

New Developments in 5G PPP

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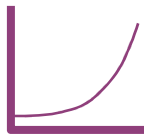
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5G Challenges

Avalanche of Traffic Volume

Further expansion of
mobile broadband

Additional traffic due to
communicating machines



“1000x in ten years”

Massive growth in Connected Devices

“*Communicating machines*”



“50 billion devices in 2020”

Large diversity of Use cases & Requirements

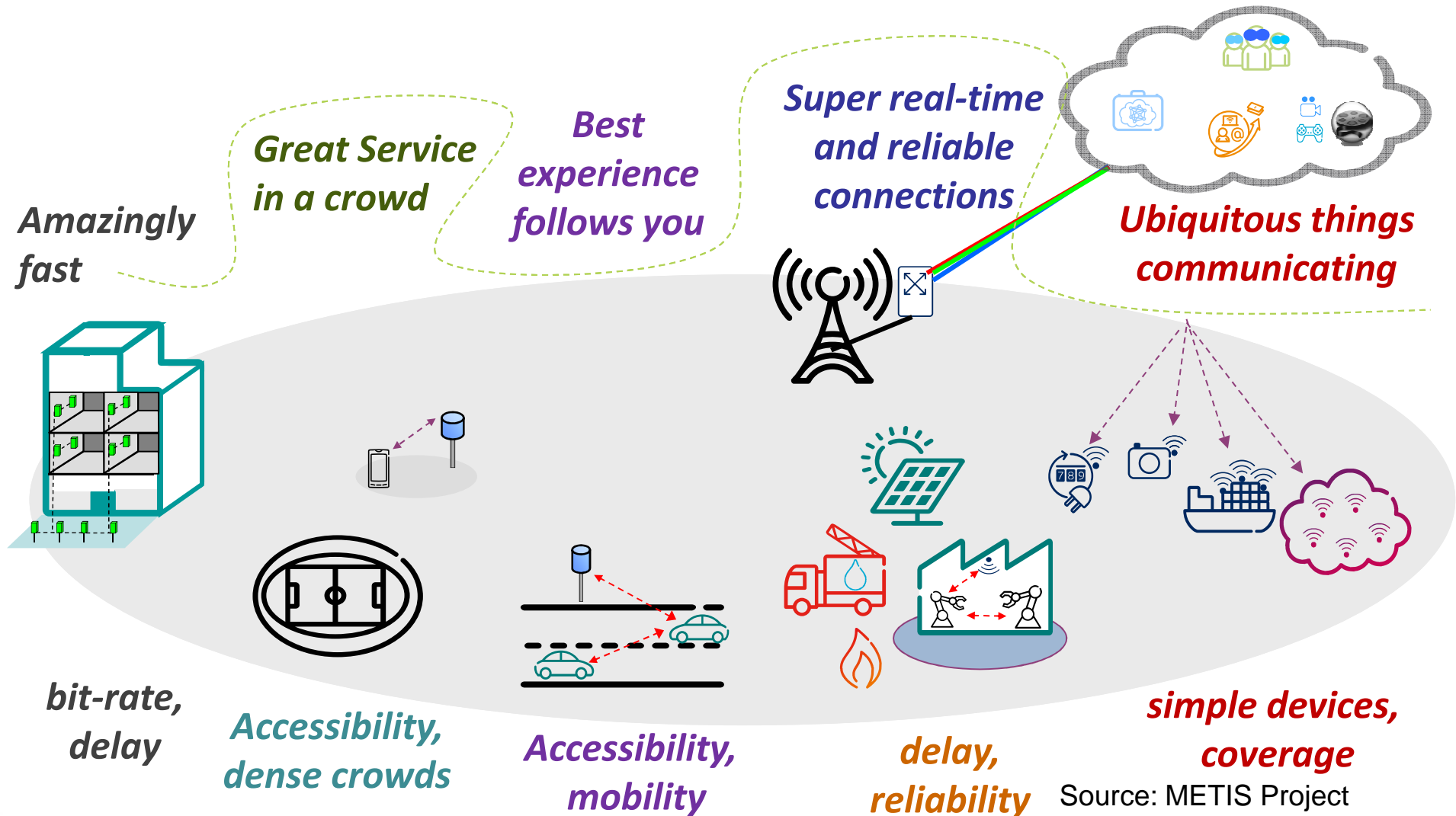
Device-to-Device
Communications

Car-to-Car Comm.

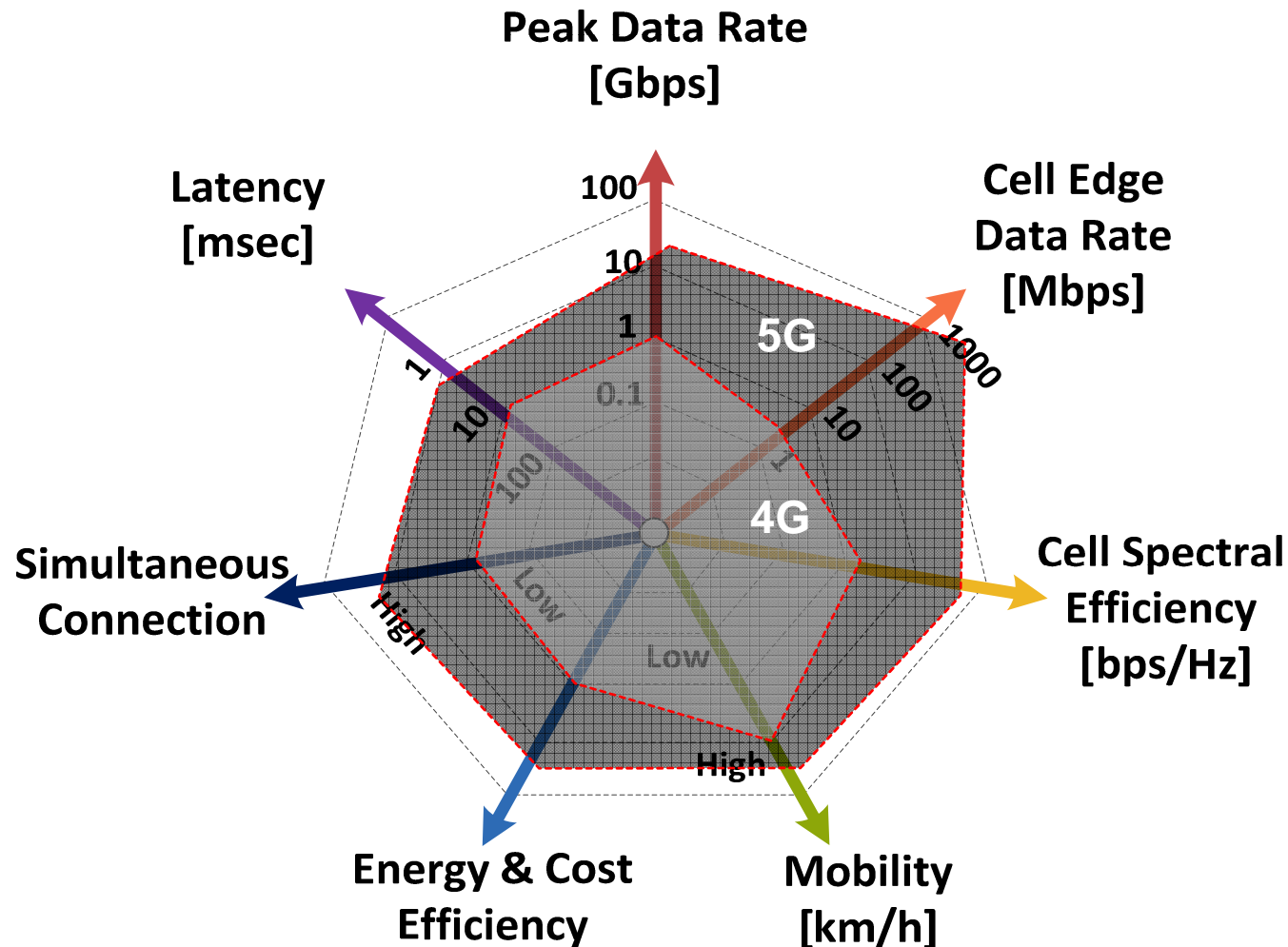
New requirements and
characteristics due to
communicating machines

Source: METIS Project

5G Scenarios



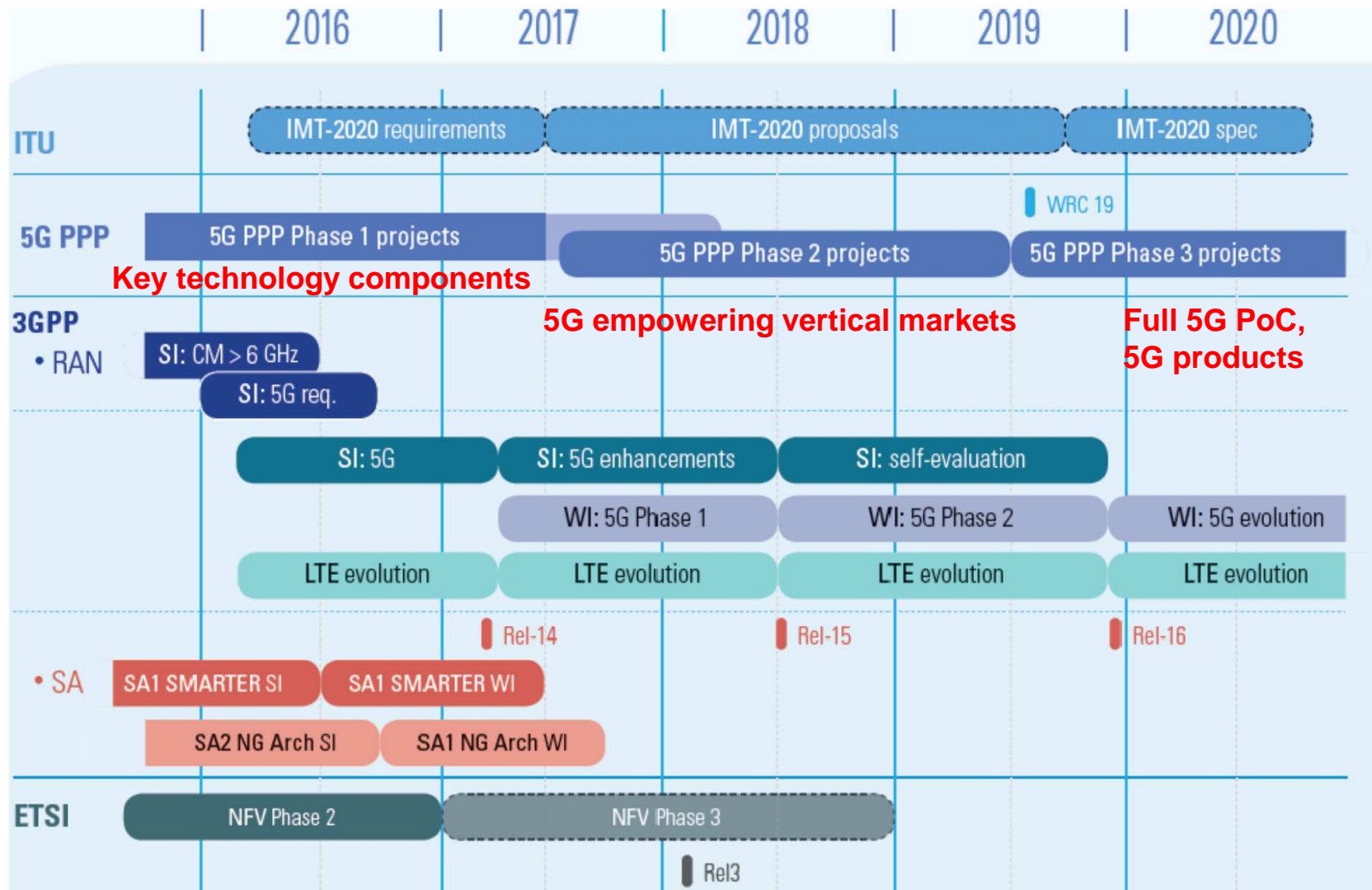
5G Technical Objectives



5G Key Enabling Technologies (Seletion)

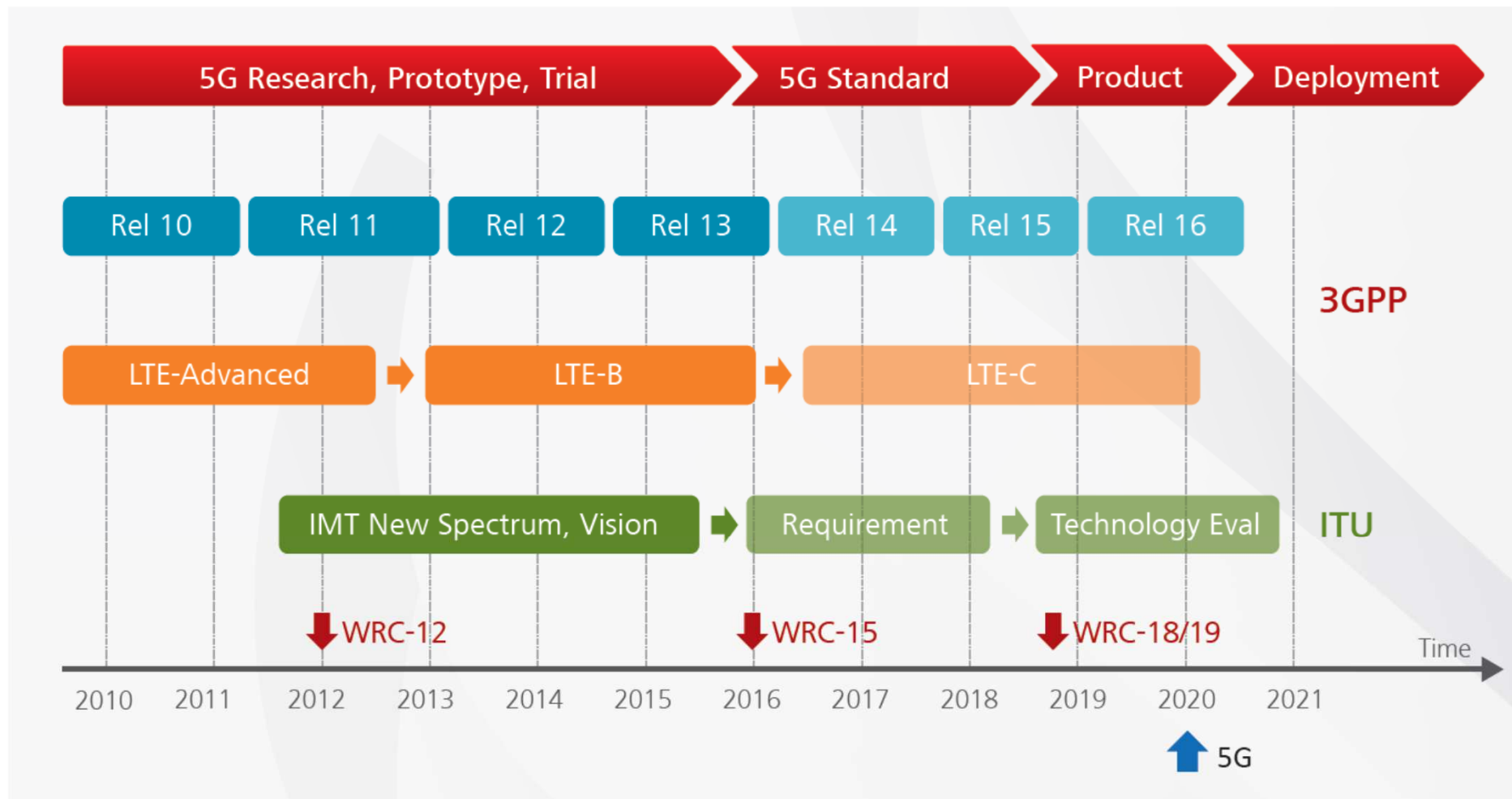
- Very **compact** and **massive MIMO** antennas
 - related beamforming
 - very high antennas' directivity
- High and agile spectrum usage (below 6 GHz & mmW)
- Wider communication bands
- Distributed **Mobile edge cloud**
- **Full-duplex** communications
- **D2D** communications
- Interference management
- New PHY **waveforms**
- **Localization & Context Awareness**

Standards & 5G PPP Timelines



EC 5G Infrastructure PPP – MWC 2016 White Paper “5G Empowering Vertical Industries”
https://5g-ppp.eu/wp-content/uploads/2016/02/BROCHURE_5PPP_BAT2_PL.pdf

Tentative Roadmap for 5G

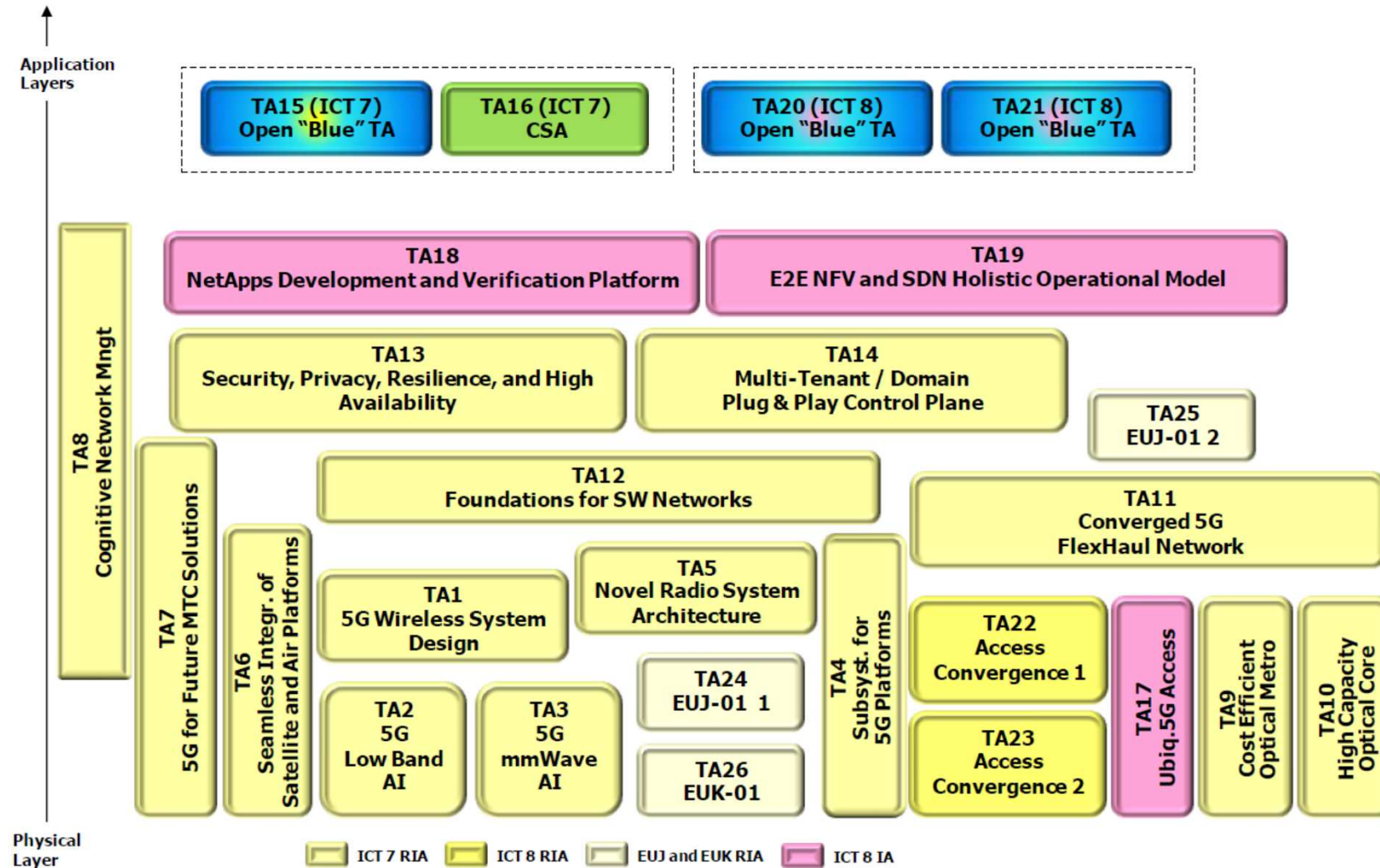


[2016-2017] 5G PPP Pre-structuring model: Phase 2

- ICT-07-2017: 5G PPP Research and Validation of critical technologies and systems:
 - RIA Strand 1: Wireless Access and Radio Network Architectures/Technologies.
 - RIA Strand 2: High Capacity Elastic – Optical Networks.
 - RIA Strand 3: Software Networks.
 - CSA.
- ICT-08-2017: 5G PPP Convergent Technologies:
 - IA Strand 1: Ubiquitous 5G Access Leveraging Optical Technologies.
 - IA Strand 2: Flexible Network Applications.
 - RIA: Cooperations in Access Convergence.
- EUJ-01-2016: RIA 5G – Next Generation Communication Networks. → **MiEdge & 5G!Pagoda**
- EUK-01-2016: RIA 5G – Next Generation Communication Networks. → **5G CHAMPION**



5G PPP Target Actions Portfolio



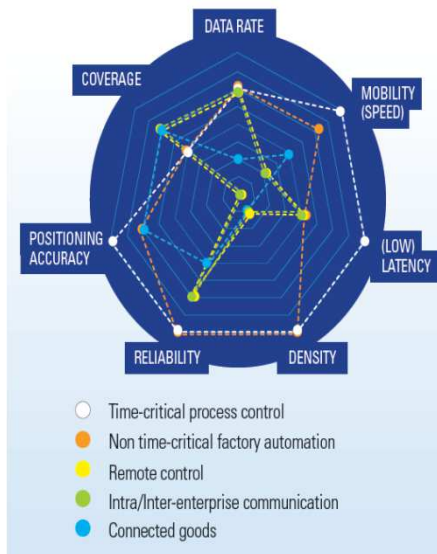
New Developments in 5G PPP

- Business demands strong support from ***vertical markets***
- **Cooperative & self-organization of networks** empowered by D2D communications, context awareness, learning techniques and AI are the next future
- **New spectrum** (WRC'19)& New spectrum management
- Issues related to **reliability of new spectrum usage** (beyond 6 GHz) are today under discussion
- Service provisioning under **high mobility** still an open issue (5G Champion will provide PoC for 5G service provisioning at **500 Km/h**)
- **Anticipation of large scale PoC from 2020 to 2018!**
 - February 2018: Winter Olympic Games – South Korea
 - Verizon (USA): big deployment down in Dallas working with Ericsson and Nokia for wireless backhauling (28 GHz and 39 GHz)

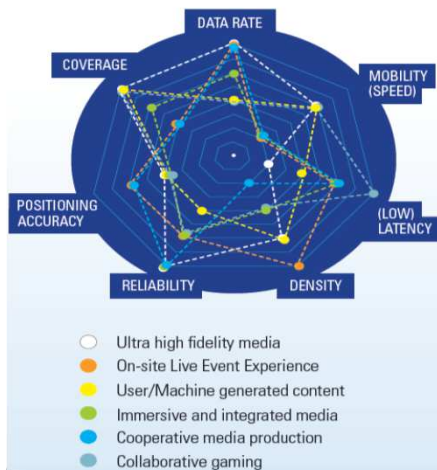


Specific KPIs per Vertical

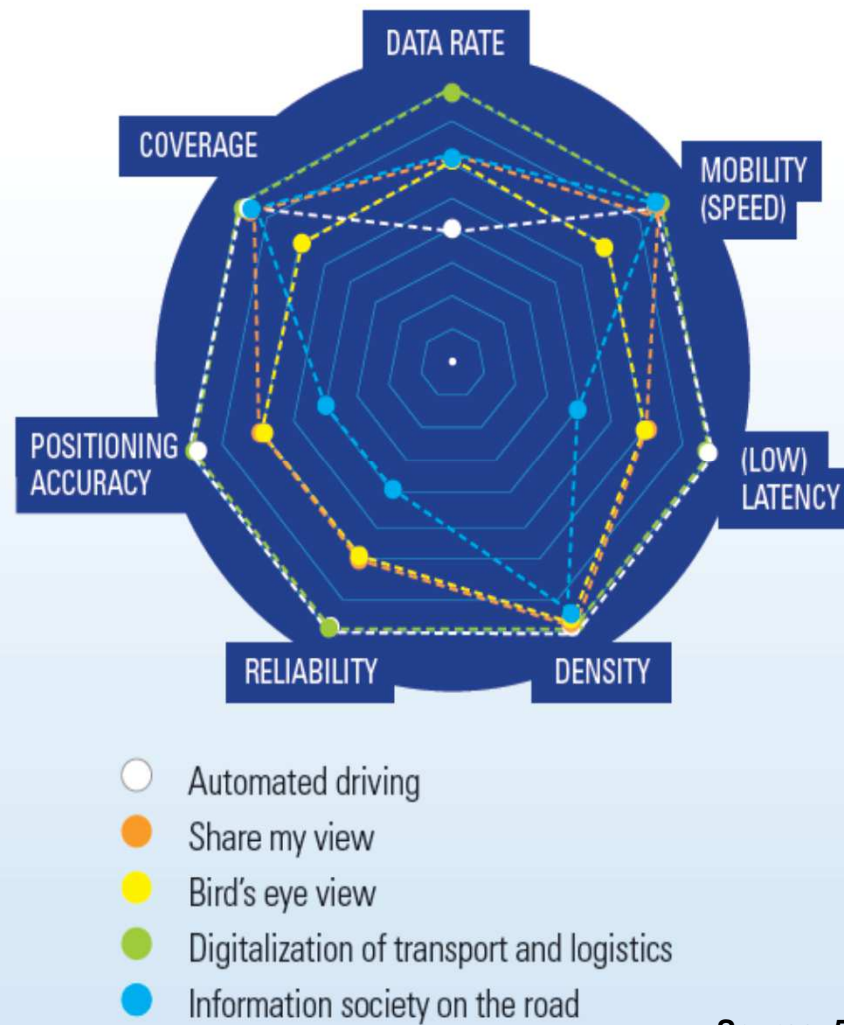
Factories



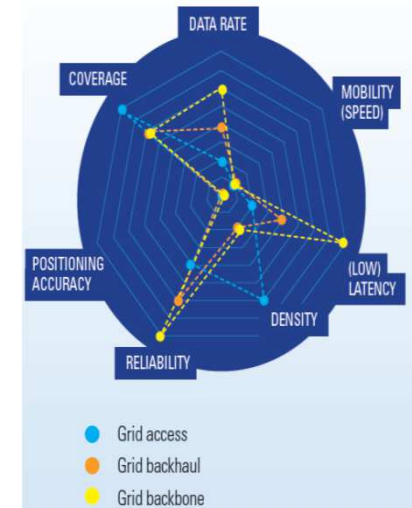
Media & Entertainment



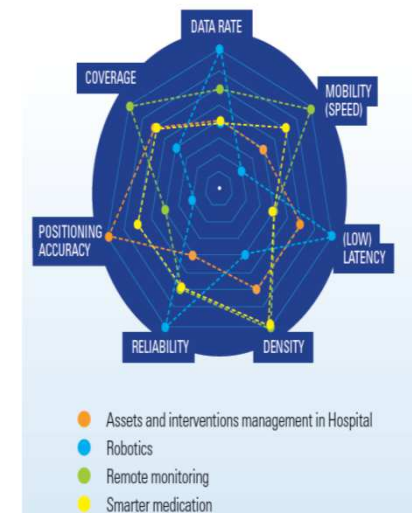
Automotive



Energy



e-Health



Source: 5G PPP

Critical Parameters for the Different Vertical Sectors

Data Rate: Required bit rate for the application to function correctly. The most demanding vertical use cases are related to **Media & Entertainment (including virtual reality)** with maximum values in the order of **Gb/s**.

Mobility (speed): Maximum relative speed under which the specified reliability should be achieved. The most demanding vertical use cases are related to **Automotive** and **eHealth** with maximum value in the order of 500 km/h.

E2E Latency: The most demanding vertical use cases are related to **Factories** with minimum values of **100 μ s to 10 ms**.

Density (number of devices): Maximum number of devices (vehicles in the case of Automotive) per unit area that are 5G capable, although they might not all be generating traffic simultaneously for the specified application. The most demanding vertical use cases are related to **Factories** with **up to 100/m²**.

Critical Parameters for the Different Vertical Sectors

Reliability: Maximum tolerable packet loss rate at the application layer within the maximum tolerable end-to-end latency for that application. The most demanding vertical use cases are related to **eHealth** with values up to **99.99999%**.

Position Accuracy (Location): Maximum positioning error tolerated by the application. The most demanding vertical use cases are related to **Automotive** with minimum values in the order of **0.3 m**.

Coverage: Area within which or population for which the application should function correctly, i.e. the specified requirements (latency, reliability and data rate) are achieved. **Most of the vertical** sectors have strong requirements on geographic and/or population coverage

Security: System characteristic ensuring globally the protection of resources and encompassing several dimensions such as authentication, data confidentiality, data integrity, access control, non-repudiation...



Automotive and Mobility



Most foreseen automotive industry applications **cannot be implemented with today's communication technologies.**

5G support

- advanced driver assistance systems
- complete autonomous driving cars (longer vision)

By enabling

- sensor information exchanges in **real time** between thousands of cars connected in the same area
- with reliability and performance levels with higher orders of magnitude compared to today
- connectivity should be possible even in areas without network coverage
 - E.g. thanks to relaying signals between vehicles

Ex. 5G Cooperative Networks

- Context-aware cooperative communications
- Multi-Modal Sensing
 - Rich source of information that can be fused, mined, exploited for learning and AI automated algorithms
- Recognition of physical environments
- Advanced automated modelling of physical environments
- Prediction of 'unexpected events'
 - Traffic congestion
 - Environment changes
 - Localized risks
- MEC: migrating from centralized to distributed computing assistance

To Conclude

- Today : **Phase 1 5G PPP**
- 'Tomorrow (almost today!)': **Phase 2 5G PPP**
 - 28 GHz will be demonstrated in 2018 (ex. 5G CHAMPION at 2018 Winter Olympic games, Korea)
 - Vertical markets as drivers for 5G innovation and usecases
 - ITS requirements to 5G
 - Higher automation level
 - Reduced latency
 - Increased reliability
 - Higher communication capacity
 - Higher connectivity density
 - ITS key transformations happening
 - Automated driving
 - Road safety & real-time warning application to drivers
 - Digitalization of transport & logistics
 - Intelligent navigation & positioning
 - Content distribution and exchange on the road
- '2020': **Phase 3 5G PPP**
 - Full scale PoC of 5G components and 5G services

To Conclude

- **H2020+**
 - **5G Network deployment**
 - Even Higher in Frequencies:
 - **100-300 GHz** presents interesting potentials that need to be explored
 - Envisioned coverage range 10 to 20 meters
 - Aggregated bands up to 220 GHz
 - 1 Tb/s
- **Do not be scared:** atmospheric attenuation is not significant for short distance (small cells scenarios):
 - @ 60 GHz up to 200-300 m access range
 - @ 250 GHz up to 20 m access range
- **AI** and self-cooperative organizing networks

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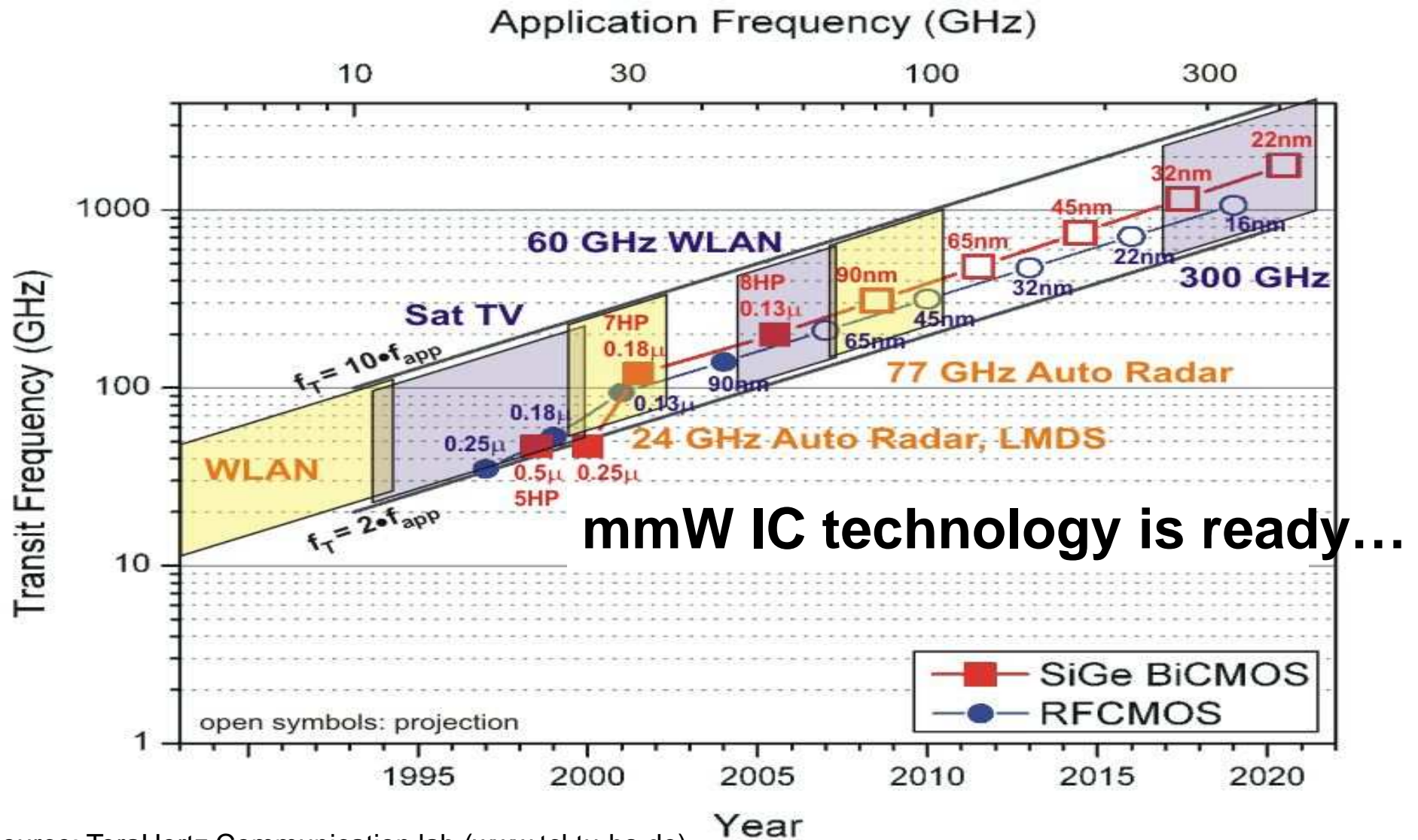
Thanks for your attention



énergie atomique • énergies alternatives

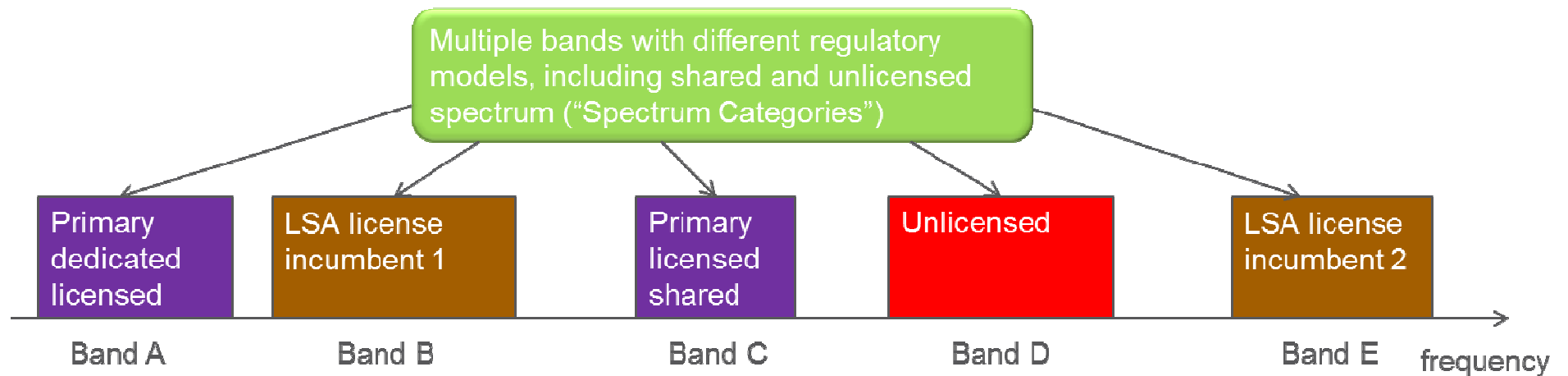


mmW technology

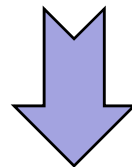


Source: TeraHertz Communication lab (www.tcl.tu-bs.de).

Spectrum Scenario: Future Landscape



- **Multiple frequencies bands:** dedicated licensed spectrum complemented with various forms of shared spectrum



"Toolbox" of different sharing enablers required
In order for **5G** system to work under such scenarios