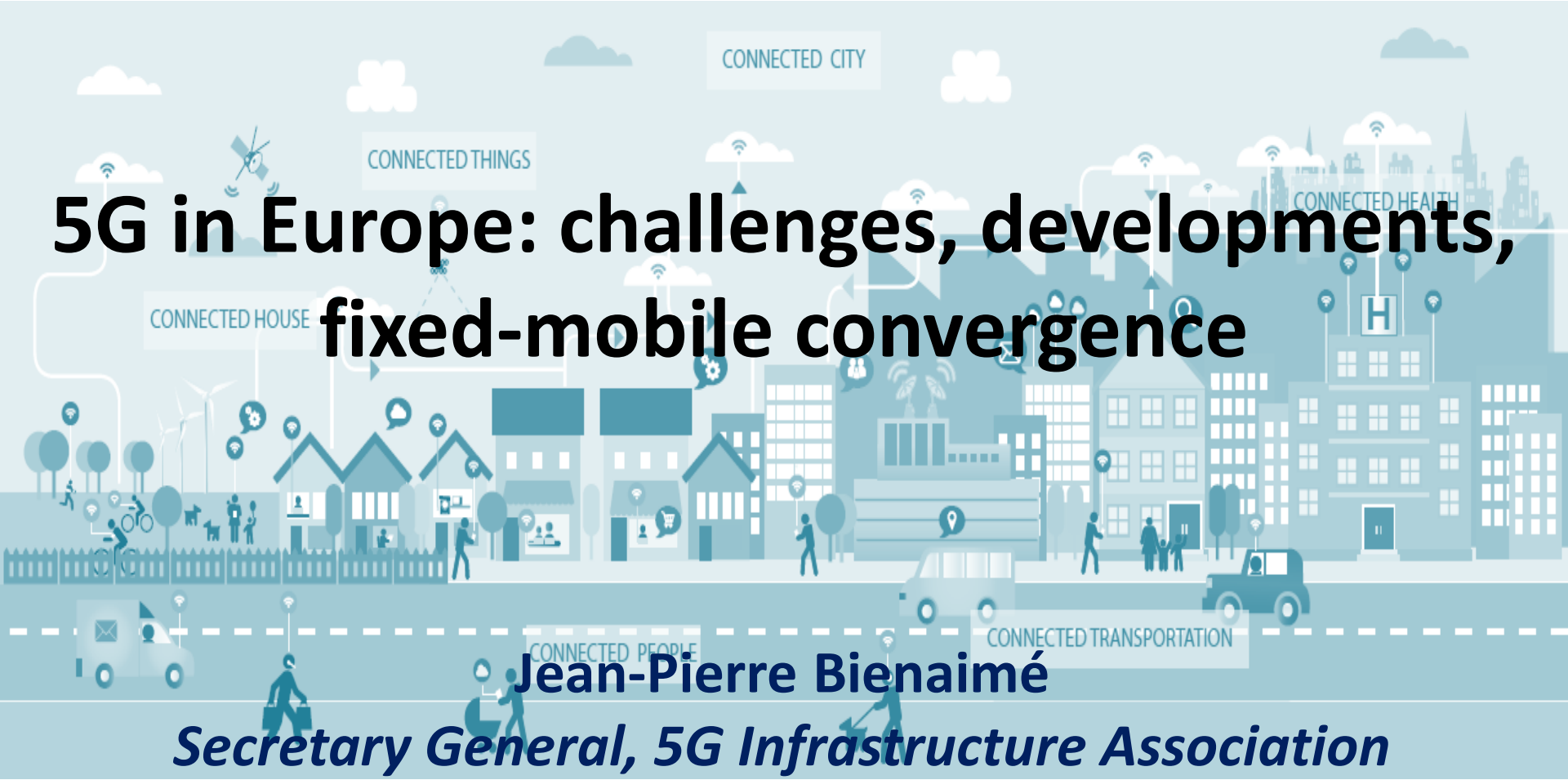
5G IA
INFRASTRUCTURE ASSOCIATION



5G in Europe: challenges, developments, fixed-mobile convergence

Jean-Pierre Bienaimé

Secretary General, 5G Infrastructure Association

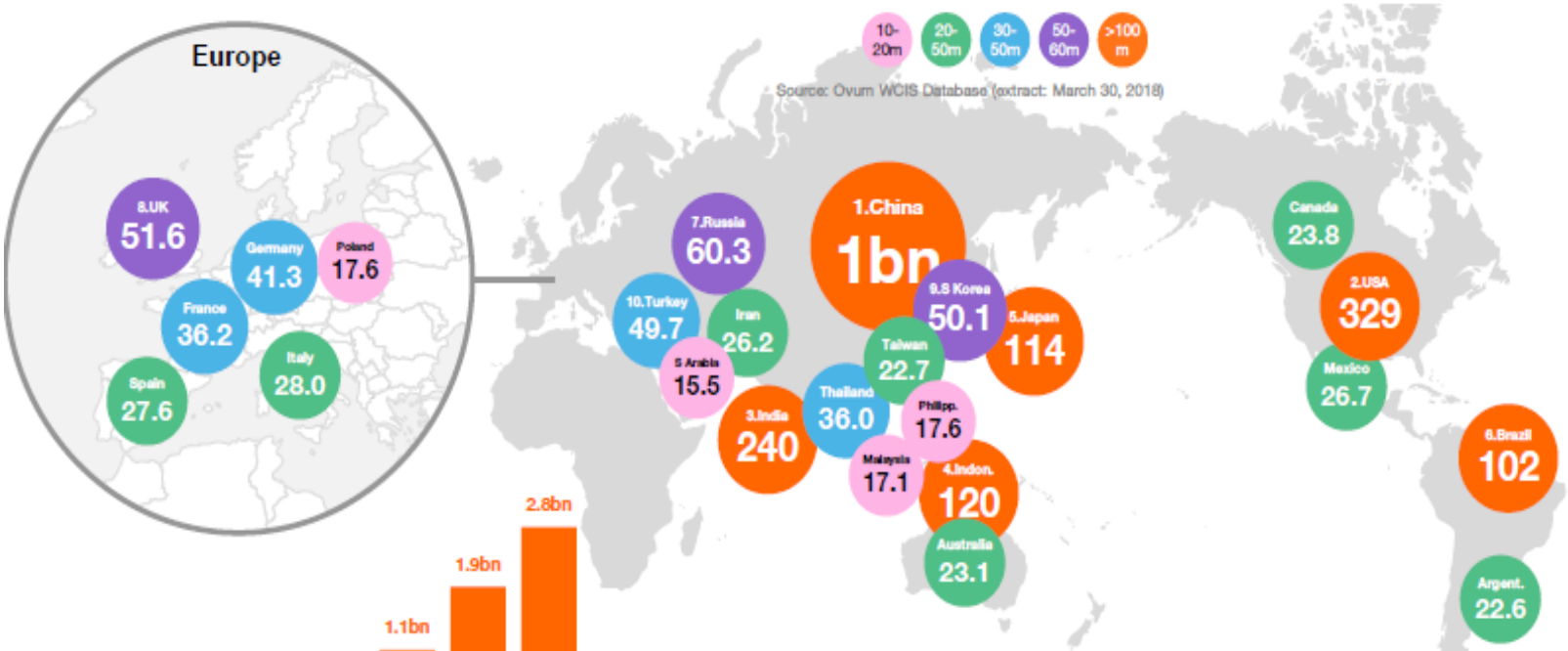
http://5g-ppp.eu/

Summary

- 4G/5G industry developments worldwide and in Europe
- 5G PPP European ecosystem & projects
- 5G innovations for new business opportunities : 5G PPP first results, Verticals & Pan-European trials roadmap
- International cooperation and perspectives of success
- Fixed mobile convergence: the role of fiber

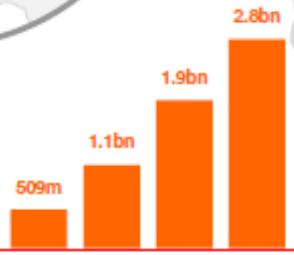
4G LTE connections worldwide

Top 25 LTE markets worldwide @31 Dec 2017



52%

weight of LTE traffic in Telefónica's total data traffic globally in 2017 (2.5x YoY). The ratio is 85% at Telekom Hungary in Q4'17 and even 86% for Orange Belgium.



2.77bn

4G subs @31 Dec 2017 (WCIS)

$511bn

of revenue generated by 4G worldwide in 2017, up 23% YoY. By comparison, monthly 4G ARPU decreased by 21% to $18 as 4G becomes a mass market product (India, China...) (Strat. Analytics)

75%

of the world's population is covered by a 4G network @31 Dec 2017 (up 9 pts YoY) but with disparities (36% in Africa vs. 97% in the European Union) (GSMAi, April 5, 2018)

1.3bn

LTE-Advanced users globally at YE 2017 according to Strategy Analytics. At the end of this period, 207 operators had already commercially launched this technology (GSMAi)

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

Source: Orange

5G Industry Developments: World

- **5G has made great progress in the last twelve months** across all measures: standard, chipset and infrastructure trials, partnerships and operators commitments to deployment. This is notably due in large part to 3GPP's completion in Dec 2017 of an intermediary step in the introduction of 5G NR with the non-standalone (NSA) specifications. It is now estimated that network rollouts will begin in 2H 2018 in the US and Asia before wider deployments in 2019 and volume build-outs in 2020.

In Europe: preparing for 5G & fully monetizing 4G…

- **Operators** : ***2020 appears to be a likely start date:***

  - Nordic & Baltic Regions: common 5G development plan for earlier launches (2018)
  - DT will introduce 5G in its entire footprint from 2020
  - Orange 5G launches between 2020 & 2022; trials with Ericsson & Nokia, and recent agreement with Peugeot to develop the 5G connected car.
  - Telefonica committed to 5G, but wants to adapt the network to the customer and not the other way around…

- **Verticals:**

  - Smart cities drive interest: 15 « trials cities »
  - interest shown for connected car: 5GAA creation
  - Euro2020**:** clear target, as a popular event, displayed on 13 different cities
  - role of SMEs, contributing to research & standardization, supported by EU Research programmes

The Orange vision of 5G

Source: Orange

5G will provide all the means to access the Internet, including

- radio: existing (4G, Wi-Fi) and a new radio (NR)
- a convergent core network managing fixed and radio accesses (fibre, 4G, NR, Wi-Fi…)

5G will deliver more than connectivity

- new business models and value propositions
- enabled by a unified infrastructure integrating networking, computing and storage resources

For high performance and new capabilities

What can 5G offer to consumers ?

Source: Orange

Enhanced and New MBB experience	• better comfort • new devices (e.g. AR/VR) and services (cloud)
FTTH-like Fixed Wireless Access	• in areas without FTTH by 202X (X dependent on spectrum availability)
More diverse IoT experiences	• new connected machines • diverse usages leveraging the complementarity of LoRa, LTE-M and 5G IoT
Connectivity for everyone	• in emerging countries • in low density areas

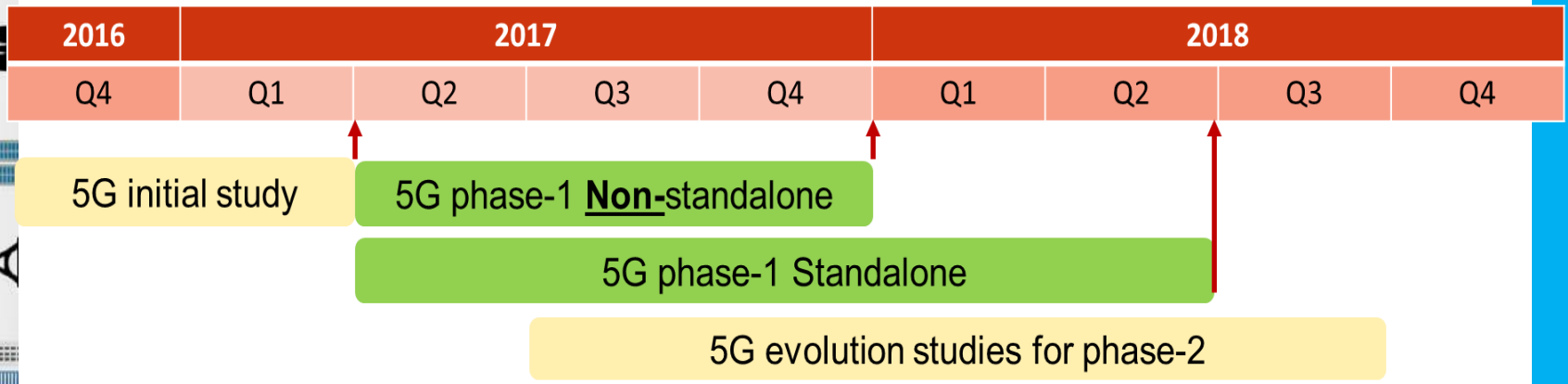
5G timeline

Non-standalone 5G

- Uses LTE core and LTE radio anchor with a 5G small cell
- Mobile BroadBand capacity boost

Standalone 5G

- Uses 5G core and 5G radio anchor
- 5G overlay
- Expansion of the wireless ecosystem



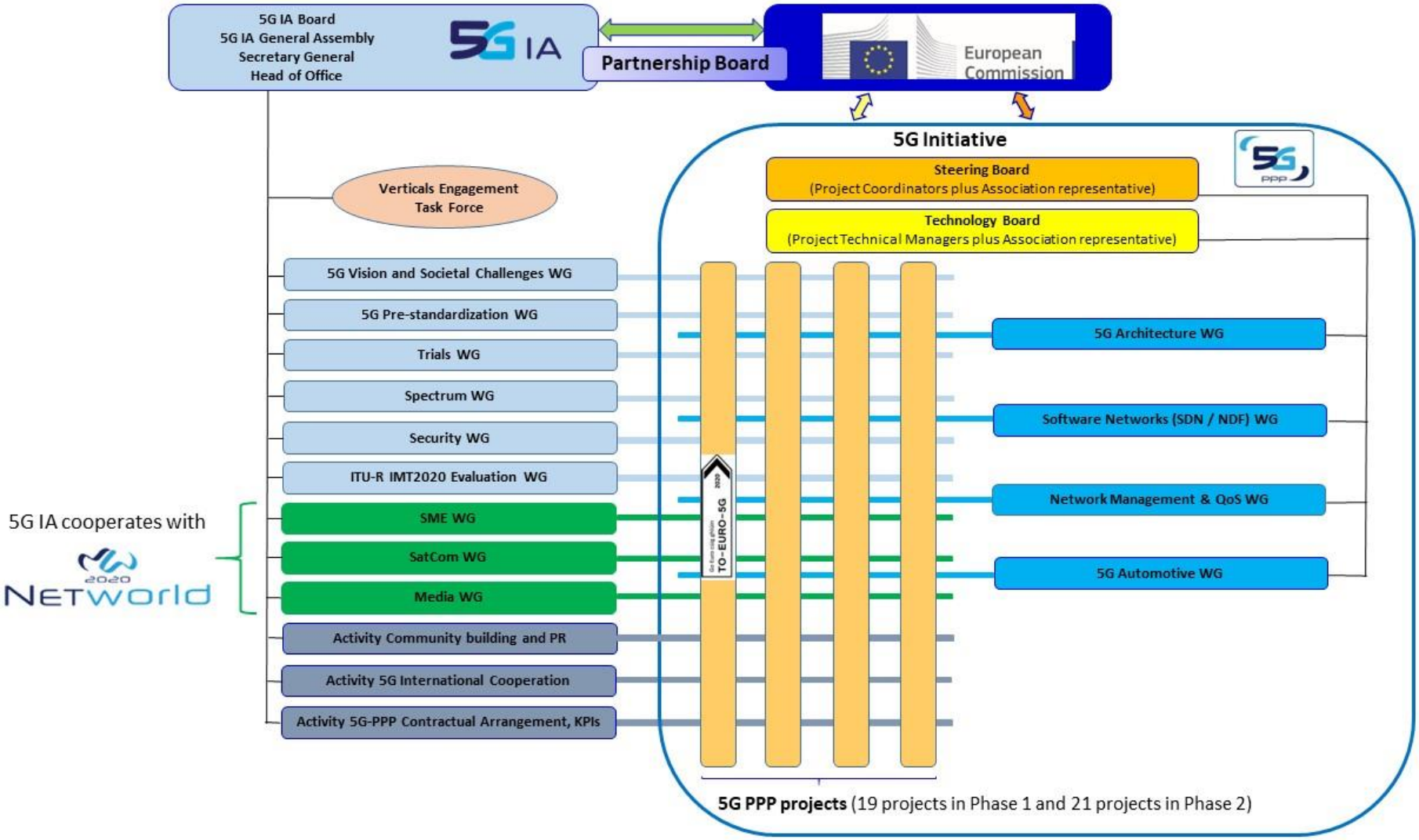
➔ Speed up of the standardization process by 6 months, approving a non-standalone implementation of New Radio (NR) in Dec 2017. The first 5G NR will use < 6GHz & mmW spectrum

5G PPP Contractual Arrangement KPIs for Monitoring

- **Business-related KPIs:**
  - Leverage effect of EU research and innovation funding in terms of private investment in R&D for 5G systems in the order of 5 to 10 times;
  - Target SME participation with an allocation of 20% of the total public funding;
  - Reach a global market share for 5G equipment & services delivered by European headquartered ICT companies above the level of 43 % global market share in communication infrastructure.
- **Performance KPIs:**
  - Providing 1000 times higher wireless area capacity compared to 2010;
  - Reducing the average service creation time cycle from 90 hours to 90 minutes;
  - Very dense deployments to connect over 7 trillion wireless devices serving over 7 billion people;
  - Secure & reliable Internet with a “zero perceived” downtime for services provision.
- **Societal KPIs:**
  - Enabling advanced User controlled privacy;
  - Reduction of energy consumption per service up to 90 % (vs 2010);
  - European availability of a competitive offer for 5G systems and technologies;
  - New economically-viable services of high societal value like U-HDTV and M2M applications;
  - Development & availability of 5G skills curricula in partnership with the EIT.

Source: 5G PPP Contractual Arrangement.

Governance Model (5G IA represents the Private Side and European Commission | the Public Side)



5G-IA Strategic 'Headline'

The voice of the European industry for the development and evolution of 5G

5G PPP Governance – Work Groups

5G IA WGs & Activities

- Pre-standardization WG
- Spectrum WG
- Vision and Societal Challenges WG
- 5G International cooperation Activity
- 5G-PPP Contractual Arrangement, KPIs Activity

- Trials WG
- Security WG
- ITU-R IMT2020 Evaluation WG
- Community building and Public Relations Activity

NetWorld2020 WGs

- SME WG (NetWorld2020)
- SatCom WG (NetWorld2020)
- Media WG (Joint NEM - NetWorld2020)

5G-PPP Projects WGs

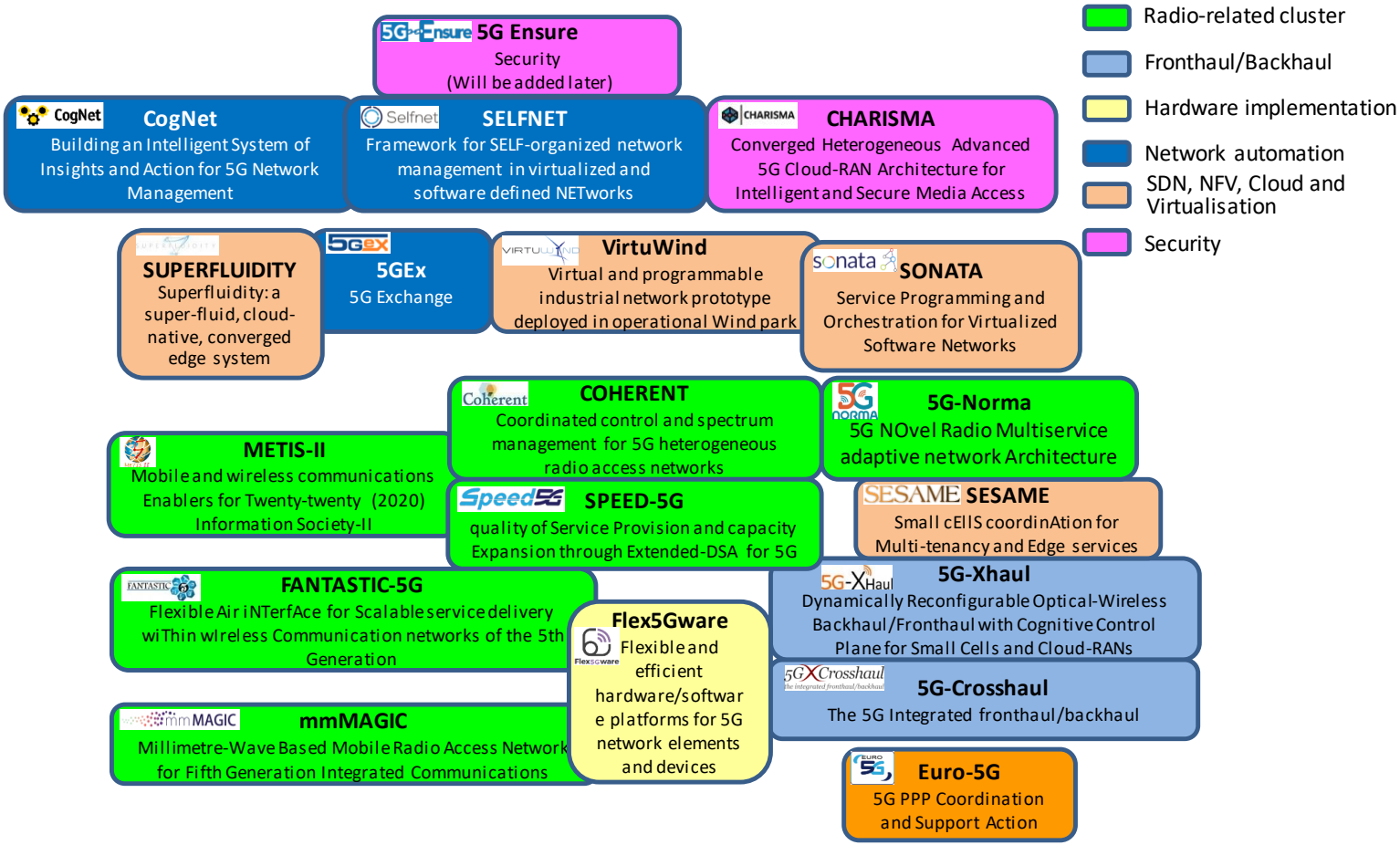
- Software Networks (SDN and NFV) WG
- Architecture WG
- Network Management & QoS WG
- Automotive WG

Trials WG membership is open (approval is required).
Verticals are welcome to join the WG.

WGs on specific Verticals

NetWorld2020 membership is free.

5G PPP Projects Phase 1
167 partners



https://5g-ppp.eu/5g-ppp-phase-1-projects/

5G PPP Projects Phase 2
224 Partners

- Readiness to Verticals
- 5G Network Control and Management
- 5G Fronthaul/Backhaul
- Novel 5G Radio and SatCom
- Compl. EU-Taiwan 5G projects

CLEAR5G
Converged wireless access for reliable 5G MTC in Factories

5GCity
Distributed multi-tenant cloud and radio platform for 5G neutral hosts

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

5G ESSENCE
Embedded Network Services for 5G experiences

5Gtango
DevOps Platform for 5G Network Services and Apps

5G TRANSFORMER
5G Mobile Transport Platform for Verticals

MATILDA
Framework for devel. & orchest. of 5G apps & services

5G-MONARCH
Mobile Network Architecture for 5G and beyond

SLICENET
E2E Cognitive Network Slicing and Slice Mgmt in 5G Networks

NGpaas
Next Generation Platform as a Service (PaaS)

NRG-5
Smart Energy as a Service via 5G Mobile Network advances

5G CAR
5G Comms for e2e V2X and multi-RAT interworking

5G Xcast
Broadcast and Multicast Comms for 5G Wireless Systems

METRO-HAUL
5G App-aware metro optical network

5G-PICTURE
Programm. Infrastr for disaggr. net&comp resources

SaT 5G
Integration of Satellite and Terrestrial network for 5G

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

5G phoxy
5G integrated Fiber-Wireless for high-density SDN networks

Global5G
Global vision, standardisation & stakeholder engagement in 5G

5G coral
5G Convergent Virtualized Radio Access Network at the Edge

blue SPACE
Bluespace
Spatial Multiplexing 5G Networks for Adv. Networking

IoRL
Internet of Radio-Light in Buildings

TO-EURO-5G 2020
Supporting the 5G-PPP especially 5G Initiative governance

https://5g-ppp.eu/5g-ppp-phase-2-projects/

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

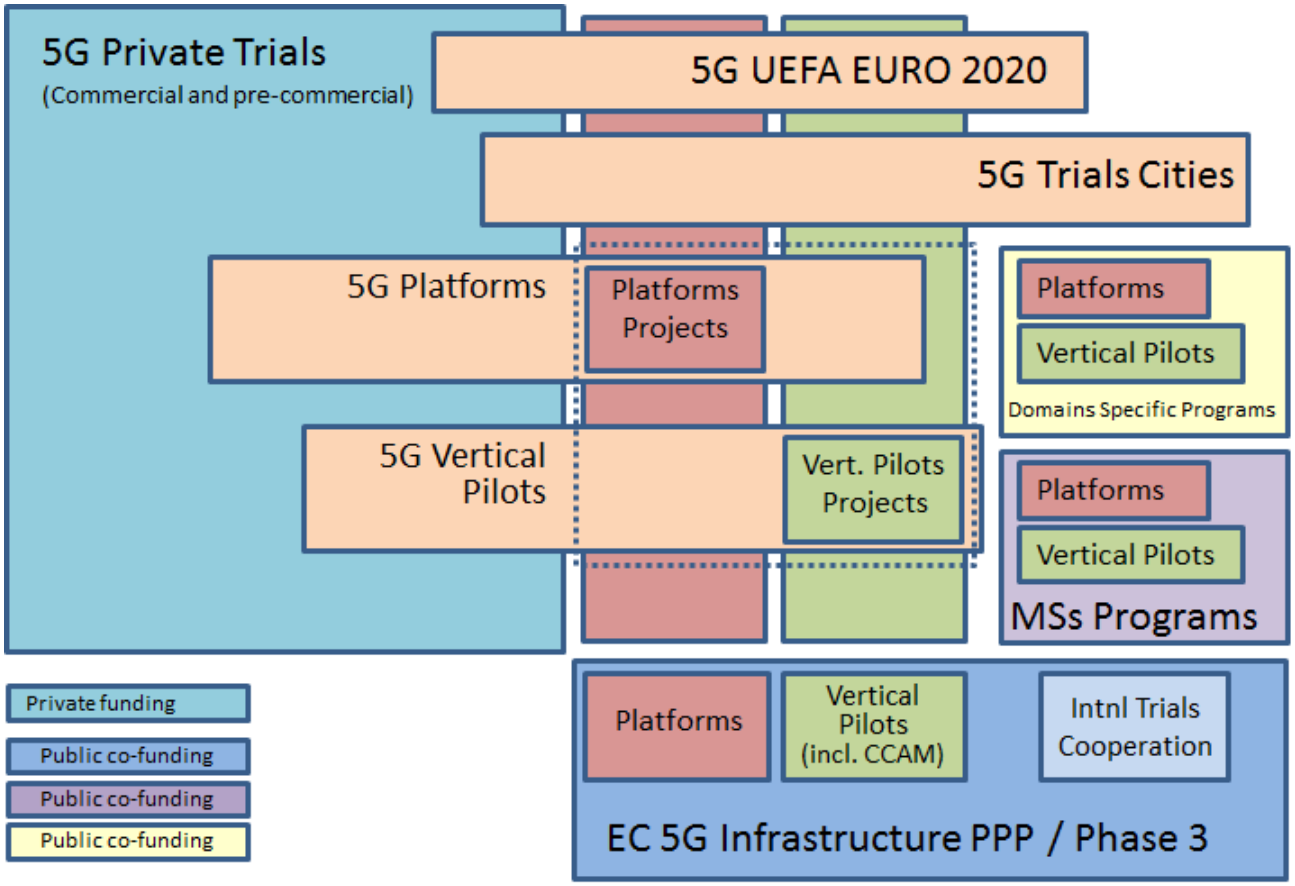
Where do we stand with 5G requirements (1)? 3rd Cross 5G PPP Workshop February 2017

KPI	Requirement	METIS-II performance	Key contributor
C-Plane latency	< 10 ms	7.125 ms	RRC Connected Inactive, reduction of processing time in BS and UE
U-Plane latency	< 1ms	0.763 ms	Shortening of TTI, reduction of processing time in BS and UE
mMTC energy efficiency	> 10 years on a single 5 Wh battery	> 10 years on a single 5 Wh battery	Extension of DRX, C-Plane latency reduction, deep sleep energy conservation features
Peak data rates	> 20/10 Gbps for DL/UL	21.7/12.4 Gbps for DL/UL	MIMO spatial multiplexing (for lower frequencies), exploitation of mmW bands
Mobility interruption time	0 ms	0 ms	Multi-connectivity + make-before-brake

Where do we stand with 5G requirements (2)? 3rd Cross 5G PPP Workshop February 2017

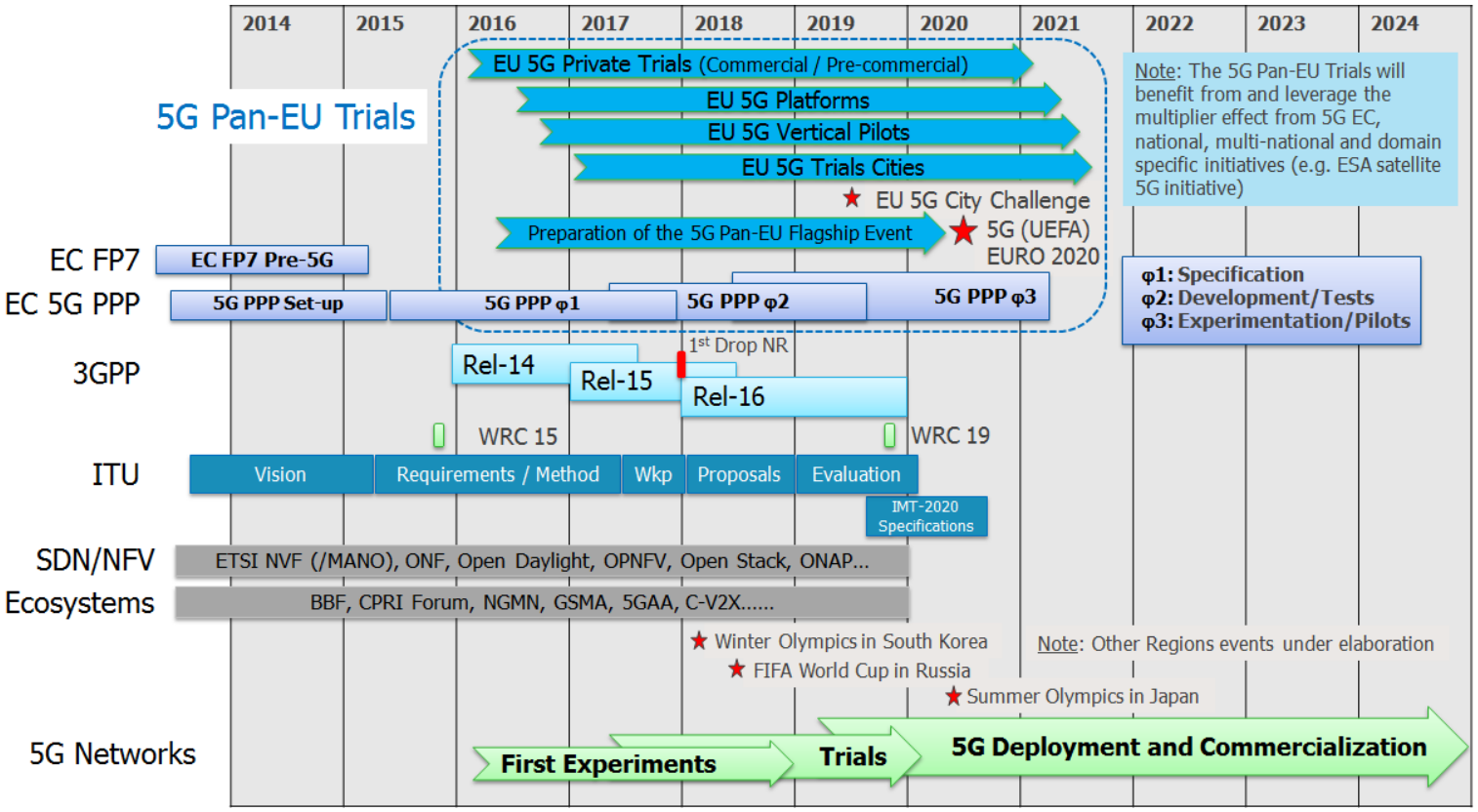
KPI	Requirements	METIS-II performance	Comments
User throughput (use case 1, UC2 and UC3)	UC1: 300 Mbps UC2: up to 5 Gbps UC3: 50/25 Mbps for DL/UL	UC1: 1 Gbps+ UC2: up to 7.85 Gbps UC3: 50/25 Mbps for DL/UL	Only DL values for UC1 and UC2 Different methodology applied for UC3 evaluation
mMTC device density (UC4)	> 1 mln/km^2	4 mln/km^2	Depends heavily on the traffic/report periodicity of mMTC devices. 1 upload of 1000 bits every 100 s was used in METIS-II
Reliability (UC5)	99.999% at 50/1000m for urban/highway	99.999% at 45/150m for urban/highway	For highway scenario, requirements seems very difficult to meet (revision needed?)
Network energy efficiency (UC1, UC3)	Should follow (at least) capacity improvement	For the capacity x1000, network energy efficiency improvements of 350-7500 were reported	Evaluation done only for Dense Urban environment. Savings depend on the load level in LTE-A/5G network

5G PAN-EUROPEAN TRIALS ROADMAP STRATEGY



https://5g-ppp.eu/wp-content/uploads/2017/05/5GInfraPPP_TrialsWG_Roadmap_Version2.0.pdf

5G PAN-EUROPEAN TRIALS ROADMAP TIME PLAN



https://5g-ppp.eu/wp-content/uploads/2017/05/5GInfraPPP_TrialsWG_Roadmap_Version2.0.pdf

5G-IA WG Trials international cooperation

- The 5G-IA trials roadmap does not only include pan-European 5G trials, but also **international trials.**
- International cooperation on trials is needed to contribute to ensure:
  - Global 5G vision, and consensus on 5G standards and spectrum requirements
  - Avoid premature "5G" launch announcements and the subsequent potential fragmentation among the different countries
- To achieve these goals, the 5G-IA is
  - Promoting joint actions, e.g., workshops (EU-China, EU-Taiwan, …).
  - Promoting **joint cooperation via participation in trials**
    - **Private trials** (the already signed multi-lateral MoU can pave the way to have bilateral agreements / MoUs on trials). Additional MoUs are being sought after: India,…
    - **5G PPP calls of H2020** (the EC funding to partially support the development of EU-X joint trials between regions/countries is of paramount importance)

International trials under 5G PPP Phase 3

- International research related to trials, under the 5G PPP Phase 3 (2018-2021 time frame), will take place with the following countries and topics
- Call for proposals EU-Japan, EU-Korea, and EU-China already closed on January 2018 (highlighted in red)

	R&D , 2018-20 Work-programme	Policy
JAPAN	- Applications and trials with 5G networks - Beyond 5G, applicability of spectrum >275 GHz	- Spectrum, interoperability at different bands
REPUBLIC OF KOREA	- Application trials at mmwave bands - Interoperability and integration of 5G vertical testbeds in heterogeneous environments	- Standards, validation of specs
CHINA	- eMBB trials at 3,5 Ghz and trials in the V2X context	- Spectrum co-operation - Standards, preparing 5G phase 2 through trial results
TAIWAN	- 5G trials addressing End to End Testbeds for specific applications	
BRAZIL	- Trials	- Spectrum co-operation - Standards - Trials

EU – China Cooperation

EU-China workshop on 5G developments and collaboration opportunities

Brussels, 12th July 2017

EU-China Workshop on 5G Developments and Collaboration Opportunities, Belgium, July 2017

- Automobiles vendors, Mobile operators, vendors, service providers, universities and research institutes from both regions were invited to present the latest 5G developments, their future plans, and to discuss together concrete opportunities of the Internet of Connected Vehicles and collaboration in 5G Trials.

5G commitment with verticals

The true differentiator for 5G is the vertical markets.

If we fail with the verticals, we fail with 5G.

5G & Verticals: the demand of services and technology readiness

Main use cases and technology requirements, by vertical

Verticals	eMBB	Massive MTC	Ultra-reliable MTC
Automotive	On-board media consumption	Telematics	Automated cars
E-health	Exchange of data, remote consultation	Wearables, fitness monitoring, asset management	Robotics
Manufacturing industry	Assistance to operators, remote control, exchange of data	Connected goods, monitoring, non-time-critical optimisations	Automation, time-critical automation, remote control
Energy	Limited	Monitoring of access/distribution network	Fault prevention and alert, grid backhaul network
Passenger transport	Media content access	Telematics	Limited
Agriculture, Forestry, Environment	Assistance to operators	Monitoring	Automation
Freight and logistics	Limited	Goods tracking, fleet control and optimisation	Limited
Media and entertainment	Anytime, Anywhere, Any Device, Any Content AR/VR, Video	Limited	Limited

Source: IDATE DigiWorld, *5G and the verticals*, December 2016

Real world Verticals are committed to 5G

LEONARDO "5G will provide the basis for relevant evolutions in vertical applications for Security (Public Protection, Disaster Relief, Critical Infrastructures). Full integration of operational Narrowband Mission Critical Systems in the 5G ecosystem, and compliance with Security specific KPI, will need ad-hoc trials and tests with final users"

VOLKSWAGEN: "Automated Driving 2.0 will need Dynamic Network Slicing and predicted QoS, THE enabler for automotive 5G use cases…"

PEUGEOT: **"**Integration of 5G in automotive responds to global needs in connectivity, as well as requests for autonomous car with connections to networks and cloud, and V2X connectivity. Autonomous car will request hybrid architecture, sensors and femtocells networks for a perfect virtual knowledge of the road…"

BOSCH: « 5G may be disruptive for the manufacturing industry: high reliability and low latency are major requirements for new applications, such as mobile robots, factory automation, augmented reality and logistics »

5G PPP Phase 2: Verticals in action

Phase 2 projects are dedicated to an industrial sector or target applications for various verticals.

Vertical industry/ main focus	5G PPP project phase 2	Rationale: objective	Vertical company involved
Automotive	5G CAR	Autonomous cars	VOLVO
Media & Entertainment	5G XCAST	Immersive media to 8K, Ultra High Definition Television, Virtual/Augmented /Mixed Reality…	BBC, EBU
	5G MEDIA	SDN and NFV concepts to media applications	rtve
Energy	NRG5	Smart Energy-as-a-Service	ROMGAZ
Transport/logistics	5G-MONARCH	Test beds in sea port and touristic city	HPA Hamburg Port Authority
Dense urban area	5GCity	Demonstration in three cities	Barcelona, Bristol and Lucca cities

https://5g-ppp.eu/newsletter-10/

5G PPP
The European path towards global next generation communication network

5G-Demand Drivers
Source: Broadband India Forum

- Most bandwidth consumed over mobile networks is related to video-centric content flowing from a distant data centre located across a city or elsewhere.
- If 5G is aggressively rolled out and delivers real-world access speeds significantly faster to today's 3G/4G networks, all parts of the wired network connected to the 5G BTS will be affected by the deluge of content flowing to and from data centres.

The only transport media capable of scaling to these demands is optical fibre, particularly in the BTS to the hundreds of thousands of small and macro cells deployed.

The Math: 4G versus 5G Speeds
Source: Broadband India Forum

- Today, a typical modern macro-cell (BTS) is served by a 1Gb IP-based optical mobile backhaul network. The typical traffic over this 1Gb physical connection is about 200Mbps to 300Mbps, and leaves room for 4G network growth.
- Thus, the aggregate bandwidth consumed by all concurrent mobile users to a typical macro-cell is roughly equivalent to the maximum theoretical download speed of a single LTE-advanced (Release 8) user connection.
- Current mobile backhaul (MBH) networks would soon not suffice even for 4G as it grows.

With the expected access speeds and throughputs of 5G, we will inevitably choke existing backhaul networks very quickly.

The Math : 4G versus 5G Speeds (Contd.)

Source: Broadband India Forum

- To lay the foundation for 5G, which has maximum theoretical download speeds from 1Gbps for high-mobility users (for example, bullet train commuters) to 10Gbps for low-mobility users (those who are stationary or walking),
- If the maximum theoretical download speed of 10Gbps was scaled down by 90% to 1Gbps, the entire 1Gb throughput to a typical macro-cell today, intended to serve all concurrent 4G users, could be easily consumed by one bandwidth-hungry 5G user.

It is, therefore, recommended to lay fibre now to small and macro cells, to cater to the immense amount of backhaul traffic that will be generated by a 5G BTS.

Recommendations for Europe: the Orange example

Investigations are underway to evaluate the economical benefits of 5G FWA compared to FTTH

In low-density areas, simulations show that 5G FWA can be 30 to 60% cheaper than FTTH (subject to household density & TV usage profile)

- the need to dig new ducts would increase the 5G FWA benefit compared to FTTH

Trials are needed to to check performance, customer satisfaction and fine tune the TCO. Orange will trial 5G FWA in Romania in June 2018

In order to encourage 5G FWA @26 GHz in Europe, EC and Member States should

- Rapidly allocate test licenses in the 26 GHz band
- Harmonize the 26 GHz band in CEPT and ITU, with a bandwidth sufficient to enable fiber-like data rates (in excess of 500MHz/operator)
  - Overprotection of adjacent services (e.g. Earth Exploration Satellite Services) can strongly limit the available BW in Europe
- Simplify and harmonize the rules to deploy small cell radio sites

Source: Orange

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Thank you for your attention!