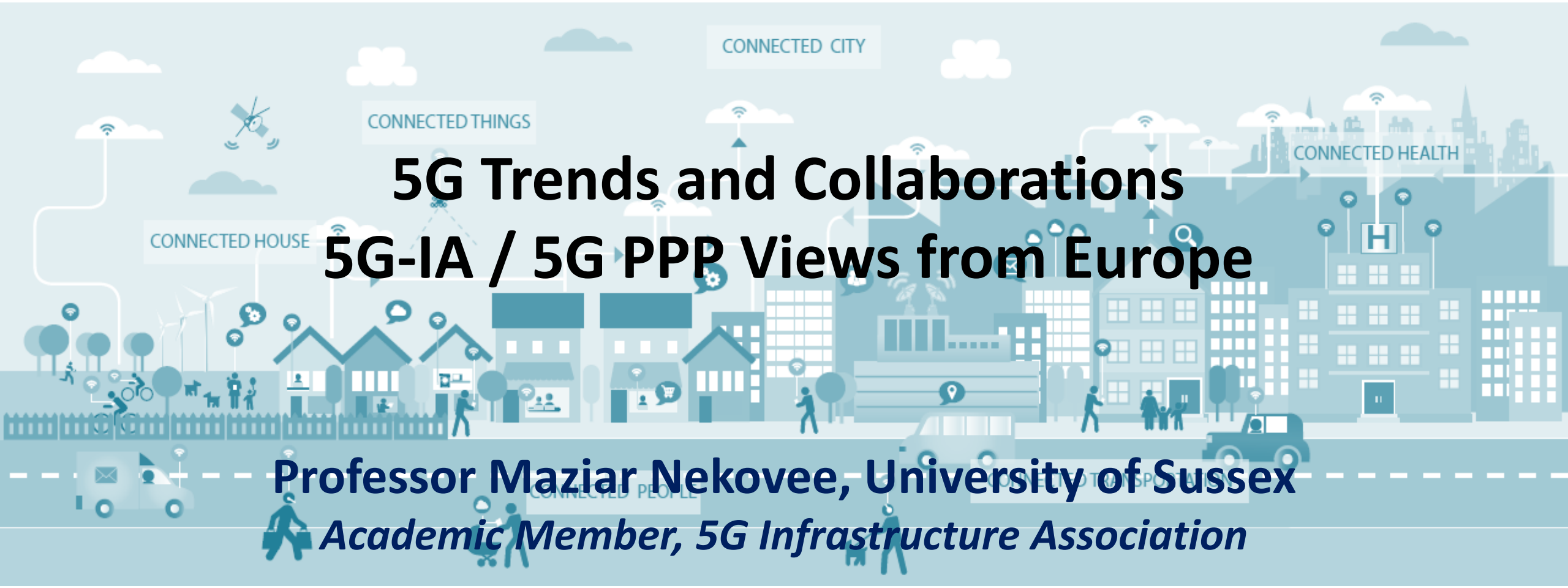
INFRASTRUCTURE ASSOCIATION



5G Trends and Collaborations
5G-IA / 5G PPP Views from Europe

Professor Maziar Nekovee, University of Sussex

Academic Member, 5G Infrastructure Association

http://5g-ppp.eu/

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5G-IA Strategic 'Headline'

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

5G Research & Development-5G PPP

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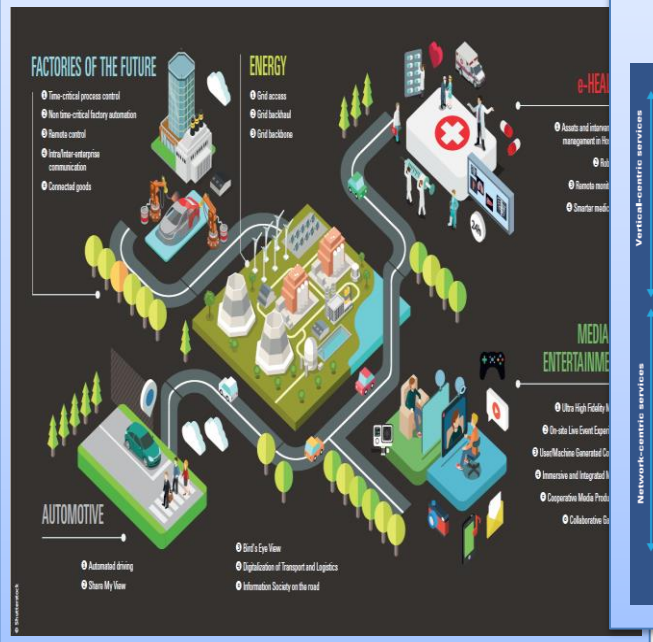
PHASE 1:
5G Core Research

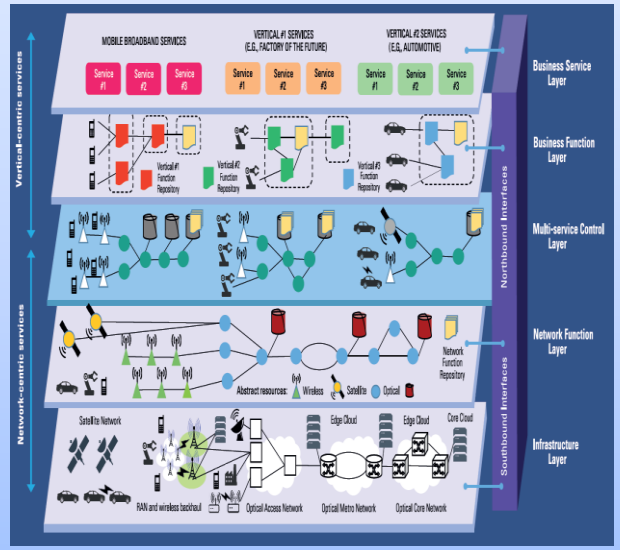
main achievements:

- 5G System design & Evaluation aspects
- 5G Air interface innovations
- Network management & Security innovations
- Virtualization & Service deployment innovations
- 100s of contributions to standardization

PHASE 2:
5G Vertical Trials



PHASE 3:
5G Innovation Platforms



2015 2016 2017 2018 2019 2020

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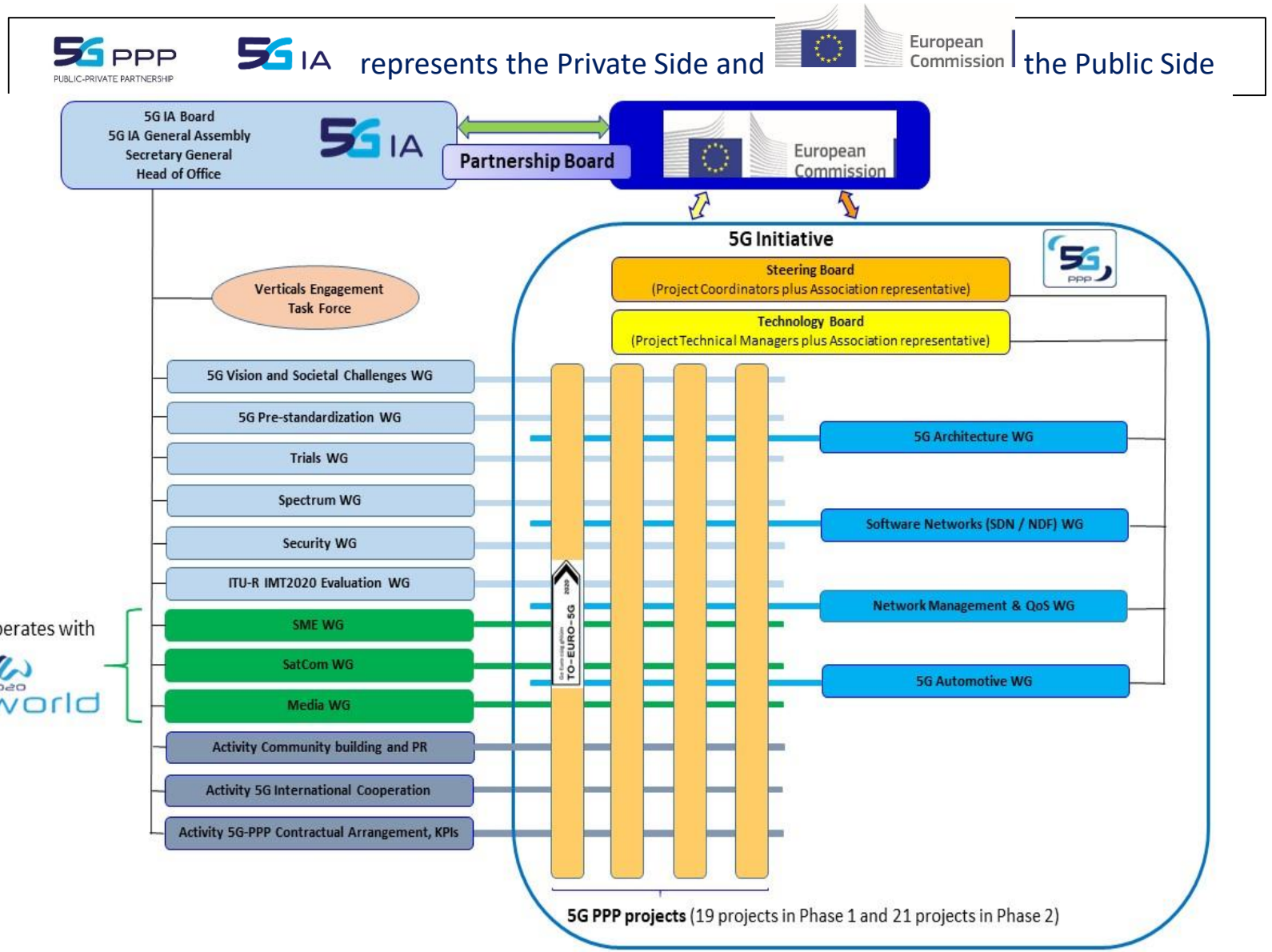
5G PPP Governance Model



5G PPP Governance – Work Groups

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5G IA WGs & Activities

Pre-standardization WG

Mandate, Rationale, Mission …
Key words

Spectrum WG

Vision and Societal Challenges WG

5G International cooperation Activity

5G-PPP Contractual Arrangement, KPIs Activity

Trials WG

Security WG

Foster development of 5G Security (Content and Community wise) the way it should be for 5G to generate the necessary trust and confidence to release its full potential

ITU-R IMT2020 Evaluation WG

Proposed description is too long

Community building and Public Relations Activity

5G-PPP Projects WGs

Software Networks (SDN and NFV) WG

Defines the cloud native design of 5G system: from the IT to Telco.

5G Architecture WG

Network Mgmt & QoS WG

Maintain network state, ensuring services are properly delivered to users, expected QoS is enforced for delivering such services, and security is preserved.

Automotive WG

Focuses on connected and automated mobility. Range of topics, such as use cases and KPIs, business aspects, spectrum usage, infrastructure capabilities, security and safety.

NetWorld 2020 WGs

SME WG

Show the expertise and innovation of SMEs in 5G and beyond, to increase their participation in global projects and collaborations

SatCom WG

Define Vision for & Prioritize SatCom related research topics. Foster: fixed/mobile Satellite network CV with 5G network and the link between SatCom Research and standards. Inputs to EC research plans

Media WG

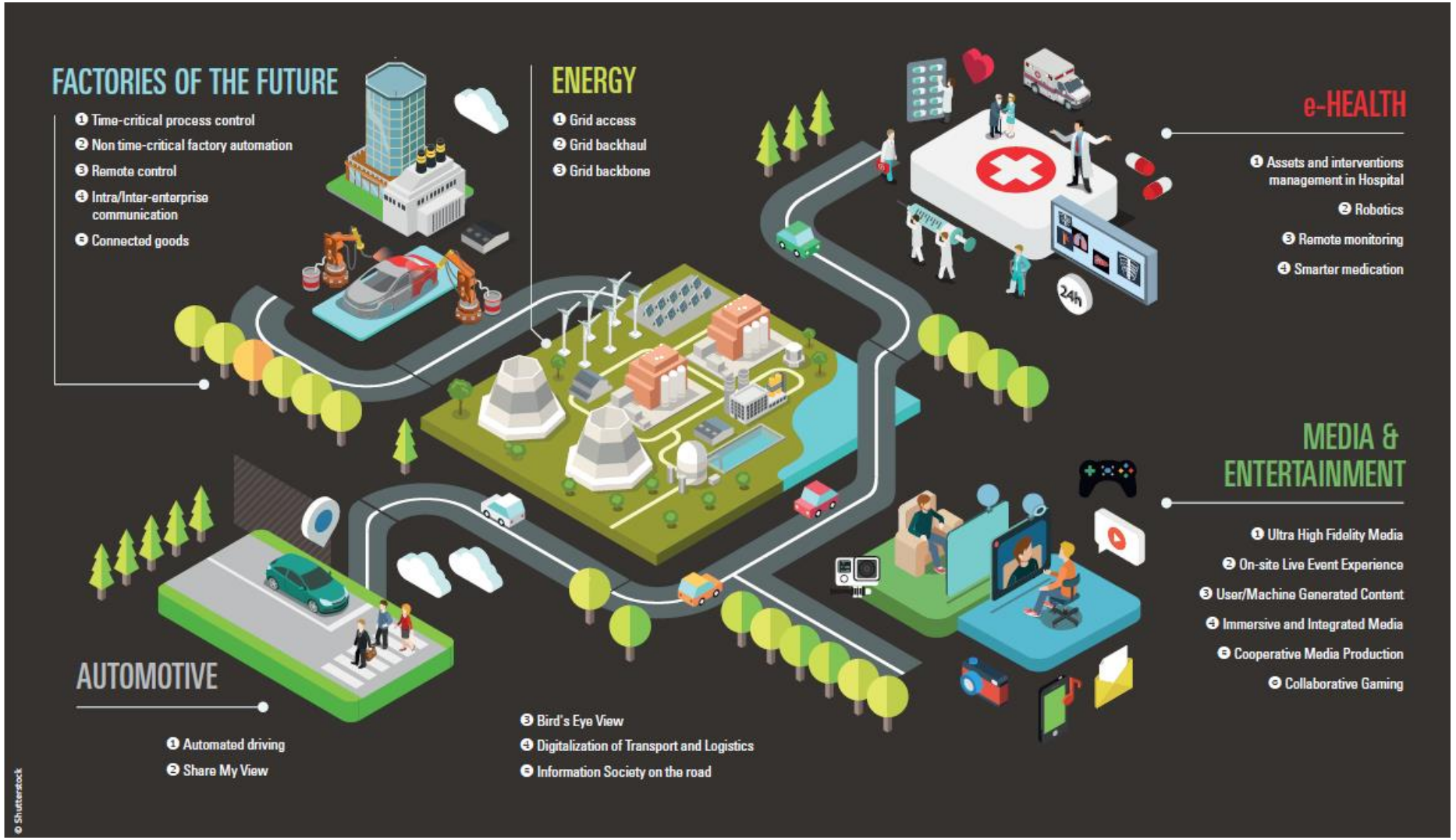
(NEM Initiative and NetWorld2020)
Identify the Media & content domain requirements and the corresponding impacts on 5G.

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

WGs on specific Verticals

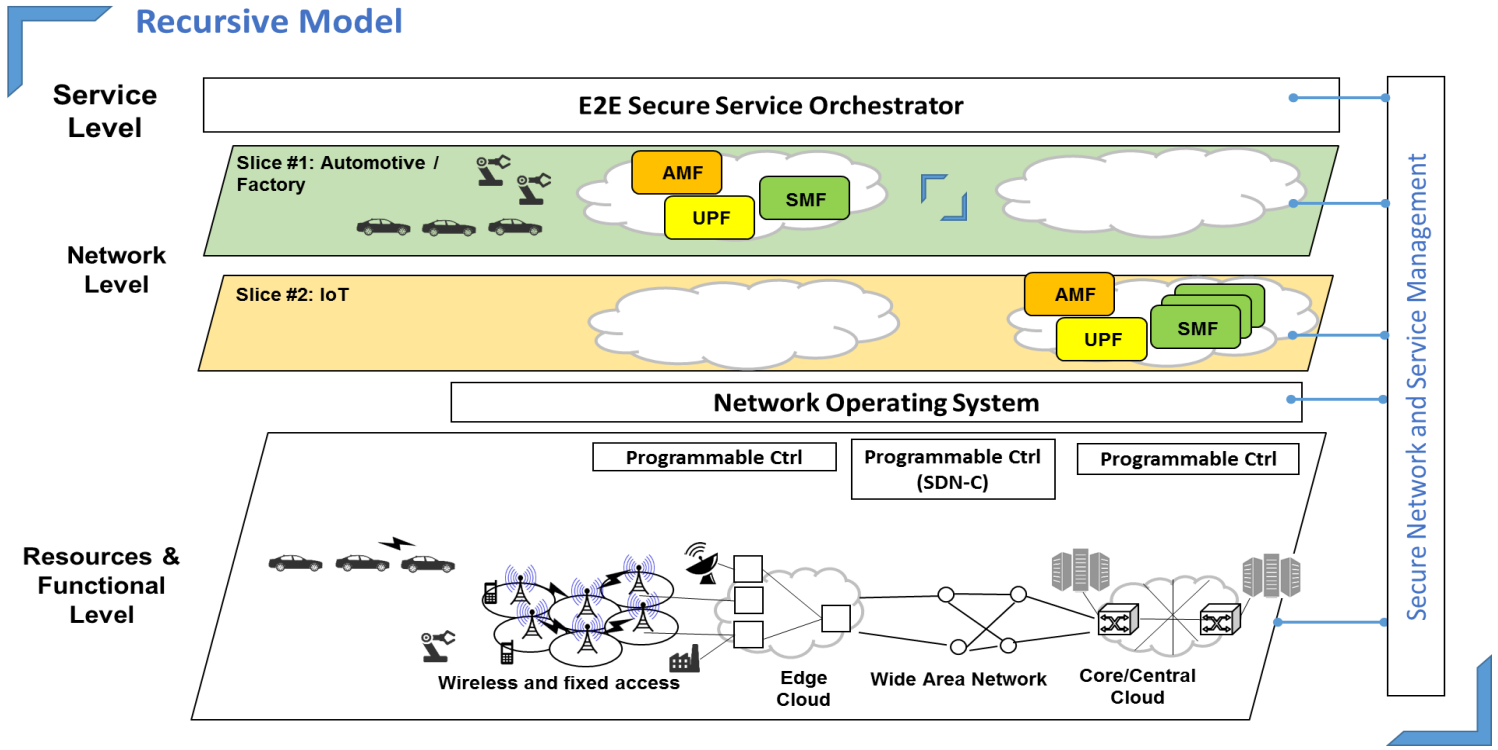
NetWorld2020 membership is free.

5G – A driver for industrial and societal changes



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.

5G PPP Architecture White Paper
Overall Architecture



5G system aims at providing a flexible network architecture, enabling new business cases and models supporting vertical industries. Network slicing emerges as a promising future-proof framework and needs to be designed from an end-to-end perspective. Furthermore, security architecture shall be natively integrated into the overall architecture. The support of verticals is enabled also by a flexible function deployment and relocation based on the requirements in terms of capacity, latency and reliability.

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

5G Action Plan: European strategy for 5G introduction

Early 5G launch in selected areas → 2018

Commercial launch of 5G services in at least one major city in all MS → 2020

5G in all urban areas and along main transport paths → 2025

Coordinated launch throughout single market

Comprehensive roll-out with geographical and sectorial focus

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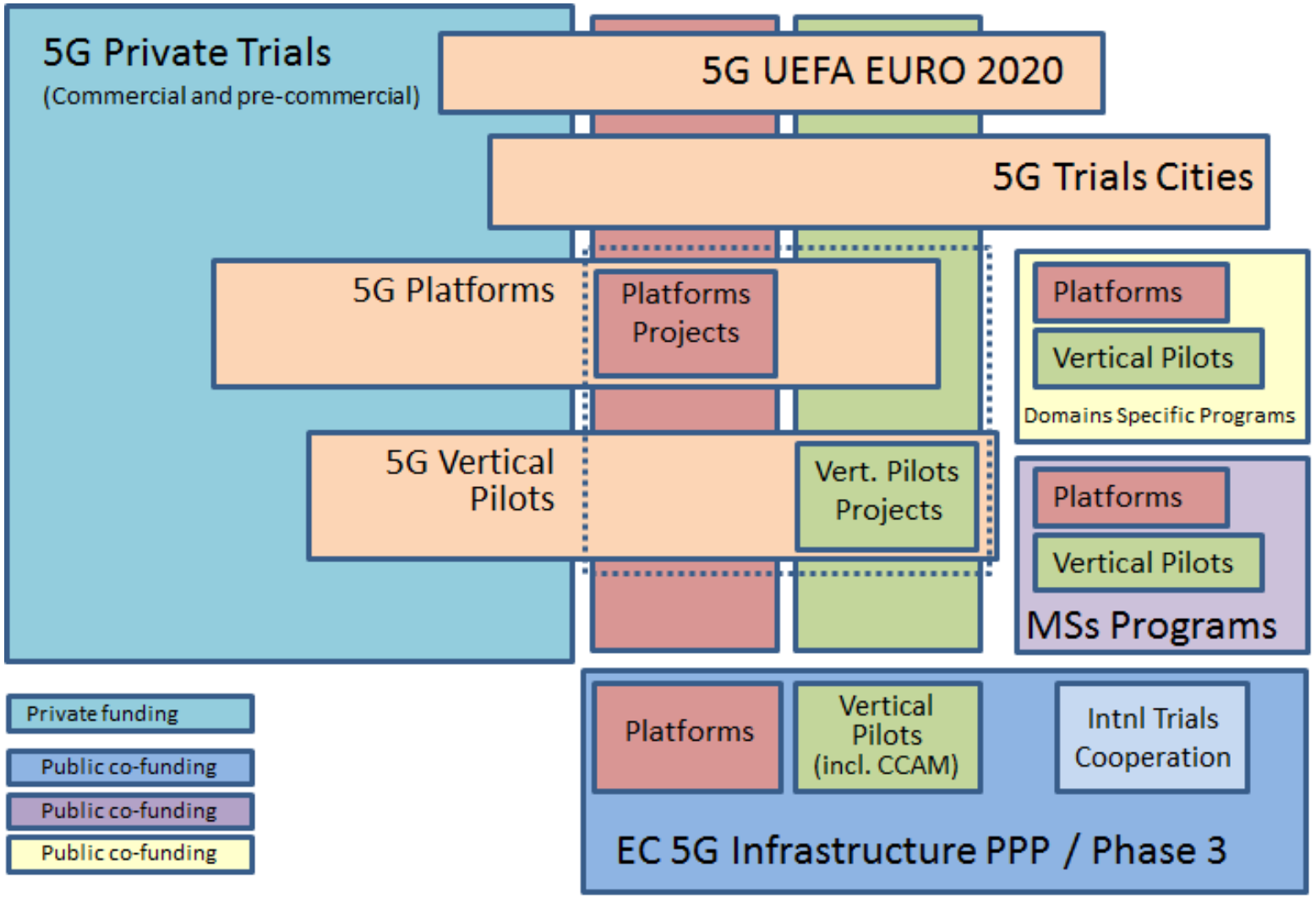
5G IA

5G PAN-EUROPEAN TRIALS ROADMAP
ROADMAP STRATEGY



https://5g-ppp.eu/5g-trials-roadmap/

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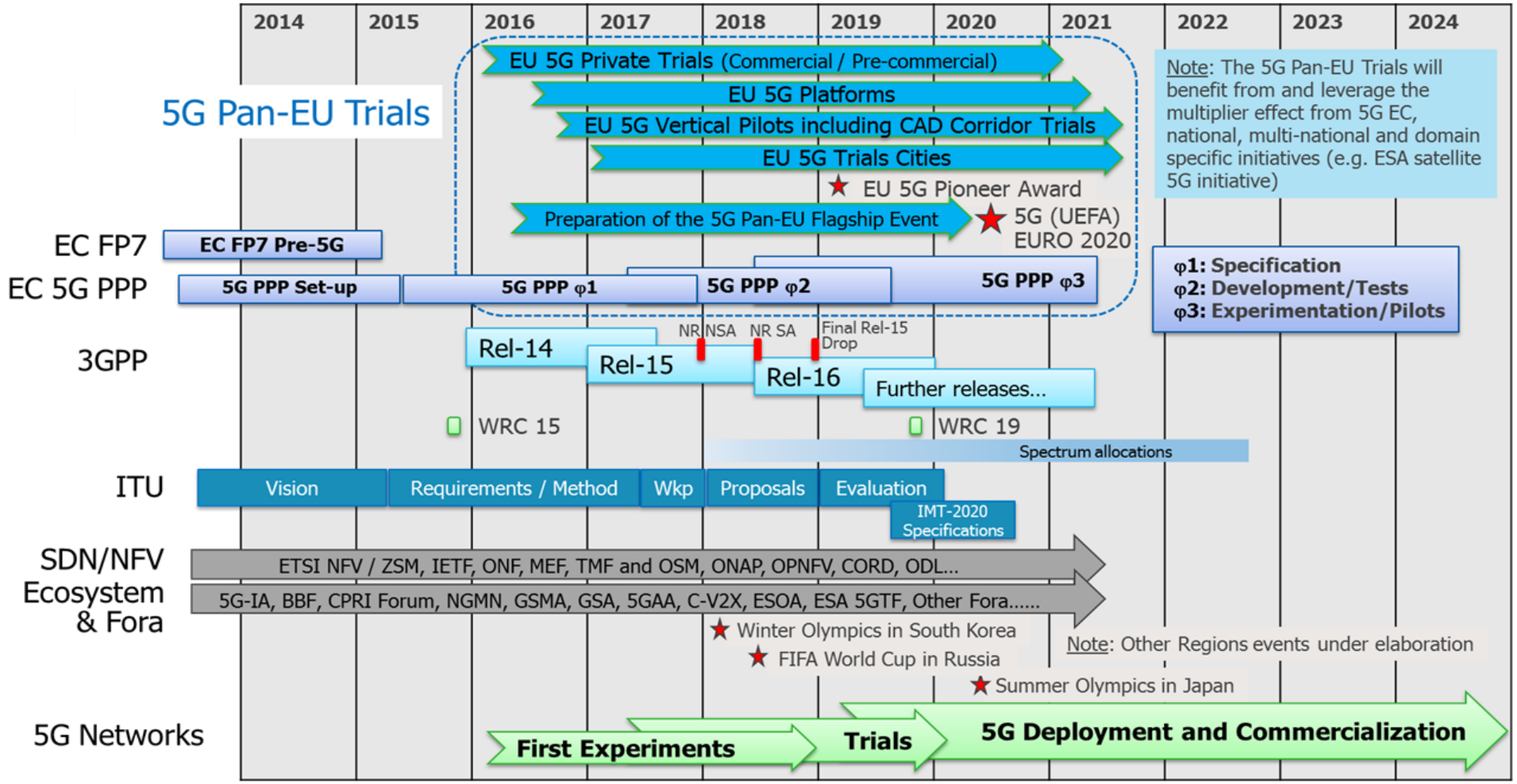
5G PAN-EUROPEAN TRIALS ROADMAP TIME PLAN



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

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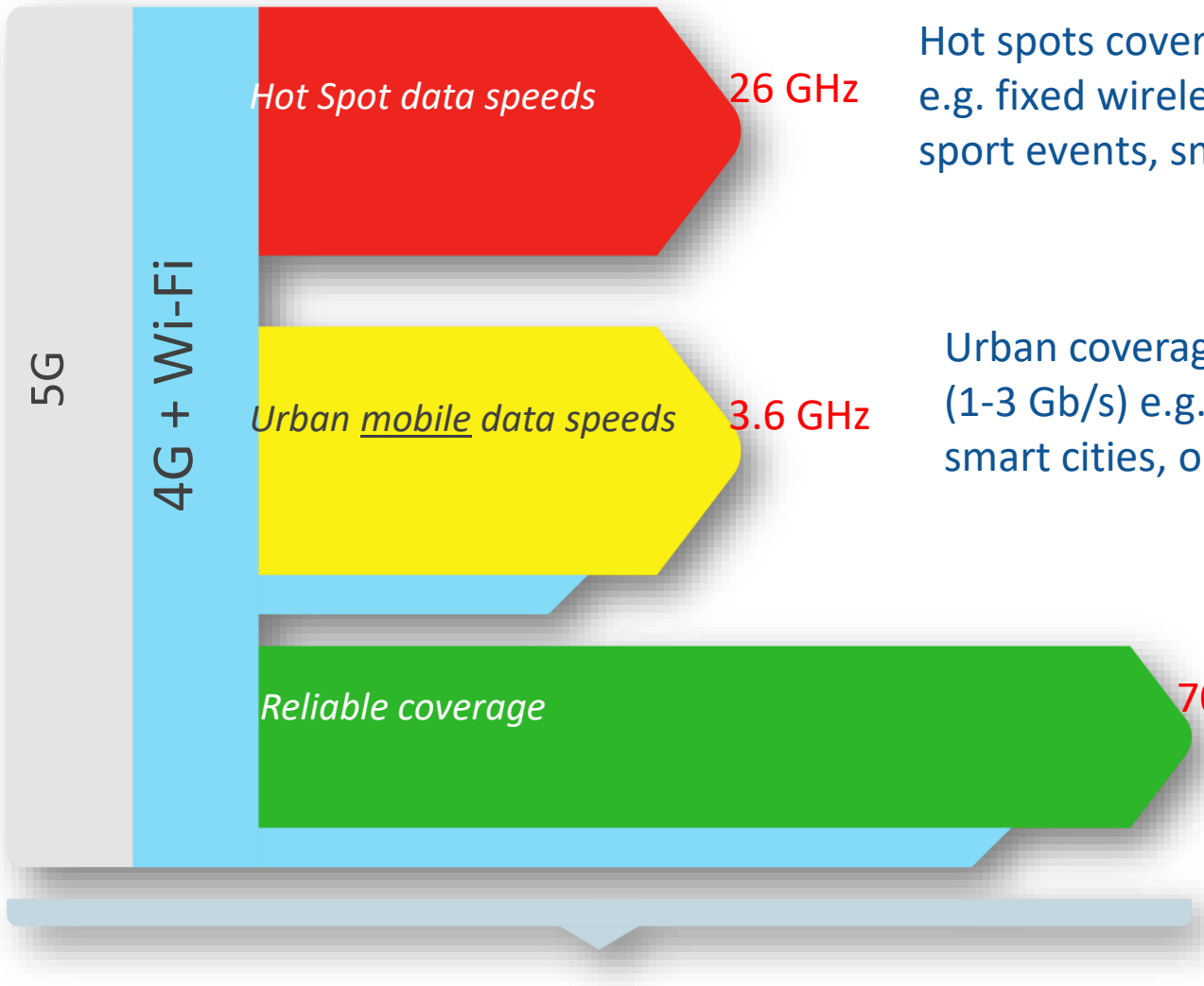
Registered IMT-2020 Evaluation Groups
Status: December 2017

5G Infrastructure Association - 5G PPP web site	**Europe**
ATIS WTSC IMT-2020 Evaluation Group - WTSC web site	USA
ChEG Chinese Evaluation Group - ChEG web site	China
Canadian Evaluation Group - CEG web site	Canada
Wireless World Research Forum - WWRF web site	Global
Telecom Centres of Excellence, India - TCOE web site	India
The Fifth Generation Mobile Communications Promotion Forum, Japan - 5GMF web site	Japan
TTA 5G Technology Evaluation Special Project Group - TTA SPG33 web site	Korea
Trans-Pacific Evaluation Group - TPCEG web site	USA – Taiwan
ETSI Evaluation Group - ETSI web site	Europe

Source: ITU-R. http://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/imt-2020/Pages/submission-eval.aspx.

EU 5G 'Pioneer' Frequency Bands



Hot spots coverage (up to 10 Gb/s)
e.g. fixed wireless access, railway stations, sport events, smart factories,

Urban coverage with dense small cells (1-3 Gb/s) e.g. mobile Gb/s society, smart cities, option for connected highways

Universal coverage (10's of Mb/s) of reliable connectivity

Source: 5G-PPP

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Deployment from the view of 5G-IA/5G PPP

(Source: Whitepaper for MWC-17)

- Cost effective, efficient, reuse 4G as much as possible, exploit new spectrum
  - Example for urban scenarios:
    - ❑ Co-locate 5G with 4G BS and exploit new spectrum (at 700 MHz and 3.4-3.8 GHz)
    - ❑ Add small cells below 6 GHz and in mm bands above 24 GHz to enhance capacity
    - ❑ Use of unlicensed spectrum and of nomadic nodes to increase coverage + capacity

- Optimised design of fronthaul + functional split
  - 5G BS (200 MHz + BF) can generate several hundreds of Gbit/s aggregate signal in the fibre, and current 100 Gbit/s optical i/f are too expensive
    - ❑ Optimise functional split to minimise TCO
    - ❑ Use of novel technologies (e.g. integrated optical chipsets / adv. mod)
- However, cost minimisation will not be sufficient!
  - Consider new business models, innovative deployment strategies
  - Involve all stakeholders: Telecoms, Content, Vertical industries for sharing deployment cost and revenue
- Network slicing: Key enabler for fulfilling heterogeneous demands for trustworthy, secure and reliable services

Europe: actively preparing 5G & fully monetizing 4G…

- **Operators** are conducting *lab tests and multiplying partnerships with vendors to assess business cases*
  - Nordic & Baltic Regions: 5G development plan for earlier launches (2018-2019)
  - TIM is testing various use cases with Fastweb and Huawei in Bari and Matera
  - Orange 5G launches in 2020-2021; trials with Ericsson & Nokia, and agreement with Peugeot to develop the 5G connected car.
  - Telefonica strongly committed to 5G, but wants « to adapt the network to the customer and not the other way around »…
- **Verticals:**
  - Following a first wave of eMBB-centric trials and demonstrations in 2018-2019, Europe targets close involvement of the verticals in trials and subsequent deployments
  - Smart cities drive interest: 15+ « **5G trials cities** »
  - strong interest for connected car, low-latency for factory automation, healthcare
  - **Euro2020:** clear target for 5G, as a popular event, displayed on 13 different cities
  - role of **SMEs,** contributing to research & standardization, supported by EU Research programmes

➔ **5G-IA/5G PPP supporting 5G standardisation, trials roadmap and verticals integration**

5G commitment with verticals

The true differentiator for 5G is the vertical markets.

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

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…"

PSA Group (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 Pan-EU Trials Roadmap
Vertical Pilots in 5G PPP Projects

Projects	Vertical Stakeholders	ITU Service Types	Locations
5G CAR	VOLVO, PSA GROUPE, BOSCH	eMBB, URLLC	Montlhéry (FR)
5GCity	City councils of Barcelona, Bristol and Lucca	eMBB, URLLC (mMTC)	Barcelona (ES) Bristol (UK) Lucca (IT)
IoRL Internet of Radio Light	bre, issymedia, ferrovial agroman	eMBB	Watford (UK) Paris (FR) Madrid (ES)
5G XCAST	BBC, EBU, LiveU	eMBB	Surrey (UK) Munich (DE) Turku (FI)
5G ESSENCE	SMART MOBILE LABS	eMBB	Egaleo (EL)
5G MEDIA	IRT, rtve	eMBB	Athens (EL) Thessaloniki (EL) Madrid (ES) Rome (IT)
5Gtango	NUROGAMES	eMBB, URLLC	Aveiro (PT) Athens (EL)
5GTRANSFORMER	CRF, Ciudad de Madrid S.A.M.U.R. Protección Civil	URLLC	Turin (IT), Pisa (IT) Madrid(ES) Nice (FR)

Projects	Vertical Stakeholders	ITU Service Types	Locations
5G-MONARCH	HPA Hamburg Port Authority	mMTC	Hamburg (DE) Turin (IT)
NRG-5	ENGIE Ineo, ROMGAZ, Emotion, ASM Terni S.p.A.	mMTC, URLLC, (eMBB)	Terni (IT)
5Gtango	Weidmüller	mMTC (URLLC)	Detmold (DE)
(Phase 1) VIRTUWIND	SIEMENS Siemens Wind Power	URLLC	Brande (DK)
5G-PICTURE	FGC Ferrocarrils de la Generalitat de Catalunya, COMSA INDUSTRIAL	mMTC, URLLC, eMBB	Barcelona (ES) Bristol (UK)
NGpaas	Vertical M2M, Virtual Open Systems	mMTC, URLLC	Paris, Grenoble (FR)
5G ESSENCE	THALES	URLLC, eMBB	Coventry (UK)
MATILDA	internet INSTITUTE://	URLLC (eMBB)	Genoa (IT) Ljubljana (SL)

https://5g-ppp.eu/5g-trials-roadmap/

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International cooperation

- **Inter-Regional Cooperation sessions:**
  - Seoul G5GE, Nov 2017
  - Singapore IEEE Globecom, Dec 2017
  - Austin 5GE, May 2018
  - Santa Clara IEEE 5G World Forum, July 2018

- **India:**
  - Approach & discussions in 2017
  - **MoU between 5G-IA and TSDSI** (« Telecommunications Standards Development Society, India ») signed in April 2018
  - Likely inclusion in the Multilateral MoU by end 2018 or 2019

Inter-regional Activities – 5G PPP Phase 3

	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

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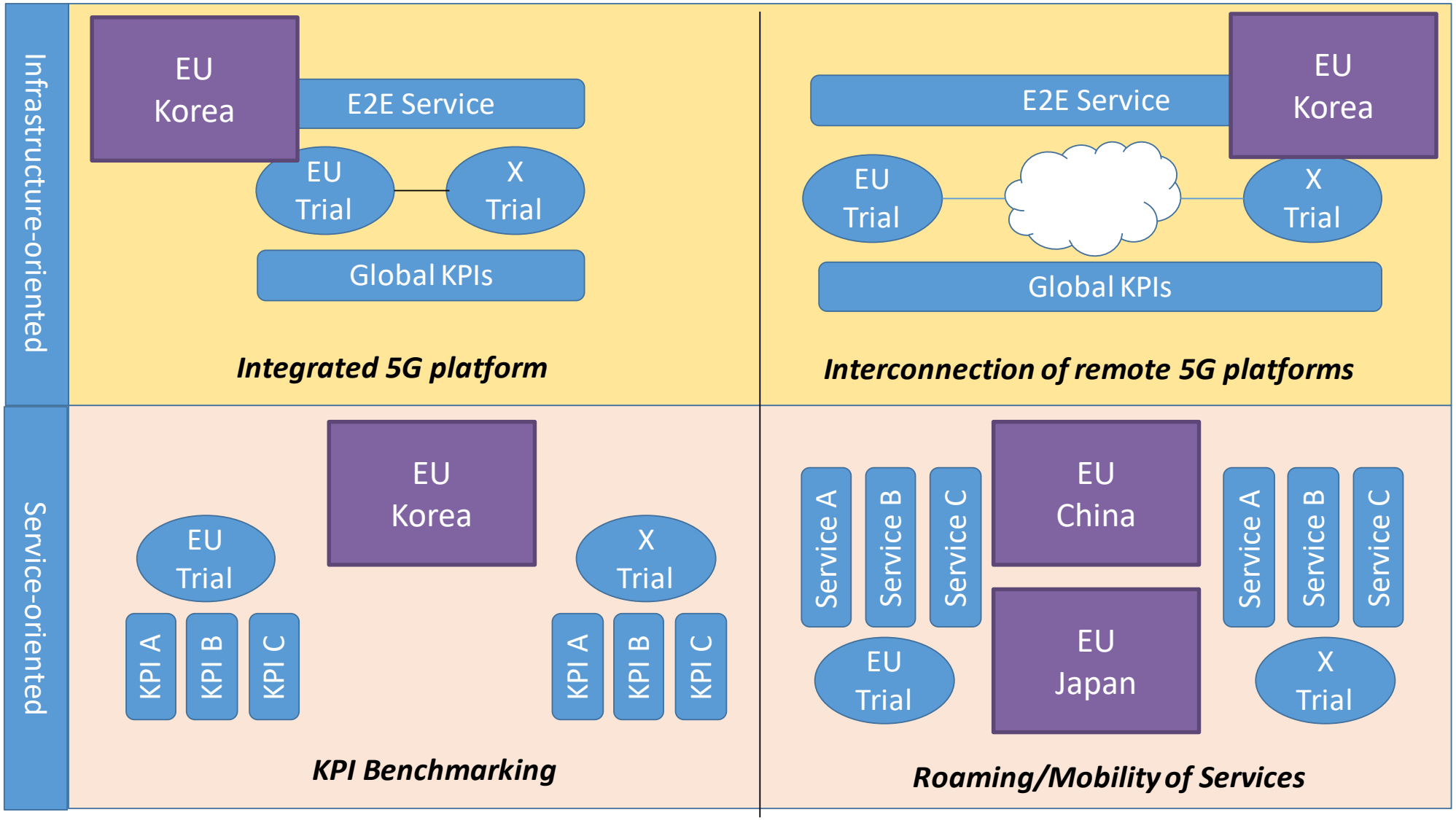
Inter-regional Activities II



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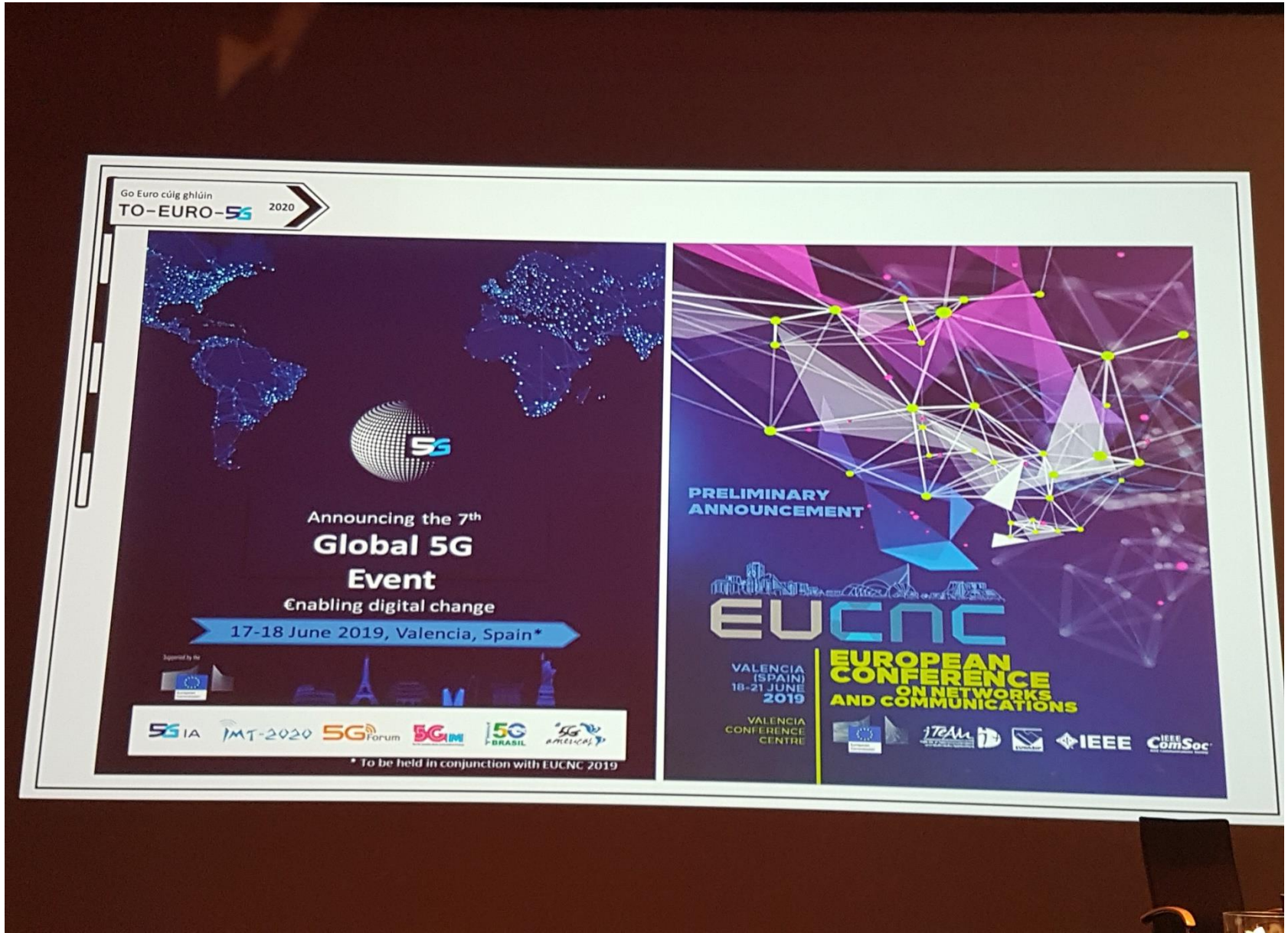
In June 2019, Global 5G Cooperation will meet EUCNC…



Some conclusions

- 5G will need to become a **global standard** before it can be rolled out on a larger scale - Release 16 planned for end 2019 –

  ➔ This suggests major roll-out expected for the first half of the 2020 decade

- However, not just a matter of technology and standards
  - 5G labelling will start much earlier **--> business aspects**
- **Spectrum availability** is another key element

  ➔ Correlation between early availability of spectrum and fast market uptake

- Transitions to 5G are expected to start before 2020, once early trials have been successfully completed, but **not pick up speed before the full standard is completed and compliant equipment is available**
- **International cooperation** & cross-continental collaborations, such as trials, are key towards the success of 5G

INFRASTRUCTURE ASSOCIATION

http://5g-ppp.eu

Thank you for your attention!