



Holistic End-to-End 6G MTC network vision

Ingrid Moerman

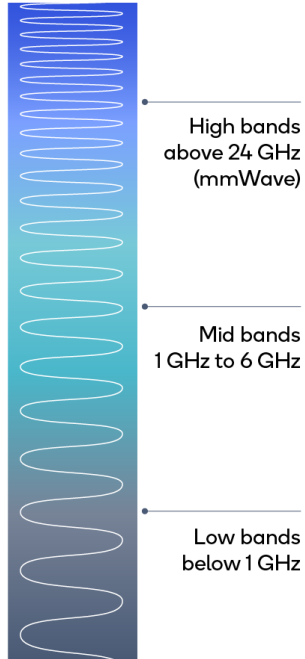
E2E NETWORKS

DIVERSITY IS KEY

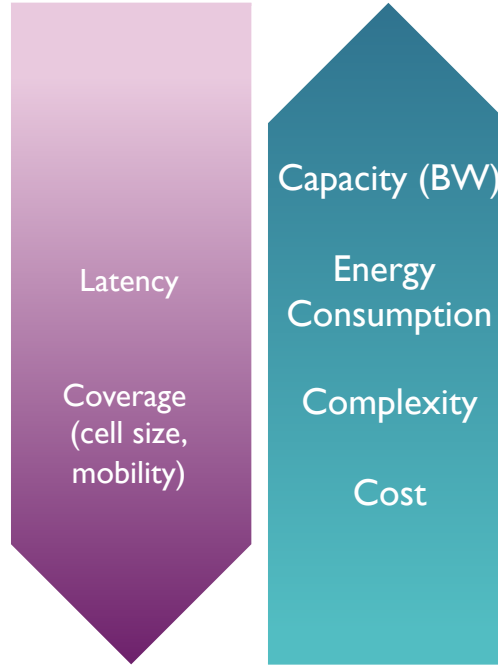


Diversity at Radio Access level

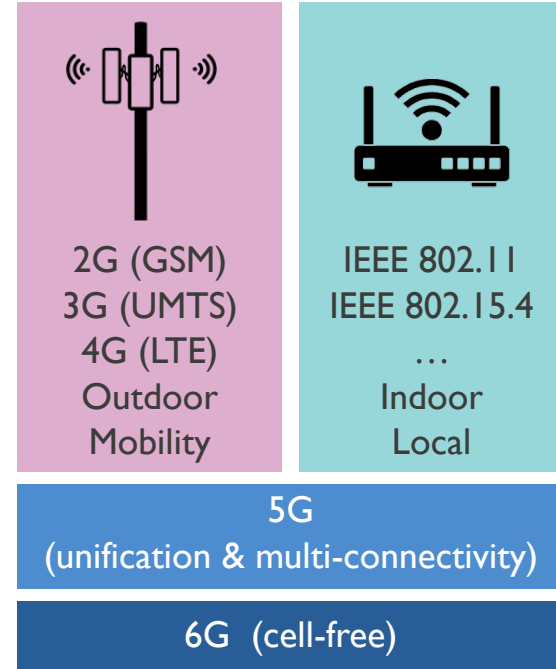
Spectrum bands



Characteristics



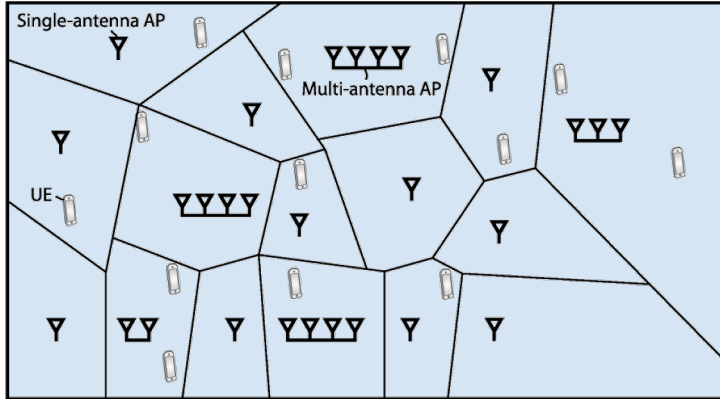
Cellular versus local area



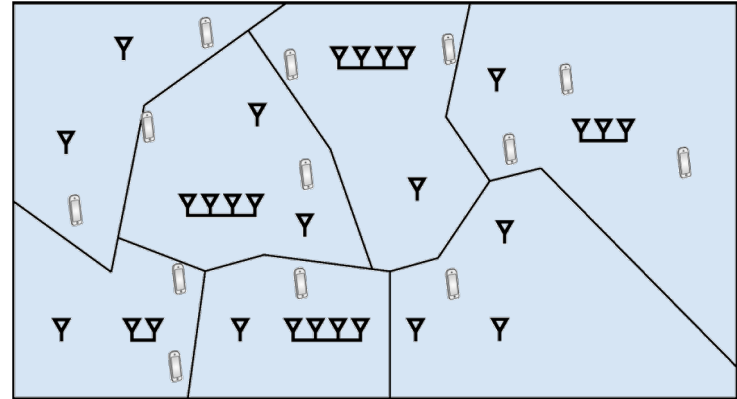
Source: <https://developer.qualcomm.com/blog/spectrum-5g-innovation-boost-starts-here>

Diverse deployment strategies

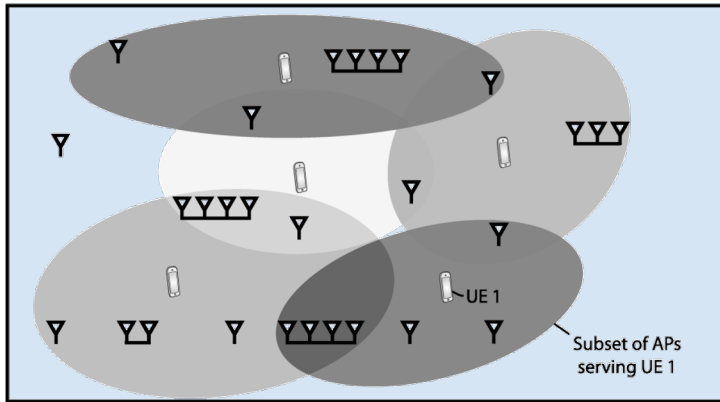
Conventional cellular



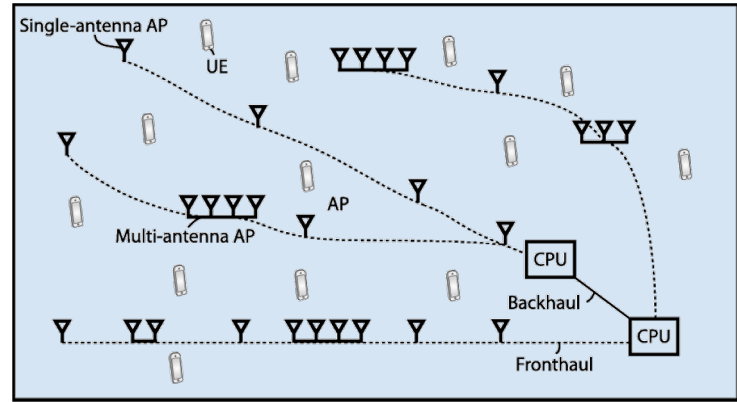
Network-centric CoMP-JT



User-centric CoMP-JT



Cell-free Massive MIMO



Interdonato, G., Björnson, E., Quoc Ngo, H. et al. Ubiquitous cell-free Massive MIMO communications. J Wireless Com Network 2019, 197 (2019)

Diverse network (control) architectures

TRADITIONAL NETWORKS
Distributed embedded control on custom physical HW

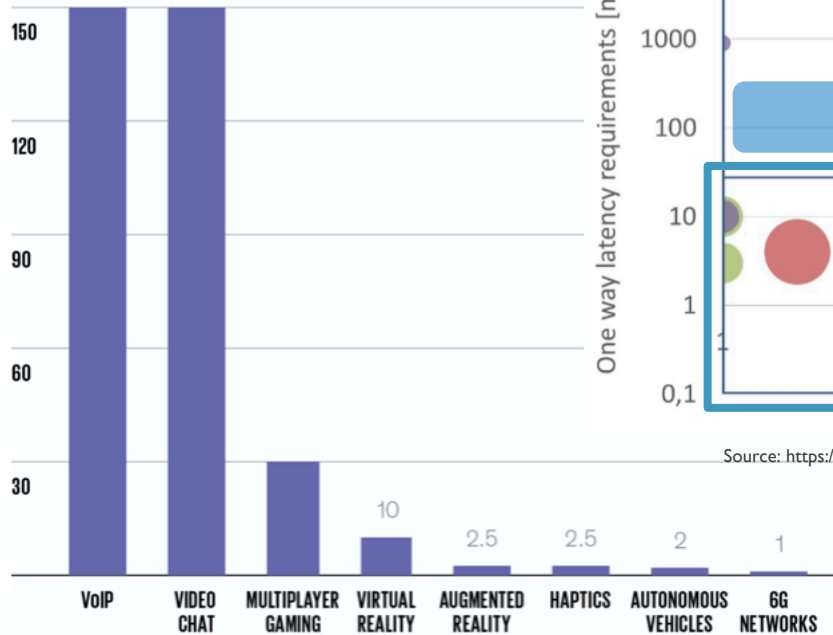
SDN
Centralized SW control of custom physical HW
Focus on control and optimisation of network traffic

NFV
SDN control + Virtualization of Network Functions

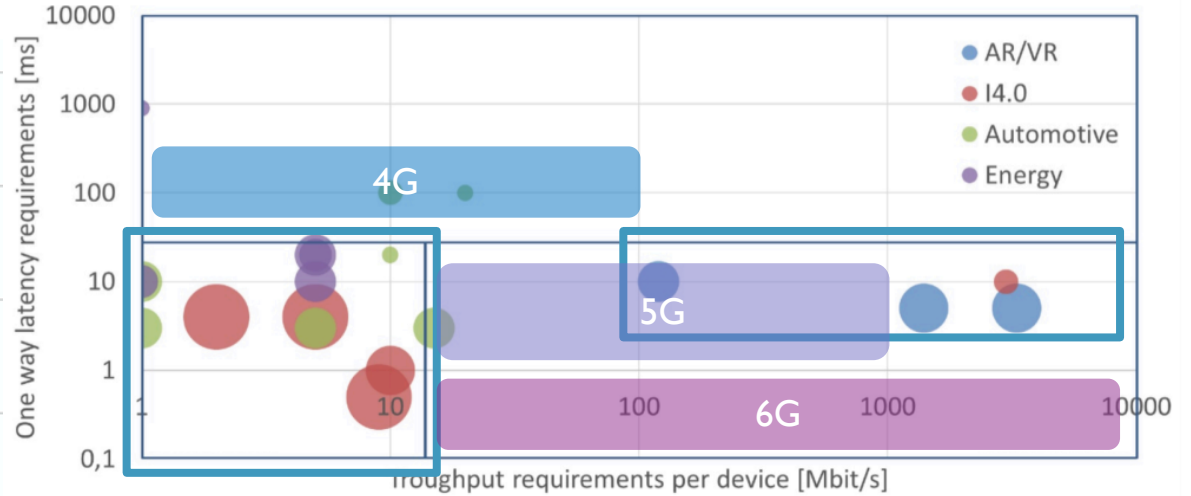
Functional split

Diverse traffic demands

END-TO-END LATENCY (ms)



Sources: ITU; TechTarget; British Esports Association; GSMA; arXiv:1803.03586v1; Samsung



Source: <https://www.gsma.com/futurenetworks/wp-content/uploads/2018/04/NS-Final.pdf>

Low latency \neq High throughput

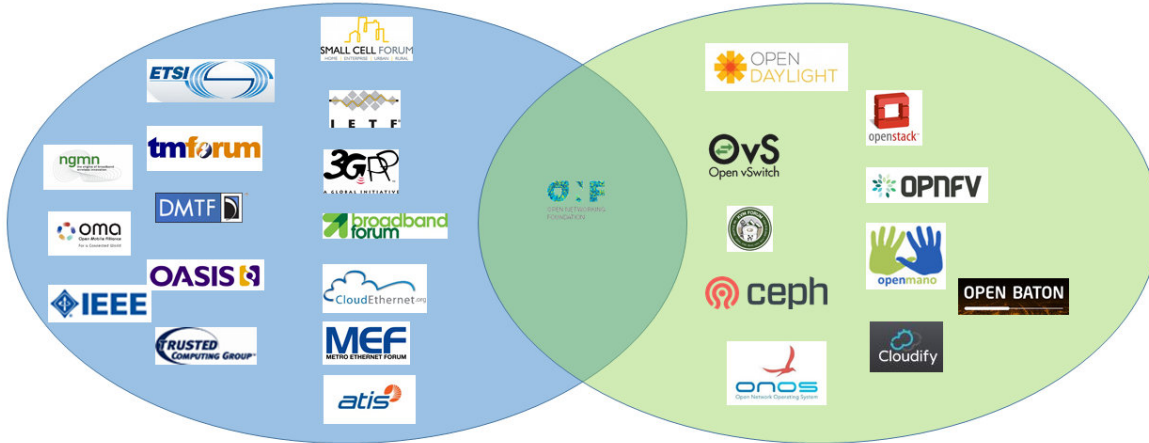


Diverse standardisation bodies

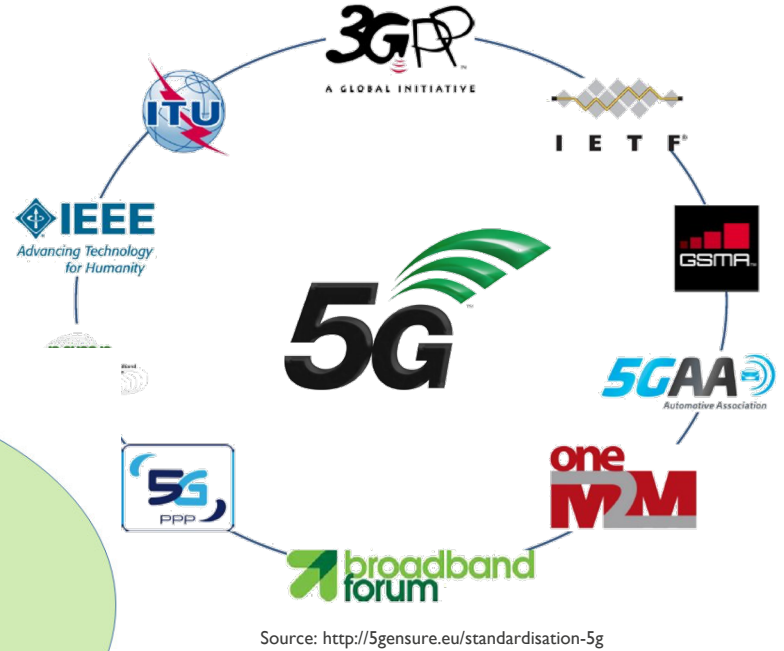
NFV standards & platforms

Standard

OpenSource



Source: <https://www.slideshare.net/wap13/sdn-nfv-opensource-and-standards-in-wireless-networks-2015-for-ncv>



Source: <http://5gensure.eu/standardisation-5g>

5GACIA
5G Alliance for Connected Industries and Automation

...

Diverse actors

5G: Accelerator for digital innovation in diverse industrial use cases

FROM

- Limited number of public mobile networks
- Consumer-oriented basic connectivity services (voice, data, video)
- Public mobile network operators, equipment vendors

TO

- Large number of local, private networks
- More granular QoS per slice, per use case
- Private network operators, industry, academy, authorities, standardisation bodies, end-users (prosumers)

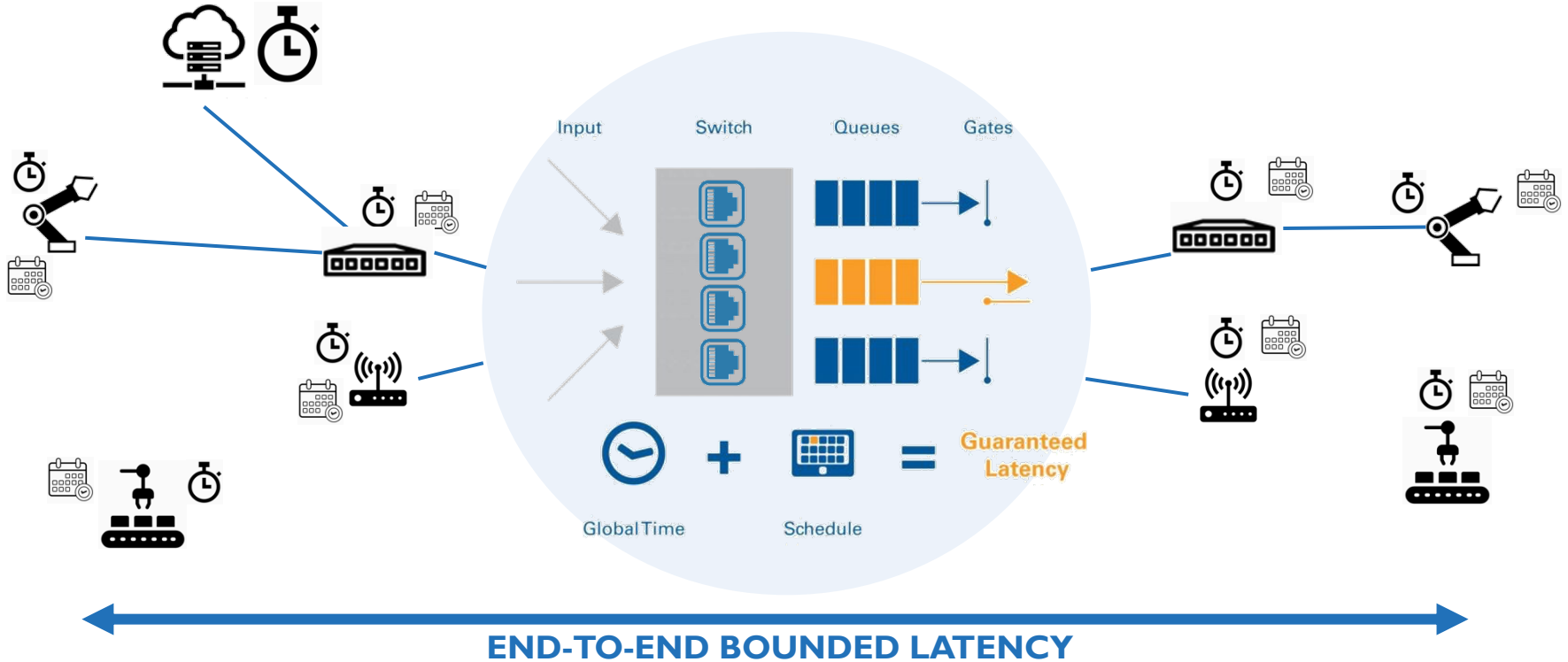
A close-up, artistic photograph of an antique clock mechanism. The image features a prominent brass gear with a sunburst pattern on the left, and a wooden dial with Roman numerals and a brass hand on the right. The lighting is dramatic, highlighting the textures of the wood and metal.

TIME SENSITIVE NETWORKING

[AN EXAMPLE]

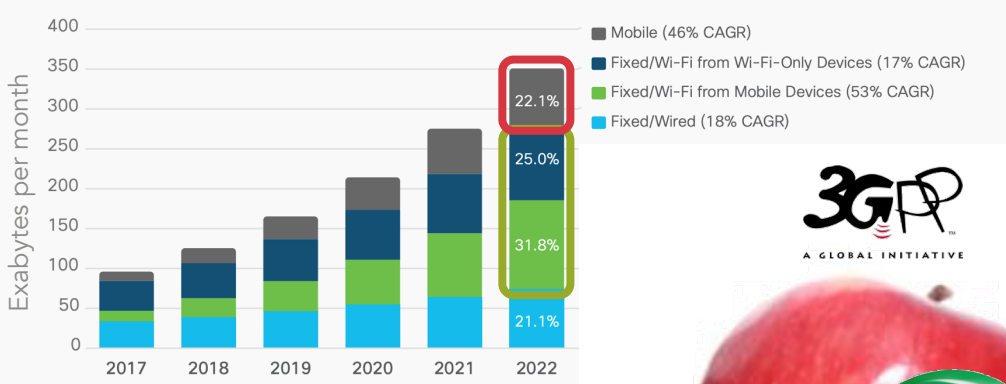
Time Sensitive Networking

De facto standard in wired networks: TSN Ethernet (IEEE 802.1 Qbv)



Diverse solutions for Time Sensitive Networking (TSN)

IEEE 802.11™



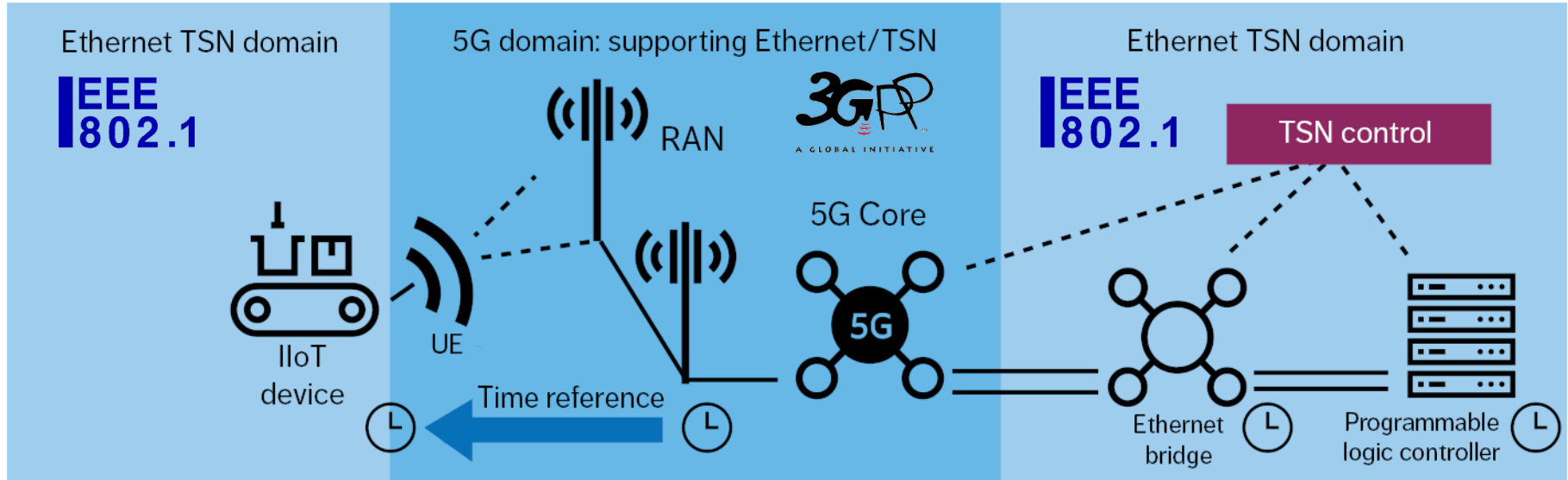
Source: Cisco VNI Global IP Traffic Forecast, 2017-2022

3GPP™
A GLOBAL INITIATIVE



TSN - 5G integration

Released in 2020, to be deployed in...



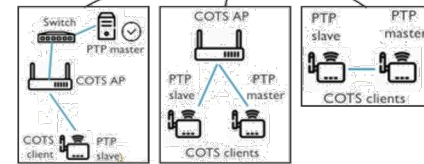
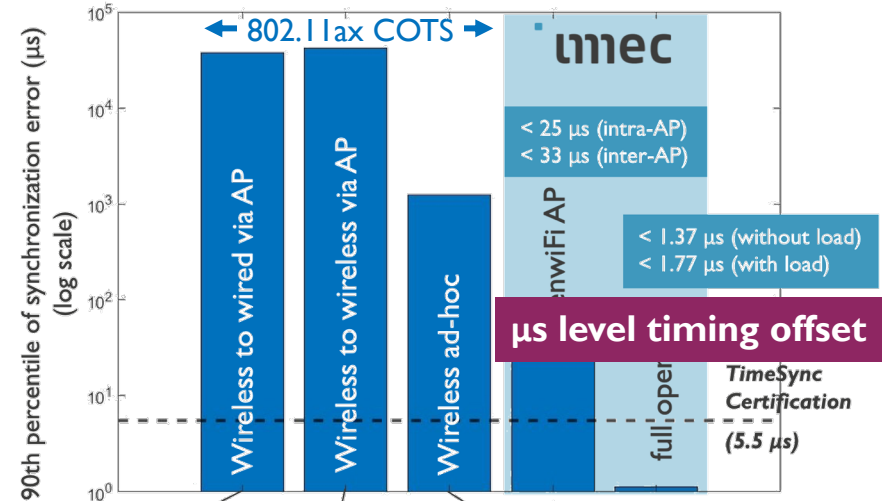
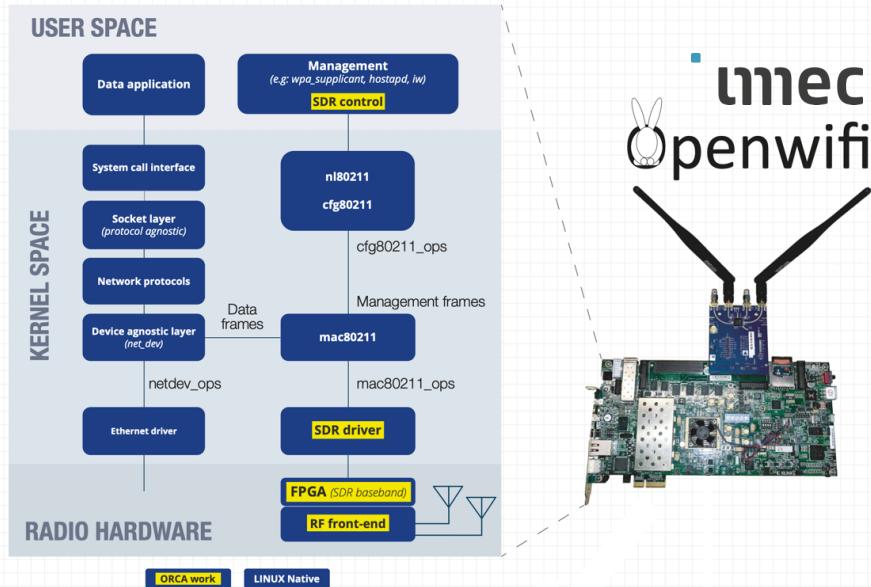
<https://www.ericsson.com/en/reports-and-papers/ericsson-technology-review/articles/5g-nr-evolution>

- Emulation of Ethernet TSN switch over 5G infrastructure

µs level timing offset

TSN - Wi-Fi Integration

Validated TODAY on imec's opensource Wi-Fi chip





<https://github.com/open-sdr/openwifi>

Compliant with commercial Wi-Fi chips

Native Linux driver

5G versus WiFi 6

Based on <https://e.huawei.com/en/material/networking/wlan/e40d5765a4d046ce90b72520b647641e>

		
UP data rate	similar	
UP latency	1 – 10 ms	<1 ms – 100 ms *
CP complexity	High	Moderate
Infrastructure cost	High	Low
Operational cost	High	Low
Deployment	Slow (months)	Fast (days)
Security	High (E2E)	High (local)

* Depending on embedded HW, interference (spectrum) & scheduling approach

~~6G = 5G or Wi-Fi?~~

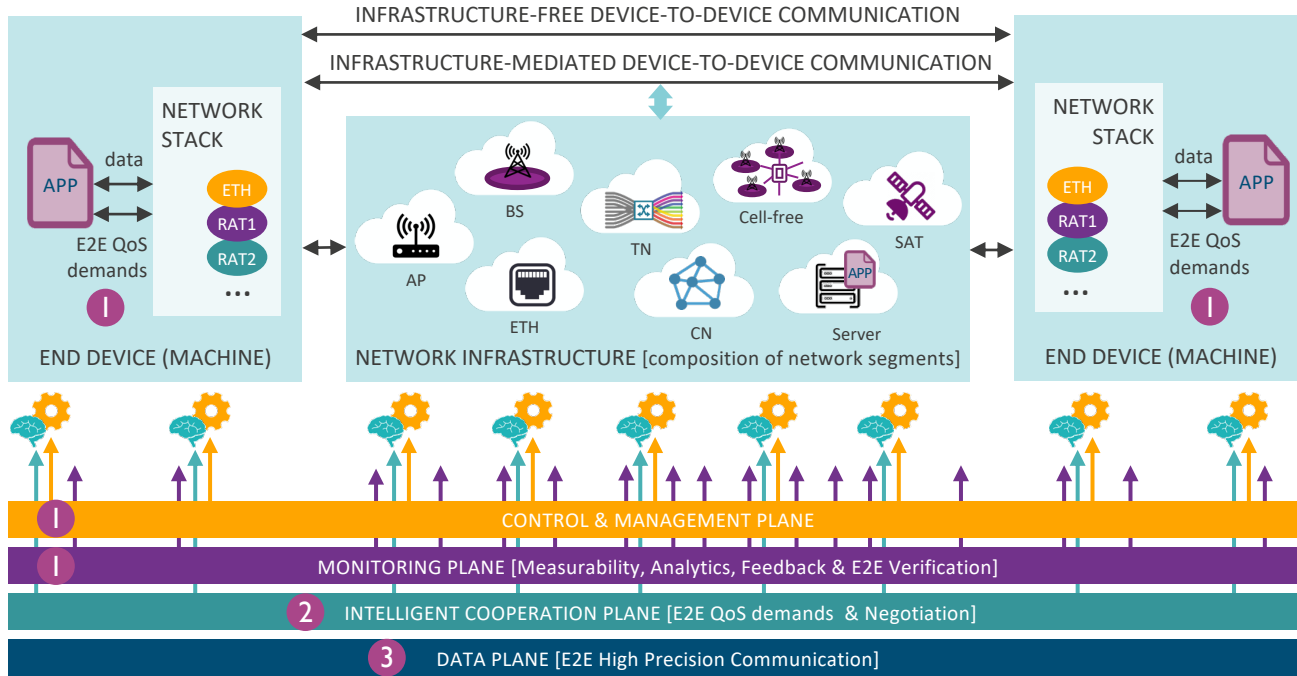
6G = 5G and Wi-Fi!

E2E MTC VISION



DEALING WITH DIVERSITY

Holistic End-to-End 6G MTC network vision



- ▶ From unification/centralisation to interoperable/cooperative segments
- ▶ Freedom of specific mechanisms & implementation within segment
- ▶ High Precision Communication = Fine E2E QoS granularity
- ▶ Open technology-agnostic, vendor-independent (descriptive) interfaces
- ▶ Exposing right level of information across segments
- ▶ Fine-grained resource allocation/slicing within segment
- ▶ **SIMPLIFIED CONTROL & STANDARDISATION**
- ▶ **EASY UPGRADEABLE & EXENSIBLE**

- 1 Application-Network Interface
- 2 API between segment orchestrators (hierarchical versus distributed)
- 3 Network SAPs + inter-segment ingress and egress gateways



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