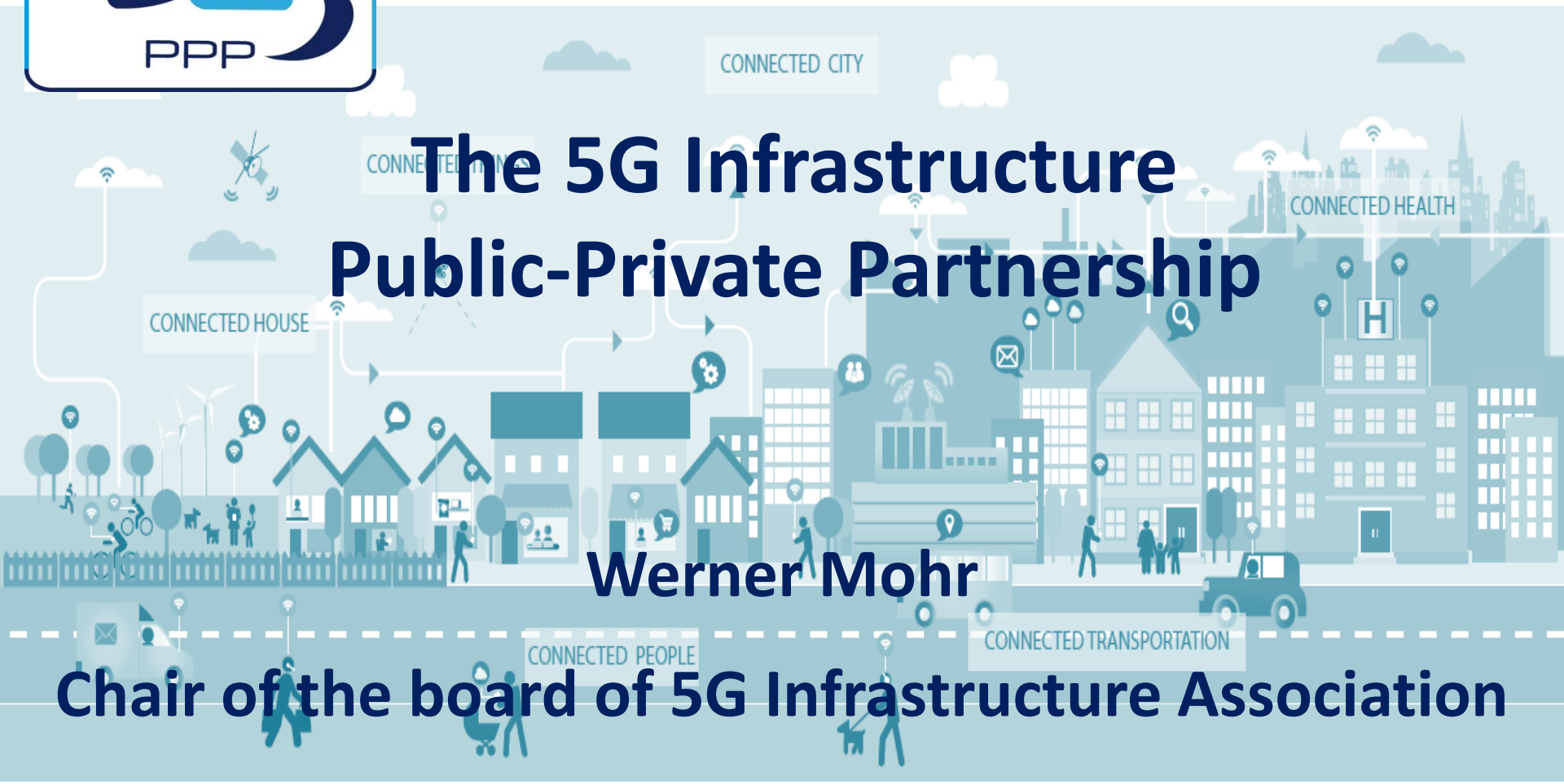


The 5G Infrastructure Public-Private Partnership

Werner Mohr

Chair of the board of 5G Infrastructure Association

http://5g-ppp.eu/

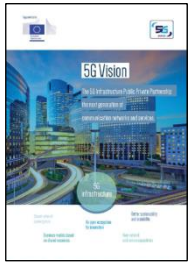
Outline

- 5G overview
- Call 1 project portfolio
- Relation to vertical sectors
- Call 2 objectives
- Time plan and exploitation
- Networking opportunities

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

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



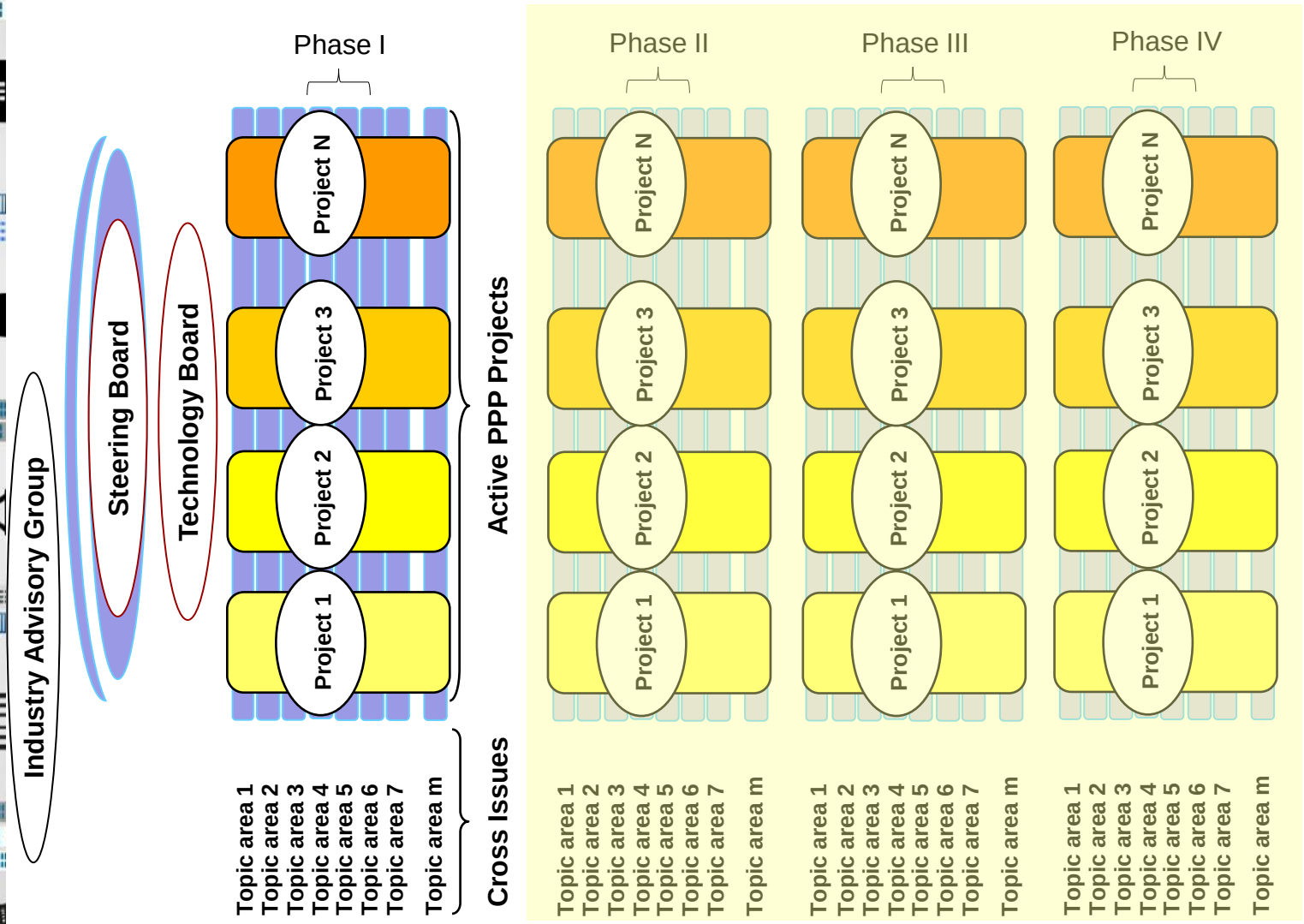
Source: 5G Infrastructure Association.

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

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

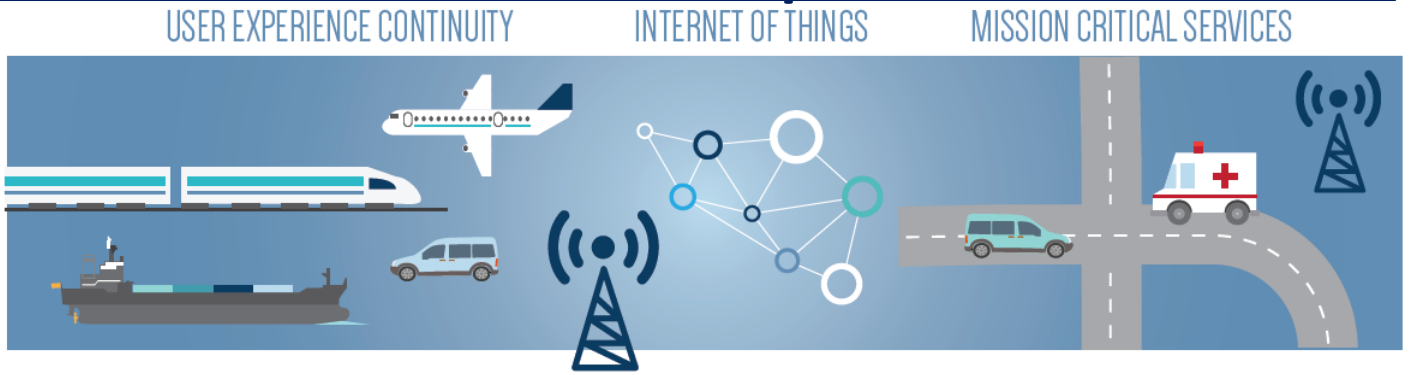
Governance model – Basic approach
Project Implementation



- Consortium Agreement per project signed by all project partners
- 5G Infrastructure Collaboration Agreement across all projects in all Phases and signed by all partners

Source: 5G PPP Annex to contractual arrangement.

5G PPP Vision and Requirements
5G new service capabilities

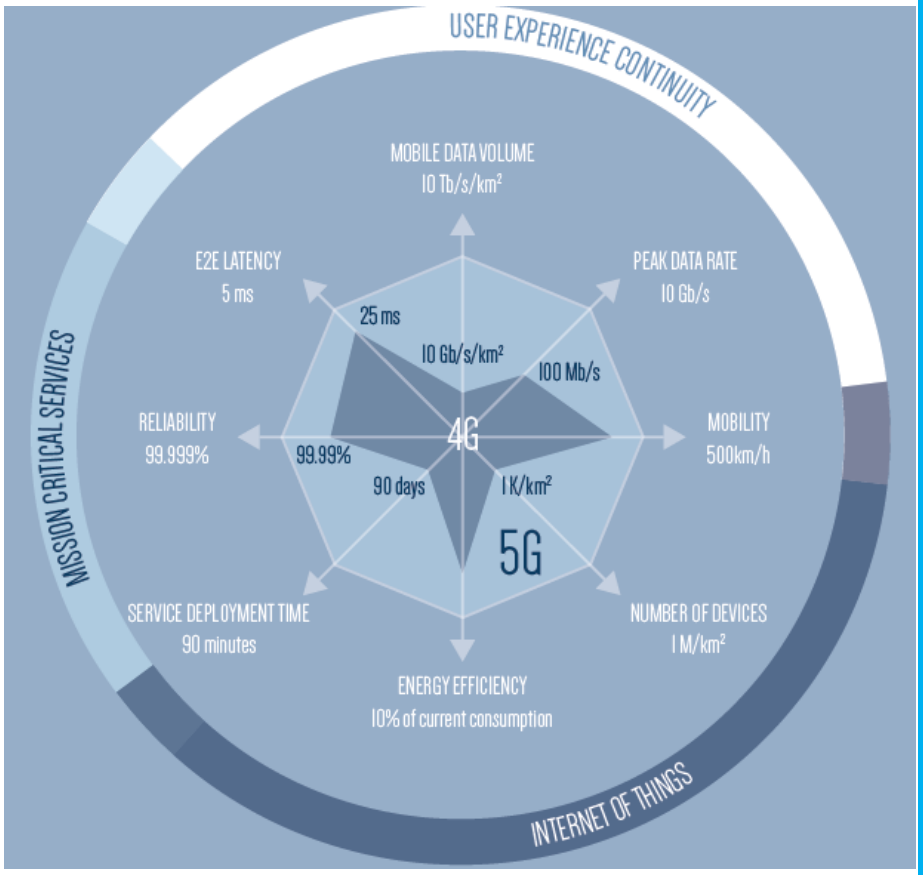


- 5G needs to support efficiently three different types of traffic profiles
  - high throughput for e.g. video services
  - low energy for e.g. long–living sensors
  - low latency for mission critical services
- 5G covers network needs and contributes to digitalization of vertical markets
  - automotive, 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 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.

International activities on 5G getting momentum

ITU-R Visions Group

EU

- Framework Program 7, e.g. METIS and 5GNow projects
- 5G PPP in Horizon 2020

Germany – 5G Lab Germany at TU Dresden

UK – 5G Innovation Centre (5GIC) at University of Surrey

US

- Intel Strategic Research Alliance (ISRA)
- NYU Wireless Research Center
- 5G Americas, MoU - signed

China

- 863 Research Program
- Future Forum
- IMT-2020 (5G) Promotion Group, MoU - signed

Japan – The 5G Mobile Communications Promotion Forum, MoU - signed

Korea – 5G Forum, MoU - signed

Taiwan – TAICS, Ministry of Science and Technology, Ministry of Economic Affairs

Russia – 5GRUS by Russia's Icom-Invest

CJK White Paper

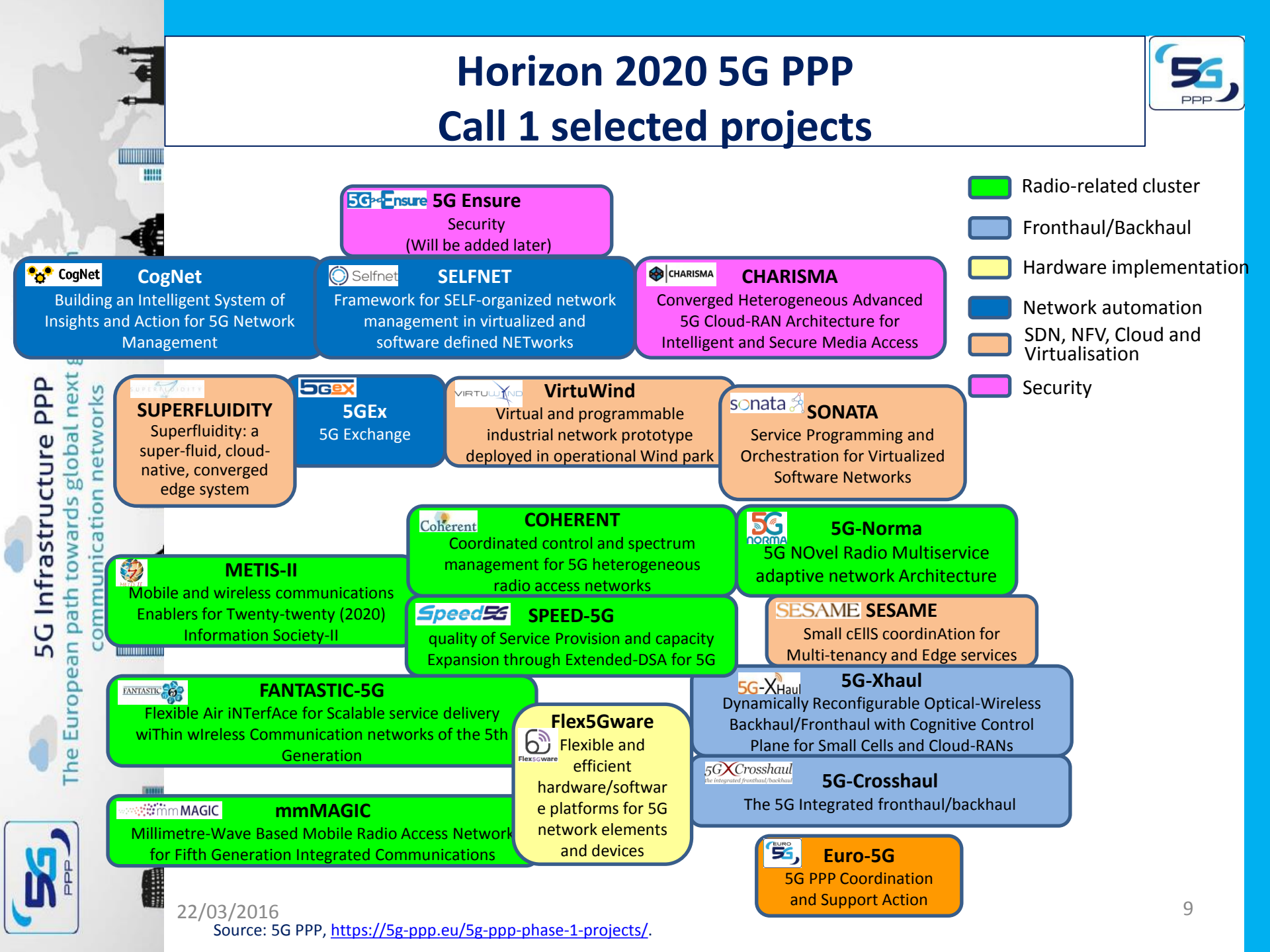
NGMN – White paper on future requirements

- Company internal research
- Multilateral MoU on a series of Global 5G Event signed on October 20, 2015 in Lisbon
  - Two events per year, rotation between continents

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

Source: 5G Infrastructure Association.

Horizon 2020 5G PPP
Call 1 selected projects



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

Vertical sectors

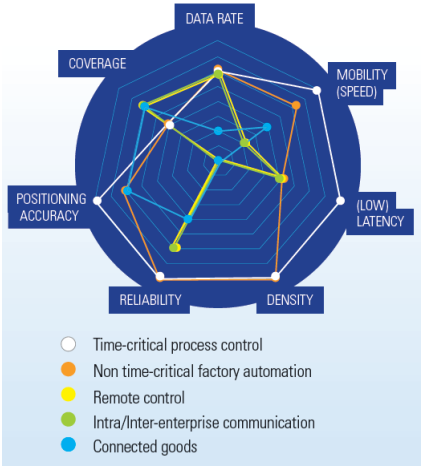
- White papers on
  - 5G and Factories of the Future
  - 5G and Healthcare
  - 5G and Energy
  - 5G and Media
  - 5G and Automotive
- Identification of
  - main use cases
  - requirements and
  - areas for research and innovation
- Vertical workshops
  - June 18, 2015
  - November 9, 2015

- White Paper will be published at Mobile World Congress 2016
  https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf

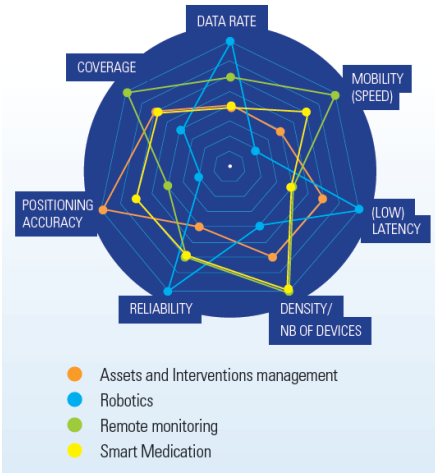
Source: 5G Infrastructure Association.

Vertical sectors
Main technical requirements

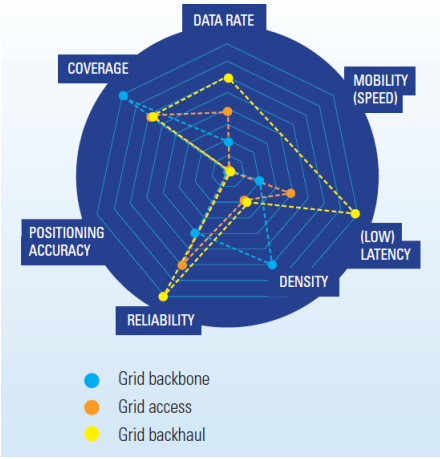
FACTORIES



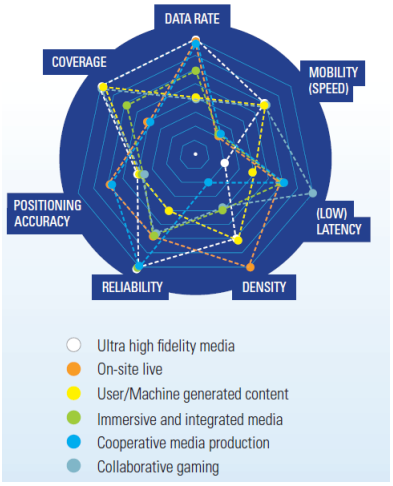
EHEALTH



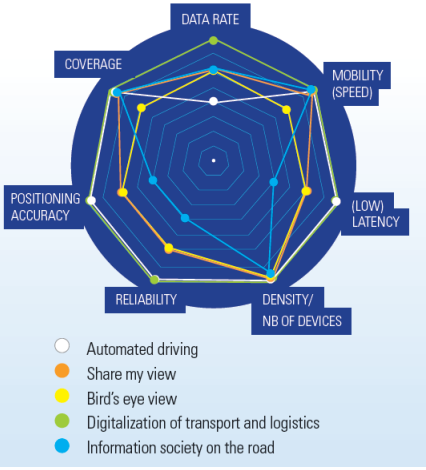
ENERGY



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.

Horizon 2020 5G PPP Call 2 objectives
154 million € Funding including joint calls

- ICT-07-2017: 5G PPP Research and Validation of critical technologies and systems
- ICT-08-2017: 5G PPP Convergent Technologies
- (EUJ-01-2016: Joint Call EU-Japan, different timing)
- (EUK-01-2016: Joint Call EU-Korea, different timing)
- Call 2: Opening May 10, 2016, Closing November 8, 2016

Wireless access and radio network architecture/ technologies

- Novel air interface technologies, heterogeneous set of requirements (low rate sensors including mission critical M2M to very high rate HD/3D TV and immersive services, supporting local and wide area systems), enabling usage of frequency bands above 6 GHz
- Hardware architectures technologies and building blocks
- (Radio) Network functional architectures and interfaces leading to vision / reference architecture for 5G
- Co-operative operation of heterogeneous access networks, including broadcast/multicast (terrestrial and satellite based) and supporting SDN and virtualization
- Multi-tenancy for Radio Access Network (RAN) sharing
- Integration of Satellite Networks to support ubiquitous coverage, resilience, specific markets

High capacity elastic - optical networks

- Support very high traffic and capacity increase originating from an (5G) heterogeneous access networks with matching capabilities from the core and metro environments, at ever increasing speeds and in more flexible and adaptive form
- New spectrally efficient, adaptive transmission, networking, control and management approaches to increase network capacity by a factor of >100 while at the same time providing high service granularity, guarantees for end-to-end optimization and QoS - reducing power consumption, footprint and cost per bit and maintaining reach
- Integration of new optical transport and transmission designs with novel network control and management paradigms (e.g., SDN) are expected to enable programmability

Software Networks

- Software network architecture to support access agnostic converged core network and control framework enabling next generation services
- Architecture leverages SDN/NFV paradigm to integrate/manage next generation transport and optical technologies
- Unified management of connectivity, with end to end security mobility and routing for flexible introduction of new services
- Scalability and efficiency related to increasing deployment of software-based network equipment and functions as well as corresponding more diverse services and usages
- Ease of deployment of multitenant networks, cost and energy efficiency, "five 9" reliability, flexibility and perceived "zero latency" where relevant
- Target is for a Network Operating System (NOS) with hardware and user interfaces to manage and orchestrate unified access to computing, storage, memory and networking resources
- Management and security for virtualised networks and services
- Network analytics tools, knowledge reasoning and cognition, may be extended towards network operations
- Management of security across multiple virtualised domains

Ubiquitous 5G access leveraging optical technologies

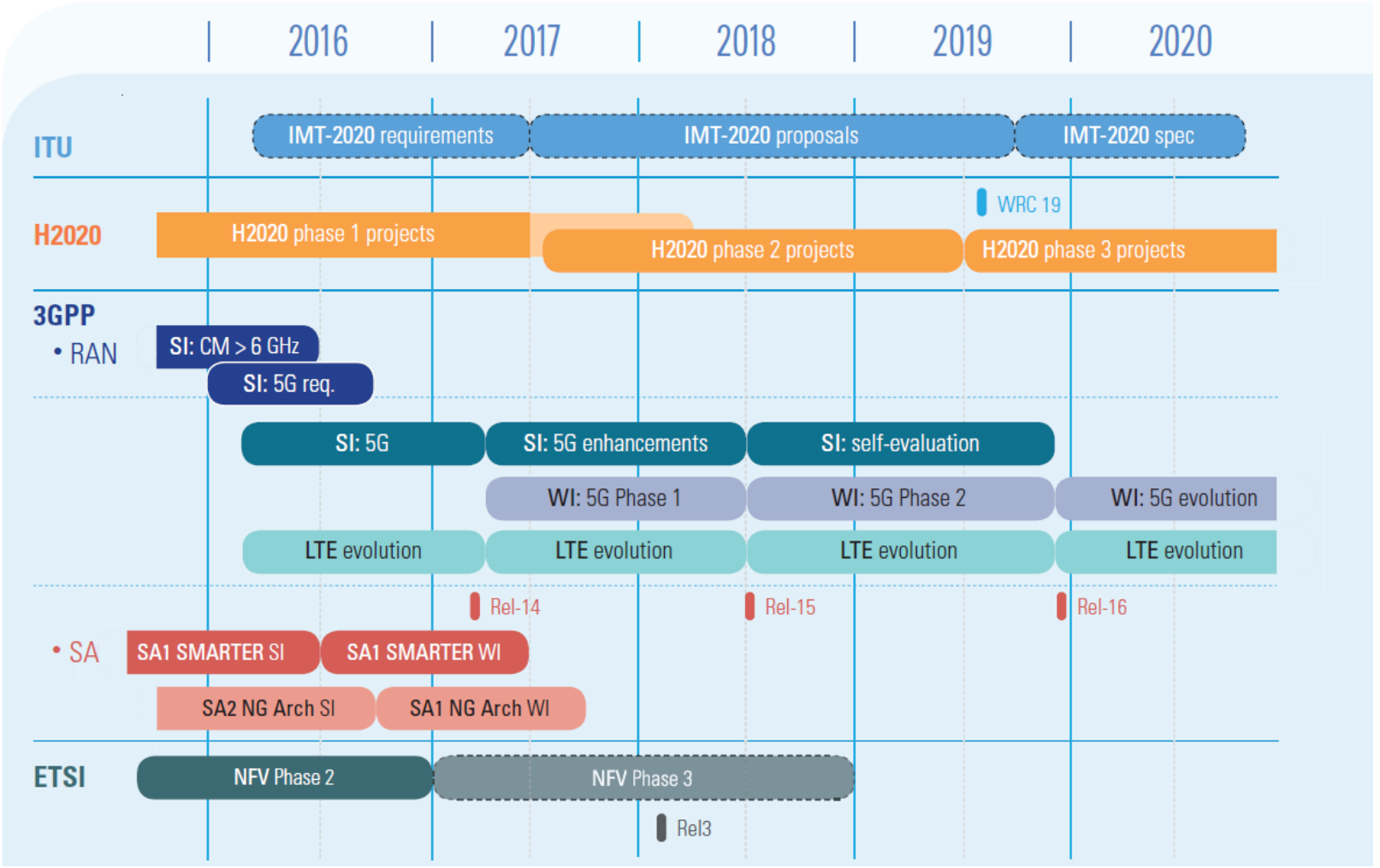
- 5G access networks have to dramatically grow in user capacity, quality of service, responsiveness, energy efficiency and number of connected devices while keeping a sustainable cost
- To develop and assess new optical access network solutions based on integrated optical device prototypes
- Co-operative radio-optical approaches are seen as very promising, also to cover intelligent interference cancellation
- Techniques to map 5G channels to optical transport and a co-design of the optical and wireless interfaces and protocols
- Scalable demonstrators validated through typical usage scenario

Flexible network applications

- Leveraging current intense research activities in relation to Virtualised Network Functions (VNF) and targeting development of a multiplicity of VNF's useful to operators, service providers and users
- Service providers or third party providers should be able to assemble virtualised 5G functions as "network apps" from NFV hosting infrastructure, to deploy them in the relevant network nodes, to orchestrate and customise resources to provision user services
- Target is for a cloud like 5G infrastructures, supporting network services, resource and service orchestration
- This environment also provides an open source development framework for control functionalities and application developments
- It also provides the link between the network –terminal functions and the app/content providers towards standards developments

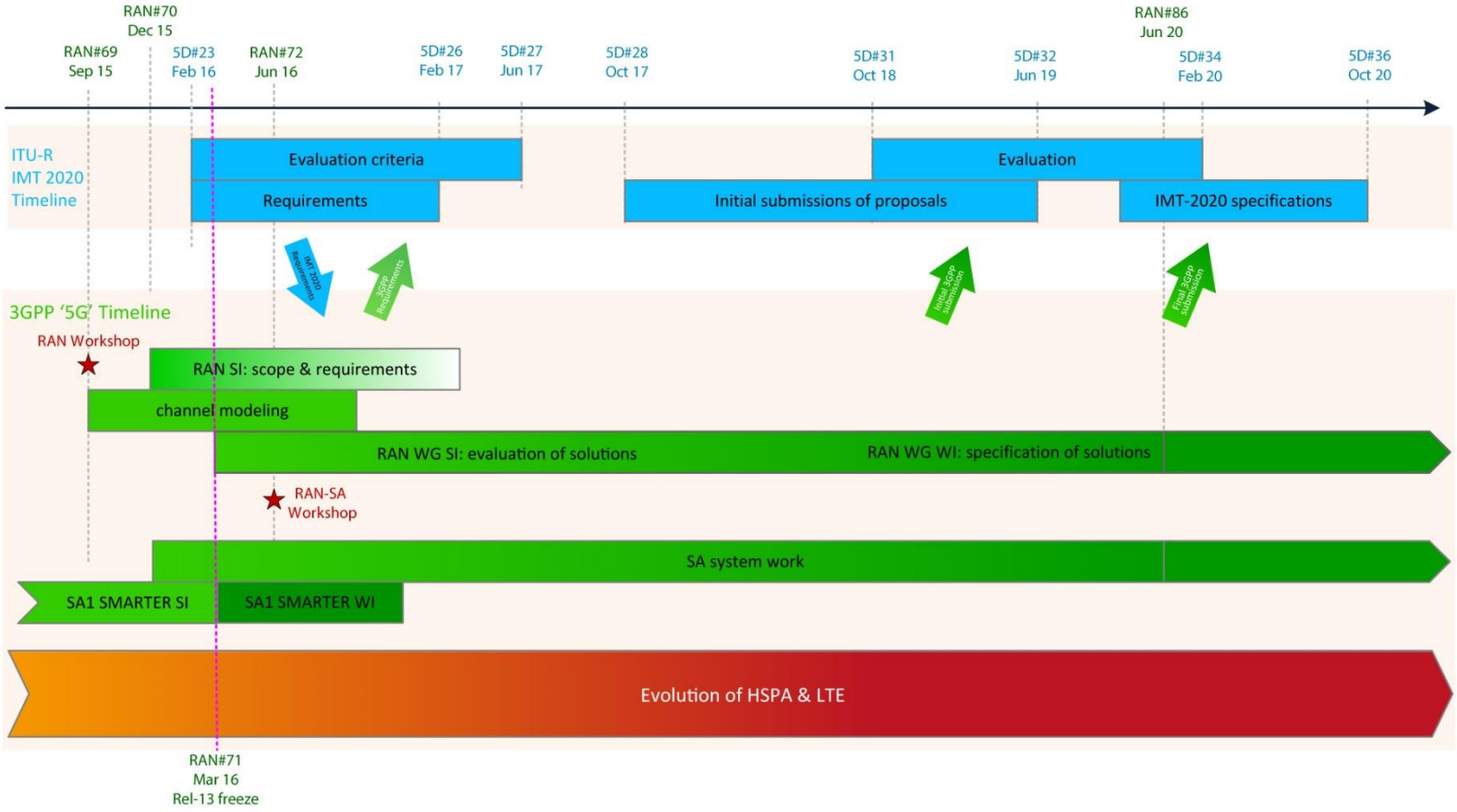
Source: EU Commission Work Program 2016-2017 / 5G Infrastructure Association.

5G PPP Vision and Requirements
5G roadmap



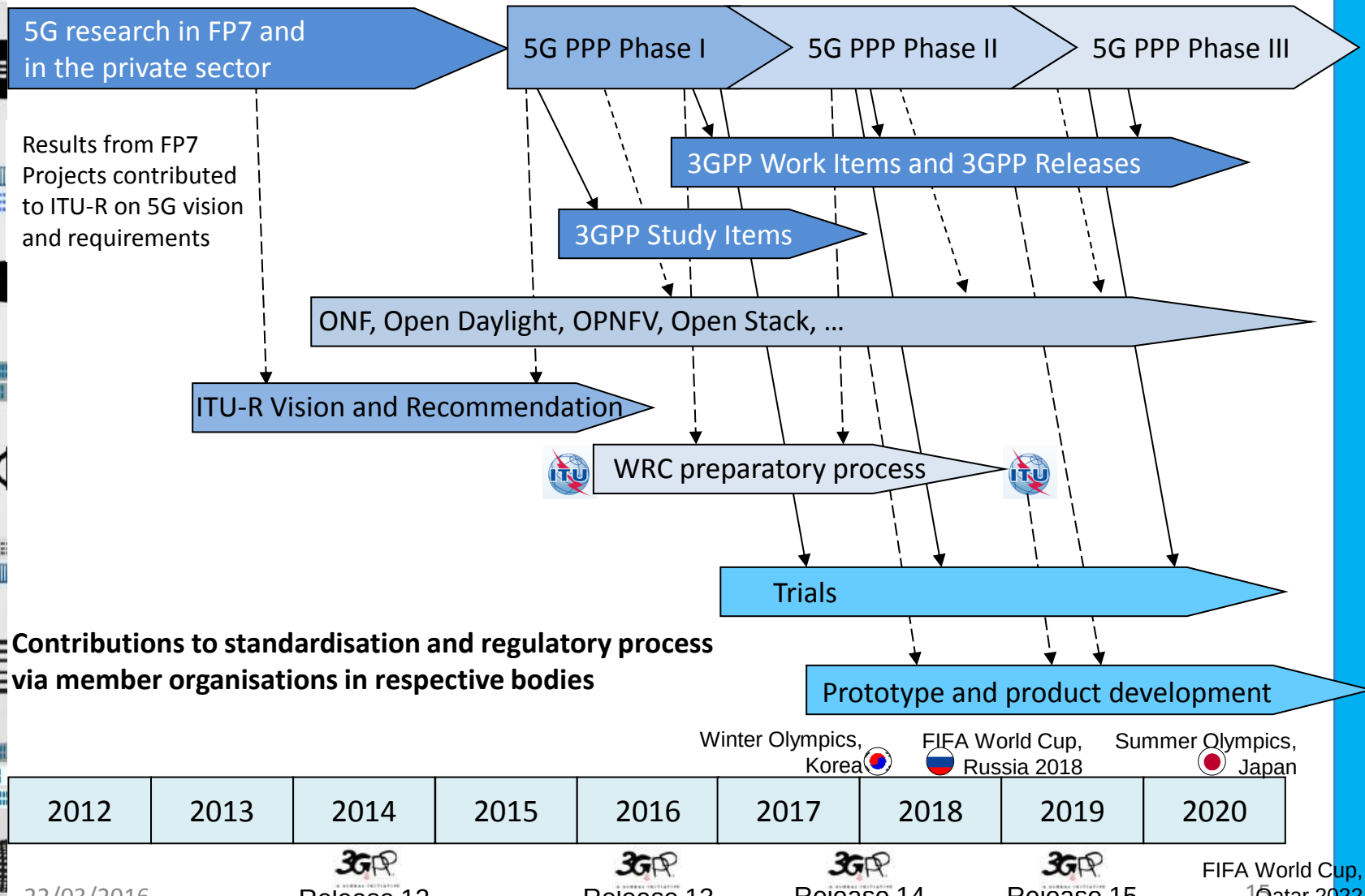
Source: 5G Infrastructure Association: Vision White Paper, February 2016.

3GPP tentative time plan on 5G standardisation



Source:3GPP, March 2015, http://www.3gpp.org/news-events/3gpp-news/1674-timeline_5g.

Exploitation of results



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

Source: 5G Infrastructure Association.

Networking opportunities

- Networld2020 website: http://www.networld2020.org/
- Networld2020 General Assembly on April 19, 2016 in Brussels: http://networld2020.eu/networld2020-annual-event-and-ga-2016/
- 5G PPP website: https://5g-ppp.eu/
- Participation in Networld2020 and 5G PPP activities like working groups
- Preparation of a Pre-Structuring Model
  - as recommendation to the community
  - as a mapping of the Call for Proposals
  - to Target Research Areas
- Information days are planned in 2016
  - first meeting on January 21, 2015 in Brussels
  - second meeting on March 17, 2016 in Bologna
  - third meeting on May 18, 2016 in Warsaw
  - fourth meeting on July 1, 2016 in Athens after EuCNC 2016
  - fifth meeting (potentially) in September 2016 in Slovakia
- Brokerage Platform on 5G PPP website will be provided in April 2016

Source: 5G Infrastructure Association.

Brokerage service for Phase 2

- 3 stage process based in www.5G-ppp.eu
  - Web form for submission
    - Profile or Proposal
    - Main characteristics – company skills or project idea
    - Background – references, work being built on
    - Link to pre-structuring model (if any)
  - Creation of a meaningful web index
    - based on the number and complexity of offers
  - Creating an easily navigable web site with search facilities and allowing people to contact submitters
- Should be online mid-April 2016

Source: Euro-5G CSA.

http://5g-ppp.eu

Thank you for your attention!

Acknowledgement: The author would like to thank his colleagues for their contributions.