

Key innovations beyond 5G for verticals: time for a new generation?

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Wireless World Research Forum

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Contents

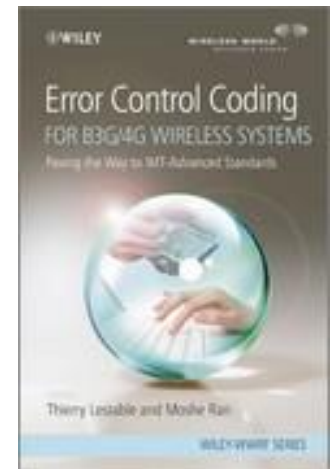
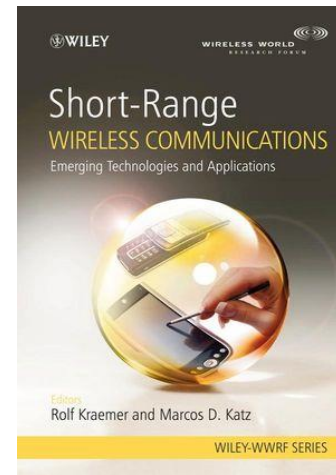
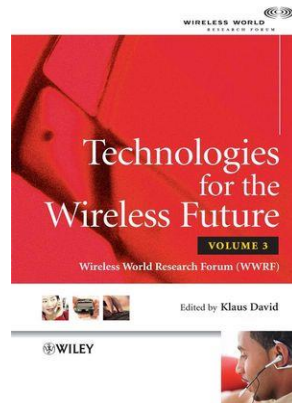
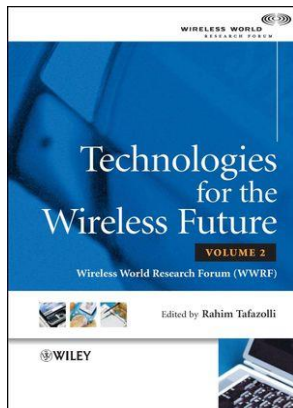
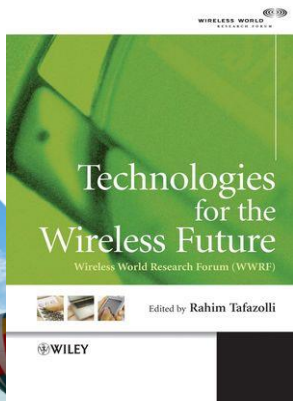
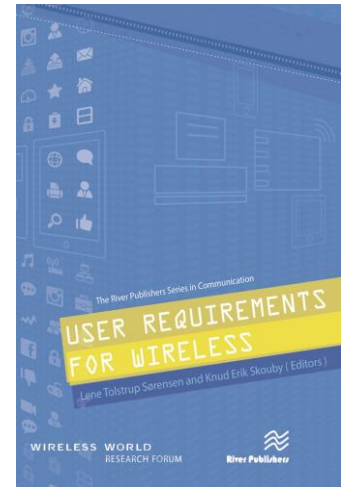
- Introduction to WWRF
- Looking beyond 5G
- 5G in industry verticals
- WWRF views on B5G
- Conclusion



WWRF outputs

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- WWRF Outlook – published version of White Paper
- WWRF Library – proceedings of each meeting
- WWRF – Wiley and River book series



WORKING GROUPS

WGA/B

User Needs & Requirements; Services, and Devices, in a Wireless World.

Promoting a secure communications environment across multiple Socio-Economic settings based on user needs and requirements.

WG HF

High Frequencies (mmWAVE and THz) Radio Communications Technologies

Higher frequency radio communication technologies are expected to enable the vision of wireless transmissions towards the region of 1 Tbit/s. Improved channel modelling and the design of appropriate waveforms, baseband processing, medium access control (MAC) schemes and antenna array configurations are addressed.

VIP Water

Vertical Industry Platform - 5G for smart water management

A discussion platform about water management and study of the communication requirements, to assess whether 5G can take us faster and further than existing ICTs.

VIP RAIL

Track-to-Train communications

The focus identifying the potential benefits and hurdles for the future adoption of what today is known as 5G by rail transport systems worldwide. Security, reliability, IoT and dependability are playing a focal role in future radio communication systems for efficient train operations and safety.

WGC

New directions in communication architectures and Technologies

Guiding the mobile industry in the use of software, virtualization and cloud computing in future networks (both wireless and wired) by developing end-to-end network architectures, identifying the specific requirements and issues and addressing them by providing solutions that are practical and business driven.

WGD

Radio Communication Technologies

Advanced radio technologies and spectrum issues are investigated, to optimise the design of the air interface, medium access and heterogeneous multi-user, multi-RAT systems and identify trends and impact the wireless evolution towards 5g and beyond.

WG WAI

AI for Wireless Communications

Artificial Intelligence applied to the wireless communications domain is referred to as Wireless Intelligence (WI). This will be in all sub-systems within the wireless ecosystem. WI is expected by the market to not only reduce operational expenditures (OPEX), but also to increase user quality of experience (QoE) as well as help the introduction of new value chains in an increasingly competitive and complex business environment.

VIP CV

Connected vehicles

Focuses on research that looks five to ten years ahead in order to meet the requirements of the automotive and transport industries based on the next generation wireless technology.

VIP EMW

Ehealth, mobile health and wearables

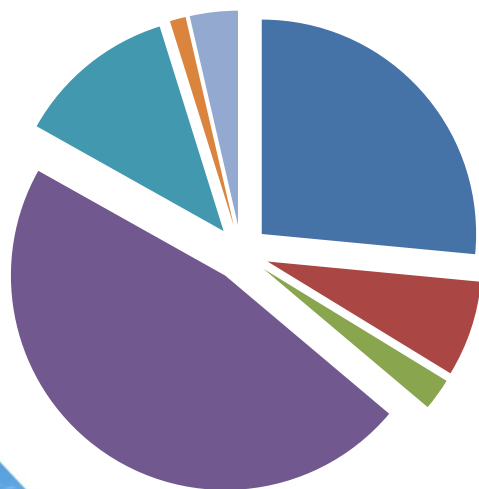
Developing an e/m-Health and wearables vertical industry paradigm to expose the requirements of such systems to be 5G-enabled



Membership

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50 members



- Manufacturer
- Network operator
- Industry organization
- Academic institute

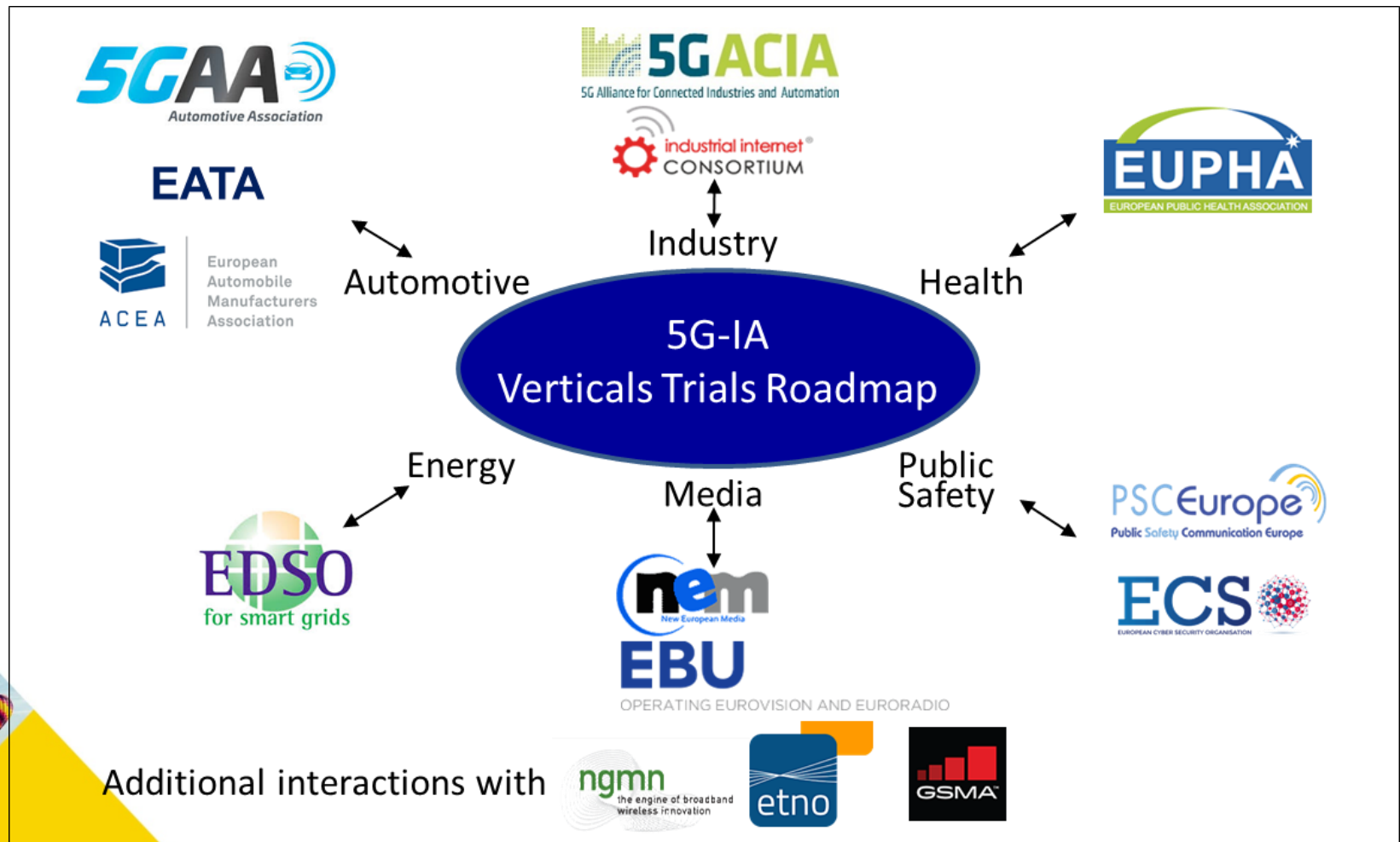


- Africa
- Americas
- Asia
- Europe



Verticals and Trial Roadmap

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Supporting Vertical Pilots: 5G PPP E2E Infrastructure

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5G EVE



5Genesis

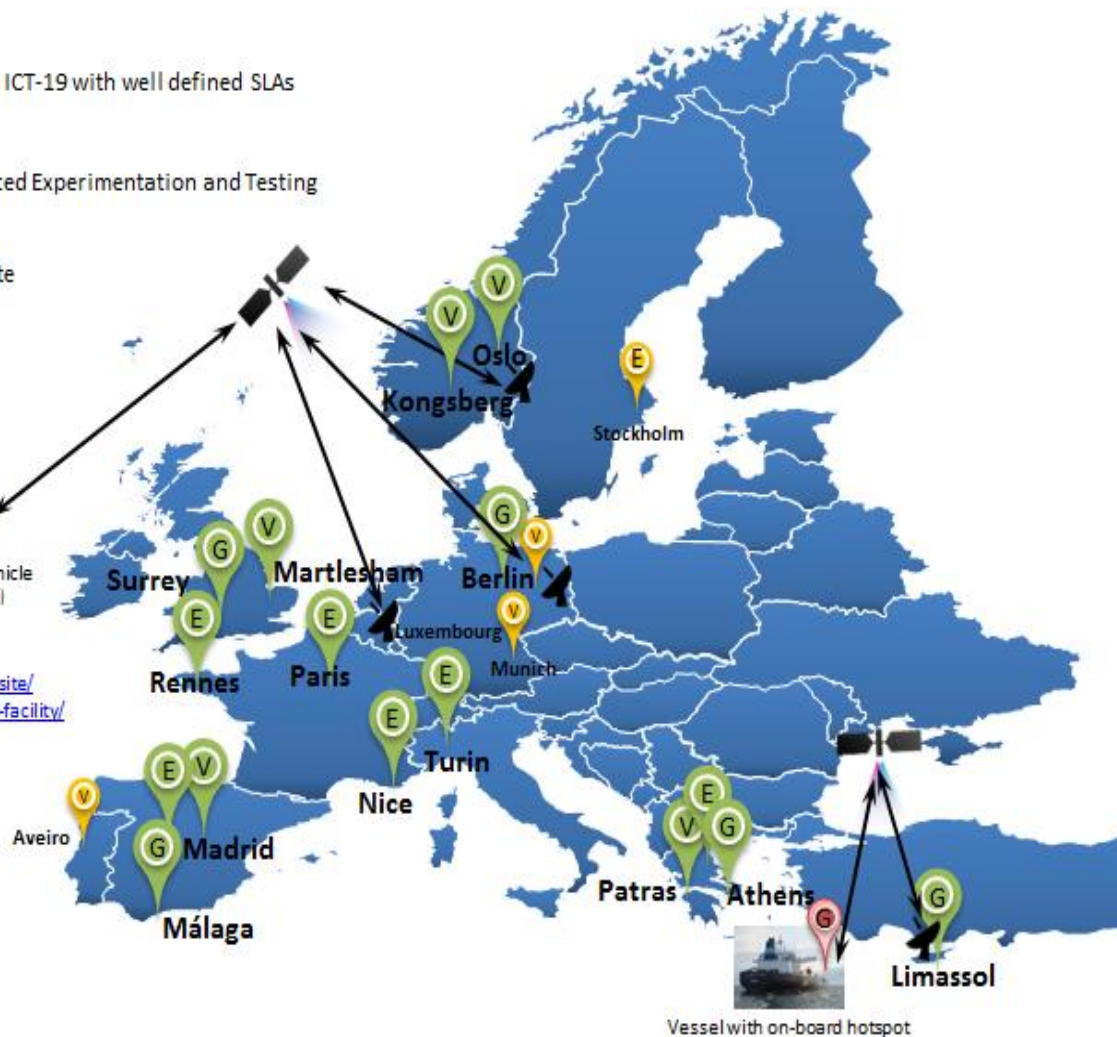
-  Main Facility that offers Services to ICT-19 with well defined SLAs
-  Experimentation Facility for advanced Experimentation and Testing
-  Moving Experimentation Facility Site

5G-Vinni
5G-EVE
5Genesis

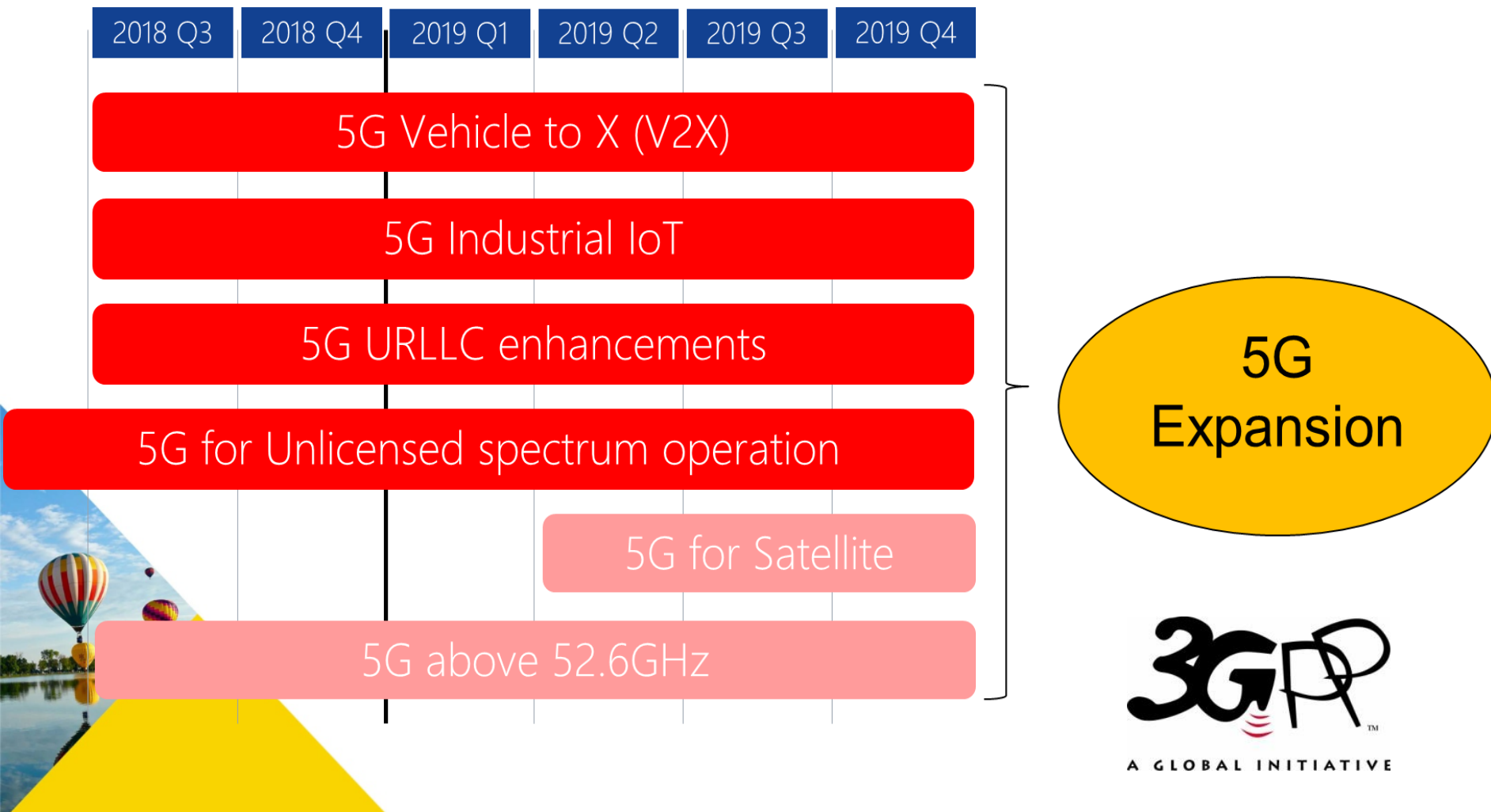


Rapid response vehicle
(any facility / location)

5G-VINNI : <https://www.5g-vinni.eu/facility-site/>
5G-EVE: <https://www.5g-eve.eu/end-to-end-facility/>
5GENESIS: www.5genesis.eu



Expanding the scope of 5G



5G Introduction in Europe

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

Consistent/quasi-simultaneous
launch throughout single market

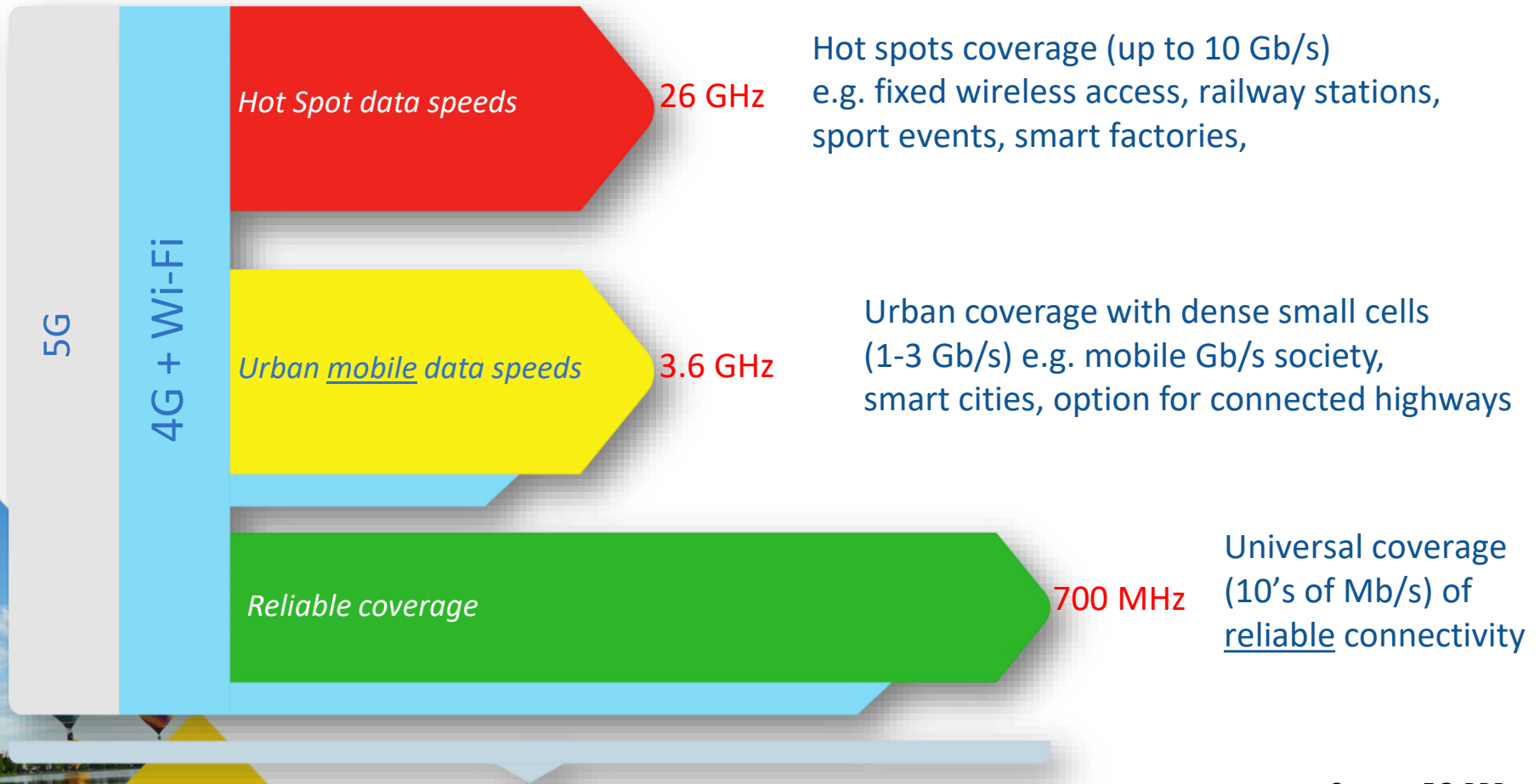
Roll-out with geographical and
sectorial focus

Verticals "centre stage"



EU 5G 'Pioneer' Frequency Bands

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Source: 5G-PPP

WWRF is also looking beyond 5G

Recent workshop identified the major technology challenges and relevant application and usage scenarios for systems B5G

1) Technology enablers/new air interface

- Molecular Communications
- THz Communications
- Large/massive antenna processing

2) New architectures/system concepts: machine learning, AI, 3) New deployment concepts (e.g. islands of BB, ..)

4) New apps/use cases (virtual reality, ..)

5) New / Critical challenges: Society impact, 'endless' battery life, cost of new technologies,..



- **Verticals to drive development**
 - Wireless connectivity offers unlimited opportunities
- **Major changes to network architectures**
 - Ultra dense networks (UDNs)
 - Short range connectivity a crucial component of the e2e connectivity
 - Varieties of network deployments
 - Cloud distributed across the network from edge to the core
 - Distributed AI and ML
- **New value chains to appear**
 - Context dependent content
 - Micro operators and virtual operators to be integral part of the eco-system and potentially extending to the end users



- **Low cost and affordable network solutions**
 - Connecting the last 4B people
 - Must contribute to sustainable development and society
 - Must address the problem of backhauling to remote areas
 - Seamless integration of terrestrial, satellite and HAP-based networks
- **Networking converges with IT and cloud**
 - Virtualization and cloud the largest disrupters to telecom
 - Software defined mobile network
 - Mobility management moves to edge of the network



- **New spectrum allocation and spectrum refarming**
 - Synergistic collaboration between unlicensed and licensed bands
 - Communication in the THz range
- **Advances in communications fundamentals**
 - Channel modeling and propagation for mmWave and THz systems
 - Short range connectivity a crucial component of the e2e connectivity
 - Adaptive signal processing and beamforming algorithms
 - Analytical modeling and design of UDNs
 - Radio resource management

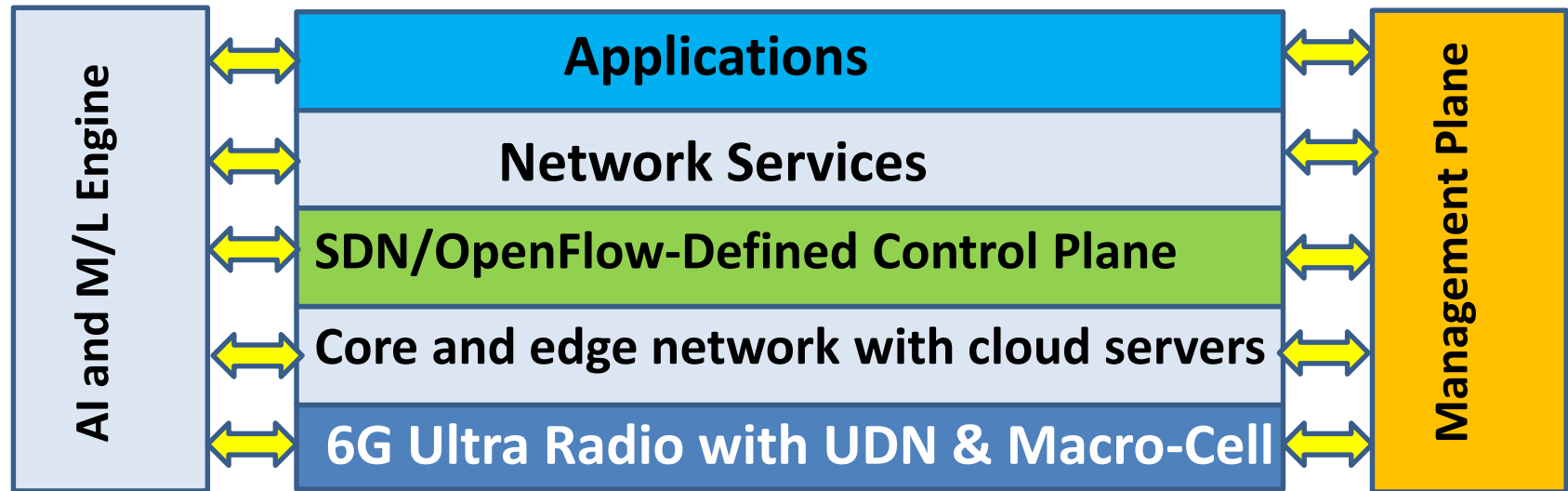


- **Advances in massive MIMO and adaptive near real-time channel estimation**
 - Channel properties and efficient channel learning techniques
 - Deal with imperfections such as antenna coupling effects, pilot contamination



Potential IT-Driven architecture

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Network 2030 (6G) Ultra Radio

- Selected Access Technologies for Network 2030 (6G) Ultra-Radio
 - Exploiting the Spatial Dimension
 - Advanced MIMO and Massive MIMO
 - Exploiting the untapped spectrum
 - mmWave & Terahertz communication systems
 - Exploiting Cost Efficiency of Cloud and Distributed Computing
 - Multi-Technology HetNets (UDN)
 - Improved Cell Edge Coverage



Thank you!
Kiitos!!



5G in Europe towards the Digital Single Market (DSM)

2013 - The 5G Public Private Partnership (5G PPP)




















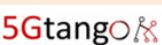




- **Supply Side**, tech/appli
- 3 Phases from R&D towards deployment
- 2015 Vision
- 2016 Vertical Strategy
- 2017 beyond, Trial Roadmap
- International strategy
















2016 - The 5G Action plan

- **Demand Side**, framework conditions towards deployment in 2020. Key milestones so far:
- 2016 Pioneer bands
- 2017+ RSPG opinions
- 2017 structured dialogue with member states
- 2017 Verticals, CAM as flagship use case, corridors
- 2018 CAM Trial implementations



5G PPP Phase 2, implementing trials

Projects	Vertical Stakeholders	ITU Service Types	Locations
	  	eMBB, URLLC	Montlhéry (FR)
	City councils of Barcelona, Bristol and Lucca	eMBB, URLLC (mMTC)	Barcelona (ES) Bristol (UK) Lucca (IT)
	  	eMBB	Watford (UK) Paris (FR) Madrid (ES)
	 	eMBB	Surrey (UK) Munich (DE) Turku (FI)
		eMBB	Egaleo (EL)
	 	eMBB	Athens (EL) Thessaloniki (EL) Madrid (ES) Rome (IT)
		eMBB, URLLC	Aveiro (PT) Athens (EL)
	 	URLLC	Turin (IT), Pisa (IT) Madrid (ES) Nice (FR)

Projects	Vertical Stakeholders	ITU Service Types	Locations
	 	mMTC	Hamburg (DE) Turin (IT)
	   	mMTC, URLLC, (eMBB)	Terni (IT)
		mMTC (URLLC)	Detmold (DE)
		URLLC	Brandenburg (DK)
	 	mMTC, URLLC, eMBB	Barcelona (ES) Bristol (UK)
	 	mMTC, URLLC	Paris, Grenoble (FR)
		URLLC, eMBB	Coventry (UK)
		URLLC (eMBB)	Genoa (IT) Ljubljana (SL)

Horizon Europe (FP9)

- Budget of **€97.6 billion**
- Biggest ever research and innovation funding programme
- Three pillars will be financed



Includes successor of LEIT programme

NGI Proposed Structure

