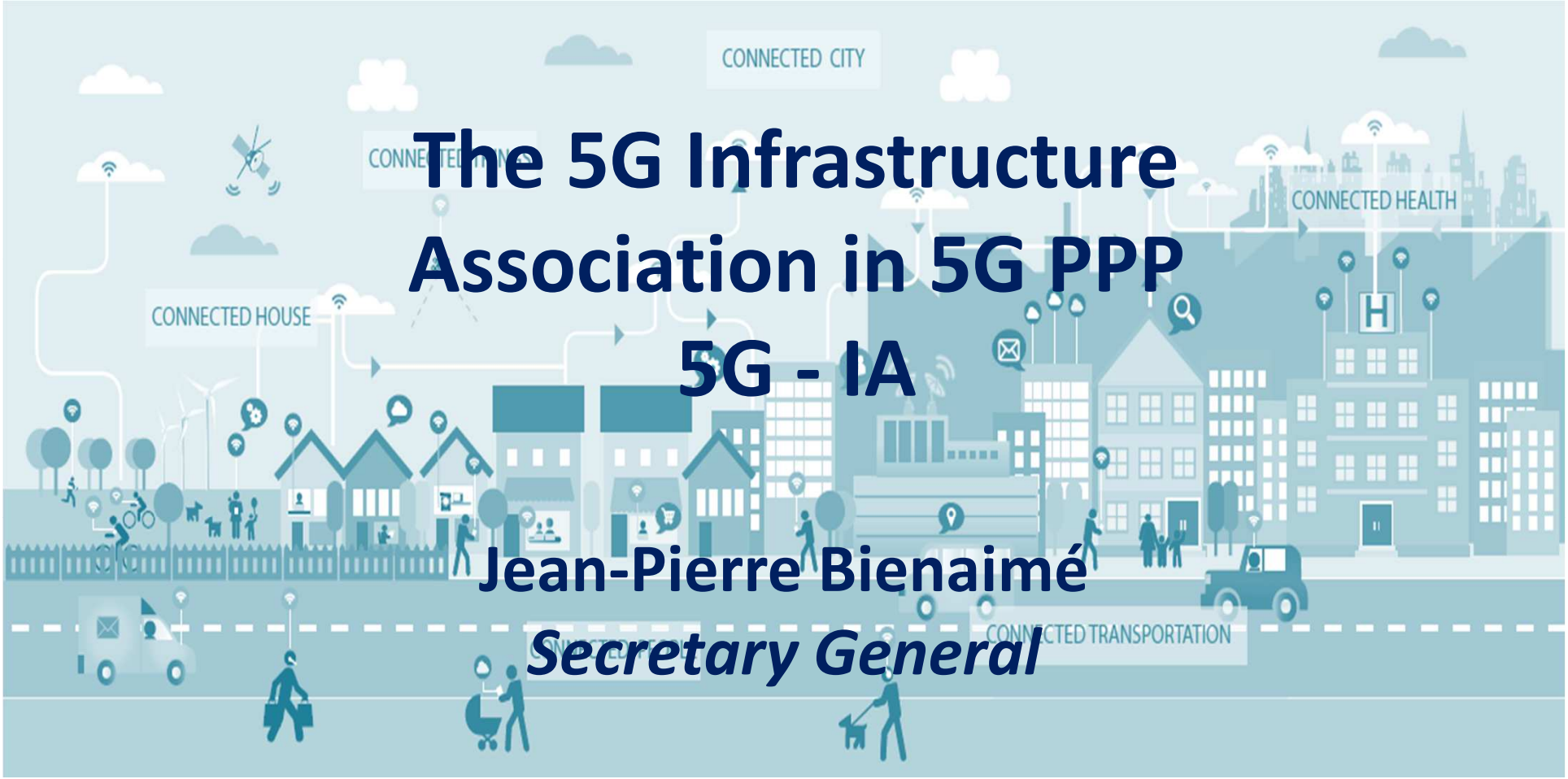
5G IA
INFRASTRUCTURE ASSOCIATION



The 5G Infrastructure Association in 5G PPP
5G - IA

Jean-Pierre Bienaimé
Secretary General

http://5g-ppp.eu/

Outline

Summary

- 5G research projects in Framework Program 7
- International activities
- 5G PPP in Horizon 2020 of the European Union
- Indicative time plan
- Implementation of 5G PPP and Call 1
- 5G Vision and Requirements

5G PPP leveraging EU Framework Program 7 results
Individual and independent projects

5G IA

5G Infrastructure PPP
The European path towards global next generation communication networks

METIS
Mobile and wireless communications **E**nablers for **T**wenty-twenty (2020) **I**nformation **S**ociety
https://www.metis2020.com

5GNOW
5th **G**eneration **N**on-**O**rthogonal **W**aveforms for Asynchronous Signalling
http://www.5gnow.eu/node/5

iJOIN
Interworking and **JOIN**t Design of an Open Access and Backhaul Network Architecture for Small Cells based on Cloud Networks
http://www.ict-ijoin.eu/

3

Tropic
Dis**Tr**ibuted computing, storage and radio resource allocation over cooperative femtocells
http://www.ict-tropic.eu/

MiWaveS
Beyond 2020 **Heterogeneous Wireless Networks** with **Millimeter-Wave Small Cell** Access and Backhauling
http://www.miwaves.eu/index.html

PHYLAWS
PHYsical **LA**yer **W**ireless **S**ecurity
http://www.phylaws-ict.org/

Combo
COnvergence of fixed and **M**obile **BrO**adband access/aggregation networks
http://www.ict-combo.eu/

MOTO
Evolving **MO**bile internet with innovative terminal-**T**o-terminal **O**ffloading technologies
http://www.fp7-moto.eu/

MCN
Mobile **C**loud **N**etworking
http://www.mobile-cloud-networking.eu/site/

Source: 5G Infrastructure Association.

International cooperation
General status of MoUs

- China
  - MoU signed with IMT-2020 (5G) Promotion Group on September 29, 2015 in Beijing
- Japan
  - MoU signed with The 5G Mobile Communications Promotion Forum on March 25, 2015 at NGMN Industry Conference in Frankfurt, Germany
- Korea
  - MoU signed with 5G Forum on June 17, 2014 after signature of Joint Declaration between EU Commission and Korean government in Seoul, Korea
- USA
  - MoU signed with 5G Americas on March 2, 2015 at Mobile World Congress 2015 in Barcelona, Spain
- Multilateral MoU on a series of Global 5G Event
  - Two events per year
  - Rotation between continents
  - MoU signed between IMT-2020 (5G) Promotion Group, 5GMF, 5G Forum, 5G Americas and 5G Infrastructure Association on October 20, 2015 in Lisbon

Source: 5G Infrastructure Association.

5G Infrastructure PPP
The European path towards global next generation communication networks
5G IA

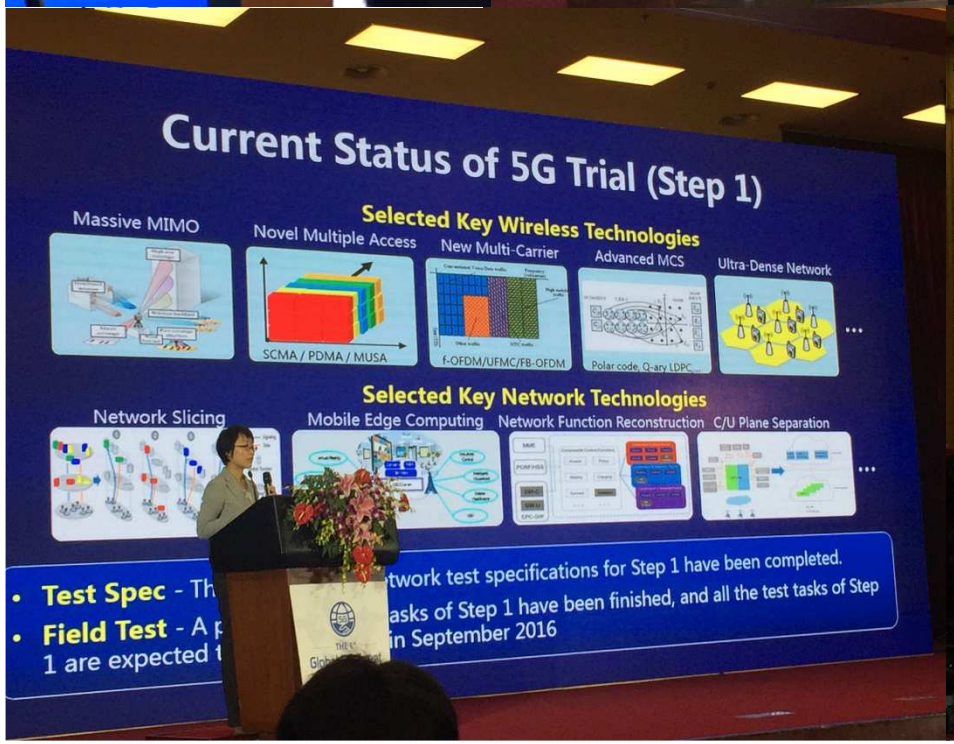
First Global 5G Event
Beijing, May 31 and June 1, 2016

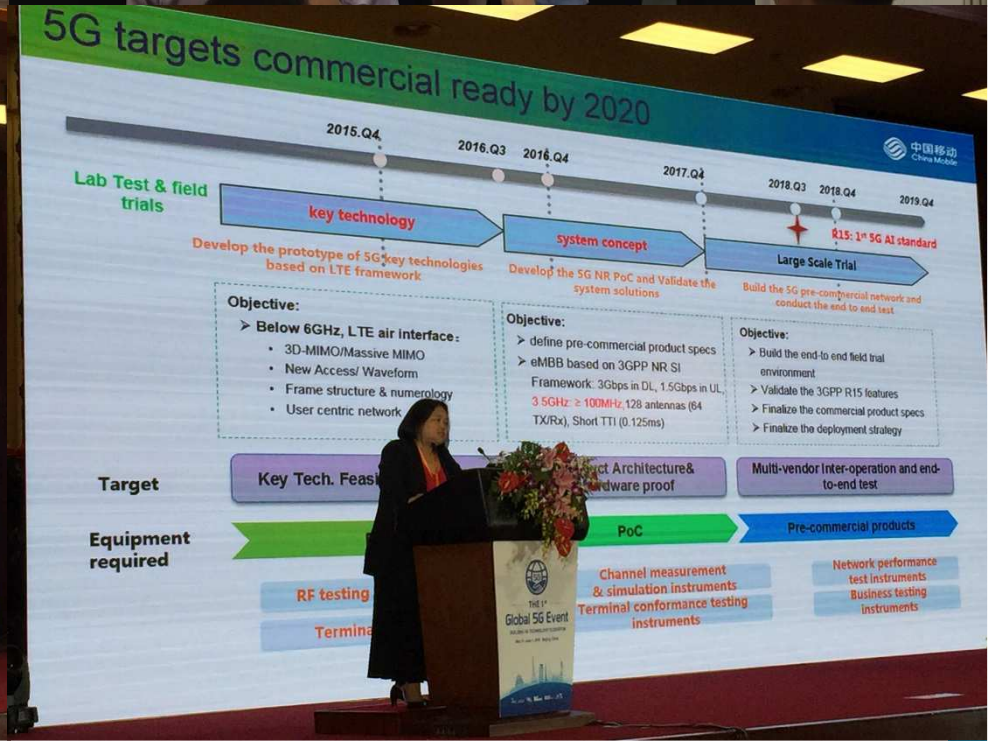
Source: 5G Infrastructure Association.

THE 1st
BUILDING

5G Infrastructure PPP
Research proj
communicatio
vertical sector
THE 1st
Global 5G Even

THE 1st
Global 5G Event
BUILDING 5G TECHNOLOGY ECOSYSTEM


Current Status of 5G Trial (Step 1)
Selected Key Wireless Technologies
Massive MIMO
Novel Multiple Access
SCMA / PDMA / MUSA
New Multi-Carrier
f-OFDM/UFMC/FB-OFDM
Advanced MCS
Polar code, Q-ary LDPC
Ultra-Dense Network
Selected Key Network Technologies
Network Slicing
Mobile Edge Computing
Network Function Reconstruction
C/U Plane Separation
Test Spec - Th
tworks test specifications for Step 1 have been completed.
Field Test - A p
1 are expected t
asks of Step 1 have been finished, and all the test tasks of Step
in September 2016


5G targets commercial ready by 2020
2015.Q4
2016.Q3
2016.Q4
2017.Q4
2018.Q3
2018.Q4
2019.Q4
Lab Test & field trials
key technology
Develop the prototype of 5G key technologies based on LTE framework
system concept
Develop the 5G NR PoC and Validate the system solutions
Large Scale Trial
Build the 5G pre-commercial network and conduct the end to end test
R15: 1st 5G AI standard
Objective:
Below 6GHz, LTE air interface:
3D-MIMO/Massive MIMO
New Access/ Waveform
Frame structure & numerology
User centric network
Objective:
define pre-commercial product specs
eMBB based on 3GPP NR SI
Framework: 3Gbps in DL, 1.5Gbps in UL, 3.5GHz: ≥ 100MHz, 128 antennas (64 TX/Rx), Short TTI (0.125ms)
Objective:
Build the end-to end field trial environment
Validate the 3GPP R15 features
Finalize the commercial product specs
Finalize the deployment strategy
Target
Key Tech. Feas
ct Architecture& rdware proof
Multi-vendor Inter-operation and end-to-end test
Equipment required
PoC
Pre-commercial products
RF testing
Termina
Channel measurement & simulation instruments
Terminal conformance testing instruments
Network performance test instruments
Business testing instruments

is inviting you to the
5G Global event in Rome, Italy
on November 9 and 10, 2016

IMT-2020 5G PPP 5G Forum 5GMF The Fifth Generation Mobile Communications Promotion Forum

5G PPP
PUBLIC-PRIVATE PARTNERSHIP

The 2nd Global 5G Event

5G Challenges and Opportunities

November 9th-10th, 2016 Rome, Italy

OBJECTIVES

- To provide a global meeting place for all parties, which are active in 5G development
- To discuss latest developments on 5G in:
  - research,
  - development and standardisation
  - and roadmaps.
- To highlight the achievements of the on-going 5G projects

WHO SHOULD ATTEND?

- Investors, CEOs, and marketing directors tracking the direction of 5G and/or advanced ICT services for all industrial sectors
- Innovation Managers, CTO's or Business Development Managers working in the ICT industry
- Industry analysts and consultants looking to understand the latest technology advances in 5G
- National authorities, regulatory responsible, and community representatives involved in enabling the future European economy through the provision of advanced infrastructure

STAY TUNED

Information on the Agenda and Registration will be available on-line in July
www.5g-ppp.eu/2nd-global-5g-event/

This event is being jointly organised by the 5G MoU partners:

5G IA INFRASTRUCTURE ASSOCIATION · IMT-2020 · 5G Forum · 5G IMIF · 5G americas

© EURO-5G project

5G PPP
PUBLIC-PRIVATE PARTNERSHIP

The 2nd Global 5G Event

5G Challenges and Opportunities

November 9th-10th, 2016 Rome, Italy

SAVE THE DATE

Discussions on the emerging global 5G Policies for spectrum, standards and roll-out as well as presentations and demos of the latest developments by the on-going 5G R&I projects.

What 5G is about

STAY TUNED

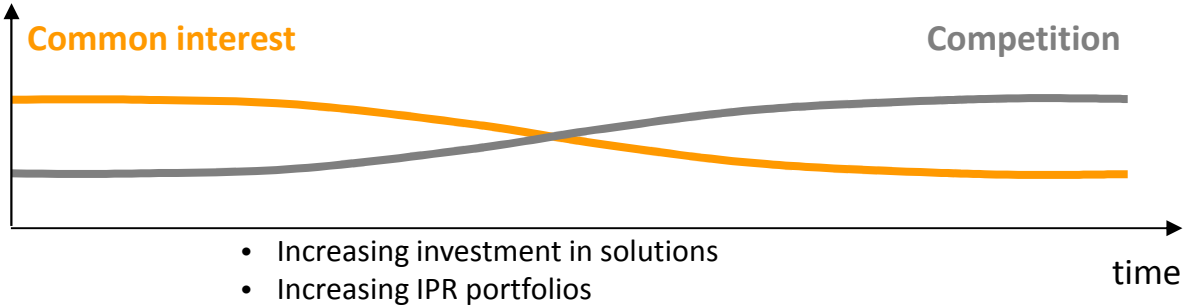
Information on the Agenda and Registration will be available on-line in July
www.5g-ppp.eu/2nd-global-5g-event/

This event is being jointly organised by the 5G MoU partners:

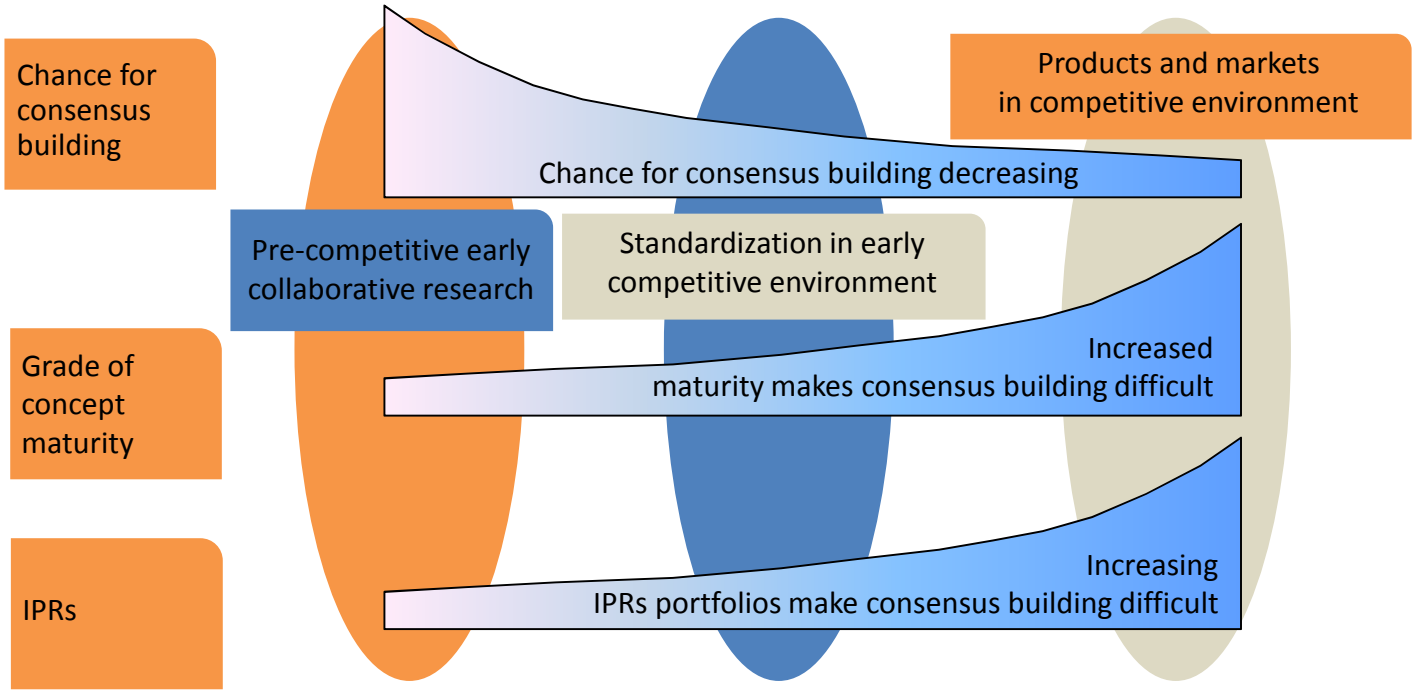
5G IA INFRASTRUCTURE ASSOCIATION · IMT-2020 · 5G Forum · 5G IMIF · 5G americas

© EURO-5G project

Why Collaborative research?
International consensus building at an early stage



- Increasing investment in solutions
- Increasing IPR portfolios



- Horizon 2020 is open for organizations from outside of Europe

Source: NetWorld2020.

5G Infrastructure PPP
The European path towards global next generation communication networks
5G IA

5G PPP in Horizon 2020 of the EU

- 5G PPP is a research program in Horizon 2020 of the EU dedicated to 5G system research

- Budget for 2014 – 2020 time frame
  - Up to 700 million € public funding
  - Matched by private side including leveraging factor 5 of additional private investment results in private value of about 3.5 billion €

- Research program is addressing all building blocks of a future communication network and a huge number of huge cases from vertical sectors

- 5G Infrastructure Association vision paper published at Mobile World Congress 2015 in Barcelona
  http://5g-ppp.eu/wp-content/uploads/2015/02/5G-Vision-Brochure-v1.pdf

- First set of projects started on July 1, 2015

Source: 5G Infrastructure Association.

Key challenges

- PPP Program that will deliver solutions, architectures, technologies and standards for the ubiquitous 5G communication infrastructures of the next decade
- Program Ambitions: Key Challenges / High level 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. The main focus will be in mobile communication networks where the dominating energy consumption comes from the radio access network
  - 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
  - Enabling advanced User controlled privacy

Source: 5G Infrastructure Association.

Research program

- Faster, More Powerful and More Energy Efficient Solutions for integrated High Capacity Access and Core Networks for a Wider Range of Services
  - Wireless Networks
  - Optical Networks
  - Automated Network Organisation - Network Management and Automation
  - Implementing Convergence Beyond the Access Last Mile
- Re-Designing the Network
  - Information Centric Networks
  - Network Function Virtualisation
  - Software Defined Networking
  - Networks of Clouds
- Ensuring availability, robustness and security
- Ensuring efficient hardware implementations

Source: 5G Infrastructure Association.

5G Infrastructure Association Work Groups

5G Infrastructure PPP
The European path towards global next generation communication networks

Pre-standards

Spectrum

Vision and Societal Challenges

Architecture

Use cases and performance evaluation models

Software Networks (SDN and NFV)

Activity 5G PPP Contractual Arrangement, KPIs

Activity 5G International cooperation

Network Management, QoS

Activity Community building and Public Relations

SME support

Security

Policy oriented Working Group under responsibility of Association

Technology oriented Working Group under responsibility of 5G PPP projects

Source: 5G Infrastructure Association.

Vertical sectors

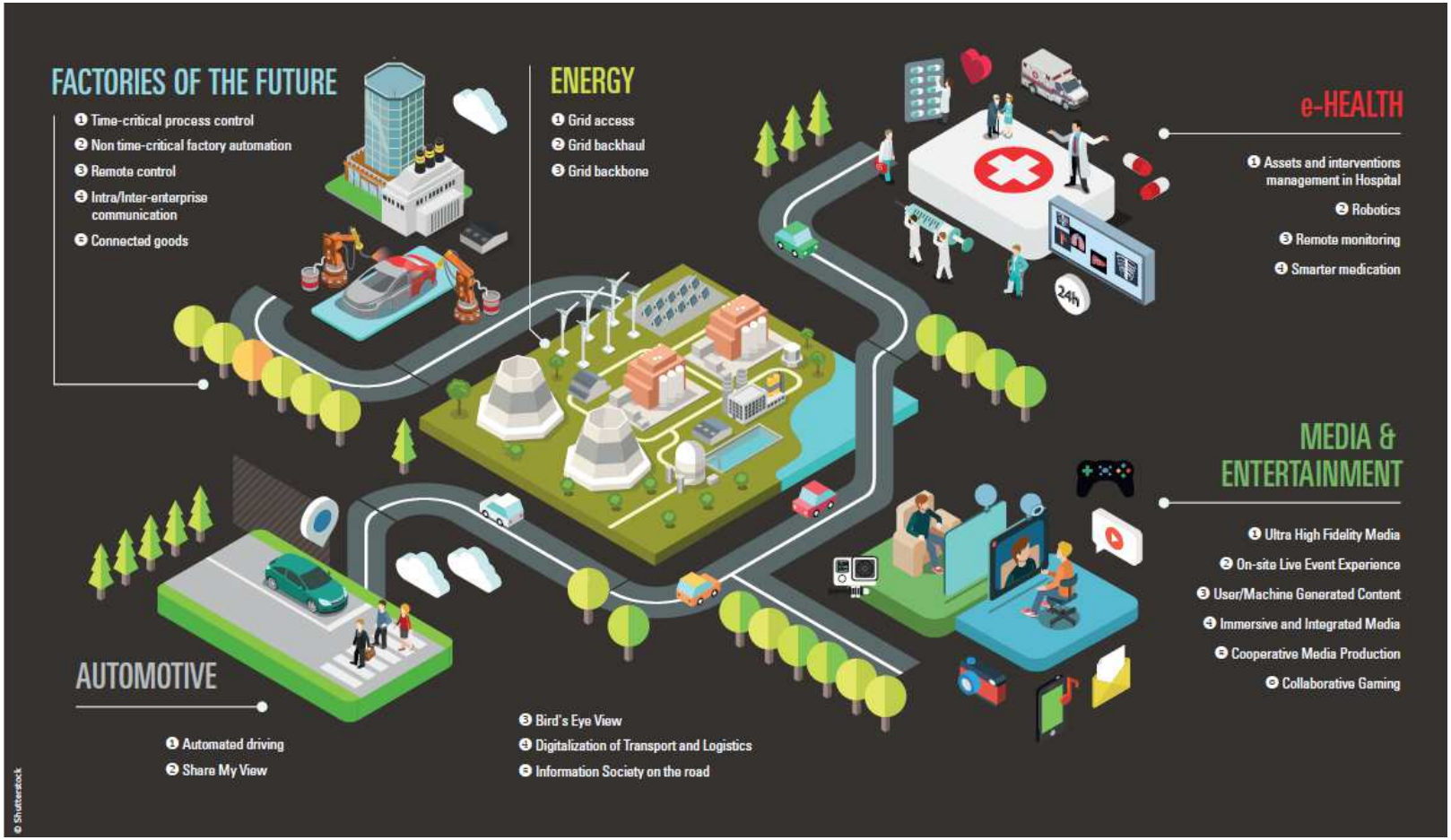
- White papers on
  - 5G and Factories of the Future
  - 5G and Healthcare
  - 5G and Energy
  - 5G and Media
  - 5G and Automotive

- Identification of
  - main use cases
  - requirements and
  - areas for research and innovation

- Vertical workshops
  - June 18, 2015
  - November 9, 2015
- White Paper published at Mobile World Congress 2016
  https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf

Source: 5G Infrastructure Association.

5G – A driver for industrial and societal changes (5G PPP)



Source: 5G Infrastructure Association: 5G Empowering vertical industries. White Paper, 2016, https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf.

An involving value chain (5G PPP)

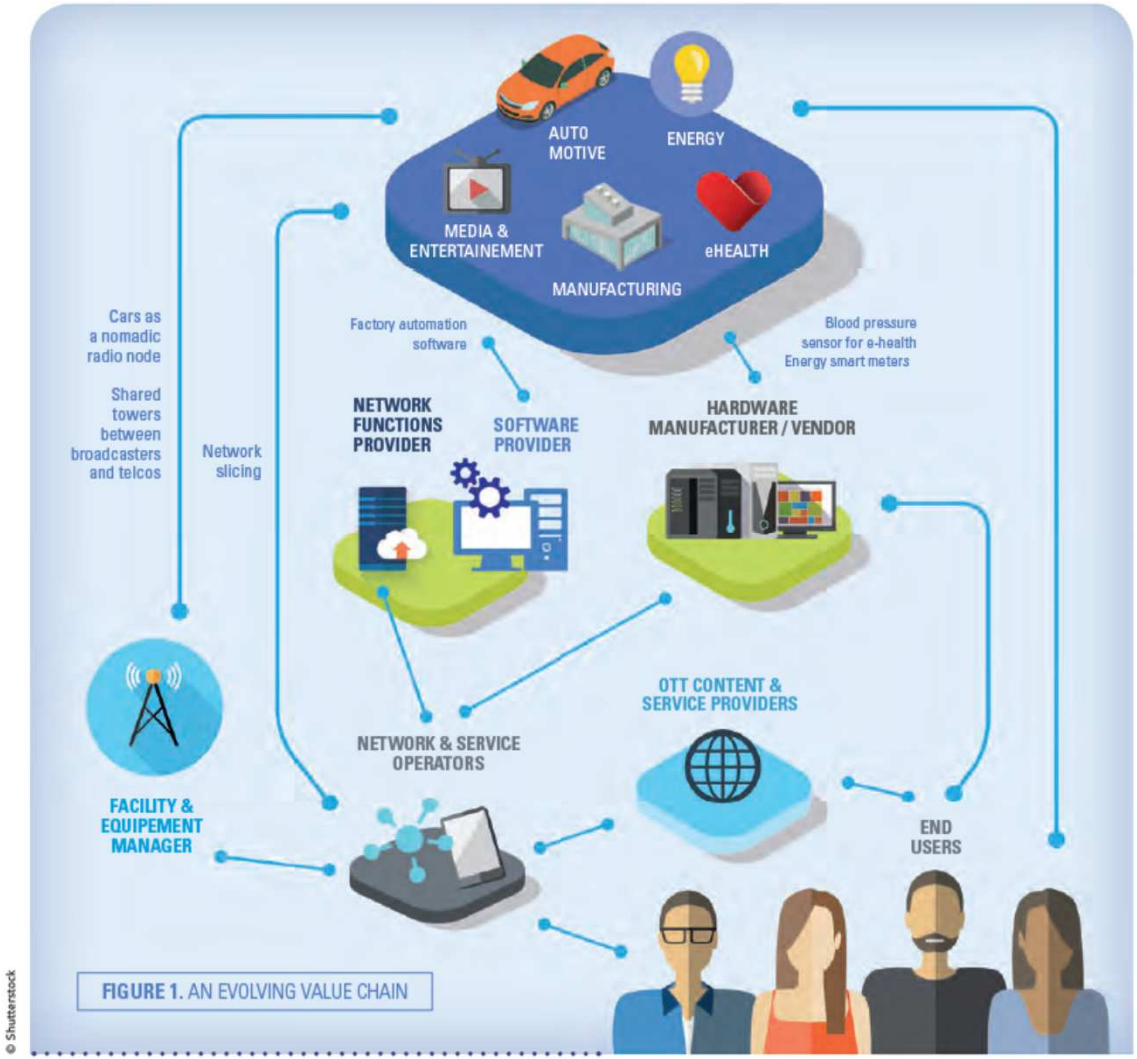


FIGURE 1. AN EVOLVING VALUE CHAIN

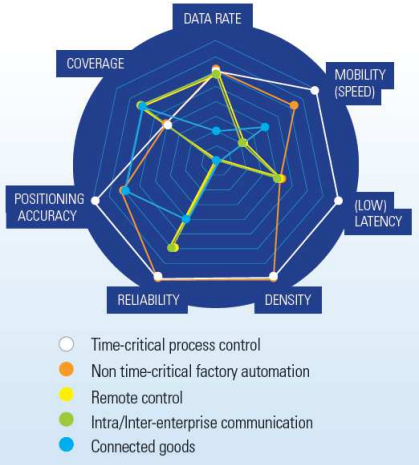
Source: 5G Infrastructure Association: 5G Empowering vertical industries. White Paper, 2016, https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf.

Networks will be transformed into intelligent orchestration platforms (5G PPP)

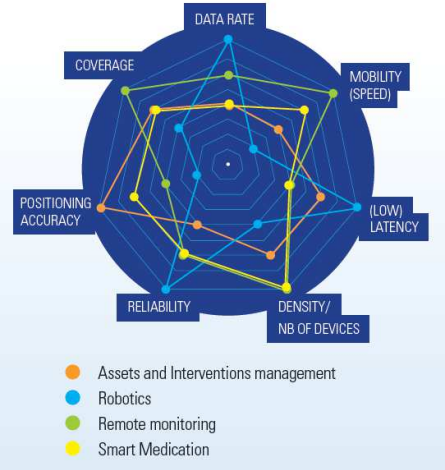
Source: 5G Infrastructure Association: 5G Empowering vertical industries. White Paper, 2016, https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf.

Vertical sectors
Main technical requirements

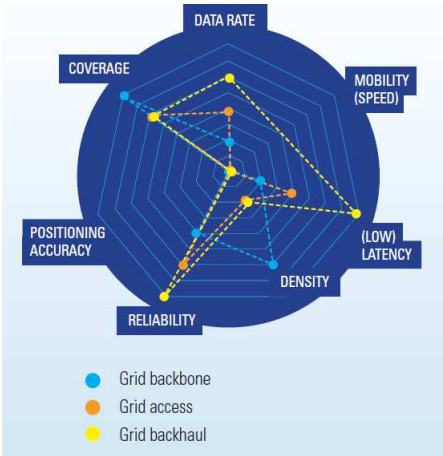
FACTORIES



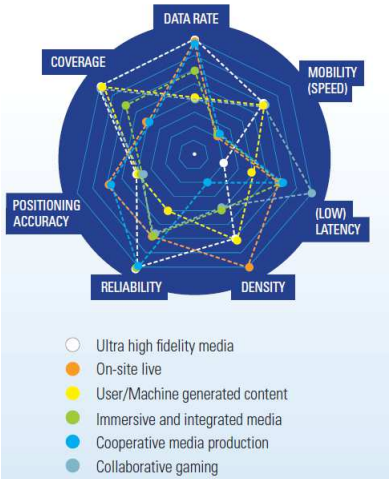
EHEALTH



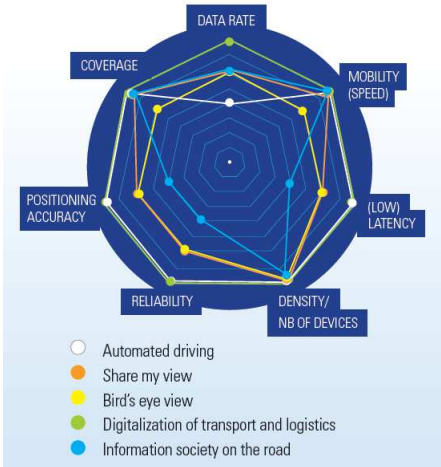
ENERGY



MEDIA & ENTERTAINMENT

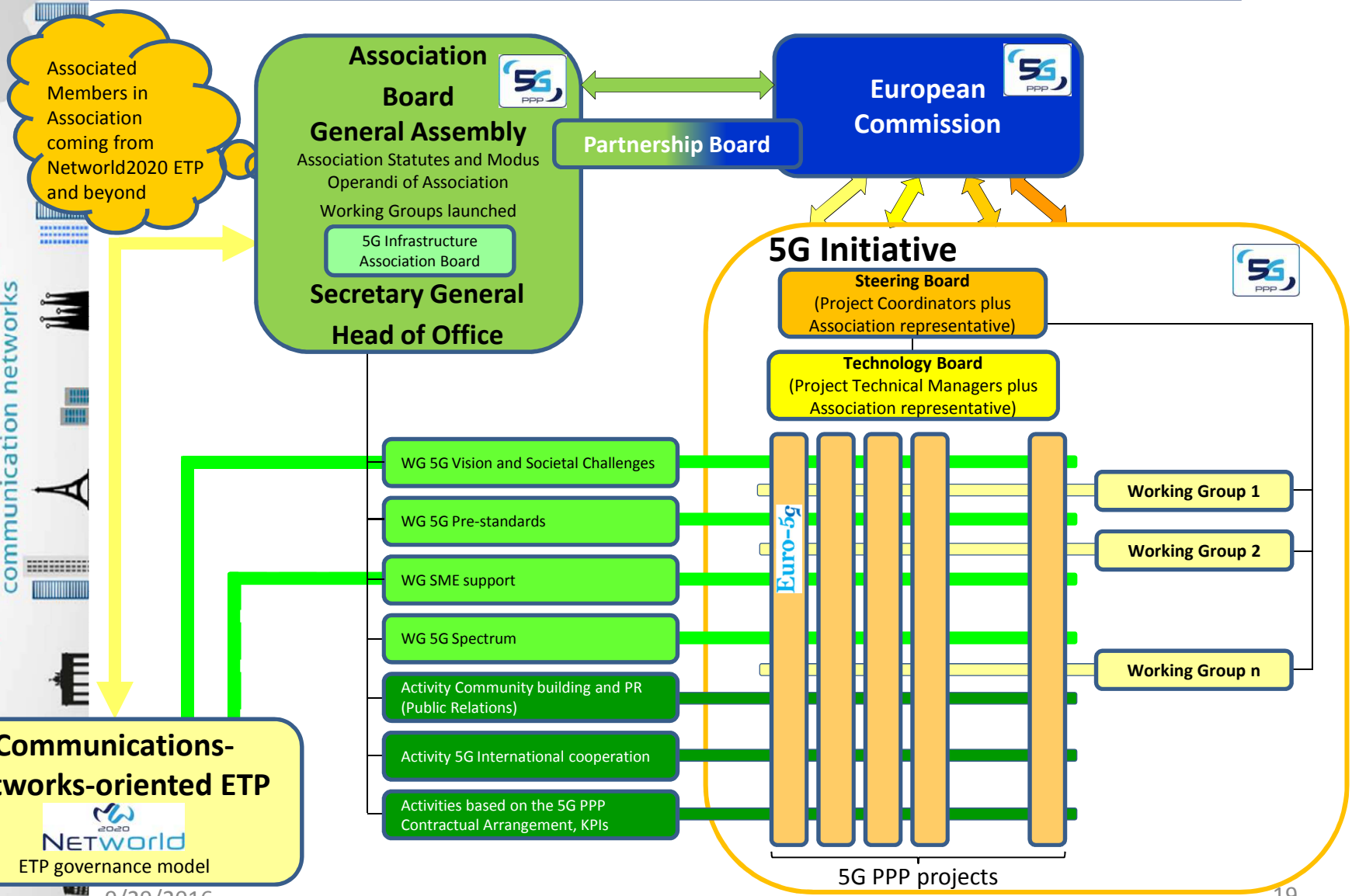


AUTOMOTIVE



Source: 5G Infrastructure Association: 5G Empowering vertical industries. White Paper, 2016, https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf.

Overall current Governance



Source: NetWorld2020 ETP and Annex to 5G PPP Contractual Arrangement.

Members of 5G Infrastructure Association

Industry

- ADVA Optical Networking SE
- Alcatel-Lucent
- Airbus
- Atos
- Deutsche Telekom
- DOCOMO Communications Laboratories Europe GmbH
- Ericsson
- Huawei Technologies Düsseldorf GmbH
- IBM Research
- Intel Mobile Communications
- NEC Europe Ltd., NEC Laboratories Europe
- Nokia
- Orange Labs
- Samsung Electronics Research Institute Ltd.
- SES
- Telecom Italia
- Telefónica I+D
- Telenor ASA
- Telespazio
- Thales Alenia Space
- Turk Telekomünikasyon A.Ş.

Research

- CEA-LETI
- Centre Tecnologic de Telecomunicacions de Catalunya (CTTC)
- Consorzio Nazionale Interuniversitario per le Telecomunicazioni (CNIT)
- Fundacion IMDEA Networks
- Instituto de Telecomunicacoes
- IST – University of Lisbon
- TNO
- University of Bologna – DEI

SMEs

- Integrasys SA
- INTERINNOV
- M.B.I. S.R.L.
- Nextworks s.r.l.
- Quobis
- Sequans Communications

Source: 5G Infrastructure Association.

Horizon 2020 5G PPP
Call 1 selected projects

5G Ensure
Security
(Will be added later)

CogNet
Building an Intelligent System of Insights and Action for 5G Network Management

SELFNET
Framework for SELF-organized network management in virtualized and software defined NETworks

CHARISMA
Converged Heterogeneous Advanced 5G Cloud-RAN Architecture for Intelligent and Secure Media Access

SUPERFLUIDITY
Superfluidity: a super-fluid, cloud-native, converged edge system

5GEx
5G Exchange

VirtuWind
Virtual and programmable industrial network prototype deployed in operational Wind park

SONATA
Service Programming and Orchestration for Virtualized Software Networks

COHERENT
Coordinated control and spectrum management for 5G heterogeneous radio access networks

5G-Norma
5G NOvel Radio Multiservice adaptive network Architecture

METIS-II
Mobile and wireless communications Enablers for Twenty-twenty (2020) Information Society-II

SPEED-5G
quality of Service Provision and capacity Expansion through Extended-DSA for 5G

SESAME
Small cEllS coordinAtion for Multi-tenancy and Edge services

FANTASTIC-5G
Flexible Air iNTerfAce for Scalable service delivery wiThin wIreless Communication networks of the 5th Generation

5G-Xhaul
Dynamically Reconfigurable Optical-Wireless Backhaul/Fronthaul with Cognitive Control Plane for Small Cells and Cloud-RANs

Flex5Gware
Flexible and efficient hardware/software platforms for 5G network elements and devices

5G-Crosshaul
The 5G Integrated fronthaul/backhaul

mmMAGIC
Millimetre-Wave Based Mobile Radio Access Network for Fifth Generation Integrated Communications

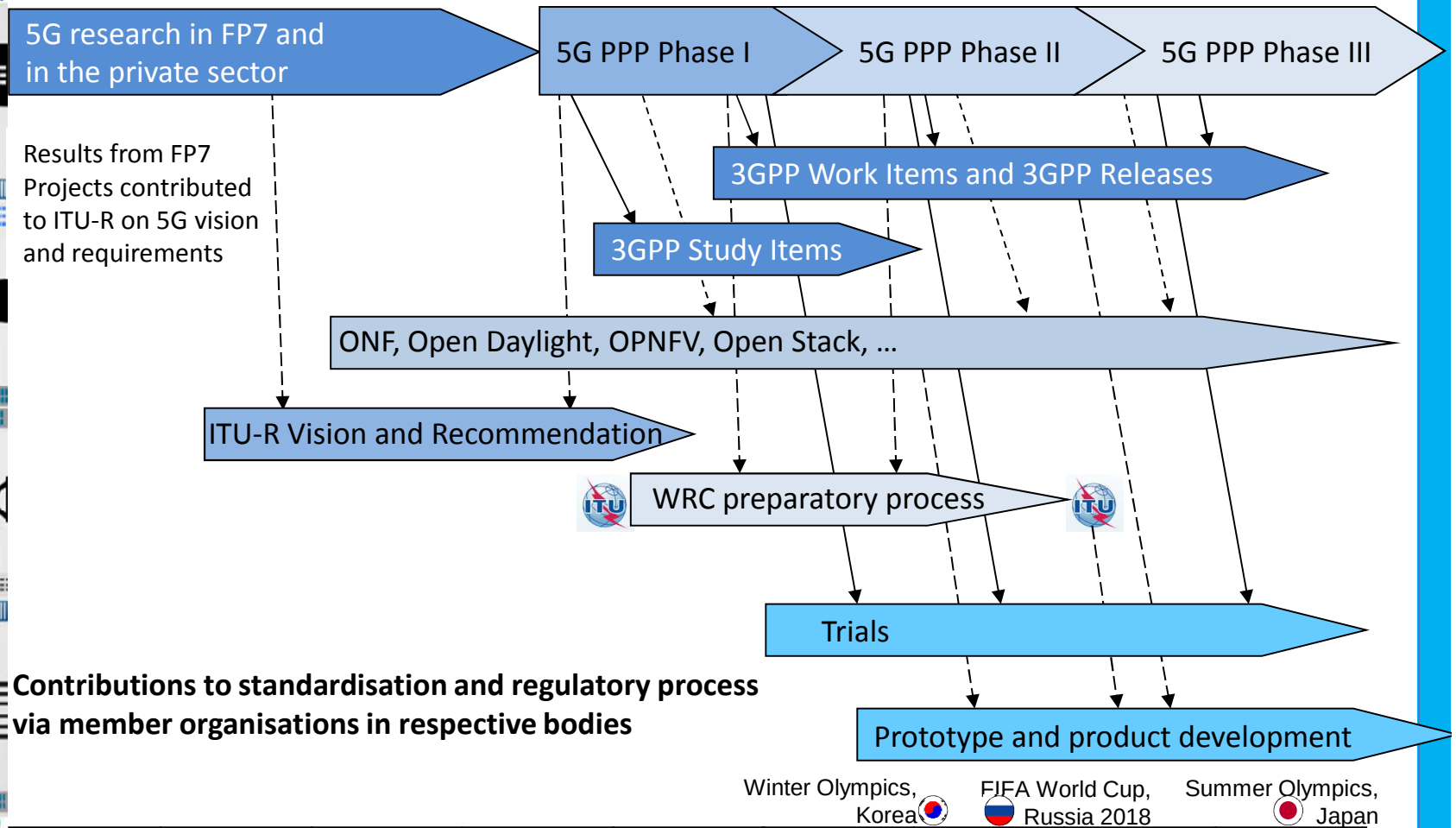
Euro-5G
5G PPP Coordination and Support Action

- Radio-related cluster
- Fronthaul/Backhaul
- Hardware implementation
- Network automation
- SDN, NFV, Cloud and Virtualisation
- Security

5G Infrastructure PPP
The European path towards global next generation communication networks

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

Exploitation of results

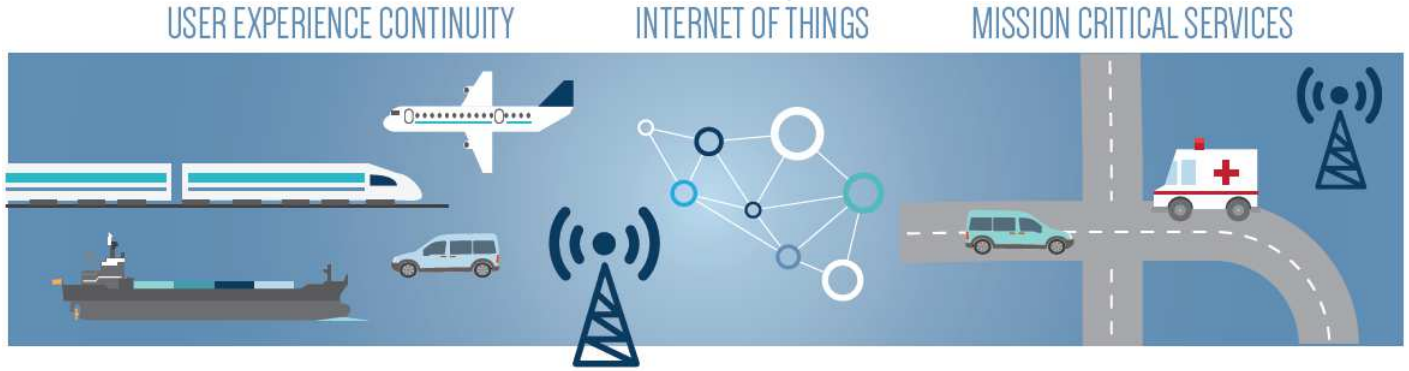


Contributions to standardisation and regulatory process via member organisations in respective bodies

Source: 5G Infrastructure Association.

5G Infrastructure PPP
The European path towards global next generation communication networks

5G PPP Vision and Requirements
5G new service capabilities



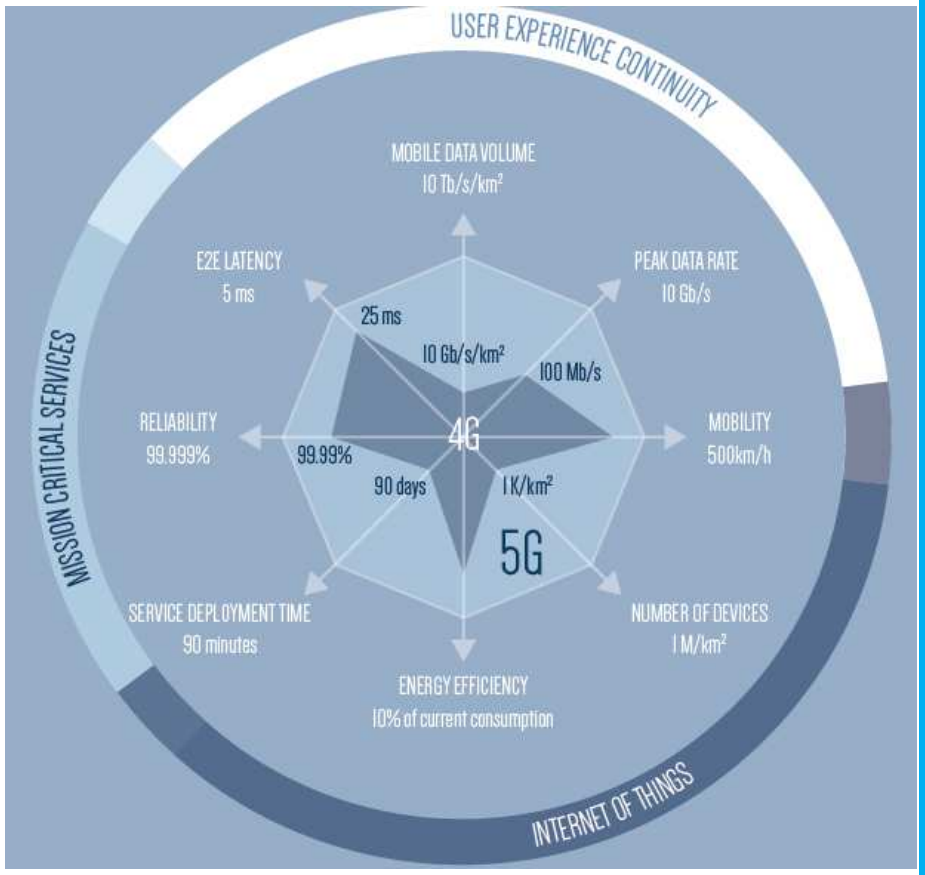
- 5G needs to support efficiently three different types of traffic profiles
  - high throughput for e.g. video services
  - low energy for e.g. long–living sensors
  - low latency for mission critical services
- 5G covers network needs and contributes to digitalization of vertical markets
  - automotive, transportation, manufacturing, banking, finance, insurance, food and agriculture
  - education, media
  - city management, energy, utilities, real estate, retail
  - government
  - healthcare
- Sustainable and scalable technology to handle
  - anticipated dramatic growth in number of terminal devices
  - continuous growth of traffic (at a 50-60% CAGR)
  - heterogeneous network layouts
  - without causing dramatic increase of power consumption and management complexity within networks

Source: 5G Infrastructure Association: Vision White Paper, February 2015.

5G Infrastructure PPP
The European path towards global next generation communication networks

5G PPP Vision and Requirements
5G will have disruptive capabilities

- **5G will provide an order of magnitude improvement in performance** in the areas of more capacity, lower latency, more mobility, increased reliability and availability
- **5G infrastructures will be also much more efficient** in terms of
  - energy consumption
  - service creation time
  - hardware flexibility



Source: 5G Infrastructure Association: Vision White Paper, February 2015.

5G Infrastructure PPP
The European path towards global next generation communication networks
5G IA

5G PPP Vision and Requirements
Key technological components

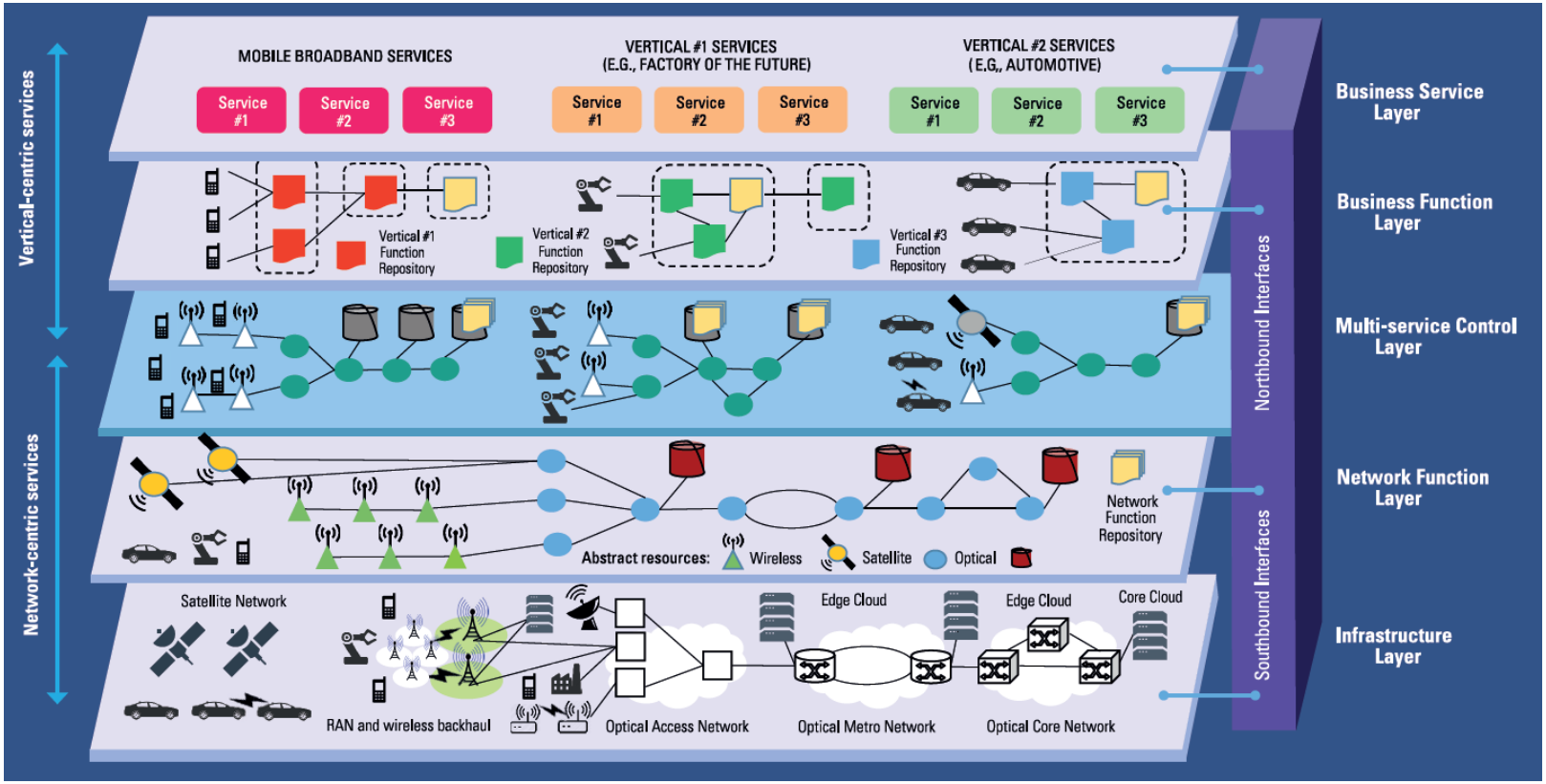
- 5G wireless will support a heterogeneous set of integrated air interfaces
  - from evolutions of current access schemes
  - to brand new technologies
- 5G networks will encompass cellular and satellite solutions
- Seamless handover between heterogeneous wireless access technologies
- Simultaneous radio access technologies to increase reliability and availability
- Deployment of ultra-dense networks with numerous small cells requires new interference mitigation, backhauling and installation techniques
- 5G will be driven by software and will heavily rely on emerging technologies
  - Software Defined Networking (SDN)
  - Network Functions Virtualization (NFV)
  - Mobile Edge Computing (MEC)
  - Fog Computing (FC)

  to achieve required performance, scalability and agility
- Easer and optimised network management by means of exploitation of Data Analytics and Big Data techniques
  - to monitor users Quality of Experience
  - while guaranteeing privacy

Source: 5G Infrastructure Association: Vision White Paper, February 2015.

5G IA
5G Infrastructure PPP
The European path towards global next generation communication networks

Integrated 5G architecture for mobile broadband and vertical services (5G PPP)



Source: 5G Infrastructure Association: 5G Empowering vertical industries. White Paper, 2016.

5GPPP Architecture Work Group
White paper published June 1, 2016

- Launched within the 5GPPP Initiative with participation of 5GPPP projects but input also from non-5GPPP projects

https://5g-ppp.eu/white-papers/
https://5g-ppp.eu/5g-architecture-paper/

Source: 5G PPP Architecture Working Group.

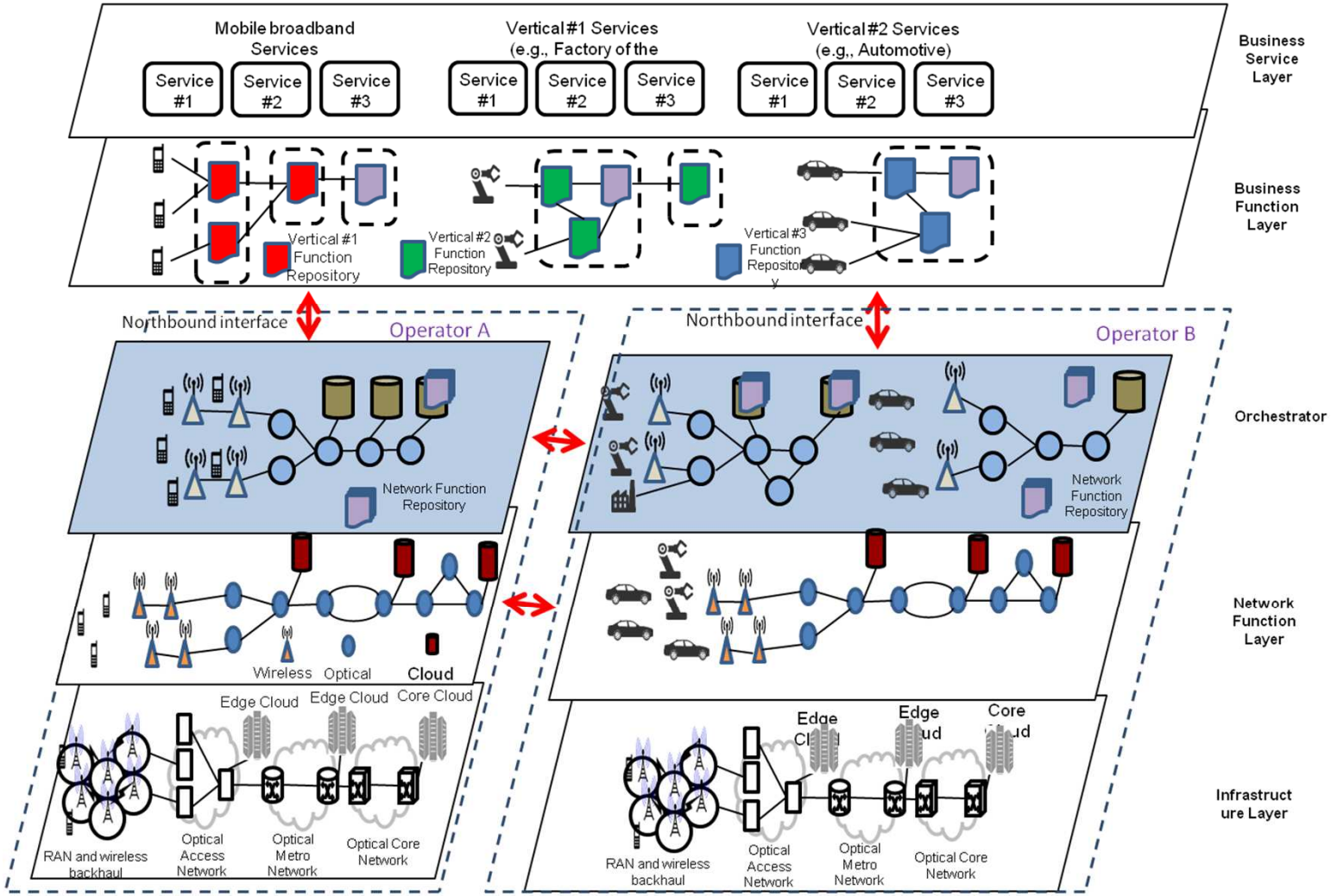
Why a new 5G Architecture?

- 5G Architecture enables
  - new business opportunities meeting the requirements of large variety of use cases
  - 5G to be future proof
- by means of
  - implementing network slicing in cost efficient way
  - addressing both end user and operational services
  - supporting natively softwarization
  - integrating communication and computation
  - integrating heterogeneous technologies (incl. fixed and wireless technologies)

Source: 5G PPP Architecture Working Group.

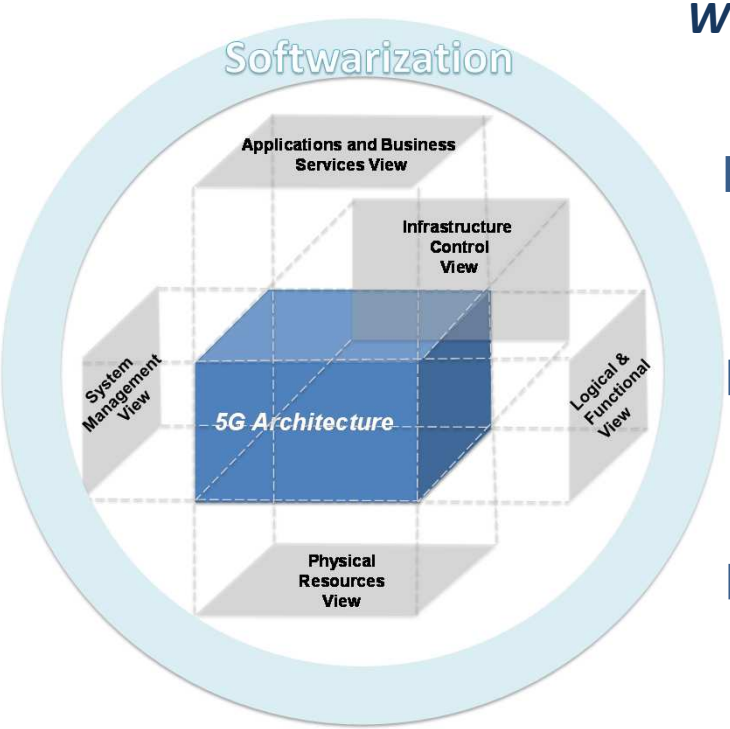
5G PPP
5G Infrastructure PPP
The European path towards global next generation communication networks

5G Ecosystem



Source: 5G PPP Architecture Working Group.

5G Architecture Views



White Paper Sections:

Logical and Functional Architecture

Physical Deployment

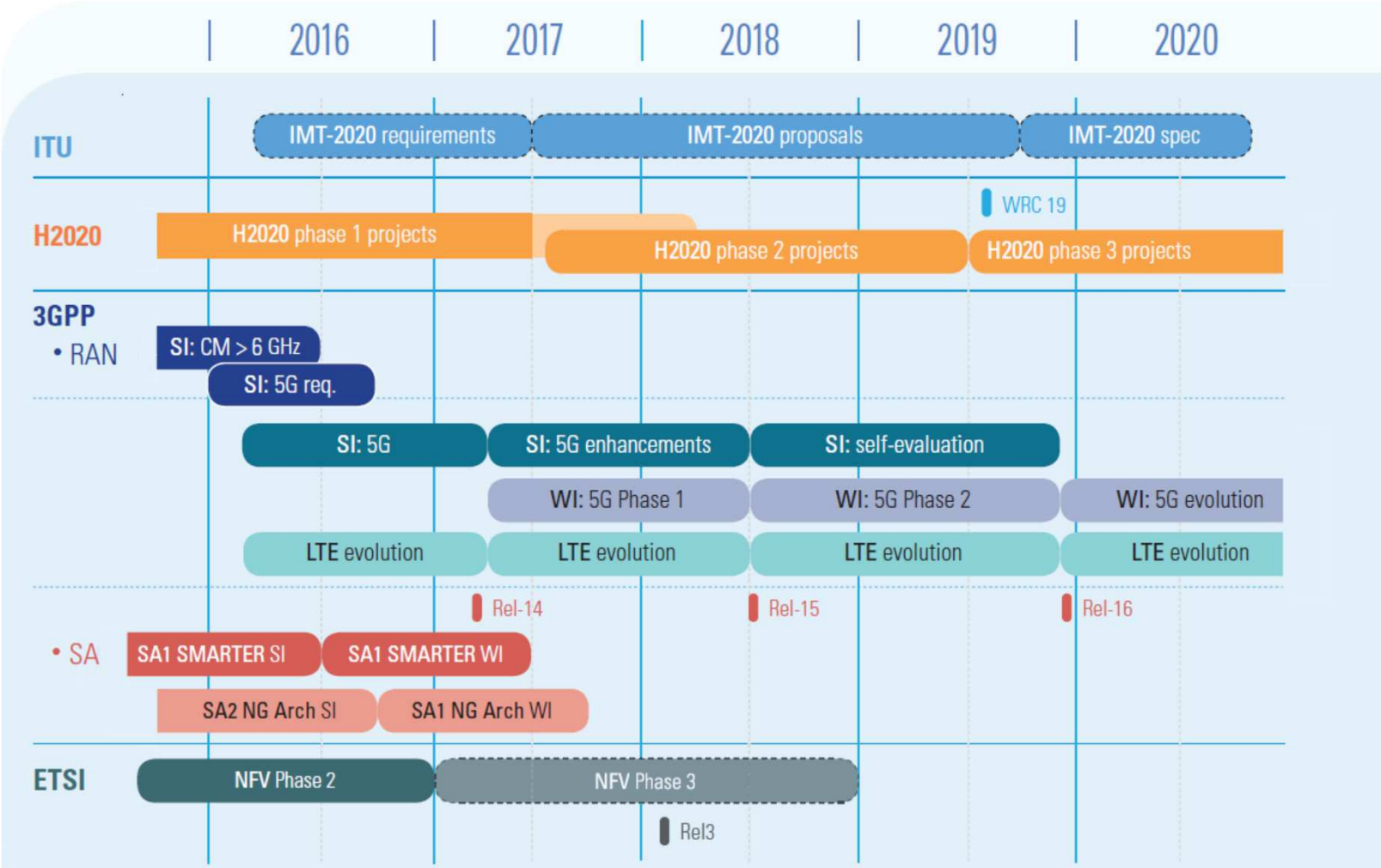
Software Network Technology

Standardization impact (with the support of Pre-Standardization WG)

Source: 5G PPP Architecture Working Group.

5G Infrastructure PPP
The European path towards global next generation communication networks
5G PPP

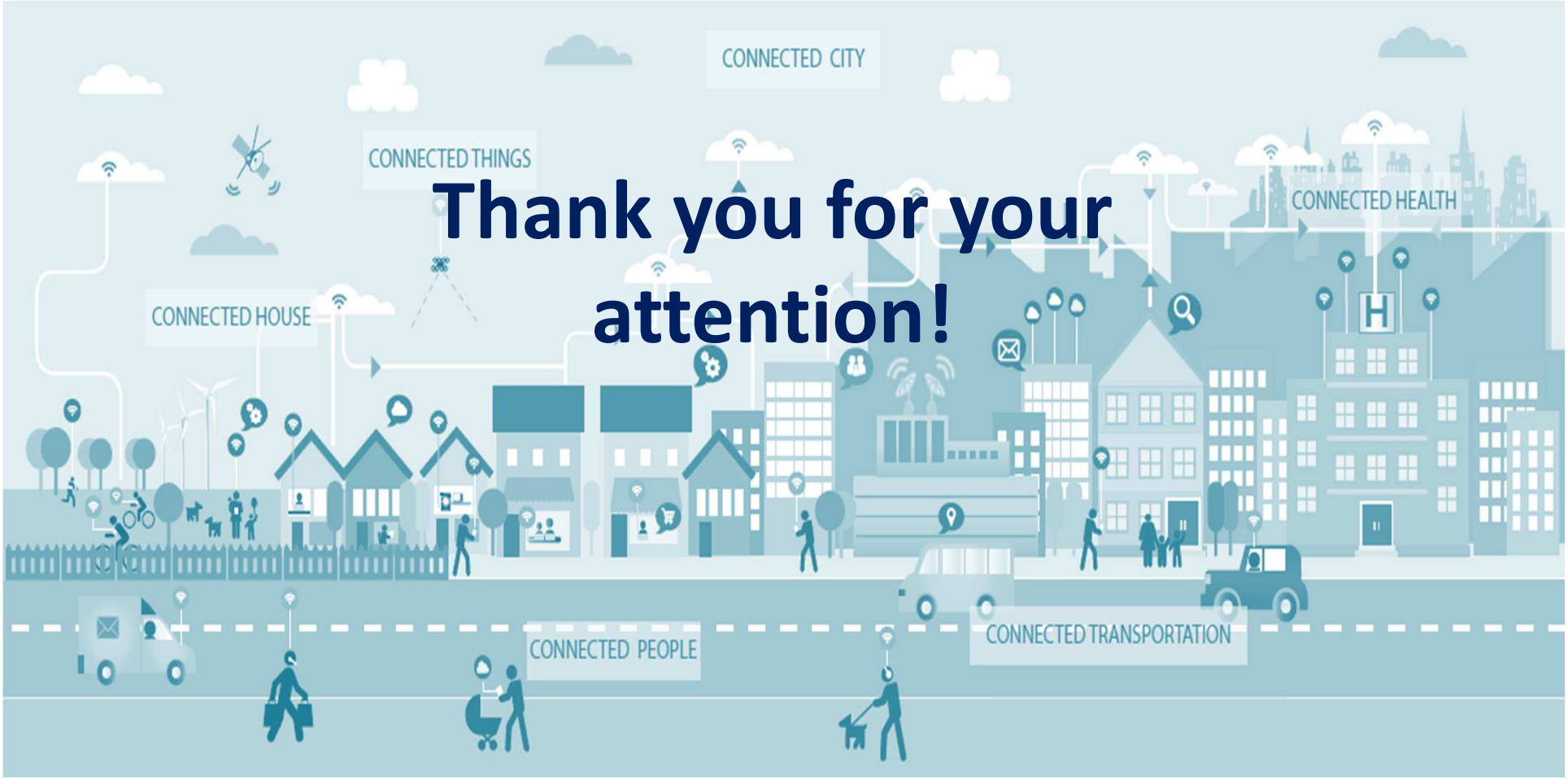
5G PPP Vision and Requirements
5G roadmap



Source: 5G Infrastructure Association: 5G Empowering vertical industries White Paper, February 2016.

5G IA
INFRASTRUCTURE ASSOCIATION

http://5g-ppp.eu



Thank you for your attention!