The European Research Framework towards the 5G Implementation: Overview, Opportunities and Challenges

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5G PPP PUBLIC-PRIVATE PARTNERSHIP
European Commission
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Introduction

Challenges for Infrastructures_(1/3)

- **The European economy has to "maintain" but also to "fortify" both its role and influence within the global international environment, *strongly influenced by the fast Internet penetration.***
- **It is important to realize innovative actions and to expand knowledge so that *"to keep a strong position in a strategically important market such as the one of the ICT sector".***

- ***The diversity of new (personal and professional) usages, leads to new network requirements on availability, latency, reliability, trustworthiness and security.***

- ***Appearance of new trends,*** *with the related features/functionalities much more closely "embedded" within the network applications.*
- ***Users gradually become more and more "demanding"*** *in terms of contents and service requirements.*
- ***Privacy and sustainability issues become of prime importance,*** *thus implying for resilient constraints on networks and service platforms.*

Challenges for Infrastructures_(2/3)

Appearance of a variety of major challenges:

- **"Handling" of the increased network traffic** together with the **provision of** all necessary **capacity and/or spectrum availability**, *so that to serve/fulfil all relevant requests coming from different services, devices and users.*
- **Accommodation of novel classes of services/facilities** *(e.g., covering attributes coming from the IoT, M2M communications or content-based applications, or by any other future "complex" environment that may potentially appear),* **while preserving a "low" *-or a kind of "reasonable"-* CAPEX and OPEX features, supporting economies of scale and avoidance of unnecessary investments.**
- **Strengthening Internet's penetration in all sectors of our lives and economies, by making it an *"indispensable means"* for realizing an explicit, ubiquitous and dependable infrastructure** in mobile, wireless and fixed communications.
  Internet "drivers" are all kind of services/applications from low (sensor and IoT) to high throughput rates (e.g. high quality video streaming) and from low to high latency.
- **Supporting of** all actions for providing a **guaranteed level of Quality of Service/Quality of Experience (QoS/QoE) together with enhancement of privacy and security over the Internet, *especially for professional uses and with the aim of offering optimal performance*.**
- **Making the communication critical infrastructures "as resilient as required" by consumers of interconnected critical infrastructures (such as smart grid).**
- Supporting measures for realizing **reduced energy consumption.**

Challenges for Infrastructures_(3/3)

The forthcoming novel 5G infrastructure "faces" most of the identified challenges and will offer reliable solutions!

5G will be much more that the next step beyond 4G: it is expected to be the "*core functional system of our modern digital society and economy*", thus **generating a truly converged and tremendously "dense" communication infrastructure**, **integrating IT systems** *(e.g., processing and storage)* **with plentiful network resources**.

5G is to become a sort of universal, highly flexible and ultra-low latency virtualized infrastructure,

- ***capable of serving immense numbers*** *of smart terminals, machines, things, sensors, cars, drones, etc.,*
- ***with significant processing and storage capabilities*** *that may be exponentially increased, via relevant Cloud-based applications .*

The European Policy Approach

The European Policy Approach to 5G_(1/12)

5G networks *will not only be based on transport and routing/switching technologies but* ***will be more "flexible and open".***

5G networks are expected ***to evolve more easily*** ***than today's networks*** *and also* ***to embed sensing, computing and storage resources*** ***in a converged and unified infrastructure,***
able to "orchestrate" the delivery of services in a secure manner.

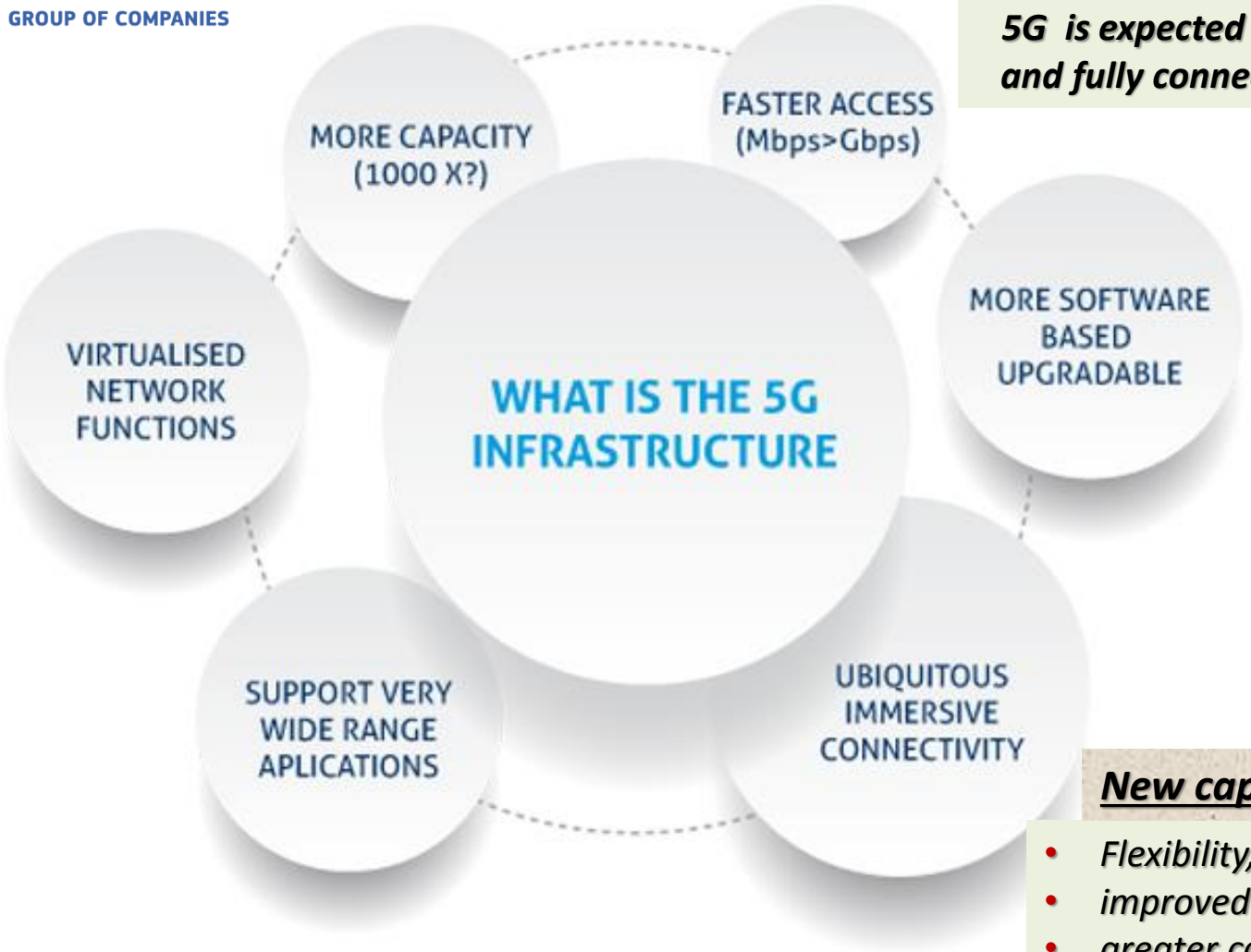
5G networks ***will provide a significantly higher system capacity than today*** *and solve any anticipated spectrum scarce.*

5G networks ***should also promote*** *-to the extent possible-* ***a common network management for mobile and wireless,*** *in terms of*

- ***constant performance optimisation,***
- ***fast failure recovery,***
- ***fast adaptations to changes*** *in network loads, architecture, infrastructure and technology.*

The European Policy Approach to 5G_(2/12)

5G is expected to assist an entirely mobile and fully connected and converged society



Source: 5G-PPP (https://5g-ppp.eu/about-us/)

New capabilities of 5G dimensions

- *Flexibility, lower energy requirements*
- *improved energy efficiency*
- *greater capacity, bandwidth, security, reliability and data rates*
- *enhanced indoor coverage*
- *lower latency and device costs*

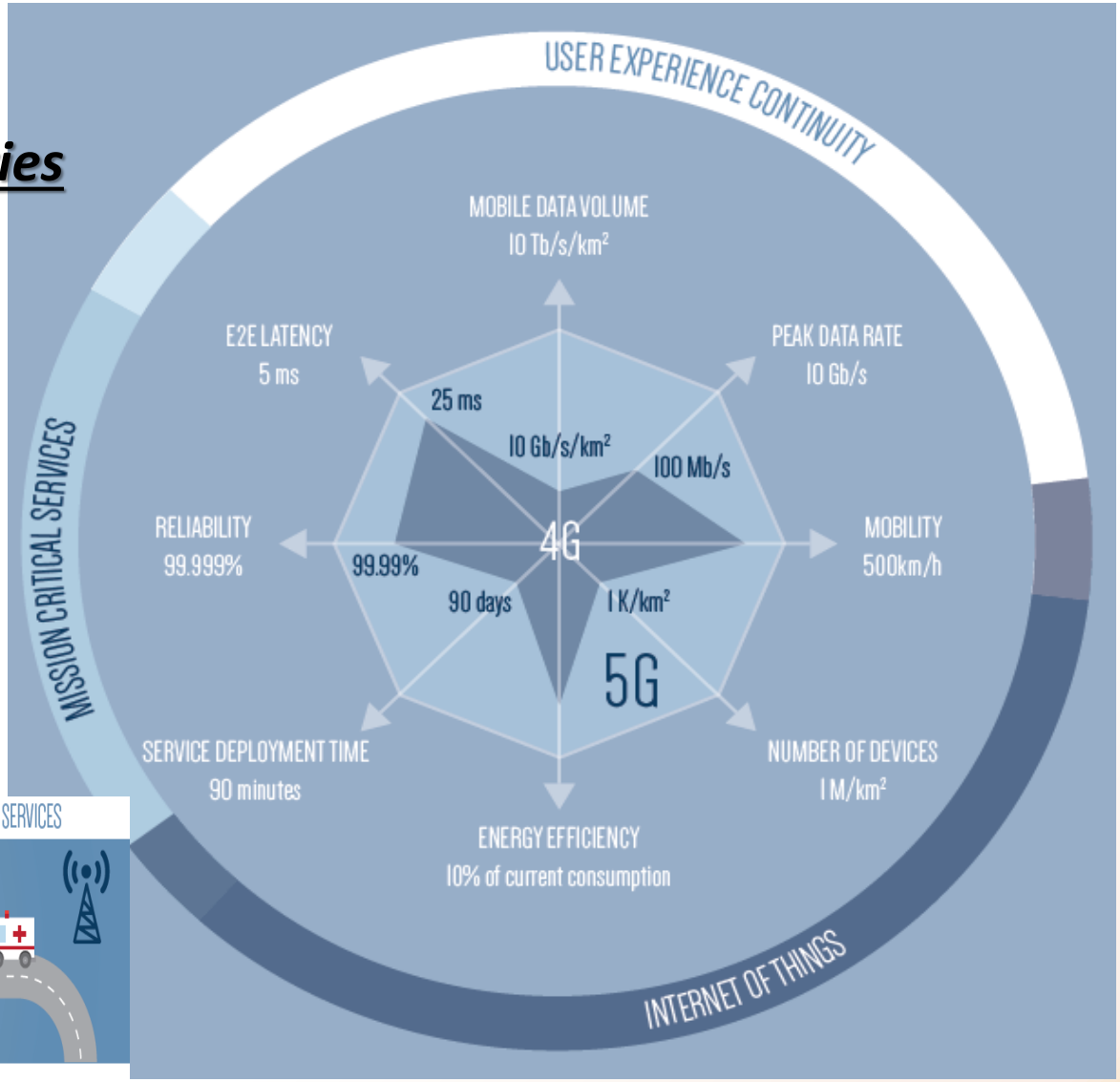
The European Policy Approach to 5G_(3/12)

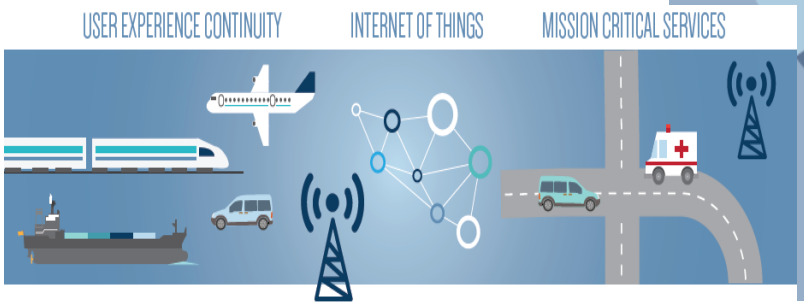
Within the 5G-PPP framework, the following KPIs have been identified:

- Possibility for the **provision of 1000 times higher wireless area capacity** and of **more varied service capabilities**, *if compared to those of 2010.*
- **Saving up to 90% of energy per service provided**. *(Here, the main focus should be in mobile communication networks, where the dominating energy consumption comes from the radio access network).*
- **Reduction of the average service creation time cycle** *from 90 hours to 90 minutes.*
- Creation of a **sufficiently secure, reliable and dependable Internet,** *with a "zero perceived" downtime for services provision.*
- Facilitating future **very "dense" deployments of wireless communication links** *to connect over 7 trillion wireless devices serving over 7 billion people,* thus realizing the option of *"connecting everything or everyone at any time at any place".*
- **Enabling advanced user controlled privacy**, *to guarantee a proper level of protection of the facilities offered.*

The European Policy Approach to 5G_(4/12)

Radar diagram of 5G Disruptive capabilities





Source: 5G-PPP, https://5g-ppp.eu/

The European Policy Approach to 5G_(5/12)

The development of the forthcoming 5G systems will be based

on an **ecosystem of close cooperation**
between industry, SMEs and the research community

with the aim of:

- ***developing innovative*** *-but also applicable/viable-* ***solutions;***
- ***guaranteeing the exploitation*** *of such in global standards & markets;*
- ***ensuring interoperability and economies of scale****, with affordable cost for system deployment and the end-users.*

The European Policy Approach to 5G_(6/12)

- *The* **development of the 5G ecosystem** ***involves numerous groups*** *of industry stakeholders, research institutions, standard developing organizations, certification bodies and other institutions and/or legal entities.*

- In particular, **5G-PPP is a "joint" initiative between the European Commission and the European ICT industry**, *intending to further reinforce the European presence in this field, at the global level.*

- The ***main objective*** is to ***design and deliver appropriate solutions, architectures, technologies and standards*** for the next generation communication infrastructure.

- ***Since 2015, the European Union (EU) funds several projects under the 5G-PPP program, covering three subsequent Phases.***
  These projects work together to deliver the critical 5G technology building block.

The European Policy Approach to 5G_(7/12)

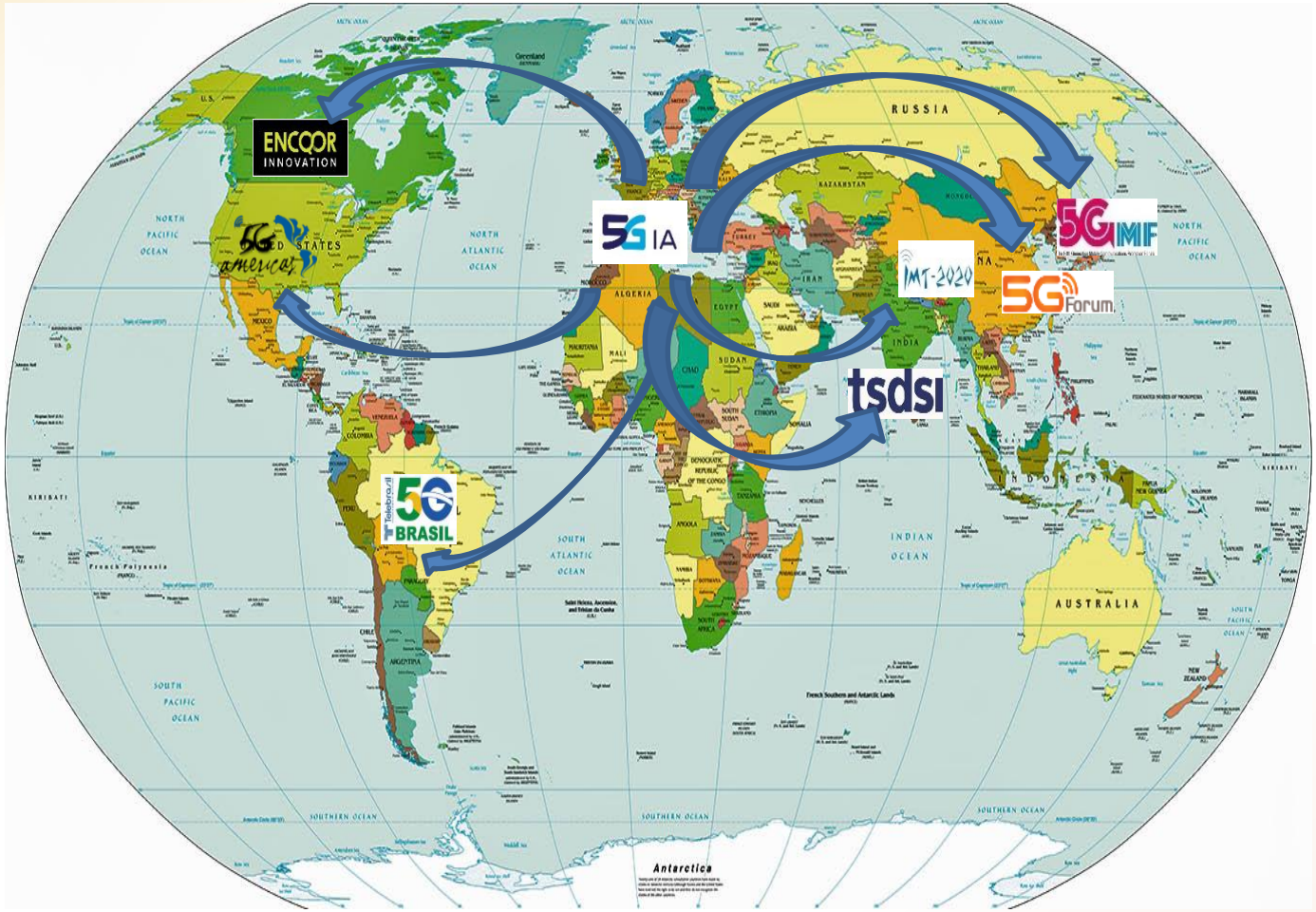
Standards developing organizations (SDO)	
FG IMT-2020, ETSI MEC, 3GPP A GLOBAL INITIATIVE	
Regional Initiatives	
Europe	European Commission, SEVENTH FRAMEWORK PROGRAMME, 5G PPP
Korea	5G Forum
Japan	5G mf The Fifth Generation Mobile Communications Promotion Forum
China	IMT-2020 (5G) Promotion Group
USA	4G americas
Industry Fora	
ngmn the engine of broadband wireless innovation	SMALL CELL FORUM

The global environment

The European Policy Approach to 5G_(8/12)

The global environment

The European Policy Approach to 5G_(9/12)



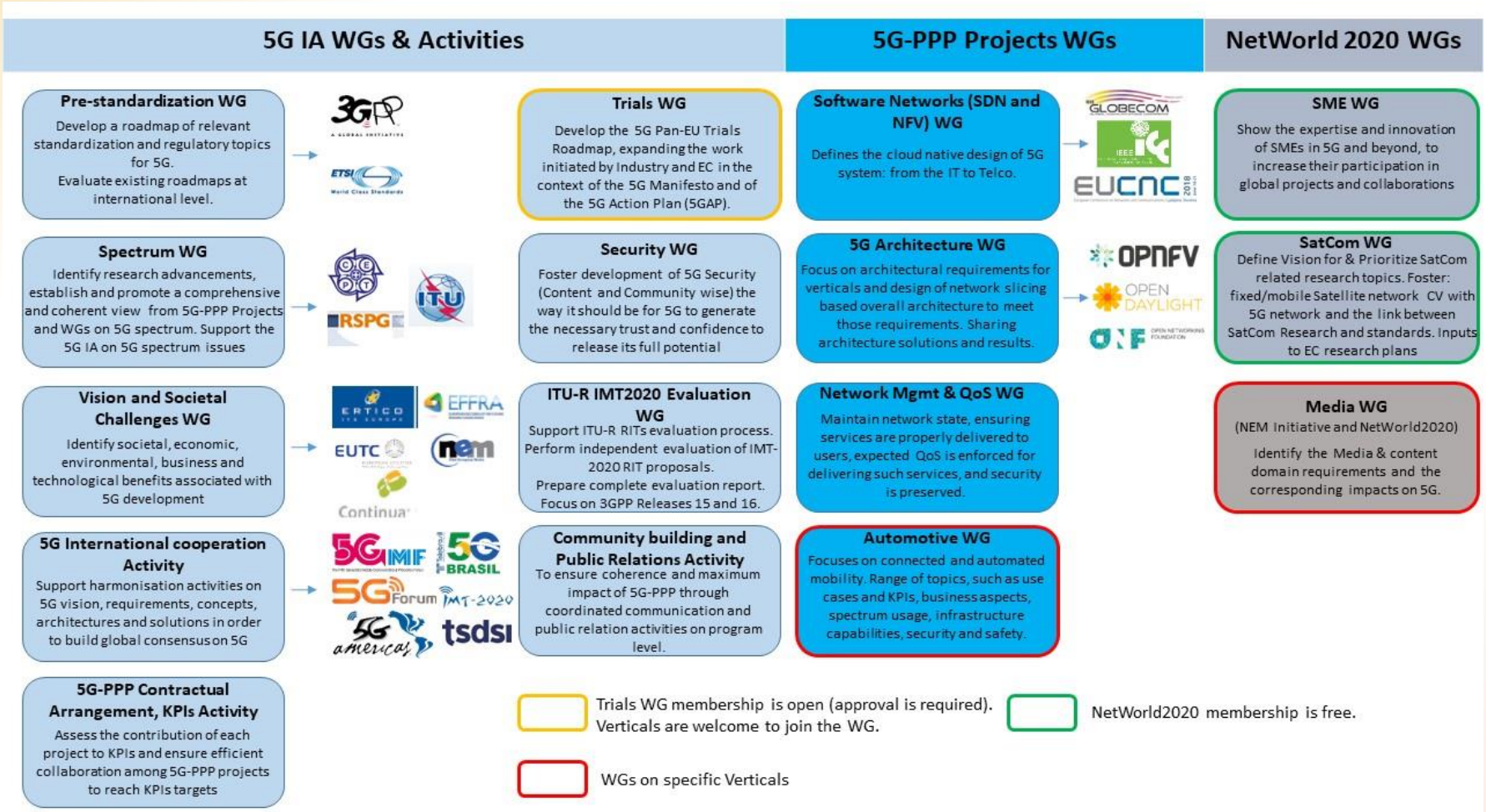
The global environment

The European Policy Approach to 5G_(10/12)

5G-PPP IA general objectives:

- **Conduct research and innovation work** that will form the "basis" of the 5G infrastructure for the Future Internet (FI) for a wide range of applications from IoT (Internet of Things) to very high throughput services;
- **develop the next generation of network technologies** taking into account key societal challenges and their networking requirements;
- **reinforce the European industrial capability** in communication network technologies;
- **serve as a consensus-*based* platform for effective collaboration of players** from industry, academia, research organizations and SMEs from both the terrestrial and the satellite communities;
- **"pave the way"** towards successful introduction of innovative business models based on more powerful and open networks;
- **support** the emergence of global standards;
- **help addressing non-technological barriers** such as regulatory issues and spectrum availability;
- **validate technologies** from a technical and business perspective through early trials and reference deployments;
- **develop skilled personnel**, which is needed to research, develop and operate advanced communication networks as well as use of new systems in vertical markets, *and*;
- **provide a reliable and trustworthy communications infrastructure**, which secures critical infrastructures.

The European Policy Approach to 5G_(11/12)



5G IA and 5G-PPP Working Groups

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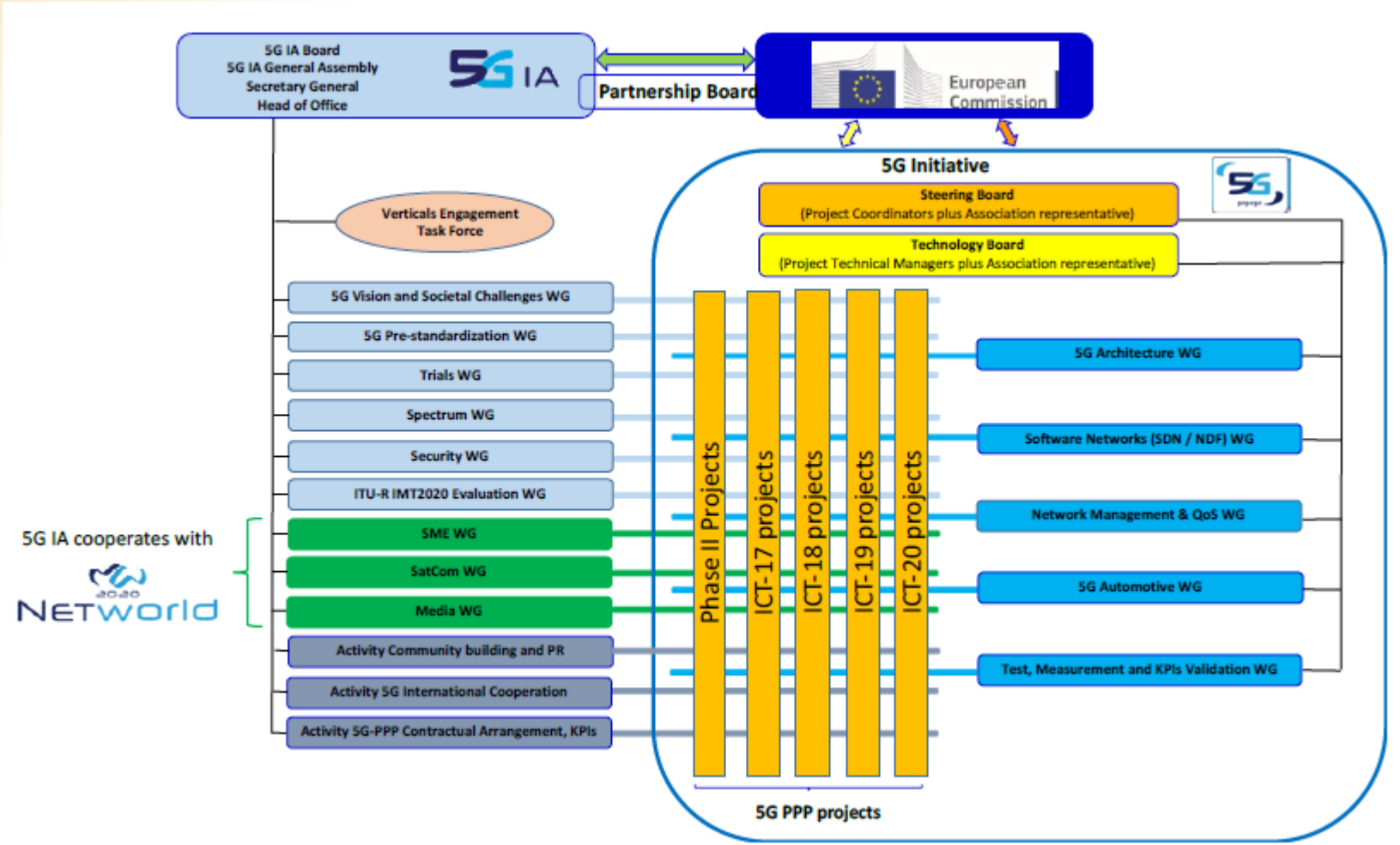
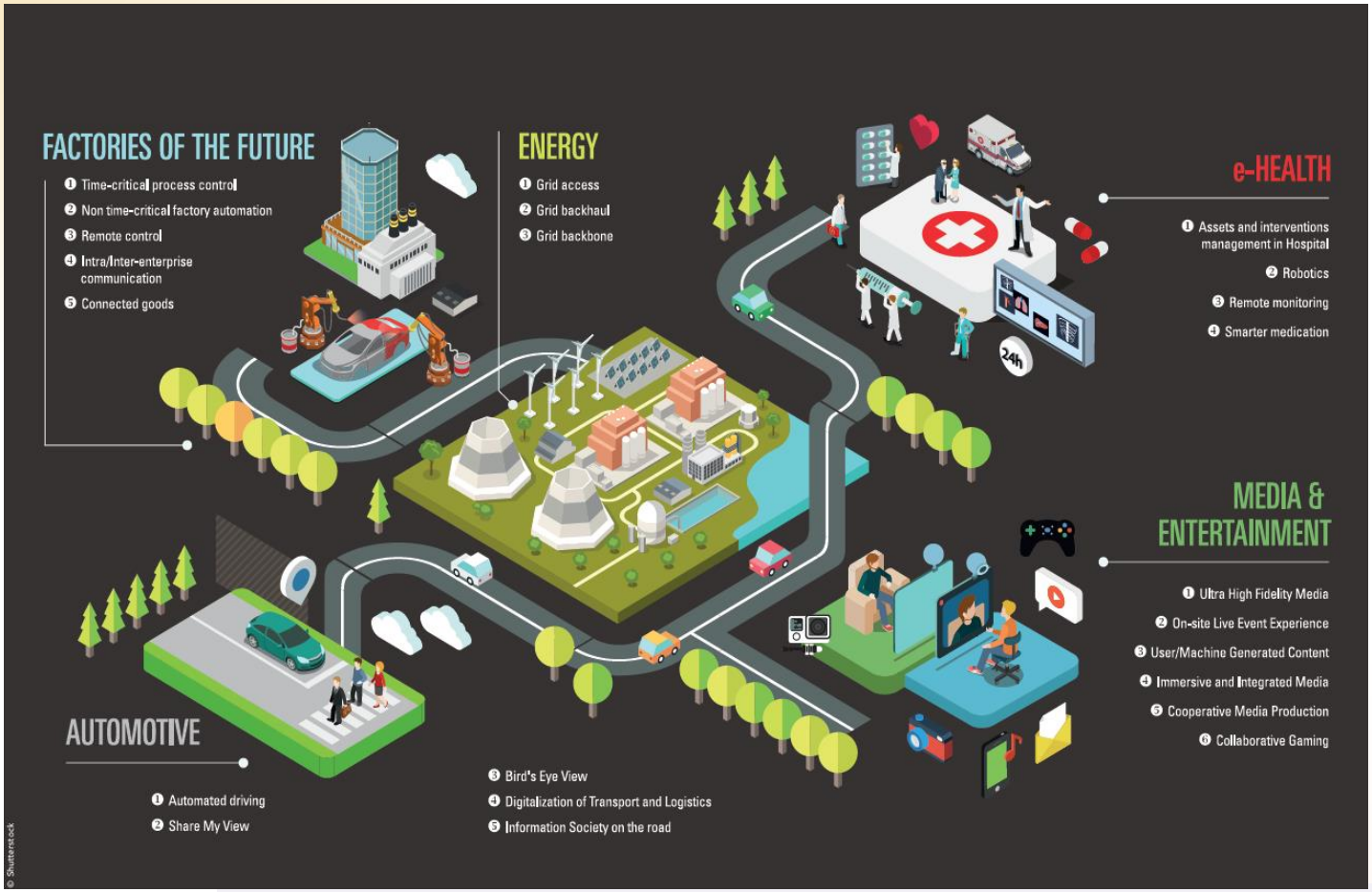
The European Policy Approach to 5G_(12/12)

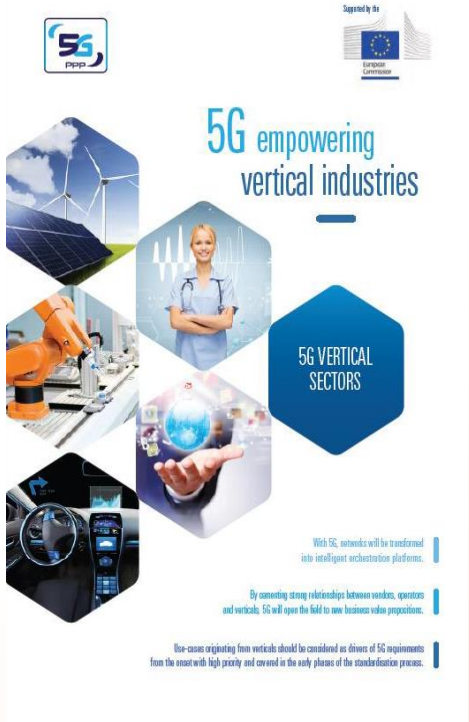
5G-PPP Governance:



Market Views
and 5G-PPP Approach (Phases I-III)

Market Views_(1/3)





European Approach within the 5G-PPP Framework

Source: 5G-PPP, https://5g-ppp.eu/

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Market Views_(2/3)

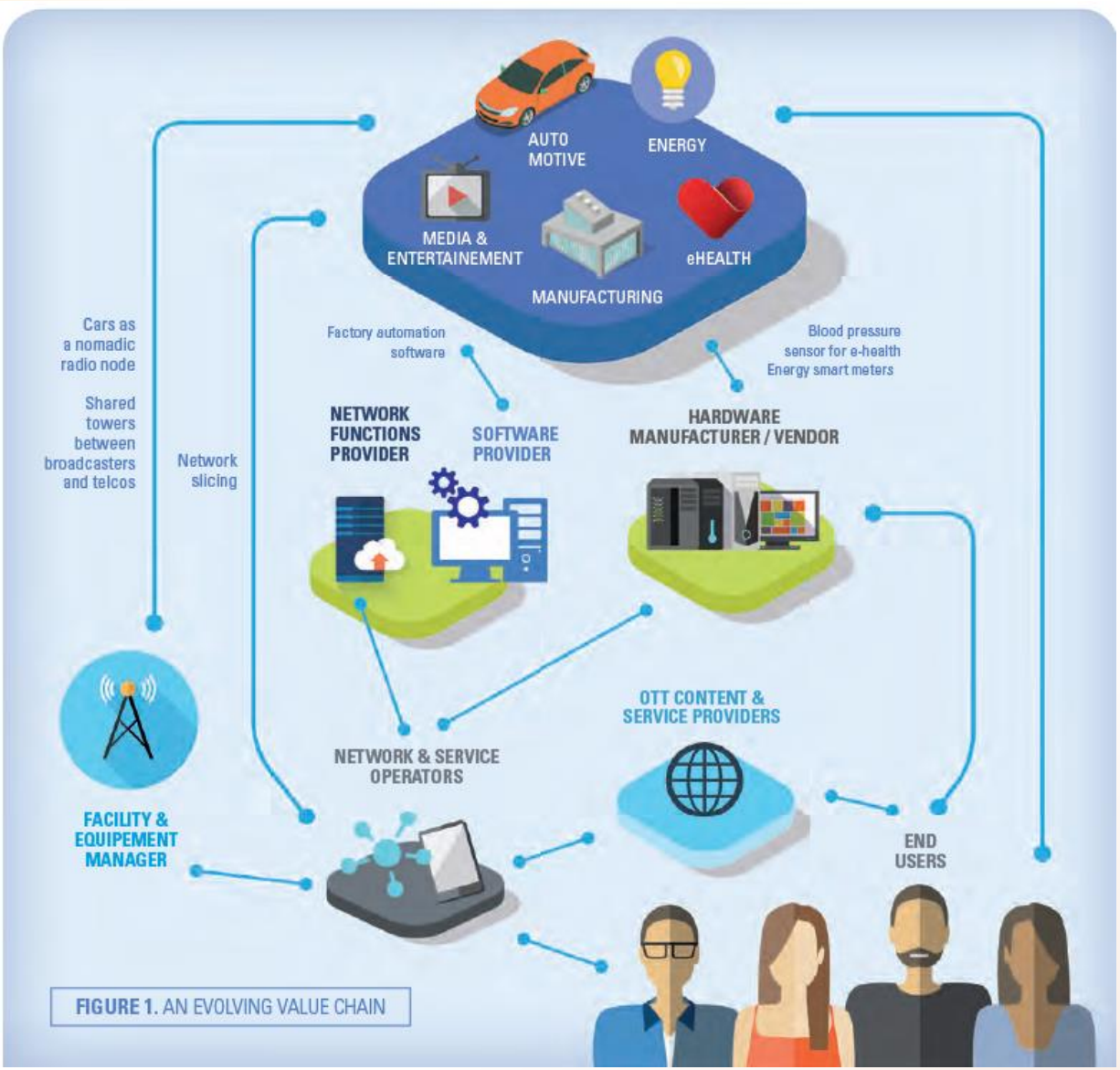


FIGURE 1. AN EVOLVING VALUE CHAIN

Source: 5G-PPP, https://5g-ppp.eu/

Market Views_(3/3)

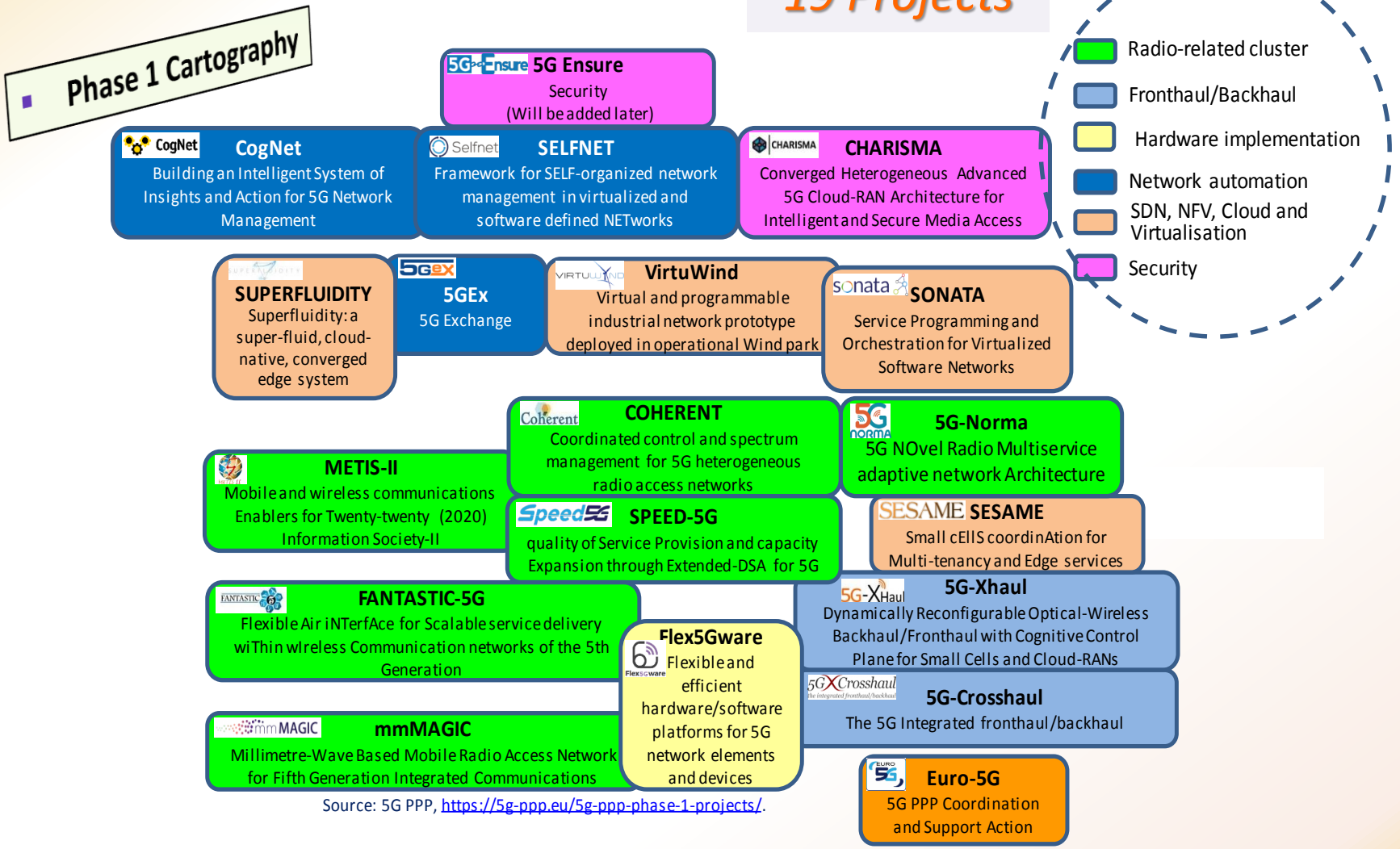
The Vision for the 5G-oriented future

Source: 5G-PPP, https://5g-ppp.eu/

5G-PPP Projects – Phase 1

19 Projects

Phase 1 Cartography



Source: 5G PPP, https://5g-ppp.eu/5g-ppp-phase-1-projects/.

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5G-PPP Projects – Phase 2

GROUP OF COMPANIES

21 projects

5G CITY
Distributed multi-tenant cloud and radio platform for municipalities and infrastructure owners acting as 5G neutral hosts

5G MEDIA
Programmable edge-to-cloud virtualization fabric for the 5G Media industry

MATILDA
A holistic, innovative framework for the design, development and orchestration of 5G-ready applications and network services over sliced programmable infrastructures

5G Xcast
Broadcast and Multicast Communication Enablers for the Fifth Generation of Wireless Systems

5G TANGO
5G Development and Validation Platform for global Industry-specific Network Services and Apps

SLICENET
End-to-End Cognitive Network Slicing and Slice Management Framework in Virtualised Multi-Domain, Multi-Tenant 5G Networks

NRG-5
Enabling Smart Energy as a Service via5G Mobile Network advances

IoRL
Internet of Radio-Light in Buildings

METRO-HAUL
METRO High bandwidth, 5G Application aware optical network, with edge storage, compUte and low Latency

5G PHOS
5G integrated Fiber-Wireless networks exploiting existing photonic technologies for high-density SDN-programmable network architectures

NEPAAS PaaS
Next Generation Platform as a Service (PaaS)

Bluespace
Building on the Use of Spatial Multiplexing 5G Networks Infrastructures and Showcasing Advanced technologies and Networking Capabilities

5G CAR
Fifth Generation Communication Automotive Research and Innovation for e2e V2X connectivity and multi-RAT interworking

5G Transformer
5G Mobile Transport Platform for Verticals

5G PICTURE
5G Programmable Infrastructure Converging disaggregated network and compUte Resources

CLEAR5G
Converged wireless access for reliable 5G MTC for factories of the future (Machine type communications)

5G MoNArch
5G Mobile Network Architecture for diverse services, use cases, and applications in 5G and beyond

ONE5G
E2E-aware Optimizations and advancements for the Network Edge of 5G New Radio

SaT 5G
Satellite and Terrestrial network for 5G for integration of satellite and terrestrial systems

5G ESSENCE
Embedded Network Services for 5G Experiences

5G-CORAL
A 5G Convergent Virtualized Radio Access Network Living at the Edge

To-Euro-5G
Supporting the 5G-PPP especially 5G Initiative governance

Global5G.org
Global vision, standardisation and stakeholder engagement in 5G

- Radio-related cluster
- Fronthaul/Backhaul
- SDN, NFV, Cloud and Virtualisation
- Optical networks and technology
- Network automation
- Security, privacy, resilience, availability
- Platforms

Most projects are cooperating with vertical use cases

Source: 5G PPP, https://5g-ppp.eu/5g-ppp-phase-2-projects/.

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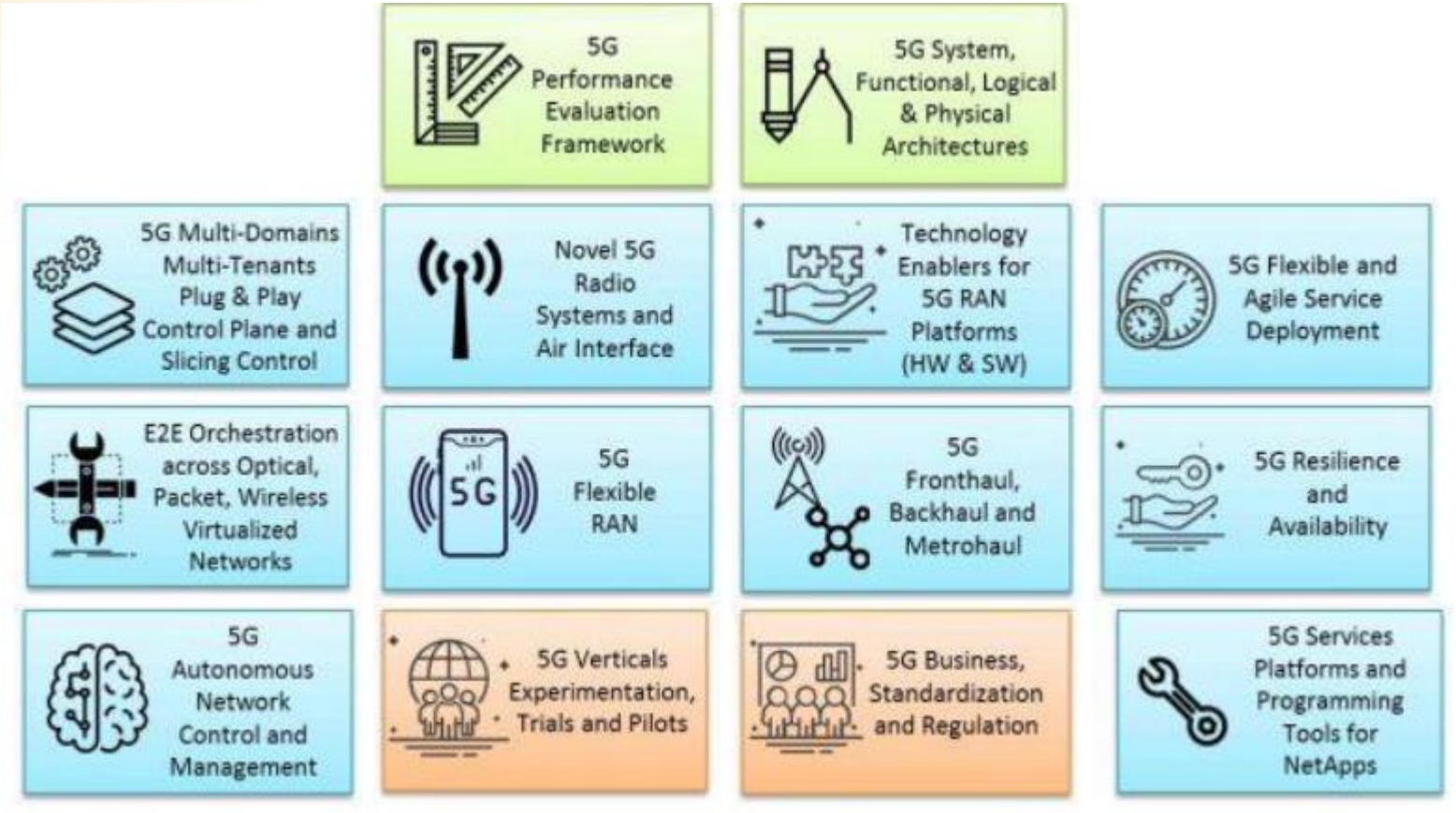
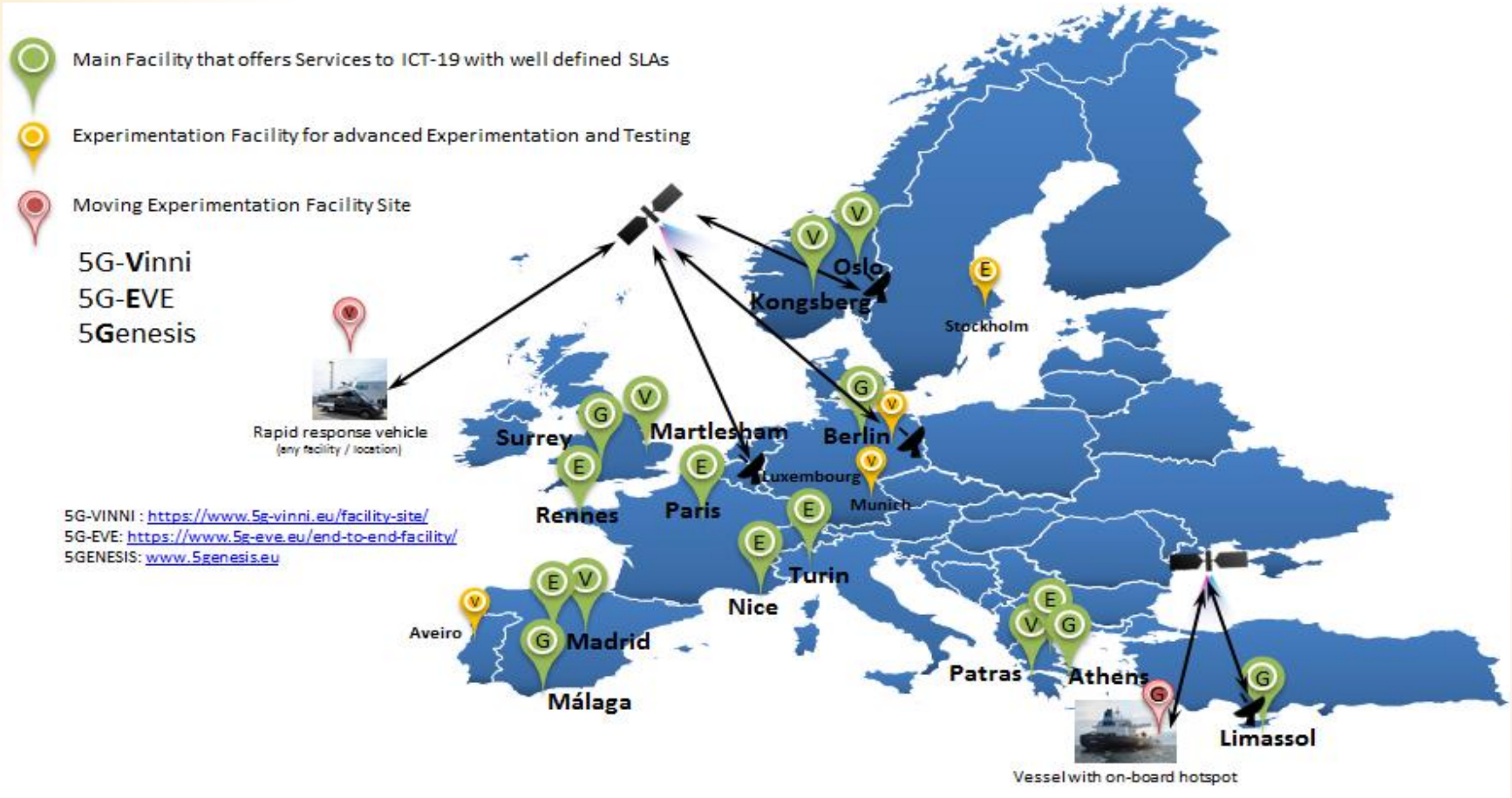
5G-PPP Projects – Phase 2
Key Achievements



Source: 5G-PPP, Progress Monitoring Report - 2019

5G-PPP Projects – Phase 3

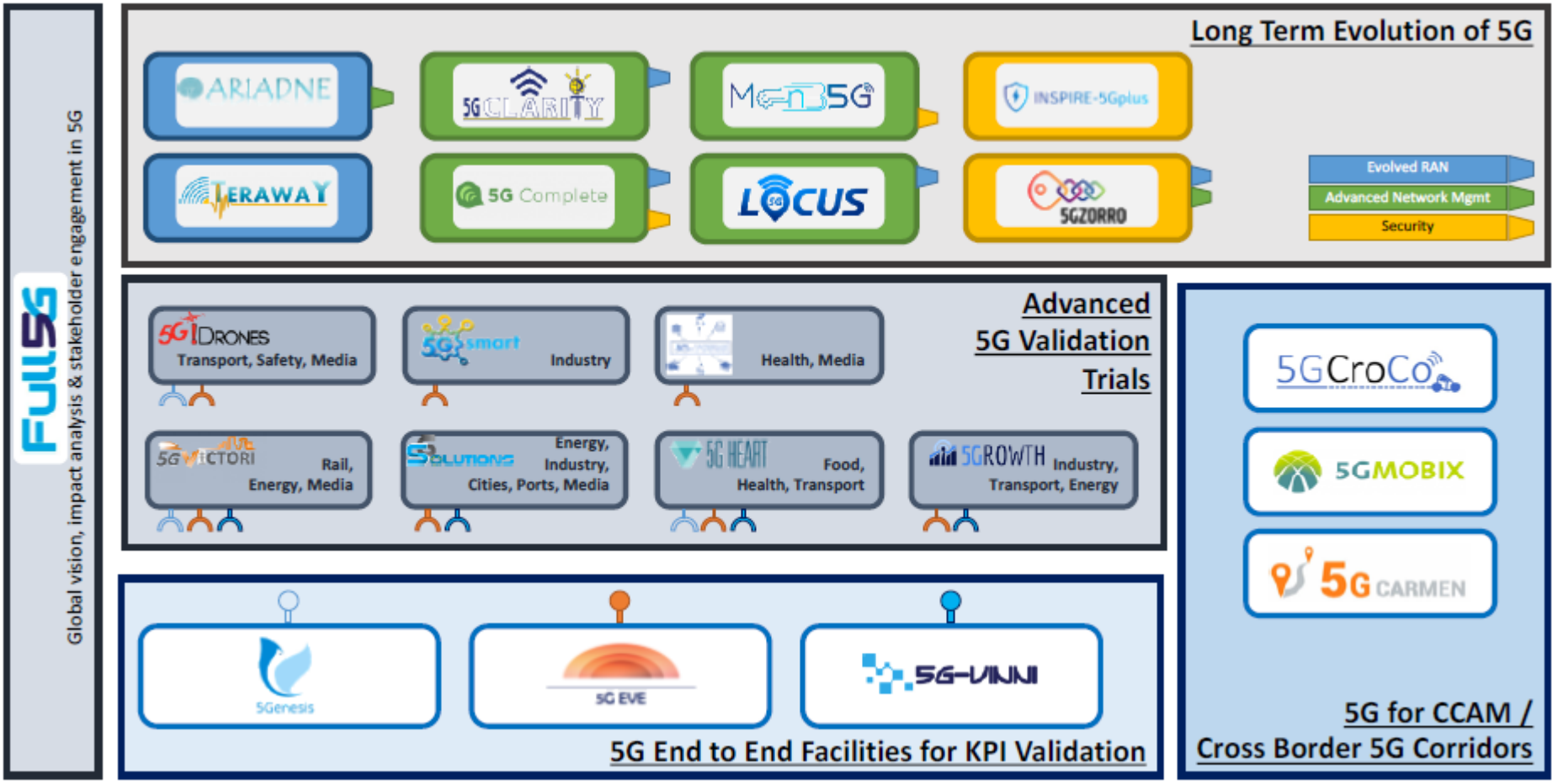
3 core platform projects



5G Infrastructure PPP Phase 3 Platforms Projects – Geographic Cartography

Source: 5G-PPP, https://5g-ppp.eu/5g-ppp-phase-3-projects/

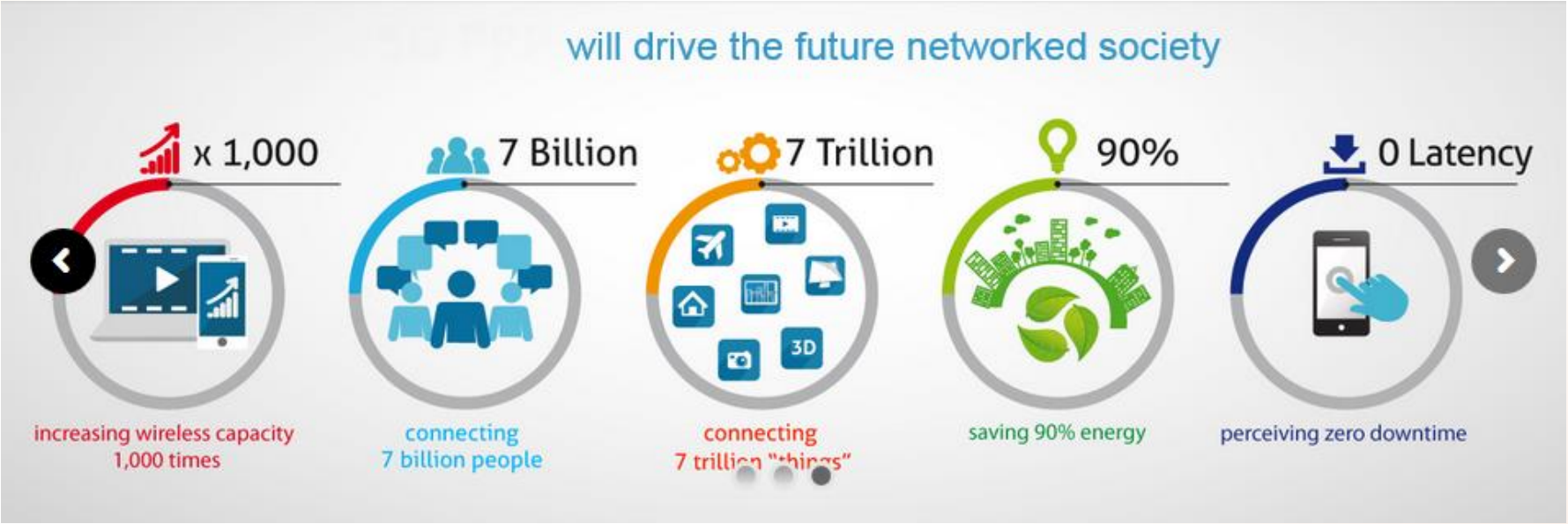
5G-PPP Projects – Phase 3



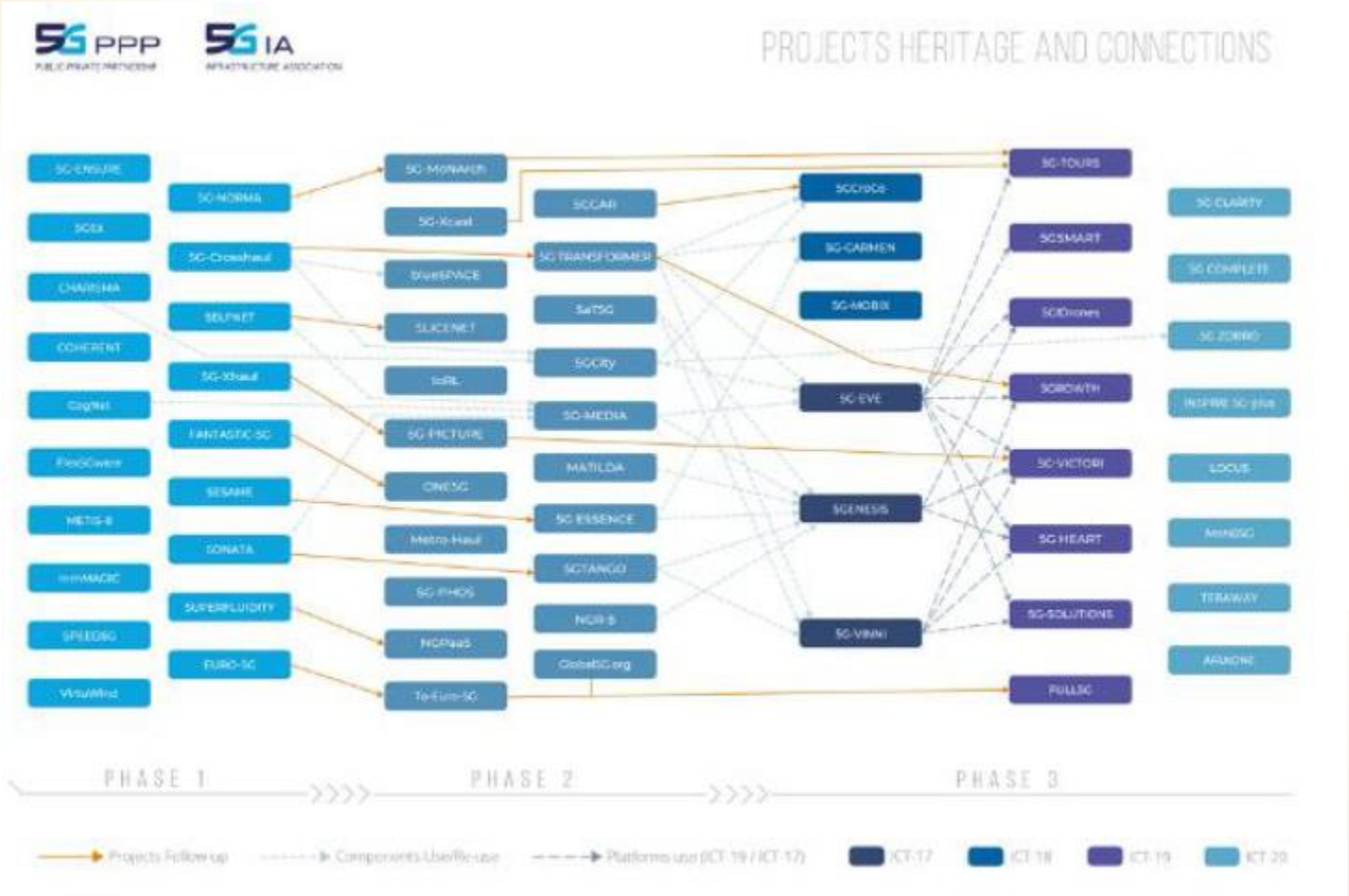
Source: 5G-PPP, https://5g-ppp.eu/5g-ppp-phase-3-projects/

Main objective:

Measurement and Validation of different KPIs for a great variety of applications, in controlled (lab) environment but also in large scale demos.



5G-PPP Projects – Phases 1-3



Source: 5G-PPP, Progress Monitoring Report - 2019

Challenges for Growth

Challenges for Growth_(1/6)

Among the actual priorities of the European Commission *(interactively with Member States (MSs) and industrial stakeholders/market actors)* ***is the voluntary establishment of a common timetable for the launch of early 5G networks*** *(initially scheduled to be operational by the end of 2018) and* ***followed by the launch of fully commercial 5G services in Europe by the end of 2020.***

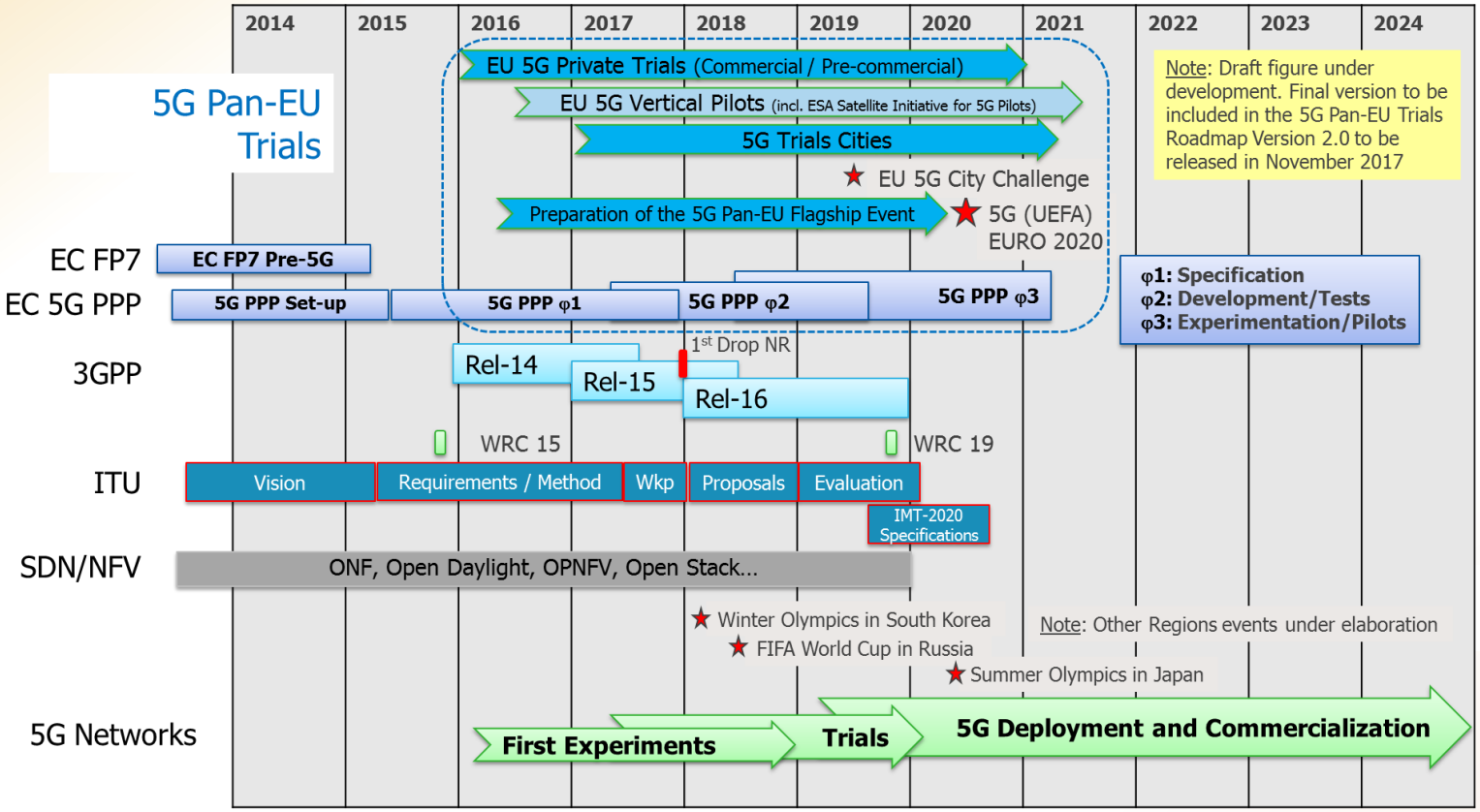
According to the 5G Action Plan (5GAP), the relevant EU timetable is actually driven by the following key objectives:

(i) ***Promoting preliminary trials****, under the 5G-PPP arrangement to take place from 2017 onwards, and pre-commercial trials with a clear EU cross-border dimension from 2018;*

(ii) ***supporting of commercial launch of 5G services*** ***in at least one major city in all MSs in 2020, and;***

(iii) ***encouraging MSs to develop national 5G deployment roadmaps*** ***as part of the national broadband plans,*** *with uninterrupted coverage in all urban areas and along main transport paths in 2025.*

Challenges for Growth_(2/6)



Pan-European Trials Roadmap

Source: 5G-PPP, https://5g-ppp.eu/

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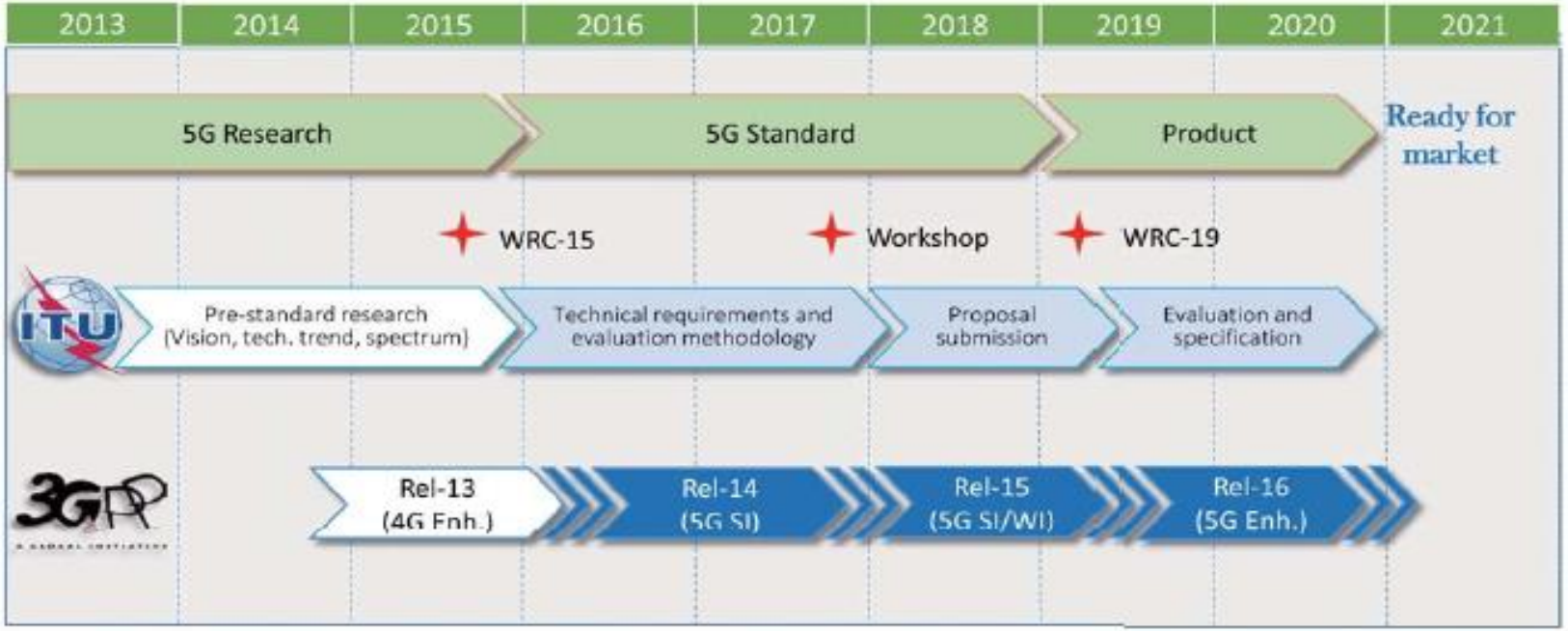
Challenges for Growth_(3/6)

Full alignment with current standardisation initiatives and the EU policy



Time plan for 5G

*Source: "***The 5G Infrastructure Public-Private Partnership" – NET Features 2015 – 5G PPP Vision** – 25.03.2015. [Presentation by Jean-Sebastien Bedo]. Available at: *https://5g-ppp.eu/wp-content/uploads/2015/07/BEDO-25Mar2015.pdf*

Challenges for Growth_(4/6)

Source: 5G-PPP, https://5g-ppp.eu/

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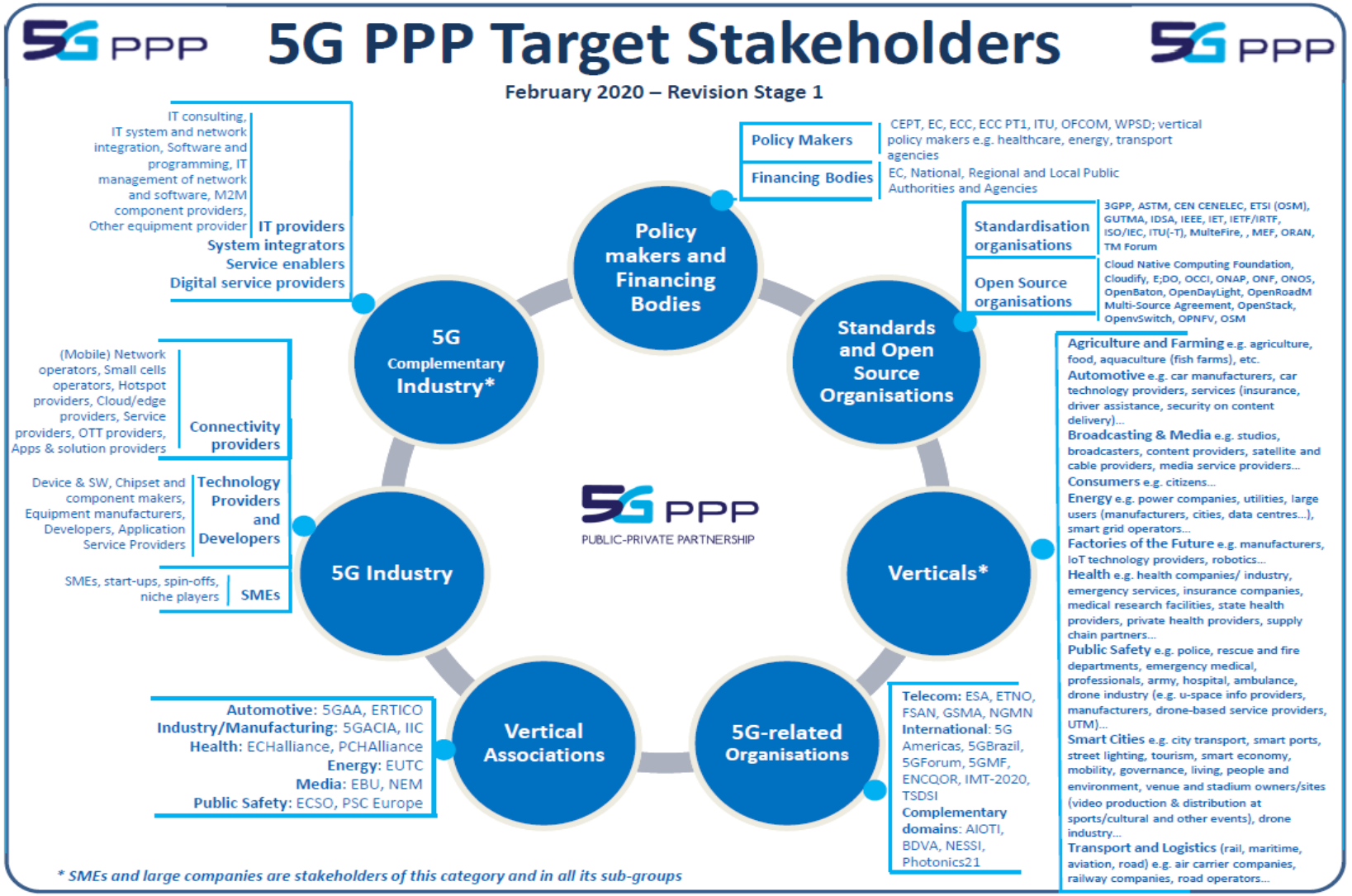
Challenges for Growth_(5/6)

Strong Interactions with the 5G Stakeholders

Source: 5G-PPP, https://5g-ppp.eu/

Challenges for Growth_(6/6)



Source: 5G-PPP, https://5g-ppp.eu/

For further communication…

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