5G mobile networks:
A catalyst for growth

November 2nd 2020

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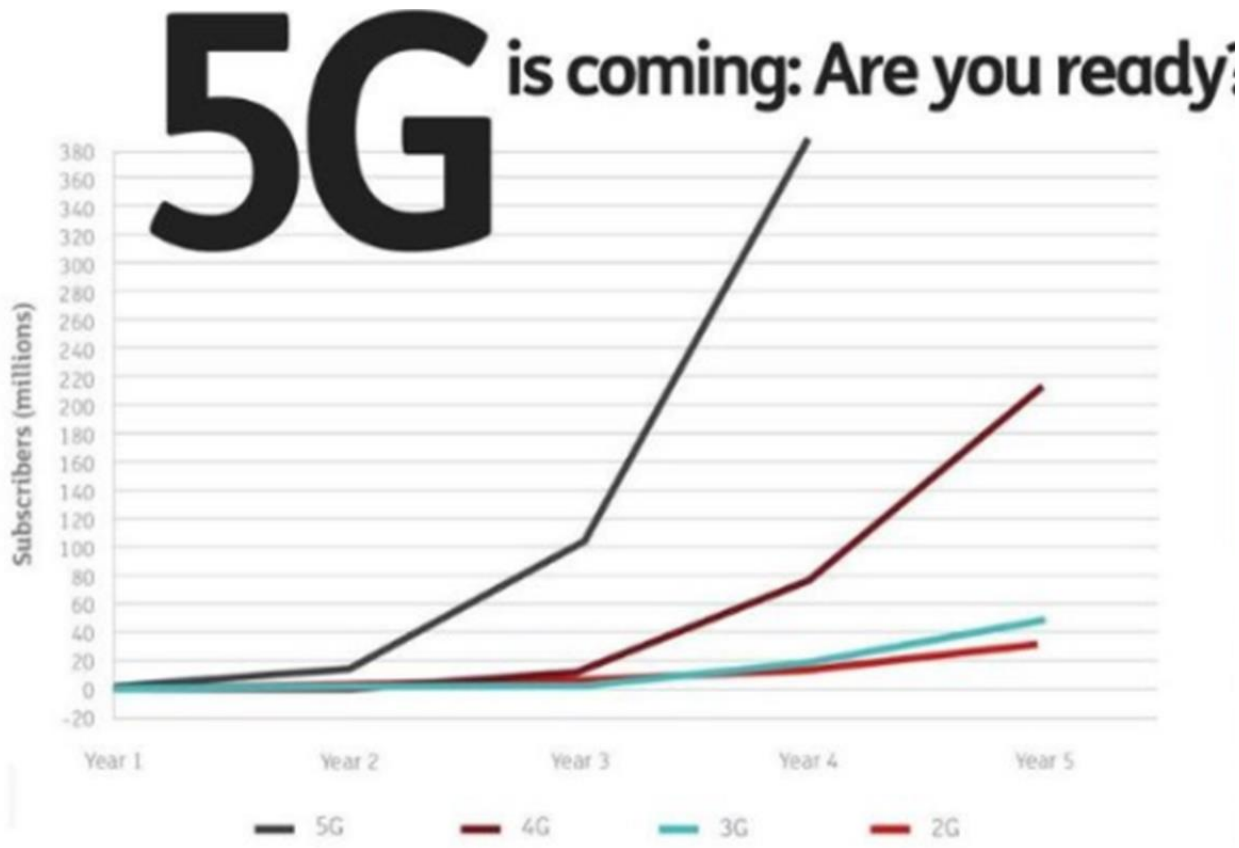
The 5th Generation of Networks for Mobile Users/Machines is underway!

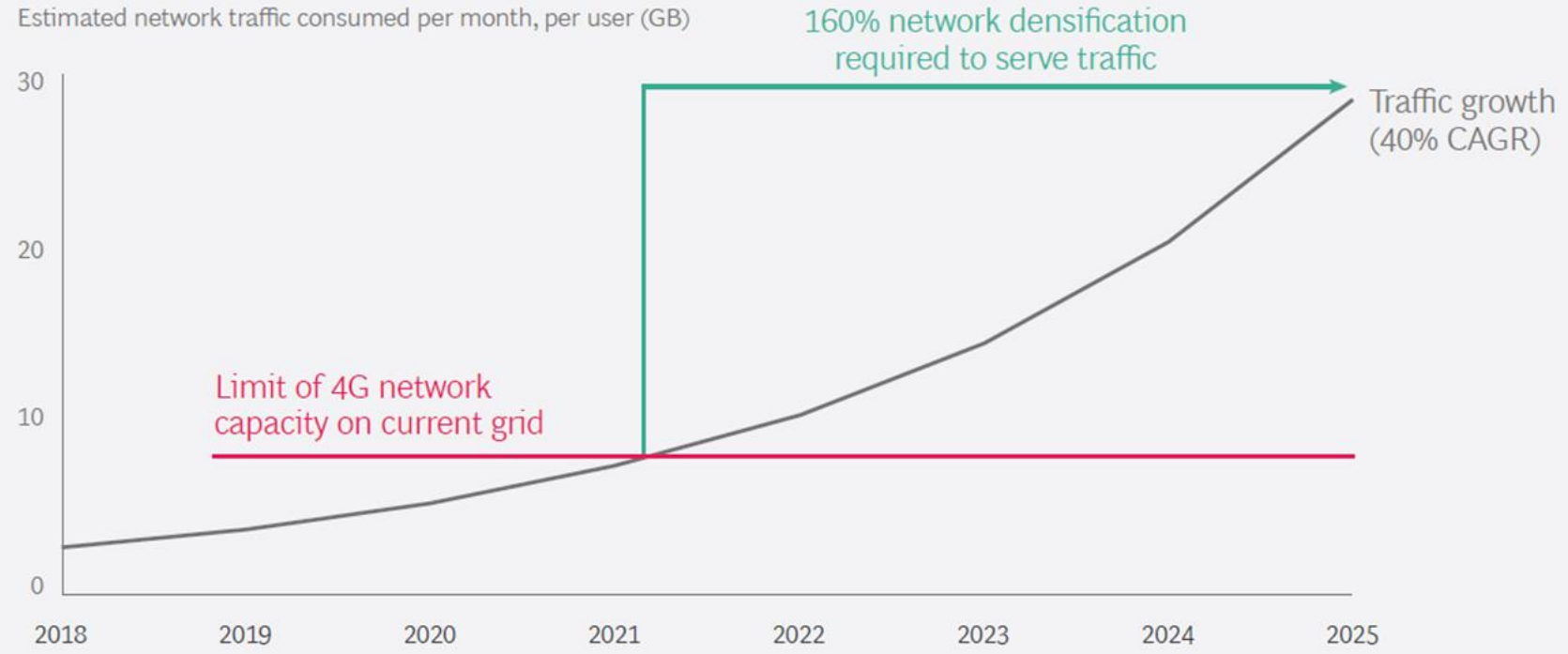


Outline – Some "burning" questions (+1)

- Why do we need 5G? When do we need it?
  - What is the current status globally?
- What an end-to-end 5G network architecture looks like?
- Which are the requirements and market opportunity for emerging 5G use cases?
- Which are the key 5G technologies to satisfy their needs?
- Do operators have much to expect from 5G networks?
- Do Governments have much to expect from 5G networks?
- Where do countries stand wrt 5G Readiness?
- What is the status of non-public 5G networks?

- *How University of Patras in engaged in 5G activities?*

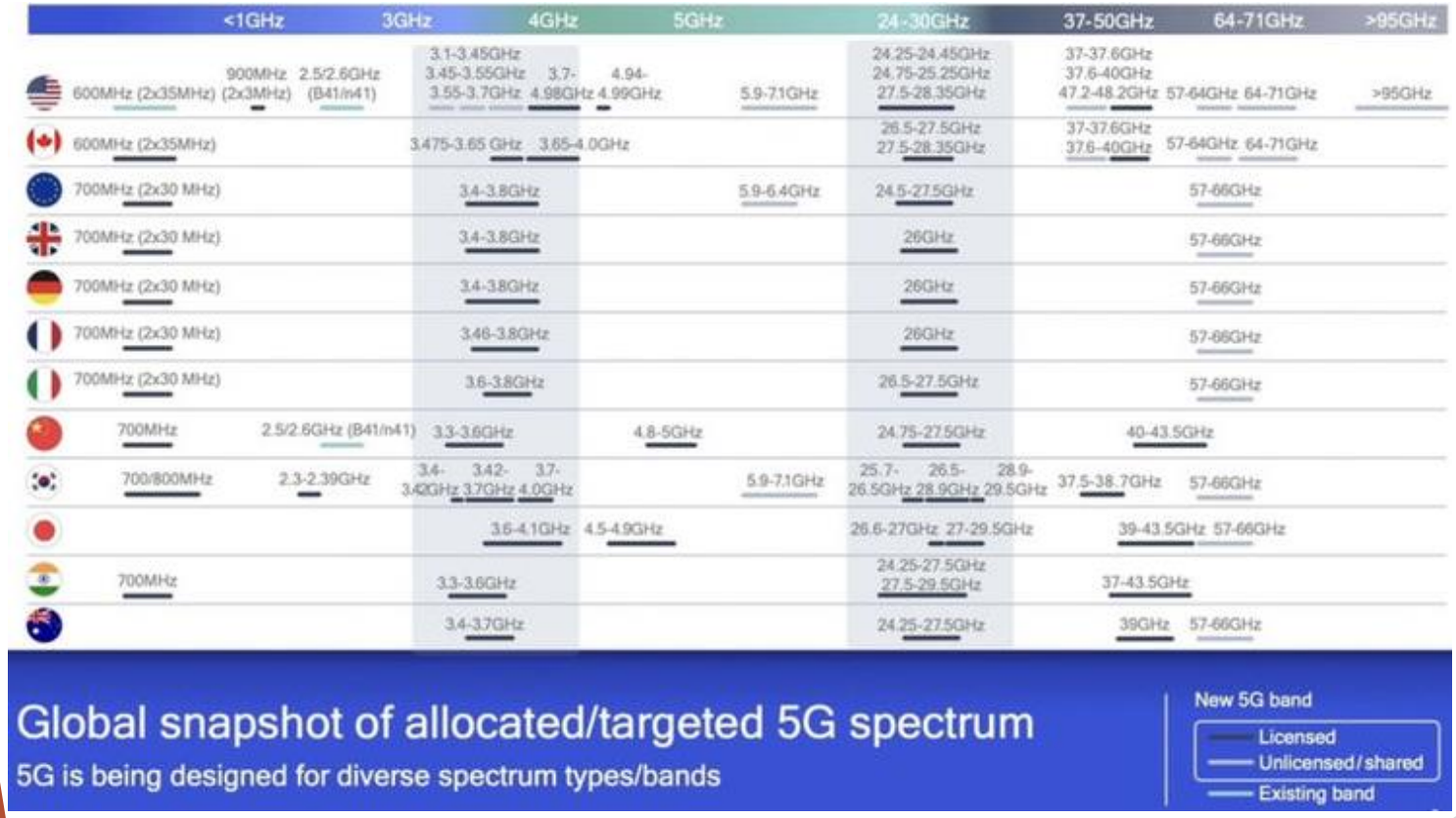
Why/when do we need 5G?



Source: BCG network model.
Note: Densification = an increase in the number of cell towers and antennas in heavy traffic areas.

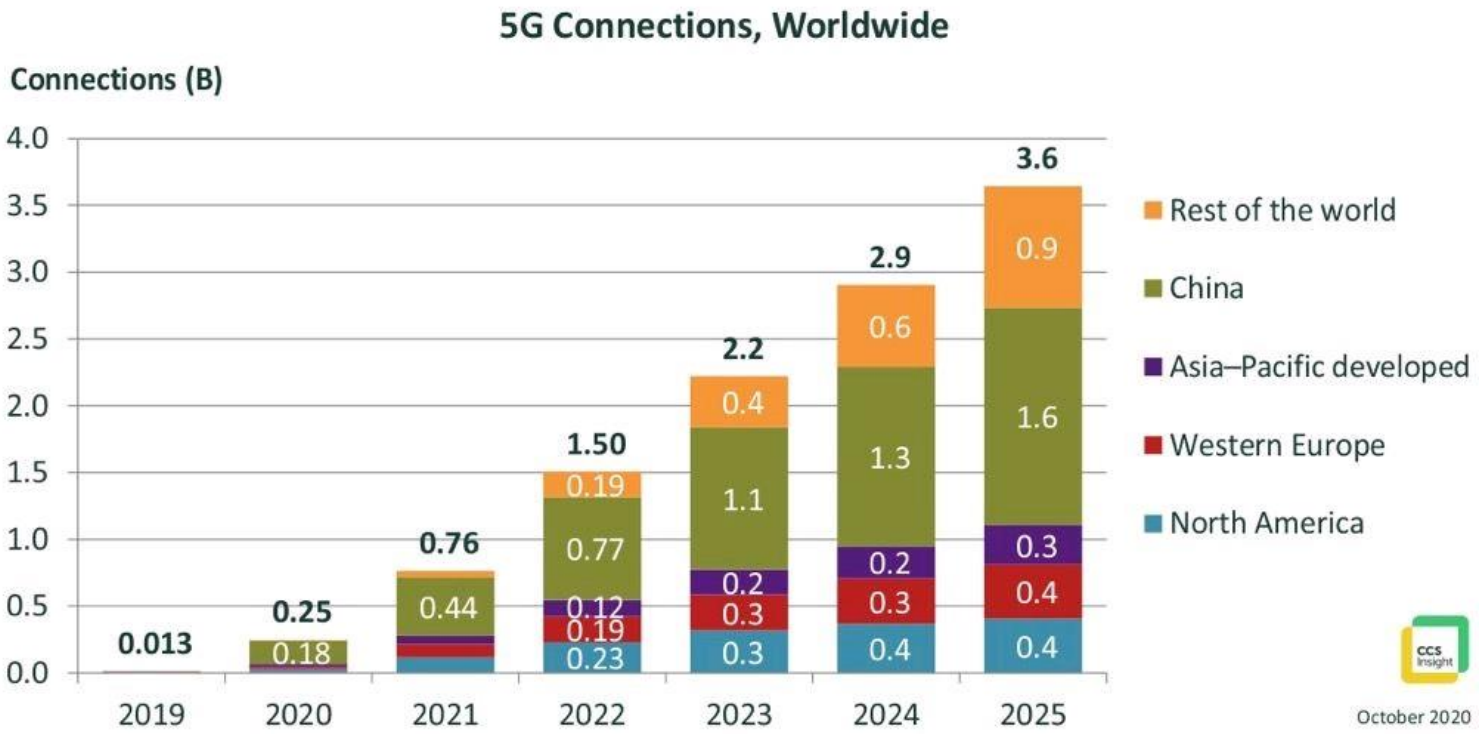
- Simple answer: because 4G can not satisfy for much longer the traffic demands in an affordable way…

What is the 5G spectrum allocation status worldwide?



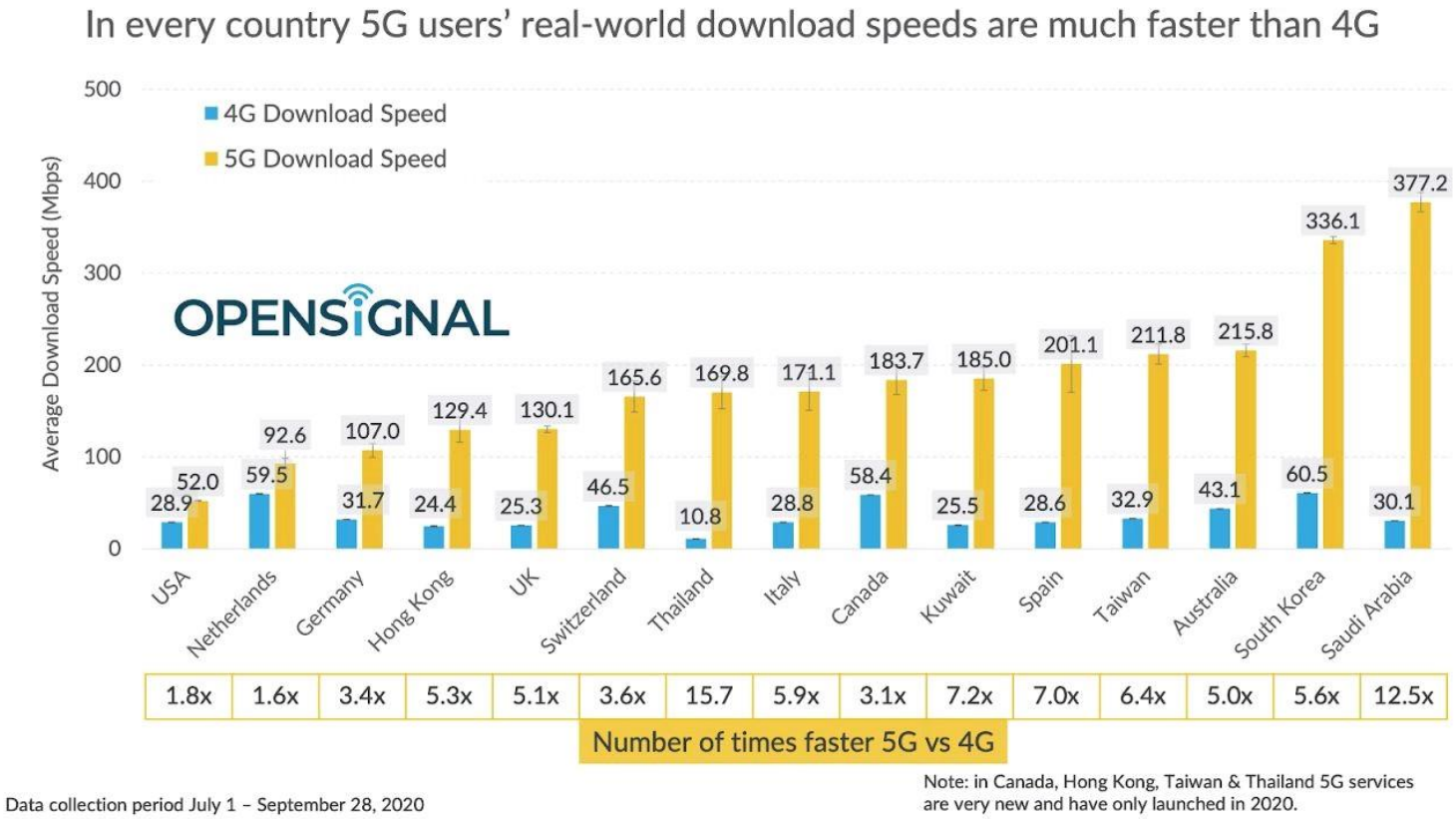
- 5G will start with the use of existing frequencies based on Dynamic Spectrum Sharing (DSS) and will move (slowly?) towards higher frequencies

What is the Current status of 5G connections availability worldwide?



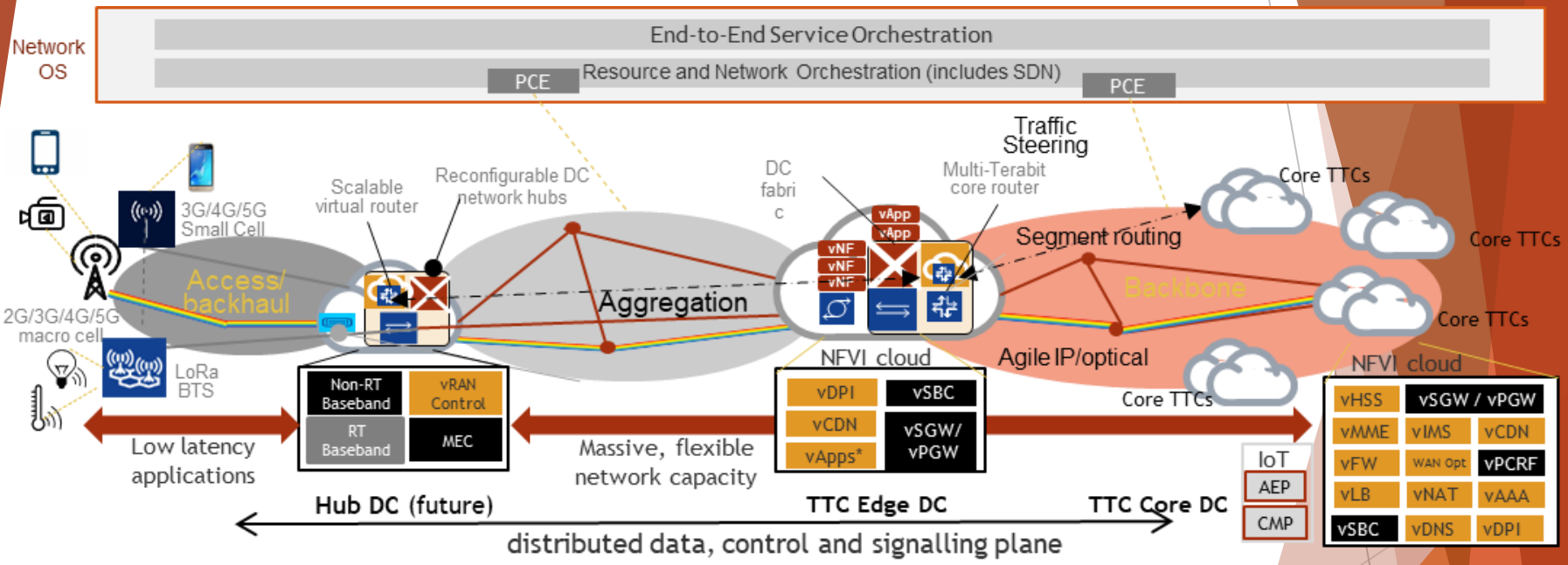
- Europe is lagging behind…

What is the actual expected performance improvement of 5G vs. 4G?



- 5G can clearly outperform 4G as evidenced by real data coming from countries that have already deployed 5G

What an end-to-end 5G Network architecture looks like?



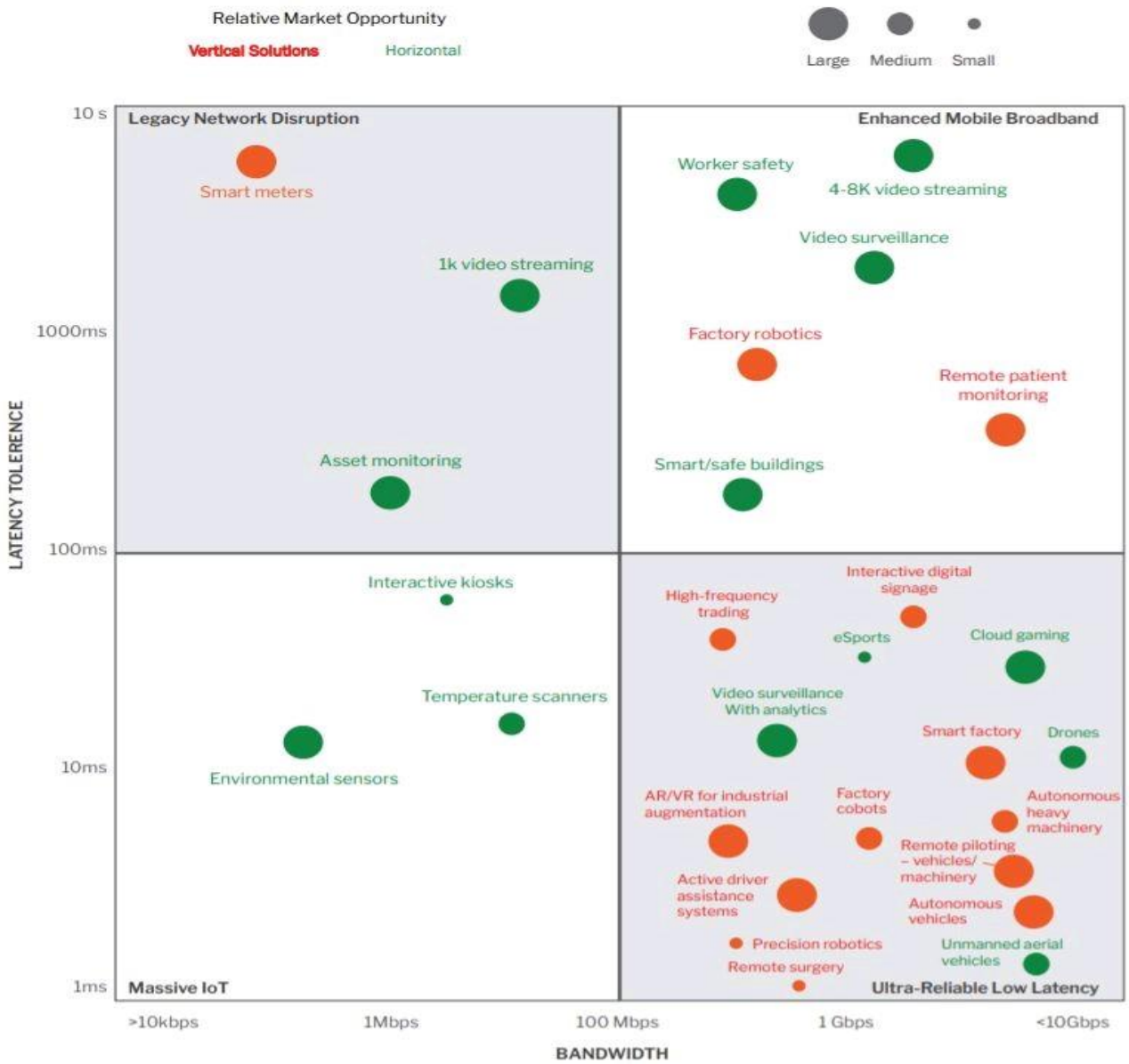
- 5G networks consists of several network segments and incorporate a multitude of hardware and software technologies

The Department of Electrical & Computer Engineering of University of Patras has expertise across all network segments and layers of such 5G infrastructure

Which are the key 5G applications and what is their market opportunity?

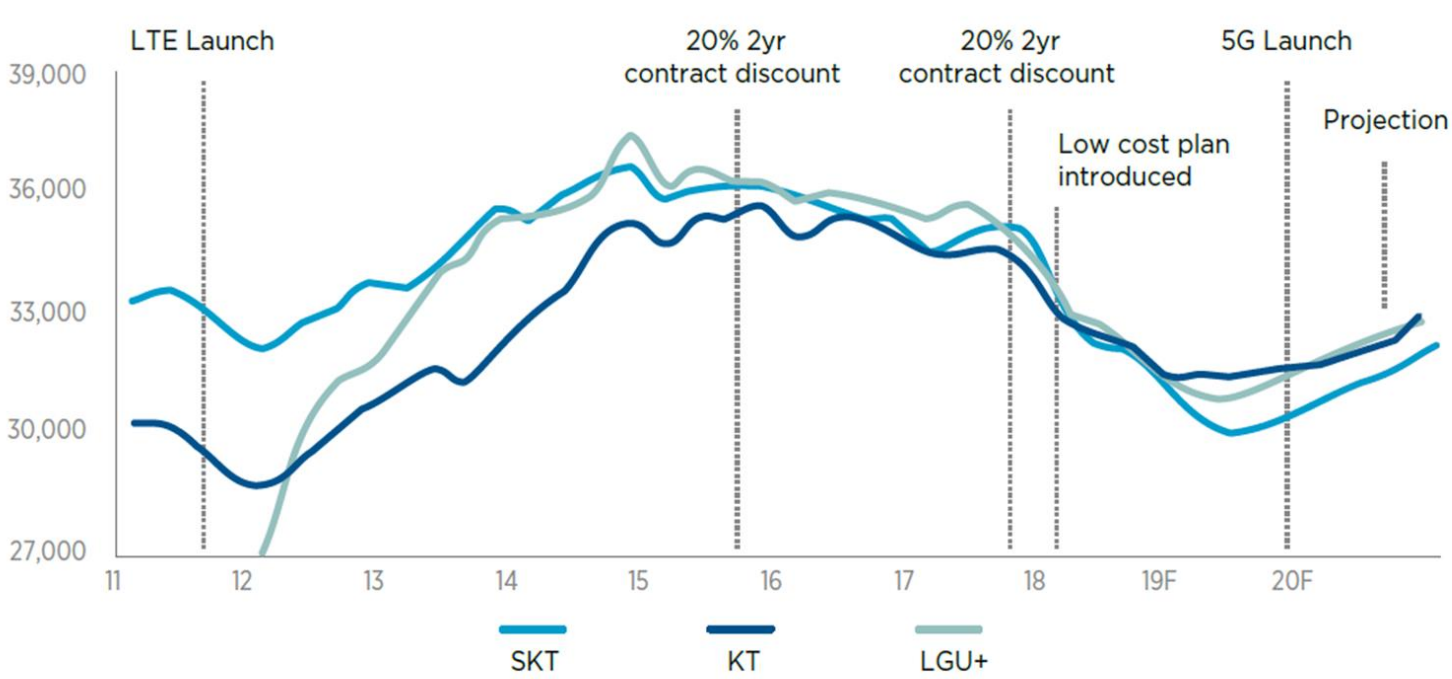
Figure 4: Plotting horizontal and vertical 5G edge cloud network use cases

Source: 451 Research



Do Operators have much to expect from 5G networks?

THE LAUNCH OF 4G LTE STARTED SEVERAL YEARS OF CONTINUOUS ARPU INCREASES FOR SOUTH KOREAN OPERATORS; EARLY MARKET SIGNS INDICATE THAT 5G COULD KICK OFF ANOTHER PERIOD OF ARPU GROWTH



Revenue YoY
SKT 2.9%
KT 1.3%
LGU+ 3.9%

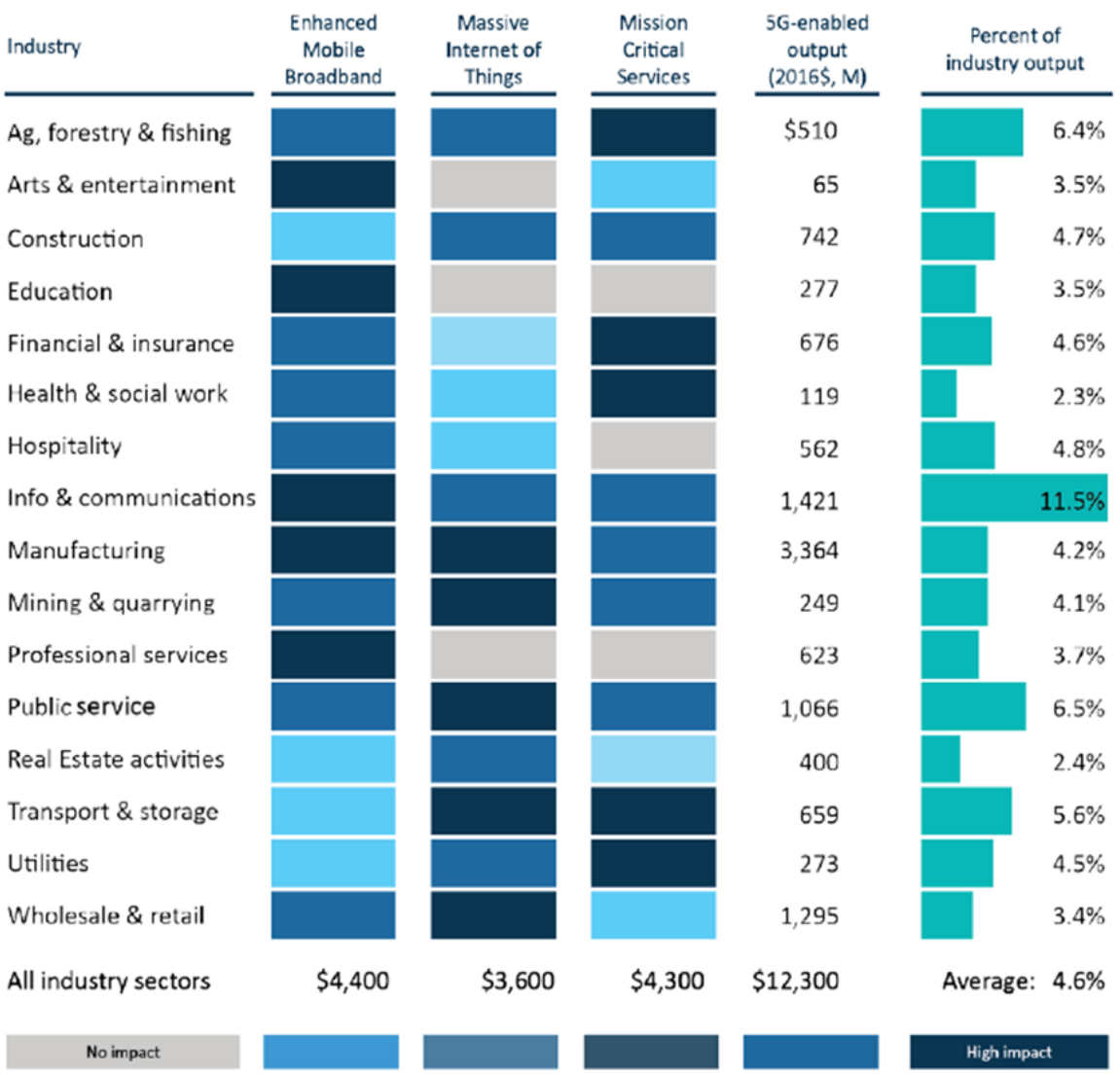
ARPU ~3%
All 3 telcos
last 6 months

GSMA

BCG BOSTON CONSULTING GROUP

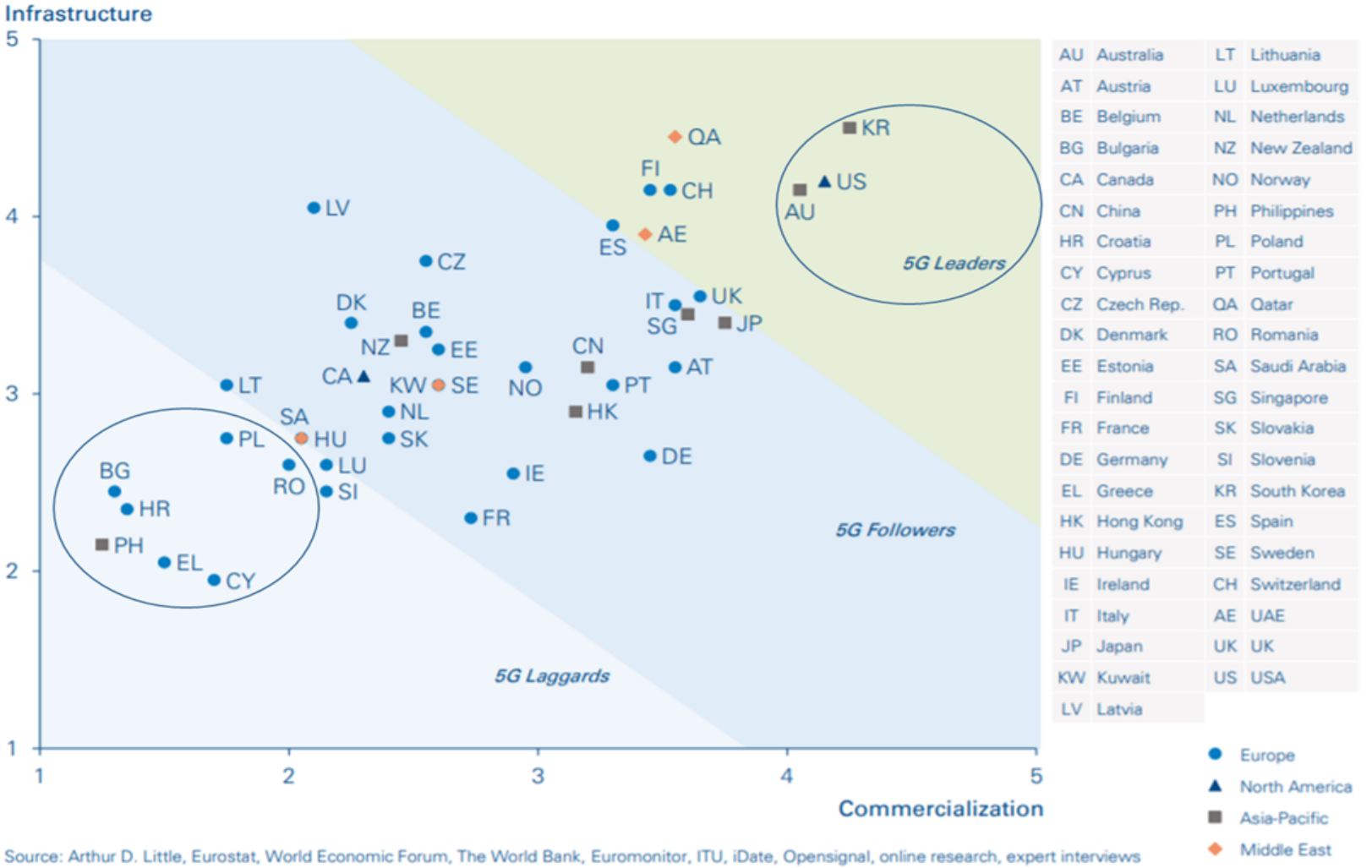
Do Governments have much to expect from 5G networks?

- 5G will enable $12 Trillion of global economic activity by 2035!
- Key enablers are the use cases that support
  - Enhanced Mobile Broadband,
  - Massive IoT, and
  - Mission Critical Services requiring low latency and high reliability
- All major sectors of the economy are impacted in a major way, with the "Lion's Share" taken by the ICT sector



Source: IHS (2017) *The 5G economy: how 5G technology will contribute to the global economy.*
Note: Mission critical services refers to any activity, device or system whose failure or disruption would cause a failure in business operations.[17]

Where do countries stand wrt 5G Readiness?



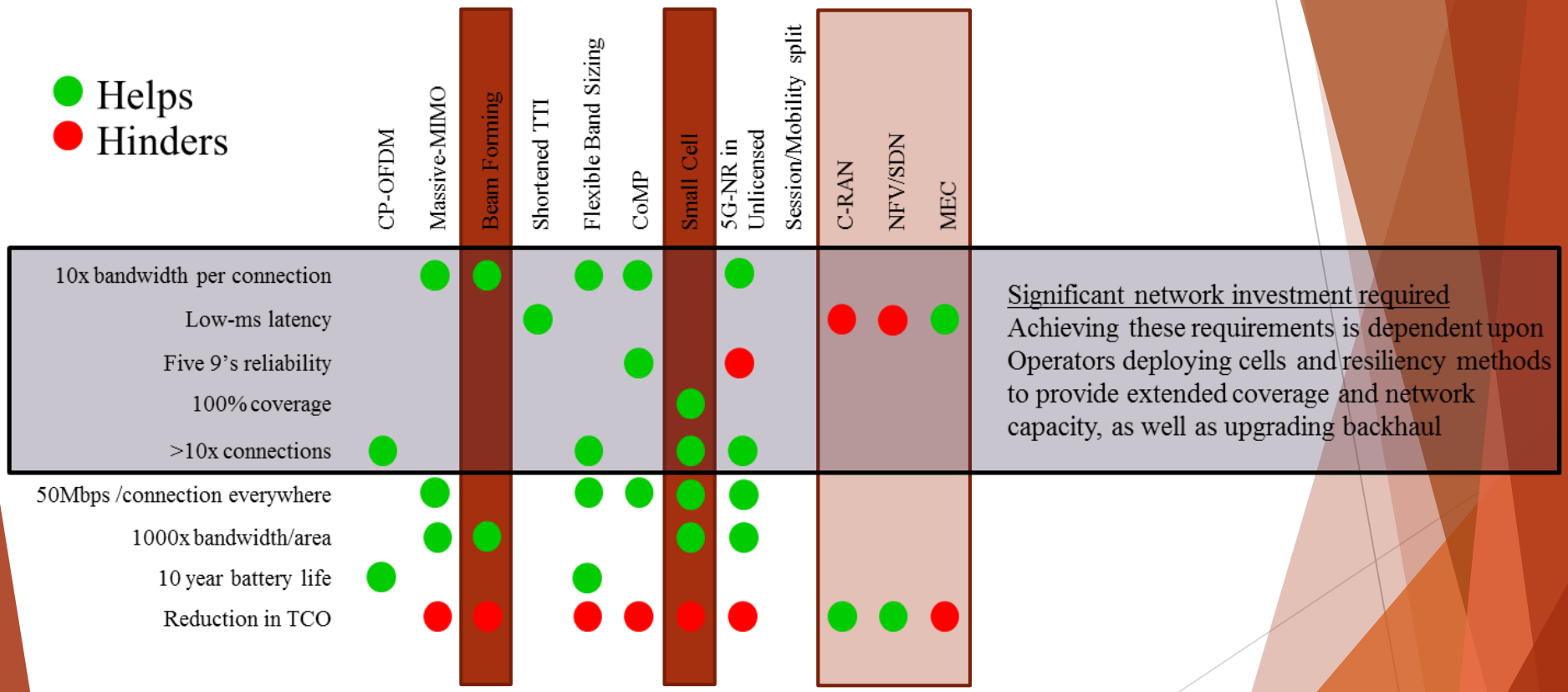
Source: Arthur D. Little, Eurostat, World Economic Forum, The World Bank, Euromonitor, ITU, iDate, Opensignal, online research, expert interviews

- Which conditions determine the leaders from the others?
- Depending on the adopted #policies and #strategies the current situation can change and for some counties must change

Example of Good Practices for National 5G Strategies by Governments: Greece!

- Typical auction-based spectrum licensing procedure is underway
- However, a major Greek Government initiative/innovation is the creation of the “Faistos Venture Capital Fund” that amounts to about 100MEuros (25% of the proceeds from the national 5G spectrum action)
- Another key government initiative was the decision to allow Greek Universities and Research Centers to get free access to the available 5G spectrum for implementing novel use cases and for assisting start-ups to test their ideas and prototypes

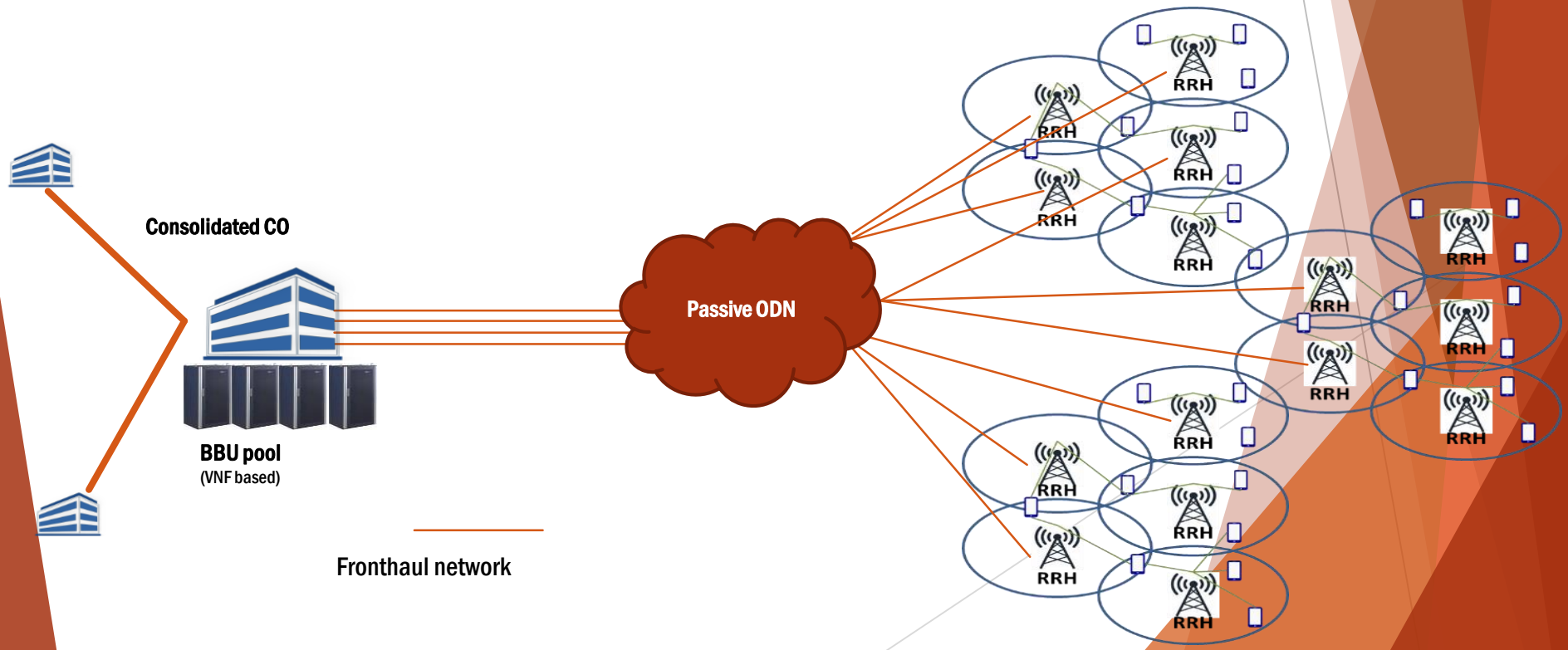
5G Enabling technologies and KPIs



C-RAN Network for small-cells support

- Consolidated C-RAN architecture
  - BBUs completely centralized
    - Processing largely centralized
  - Requires certain functions in dedicated HW
    - Encryption/HARQ/FEC
  - **Dense optical distribution network**
    - To reach the RRHs with dedicated fiber

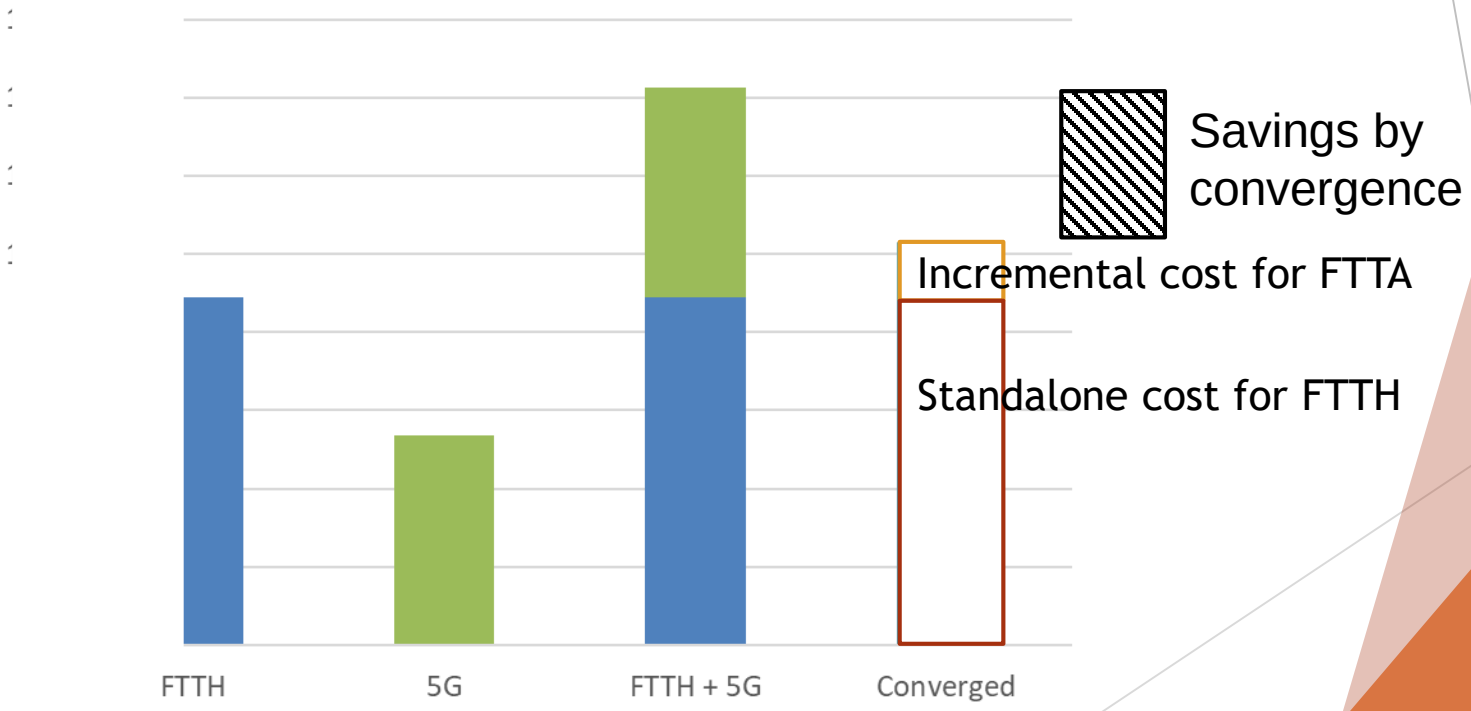
5G needs Fibre to every Cell Site to connect them to the BBU pool



Results for expected savings arising from joint FTTH/5G deployments

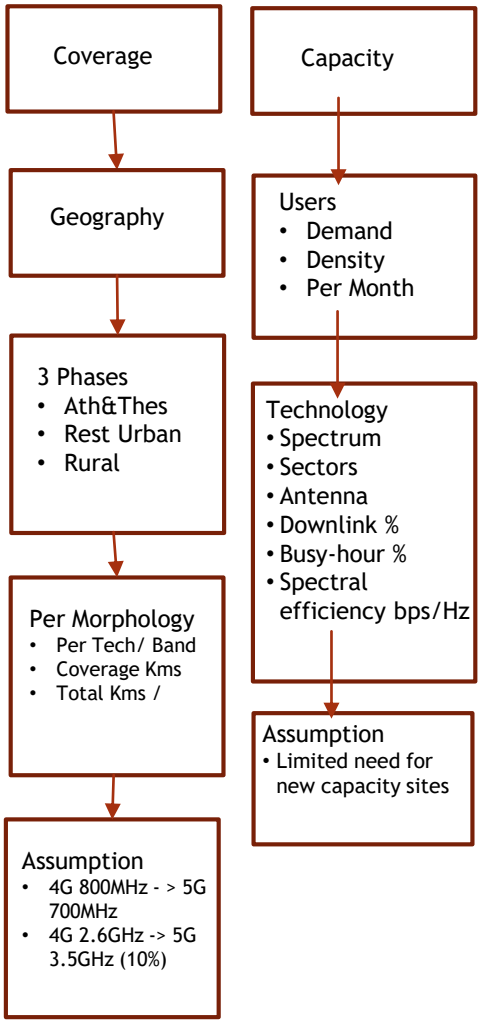
Synergy opportunities from joint deployment of FTTH & 5G networks:

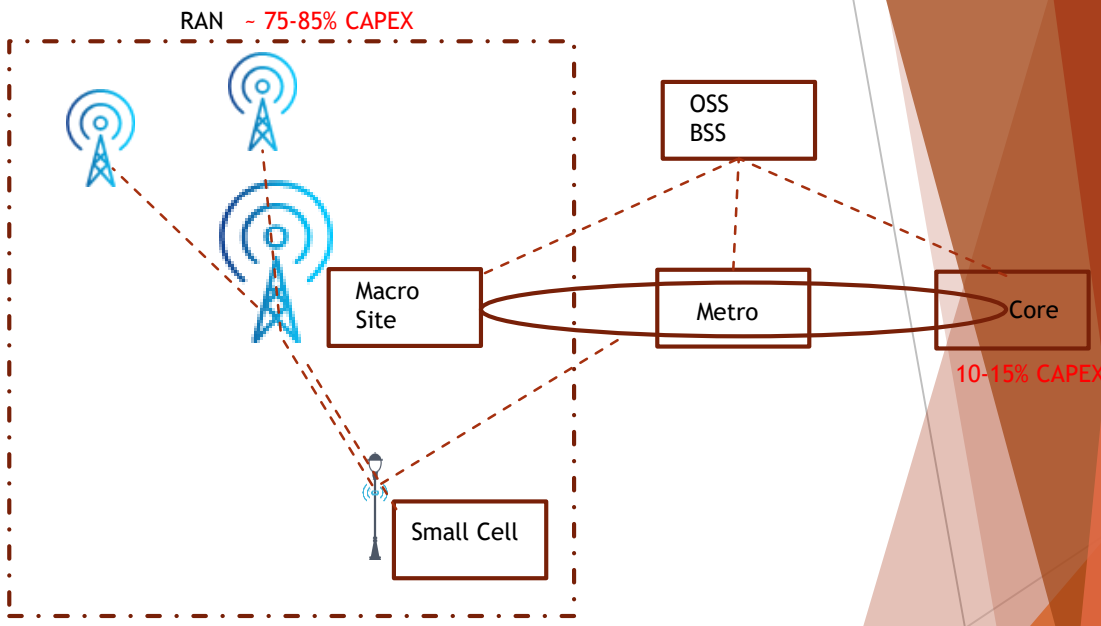
- Similar routes/trenches?
- Shared ducts?
- Shared cables?
- Shared fibres and active components?



Study contacted in collaboration with the FTTH Council Europe

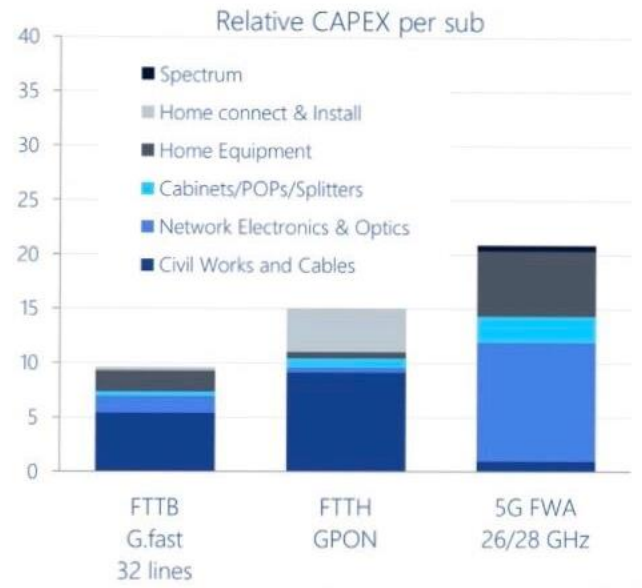
Where/How-much are the costs for a Nationwide 5G Network deployment?



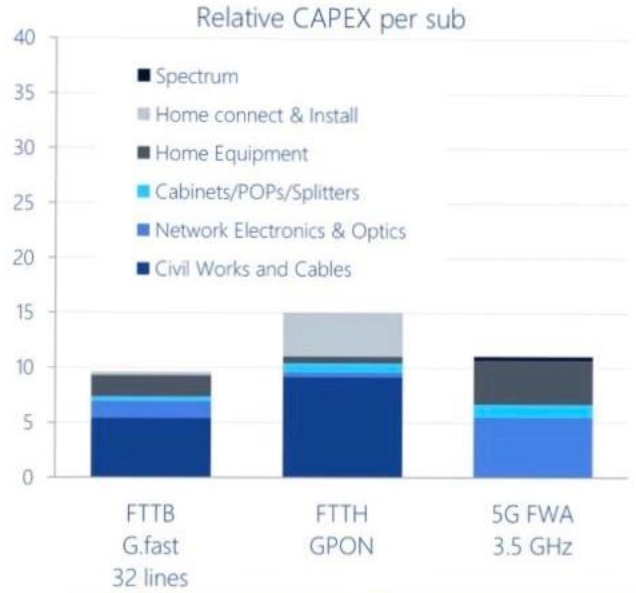


Initial estimates for early-stage investments from the 3 operators exceeds 1.5BEuros

Relative CAPEX per Subscriber:
FTTB/G.Fast vs. FTTH/PON vs. 5G 3.5G/28G



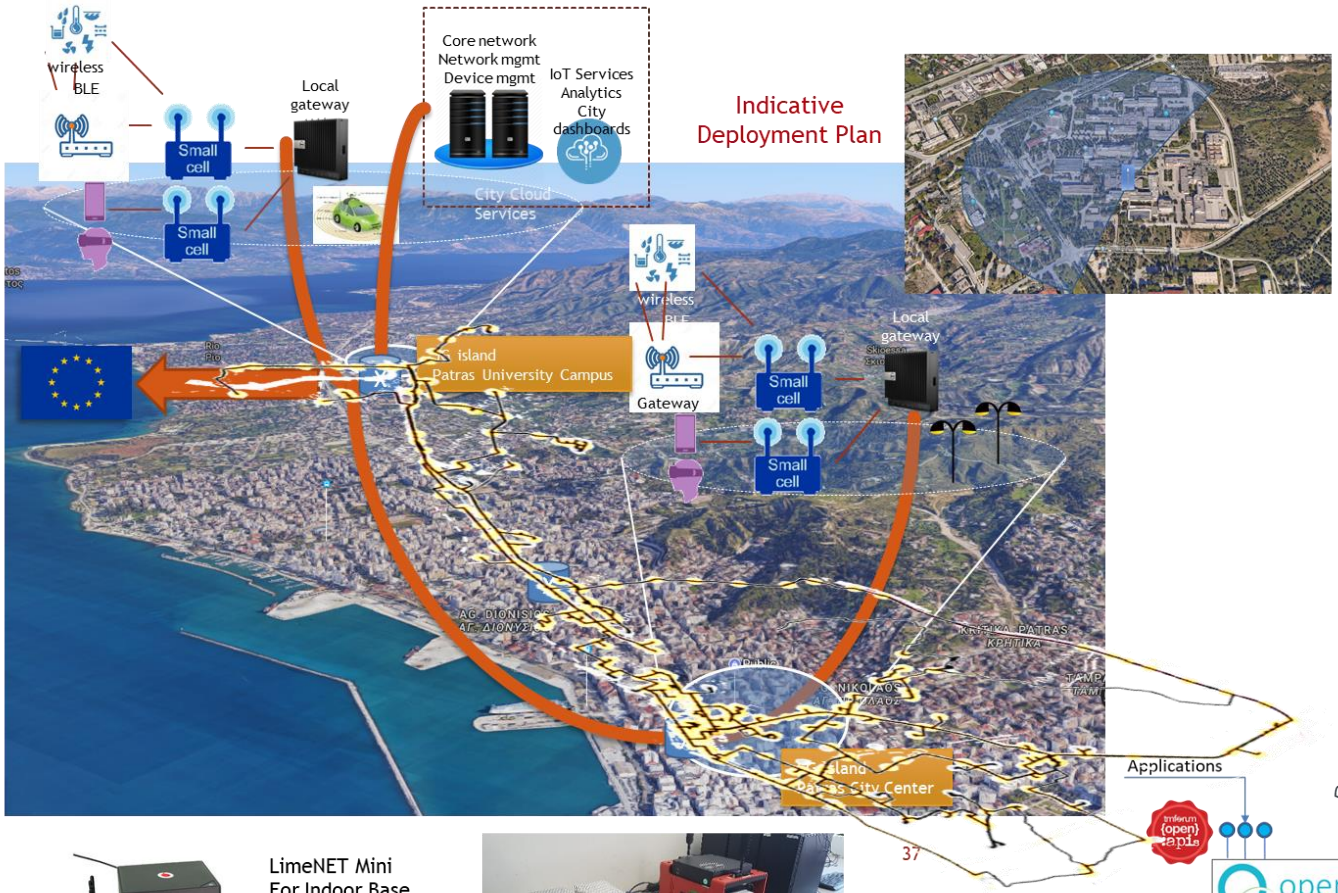
Technology	DL Peak	DL Sustained
FTTH GPON	1Gbps	100 Mbps
5G FWA (mmWave)	1Gbps	100 Mbps



Technology	DL Peak	DL Sustained
FTTH GPON	1Gbps	100 Mbps
5G FWA (3.5 GHz)	1Gbps	35 Mbps

- For 5G, using 80MHz of mid band (3.5GHz) provides the best performance/cost ratio and can be more cost effective that FTTx deployments when services requirements are not very demanding. When using mmWaves then the current performance/cost is relatively higher.
- A good approach by operators is to start with 5G mid-band and then add mmWave as a capacity booster once the site start demanding more capacity.

5G Lab/testbed @ Upatras/Patras



LimeNET Mini
For Indoor Base
Station test
as “crowdcell”
and as UE

LimeNET 5G Base Station Deployed outdoor

Outdoors
Antenna

Drone

5G NSA,SA
UEs/CPEs

SDRs

AMARISOFT 5GNR stations
deployed Indoors

Thank you for your attention!

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3rd BALTIC SEA REGION 5G ECOSYSTEM FORUM

5G TECHRITORY

RIGA, LATVIA | November 11 – 12, 2020

PHYGITAL EDITION

Smart Mobility

Logistics: data-driven secure flow of things

Green Mobility: shift to environmentally conscious practices

Urban Mobility: Mobile tech-enhanced commuting experience

Future Mobility: How far can 4G take us?

Smart Cities

Testbeds and Innovation Districts

Innovation and Legal Framework

Green Cities: Do's and Don'ts

Data-driven city & society: big data in a smart city

5G for all Needs

Security & Risk

Cybersecurity

Data Integrity

Transparency

High Risk AI – EU paper

Smart Business

Smart Enterprise: the future of enterprise

Industry 4.0: digitalisation of industry sectors

Digital Construction/Real Estate

Edge Cloud (MEC)

Innovative New Applications

Tele-medicine

Tele-training

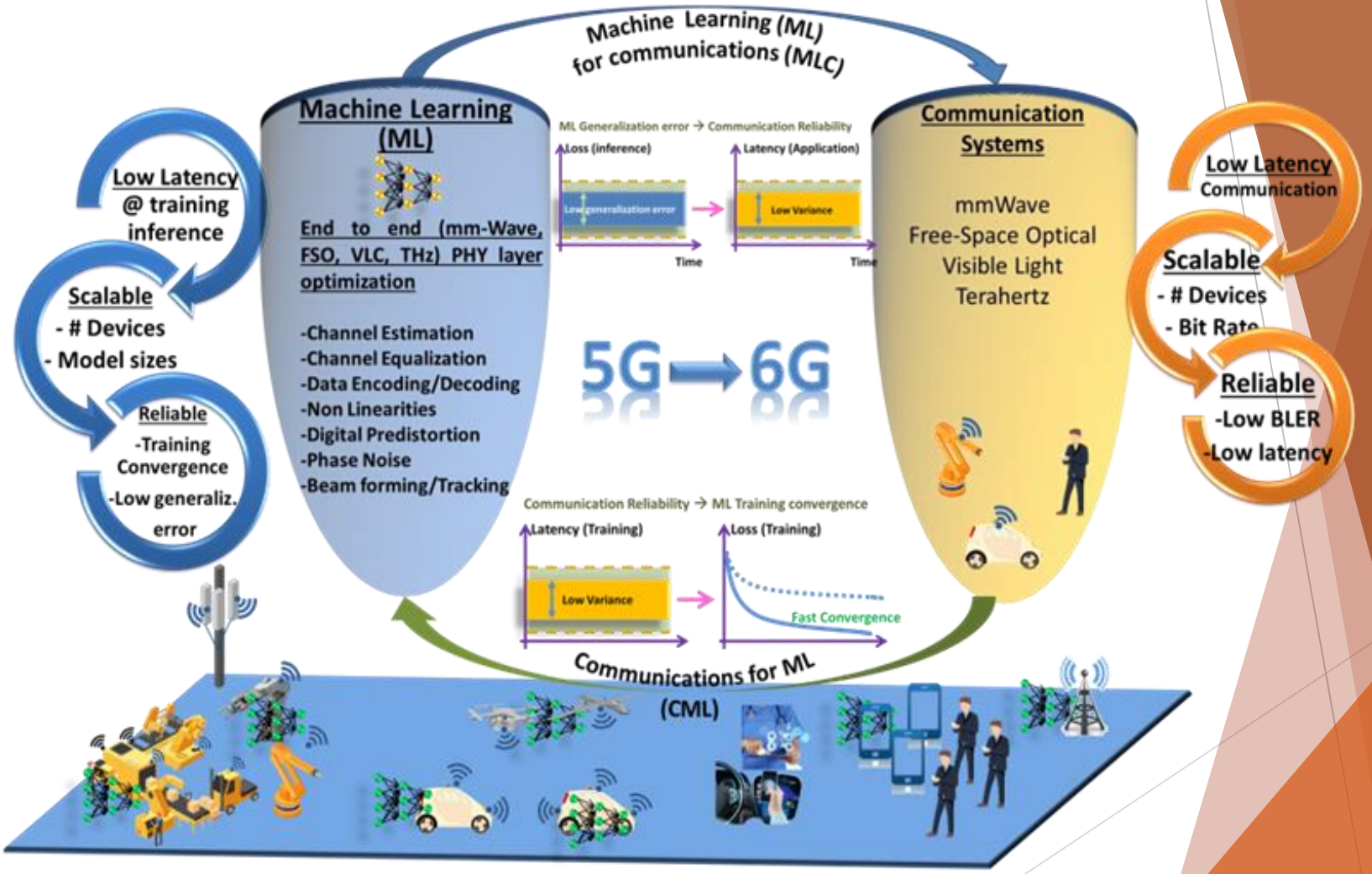
XR

Gaming / Cloud Gaming

Next Gen media and broadcasting

https://www.5gtechritory.com/updates2020/agenda

On the road to 6G: ML@Edge via Comms (and vice-versa)



"Toward the 6G Network Era: Opportunities and Challenges", I Tomkos, D Klonidis, E Pikasis, S Theodoridis, IEEE IT Professional 22 (1), 34-38, 2020

(has become one of the most popular articles at IEEE Xplore on the topic of 6G!)