the European industry to benefit from an early 5G launch when the standards will be fully stable. Some of these initiatives will be inspired by the Trial and Test Initiative (TTI) project, approved by NGMN in June 2016, consisting of four streams: Tests of Technology Building Blocks (TTBB), Proof of Concept (PoC), Inter-Operability and Pre-commercial Networks Trials. The goal of the NGMN TTI initiative will be testing performance of individual technology components and 5G features (e.g. massive MIMO, beamforming, numerology and frame structure, channel coding…). Tests will be performed with non-standard equipment in laboratory facilities and in small-scale outdoor environments. The TTI project will enable a global collaboration on testing activities, consolidating contributions and report on

industry progress, and testing future 5G use-cases with industry stakeholders (in particular from vertical industries). The 5G-IA Trials WG is developing a connection with the TTI WG. The tests and trials conducted by NGMN TTI partners in the framework of EC 5GAP are naturally entitled to be shared within the framework of this global initiative.

During and after 2018, European stakeholders will move to agree on detailed trials specifications (use-cases, scenarios, interfaces, agreement to transfer use-cases across trial networks) valid for Pan-European trials, largely based on standard-compliant systems. These trials will take advantage of the first 5G release of the 3GPP Standard (Rel-15 Stage 3 - December 2017). In particular, it is expected trials will initially be based on 3GPP Release 15 "early drop" (June 2018) compliant equipment, which will include a small set of 5G features and will be based on non-standalone LTE assisted NR, and to continue to full 5G System (5GS) trials, featuring standalone NR after June 2018. Trials will use some of the additional frequency spectrum proposed for identification in WRC 2019, enabling the full performance capabilities of 5G in terms of capacity and speed. These trials will aim to demonstrate wider interoperability and support for vertical use-cases in order to validate new business models.

## 4. 5G Platforms – Key component of 5G developments

As methodological key steps towards actual 5G deployment, the development of 5G platforms feeds the roadmap with milestones representative of demonstrated technologies. Maturity and availability of 5G features as platforms are the result of continuous private (multilateral) industrial efforts and/or cooperative projects at Member States or European level. Accelerating trial capabilities and other pilots, the platforms remain subject to continuous efforts targeting the full 5G picture and future evolutions. As such, actual 5G infrastructure deployment roadmap is highly dependent on the capability to deliver relevant and comprehensive set of platforms addressing remaining gaps & challenges. One should also consider platforms as valuable and demonstrated set of 5G enablers, beyond trial objectives.

Sourcing of platforms may be distributed on private, national or European projects. Complementarity and efficiency of the efforts deserve coordination among the diversity in scope and ambition of the platforms, this is the intent of this roadmap iteration. The overall approach is built with clear expectations on integration and validation methodologies and sharing common objectives, i.e. KPIs demonstration, trial enablers, and implemented as much as possible as a programmatic complementary bundle. The part relative to cooperative projects has to be recognized with unique value with respect to interoperability, integration and governance issues to cite a few. This value may be derived in turn into related KPIs illustrating for instance usage of standards across diversity of providers.

Platforms should serve both demonstration of expected 5G KPIs and enable faster deployment of trials covering a wide set of vertical use cases. The ambition is to actually cover every facet of 5G features and usage. Platforms or cluster of platforms, seen as end-to-end facilities should be representative of the unique 5G network and service capabilities defined in the 5G Infrastructure PPP vision. Besides, platforms should enable the demonstration of the integration of several heterogeneous networks e.g. wireless terrestrial and satellite, optical fibre, fixed and mobile networks, as well as architectural and business-related (including openness to non-ICT ecosystem) solutions. Amongst the architectural solutions, the provisioning of 5G end-to-end slices in support of several vertical is the subject of particular emphasis, as it captures and integrates large part of the 5G promises.

Platforms capabilities will span the three main types of targeted services eMBB, mMTC and URLLC. This lead to specific platforms specifications and methodology commonalities. First of all, integration and validation should be considered at system level with the perspective of related KPIs (applicability may differ as per the type of service). Then, both for deployment and scientific objectives, reproducibility properties of the experiment are expected. Although methodologies will be exposed and shared, allowing agreement and efficient integration beyond. In the same spirit, but with respect to features and services, descriptions exposure should be provided. Also attention is given to security (by design) as a common must-have platform requirement. This addresses the (specific) threat management, protection, detection and remediation capabilities. Beyond properties of platforms, security is an intrinsic pre-requisite for 5G systems and services in particular for mission-critical applications.

Anticipating real 5G services deployments issues, a key aspect of successful integration will rely on open APIs allowing interworking within and potentially between platform clusters/projects. This requires coordination and overall governance overcoming potential blocking legal or commercial constraints. As an ambitious contribution and a major step in the 5G deployment, platforms integration and development will be incremental (for instance through iterative cycles) ensuring availability towards trials experimentation. This will allow phasing of delivery, which depends in turn of technology and standards maturity (or gaps) and expedites demonstration and trialling of new capabilities and features.

Any type of initiative has to be leveraged as contribution to the global objectives. This relies to private industrial platforms from the ecosystem (pure 5G players but also verticals), capitalization from coordinated and cooperative projects at European level from initial phase to current ones, national initiatives, collaborations with Domain Specific Initiatives as well as well as opportunities for international cooperation.

As mentioned above, the platforms are relying on complementary private and projects-based continuous efforts. Through actively contributing members, the richness can be illustrated in technical coverage and diverse mix private/projects using and developing existing platforms (not exhaustive list): 5GBarcelona (www.5gbarcelona.cat/) in Barcelona, 5GTNF (5gtnf.fi/) in Espoo and Oulu, 5SECC (private, no public access yet) mainly in France, 5TONIC (https://www.5tonic.org/) in Madrid, ATHENS5GLINK (www.athens5glink.eu/) in Athens, 5G-Ready-Trial-Platform and the 5G Berlin Testbed (http://5g-ready.org/ and http://www.5g-berlin.org) in Berlin, FlexibleNetLab (no public URL) in France, LUCY (private project) in France, SATis5 (https://artes.esa.int/projects/satis5) in Germany, Luxembourg… and TRIANGLE (http://www.triangle-project.eu) in Malaga. Most common features in these platforms are HetNets, ultra-low latency communications, Fog/edge/cloud computing, NFV and vEPC, SDN, SDR, eMBB as well as mMTC and URLLC. Achieved or on going, a complete coverage of expected KPIs is targeted, addressing in turn diverse verticals such as Public Safety, eHealth, Automotive and Transport/Logistics and Media & Entertainment.

While those platforms represent already significant 5G capabilities, more efforts are required to extend to Pan-European, large-scale deployments and/or to enrich with 5G features as soon as they become standardized and available. Private trials, Member State initiatives, Domains specific initiatives and 5G Infrastructure PPP projects, will continue to foster coordinated and optimized efforts in that direction. Detailed information about platforms and their up to date capabilities will be made accessible online through dedicated 5G-IA webpages.

**5. 5G for Vertical Industries - Building the case through Pilots Projects**

Once 5G technologies have reached a maturity level beyond pure laboratories experiments, trials and pilots at local as well as Pan-European levels will be targeted to accelerate the deployment of these new technologies. Validating the stability and advantages in specific vertical environments will be an important step in moving 5G technologies into the market. Specific vertical environments mean that 5G services are validated through pilots involving vertical industries but as well pilots across several vertical industries. This concept is based on perceived common business interaction patterns that exist among vertical industries today and, more importantly, how these patterns are perceived in the future. In addition, a secondary goal is to increase the understanding of the new possibilities 5G offers to industry segments which are less ICT focused and thereby help to jump start 5G adoption. Overall, the validation is for the 5G vertical services and the new eco-systems that shall be enabled by 5G either in a B2C or B2B2C setting.

From a business point of view it is more reasonable to perform pilots that embrace several verticals. For example a company in the manufacturing vertical is handicapped without being properly linked to companies in the transport/logistics vertical and/or companies in the smart grid/energy vertical. This approach can prevent the development and deployment of platforms that each is specialized for one vertical only. Specialized platforms would jeopardize the intention to provide a generic platform that can flexibly accommodate and support multiple verticals requirements.

The ambition and the reality of demonstration coming from vertical trials have a strong dependency on the underlying platform capabilities. Platform interoperability issues are considered from different angles:
- Verticals should benefit from meaningful, e.g. representing 5G services offers, common and standard interfaces and APIs. This will allow discovering, triggering, negotiating and controlling the platform capabilities.
- Since many verticals should involve several platforms to demonstrate end-to-end capabilities, interoperability between platforms is a must.
- Last but not least platforms should validate KPIs. Platforms should also be replicable and deployed where the vertical stands.

In order to facilitate the ambition and to provide some structure to support developing concrete plans, five so-called vertical clusters have been identified. These clusters are to be understood as illustrative and only provide indication of possible future pilots. The identified cluster pilots are the following ones:
- Smart City cluster embracing Public administration, Tourism, Assisted living, People mobility and Residential energy management and provisioning.
- Consumer and Professional Services cluster embracing Media & Entertainment (B2C, B2B2C), Personal communications, Emergency communications, Smart buildings, Smart health and On the move services
- Industry Cluster embracing Factory and process automation, Energy, Logistics/Transport and Farming technology.
- Digital Health (eHealth) cluster embracing Smart pharmaceuticals, Smart pharmaceuticals augmented with supply chain and cost clearing and Medical emergency management.
- Public Safety & Digital divide resorption embracing Rapid disaster response, Public event management, Critical asset protection and Remote area coverage

There can be other verticals combinations as pilots, there can be overlapping pilots, and there can be pilots with a focus not covered by the proposed clusters, as long as several verticals are engaged in a business relationship and that this covers the whole value chain.

It has to be noted that different vertical industries have different levels of 5G readiness. In some verticals large industry alliances or consortia exist, e.g. the EATA and 5GAA in the automotive sector or the IIC in the manufacturing industry. These may drive and shape 5G adoption within their verticals. From that perspective, Connected Cars is considered as one of the vertical priorities for a strategic 5G European roadmap. This is emphasized with the initiative by the EC, European Ministers and Industry who agreed to work together on digital cross-border corridors. These corridors include Metz-Merzig-Luxembourg, Rotterdam-Antwerp-Eindhoven, Porto-Vigo and Merida-Evora (corridor Lisbon – Madrid), the E8 "Aurora Borealis" corridor between Tromsø and Oulu and the "Nordic Way" between Sweden, Finland and Norway.

In addition, there are already agreed and planned pilots announced for smart cities and communities (see https://eu-smartcities.eu/). A number of projects in EC 5G Infrastructure PPP Phase 2 include participation from verticals (e.g. Hamburg Harbour Authority) and have a clear focus on vertical use cases. Further, private trials/pilots are addressing verticals from e.g. Media & Entertainment and Smart Cities. Besides, there will also be pilots supported by Domains specific initiatives e.g. ESA satellite for 5G Initiative in areas specific to satellite technology and satellite affine verticals.

In order to complement these activities, it is recommended putting a focus on other less addressed verticals, e.g. from public safety cluster. As of now such cross-vertical pilots should be further encouraged and therefore the roadmap is emphasizing the necessity having means to remedy this lack of commitment.

Last, vertical pilots may explore advanced network orchestration features that should enable full federation management between verticals and users, allocation of user priority rights, intelligent bandwidth controller managers, mobility control management, QoS management (the last two may be consider among the above mentioned KPIs). There should be no requirement for any dedicated terminals.

**6. 5G for UEFA EURO 2020 – An opportunity for a Pan-European Showcase Event**

In order for 5G to be truly successful high profile trial(s), accessible to large public audiences are planned. The target flagship event has to get widespread media attention and serve as a milestone for industry, governments and the general public that 5G is coming now and is beneficial for individuals and society.

The UEFA EURO 2020 football championships will be played in 13 different cities in Europe (Glasgow, Dublin, Copenhagen, Budapest, Bucharest, Brussels, Bilbao, Amsterdam, Saint Petersburg, Rome, Munich, Baku and London). This makes the EURO 2020 an excellent opportunity for a 5G Pan-European trial, also because of the media attention it will get. The timing of EURO 2020, summer 2020, just before the 2020 Olympics in Japan, fits well with the EC 5GAP.

The proposal is that the EURO 2020 acts as the "launching event" for 5G in Europe with a number of 5G services that will be trialed around the EURO 2020 football cup. Three different types of trial services are proposed, the triple A trials:

A. For the stadiums, around the stadiums and in fan zones, 5G Augmented and virtual reality applications related to EURO 2020 or football in general can provide ways to entertain fans before, during and after the game, including through immersive experiences around the competition. These services could be available in hosting cities but also in other cities.
A. The EURO 2020 will be the opportunity to demonstrate services in Automated transportation around the stadiums and relevant transport routes. Scenarios include transportation to and from the airports and automated vehicles for the transport of officials, staff and supporters.
A. Public safety authorities present for security around the stadiums could benefit from Advanced public safety services. For example augmented reality can be used to visually mark persons of interest based on facial recognition. Tailored services (e.g. access security, persons localization) will create a significant improvement in safety and security.

In each of the cities a consortium is needed of local governments, playing stadiums, operators, infrastructure vendors and application providers. Local funding through private trials or/and national or/and regional initiatives will be used to develop the trials. The City of Amsterdam, with the Amsterdam Arena as EURO 2020 host stadium publicly announced at the MWC 2017 in Barcelona that they are committed to participate in 5G trials and to get as many playing cities on board. For each playing city, an agreement with (at least one) operator is targeted to ensure there will be a 5G coverage on which the intended 5G services can be trialed. There will need to be a trade-off between what coverage specific trials need and what local operators and manufacturers/vendors can deliver. Sufficient spectrum (at least 100 MHz per operator across the 3.4-3.8 GHz band, several hundreds of MHz in the 26 GHz band) is targeted for availability from the related Member States, in order to allow demonstrating the full performance capabilities of 5G. Cities that are not a playing city can participate with 5G Augmented and virtual reality applications at local fan zones, which will also reduce the requirements on coverage and spectrum. The trial services will be developed together with the local partners, e.g. public safety trials will need collaboration with local governments. Though the different local governments and local initiatives may lead to differences in the trials, replication of 5G trial services across multiple cities is aimed for as far as possible. A Pan-European steering committee, including representatives of the cities, the playing stadiums and telco partners, will ensure a consistent coordination of trial objectives and implementation. This steering committee will also address the marketing and communications aspects of this profile event across Europe and the world. These pan-European activities will be greatly helped with an EC funding contribution to the required coordination activities.

Many of the trial services are not only relevant for EURO 2020, but are also related to Smart City type applications. A relation with UEFA will be established in order to investigate the rights and constraints associated with using EURO 2020 as a flagship event and to ensure the trials add to the success of UEFA as well. A win-win-win perspective between 5G Infrastructure PPP, EC and MSs (and related Cities) and other stakeholders is sought. Specific actions may be partly funded by EC in the context of PPP Phase 3 and by MSs at National level.

**7. 5G Trials Cities**

In complement to the 5G private trials under development and the 5G for UEFA EURO 2020 flagship event definition, specific cities in Europe already announced their plans to become 5G Trials Cities, at the forefront of 5G trials and pilots. The different involved stakeholders come together to enable societal infrastructure benefits to the public, as new technology provided by 5G is seen as an opportunity to enhance and enrich the public services, increase the cities attractiveness and streamline the cities functions. There is also a clear need to modernize city governance and processes in the framework of constrained public expenditure and a related demand for deploying disruptive technologies enabling further digitization in public service delivery. 5G will clearly be part of future cities, and to conduct relevant trials is a way to ensure the development of the best feasible 5G solutions.

A non-exhaustive list of 5G Trials Cities is: Amsterdam, Barcelona, Bari, Berlin, Espoo, L'Aquila, London, Madrid, Malaga, Matera, Milan, Oulu, Patras, Prato, Stockholm, Tallinn and Turin. These trial cities aim to provide support for variety of technology and service demonstrations carried out during the 5G trialling phase, and provide valuable vertical use cases especially for Smart City concept to validate the trials in real user environments. When compared to the private sector, public entities such as cities usually have different interests even in similar use cases focusing e.g. on eHealth, energy, transport, smart buildings or digital service portals. In all of these domains, shared technology platforms, free access, open data and interfaces as well as the maximal involvement of local ecosystems and residents are common priorities from the perspective of the trials cities.

There are also 5G Research & Innovation Programs running in several Members States, including the development of specific labs and experimentation and trials platforms. These platforms, being generally anchored in specific labs / cities (before their replication), contribute to the 5G momentum in these specific areas. For example, some of the 13 cities where the EURO 2020 competition will be organized already work on the possible 5G demonstrations and showcases. It is also anticipated that Members States will communicate before end 2017, in the context of the 5GAP the information on their 5G Pioneering city (or multiple cities) where 5G will be deployed in 2020. These different actions clearly create a strong momentum on 5G from cities and countries perspectives.

Under the 5G Infrastructure PPP initiative, a "5G City Challenge" will be organized as a call for interest towards interested cities prepared to sign a 5G charter and aiming at supporting cooperation among the cities involved in 5G experimentation and trials, e.g. for the possible development of best practices and sharing of lessons learnt. The number of collaborations are foreseen to grow as the various trial activities in the cities are maturing. In connection to the current European Smart Cities developments, a Charter/Alliance of 5G Trial Cities can be developed in that context. In addition, 5G Trials Cities are welcome to contribute and support the end-to-end facility trials and joint vertical industry pilots in order to expand the coverage and public visibility of the activities related to the EC 5G Infrastructure PPP Phase 3. Here again, the availability of sufficient amounts of spectrum will be sought to deliver the full benefits of the large-scale 5G city trials.

**Trials WG Members organizations contributing to the Trials Roadmap Strategy**
ABB, ADVA Optical Networking, Ahlers, Airbus, Altice Labs, Atos, Avanti Communications Group plc, BMW, Bosch, BT, Deutsche Telekom, DOCOMO Communications Laboratories Europe, Engineering, Ericsson, Eurescom, Eutelsat, Fiat, Huawei Technologies, IBM Research, IDATE, Indra Sistemas, Inmarsat, Intel Mobile Communications, KPN, Leonardo, LiveU, Mitsubishi Electric R&D Centre Europe, NEC Laboratories Europe, Netaş Telecommunication, Nokia, Orange, Philips, Proximus, QinetiQ, Samsung Electronics Research Institute, SES, Siemens, Telecom Italia, Telefónica I+D, Telenor, Tele2, Telespazio, Telia Company, Thales Alenia Space, Thales Communications & Security, Trenitalia, Turk Telekomünikasyon, Vodafone, ZTE Wistron Telecom, European Broadcasting Union (EBU), ECTA, ETNO, T-REGS, AICO Software, AMBEENT WiRELESS YAZILIM, CityPassenger, Ingeniería y Soluciones Informáticas, Integrasys, InterInnov, M.B.I., Nextworks, Quobis, Sequans Communications, WINGS ICT Solutions, CEA-LETI, Centre Tecnologic de Telecomunicacions de Catalunya (CTTC), Consorzio Nazionale Interuniversitario per le Telecomunicazioni (CNIT), DLR (German Aerospace Center), Fraunhofer Gesellschaft zur Foerderung der angewandten Forschung e. V., Fundacion IMDEA Networks, IMEC, Institut Mines-Télécom, Instituto de Telecomunicações, IRT, TNO, Universidad de Málaga, Universidad Politecnica de Madrid, Universitat Politècnica de Catalunya, University of Bologna, University of Oulu/CWC, University of Patras, VTT Technical Research Centre of Finland, Universidad Carlos III de Madrid.

Note: Specific comments / questions can be communicated to the 5G-IA Trials WG @ TrialsRoadmap@5g-ppp.eu.