Seventh SG13 Regional Workshop on
"Standardization of Future Networks towards Building a Better Connected Africa"

QoS Requirements of IMT-2020

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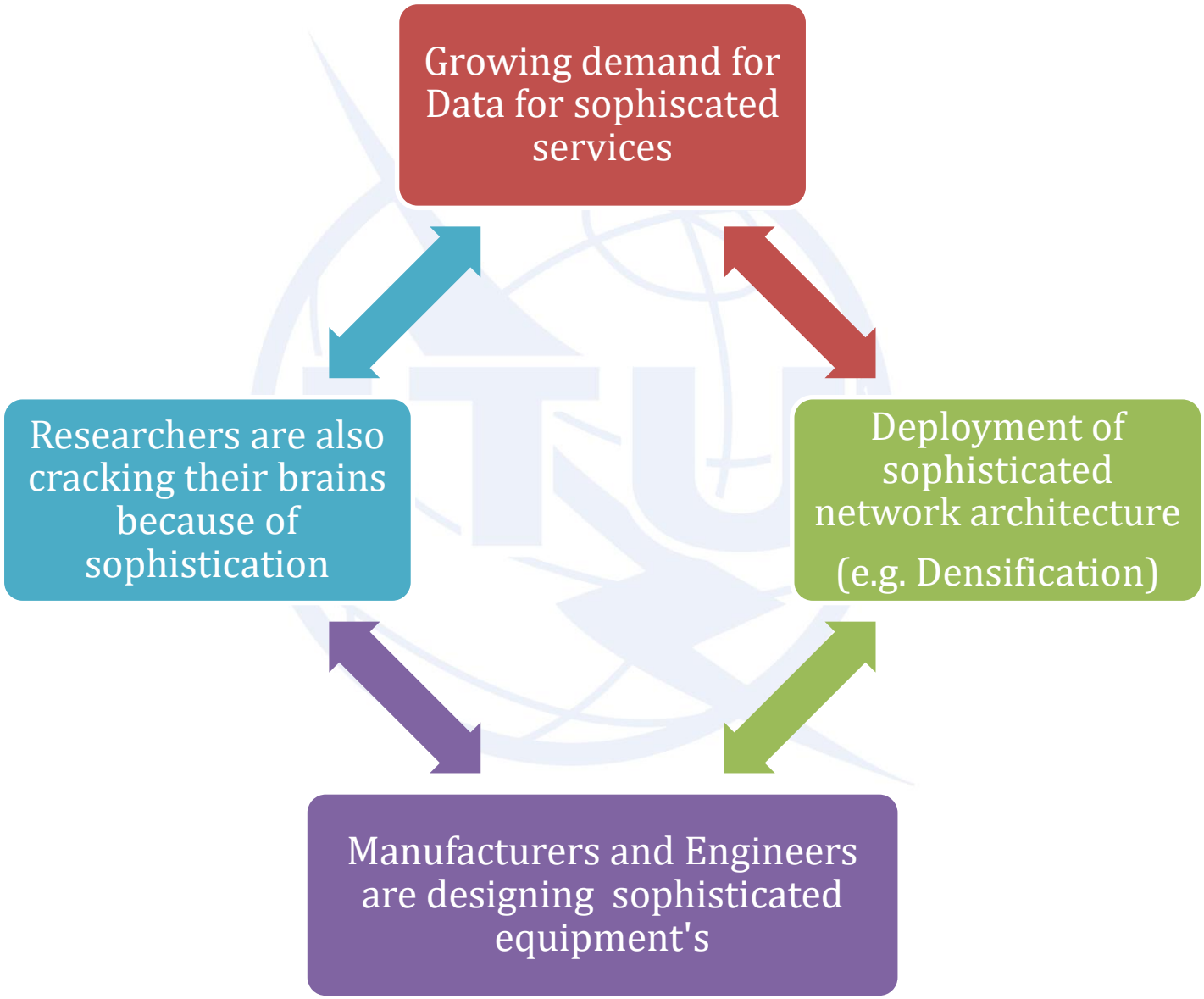
Presentation Outline

- Introduction
- Background and Evolutions
- Speed&Latency&Subscription Evolutions
- 5G in Perspective
- Specifications of IMT 2020
- 5G Candidate Techniques
- Network Slicing
- QoS Requirements
- Food for Thought

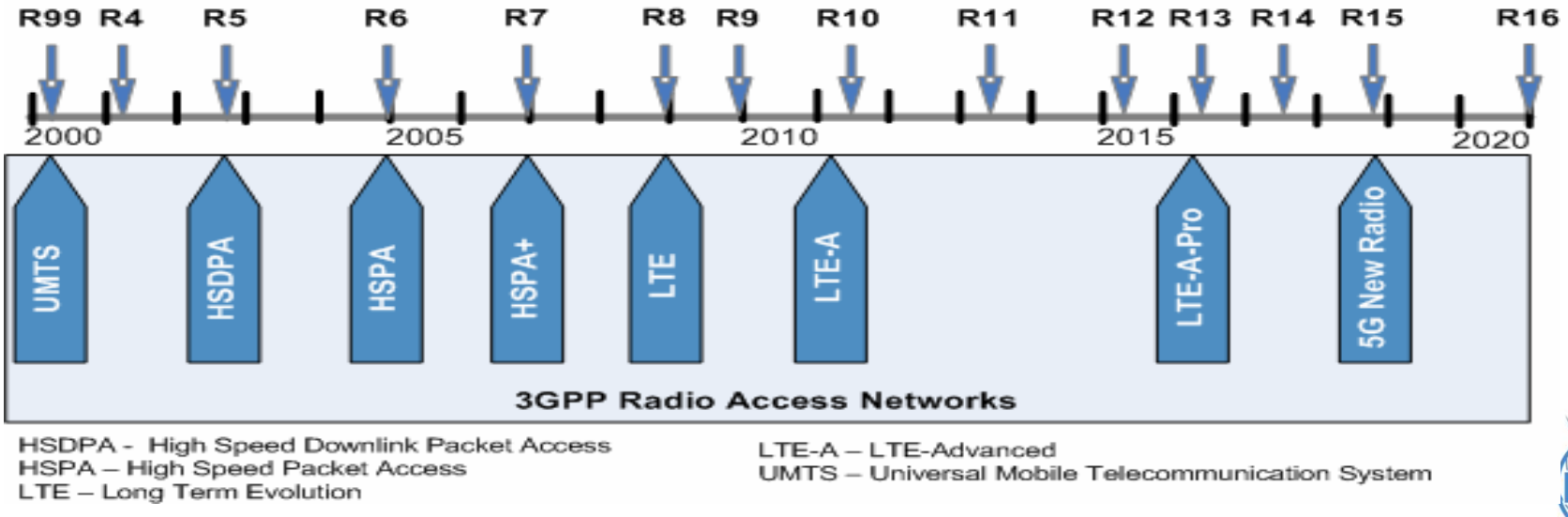
Introduction



Speed and latency evolution of mobile networks

	1G	2G	3G	4G	5G
Approximate deployment date	1980s	1990s	2000s	2010s	2020s
Theoretical download speed	2kbit/s	384kbit/s	56Mbit/s	1Gbit/s	10Gbit/s
Latency	N/A	629 ms	212 ms	60-98 ms	< 1 ms

Speed and latency evolution of mobile networks from 1G to 5G



The 3GPP mobile networks evolution

Evolution Towards 5G

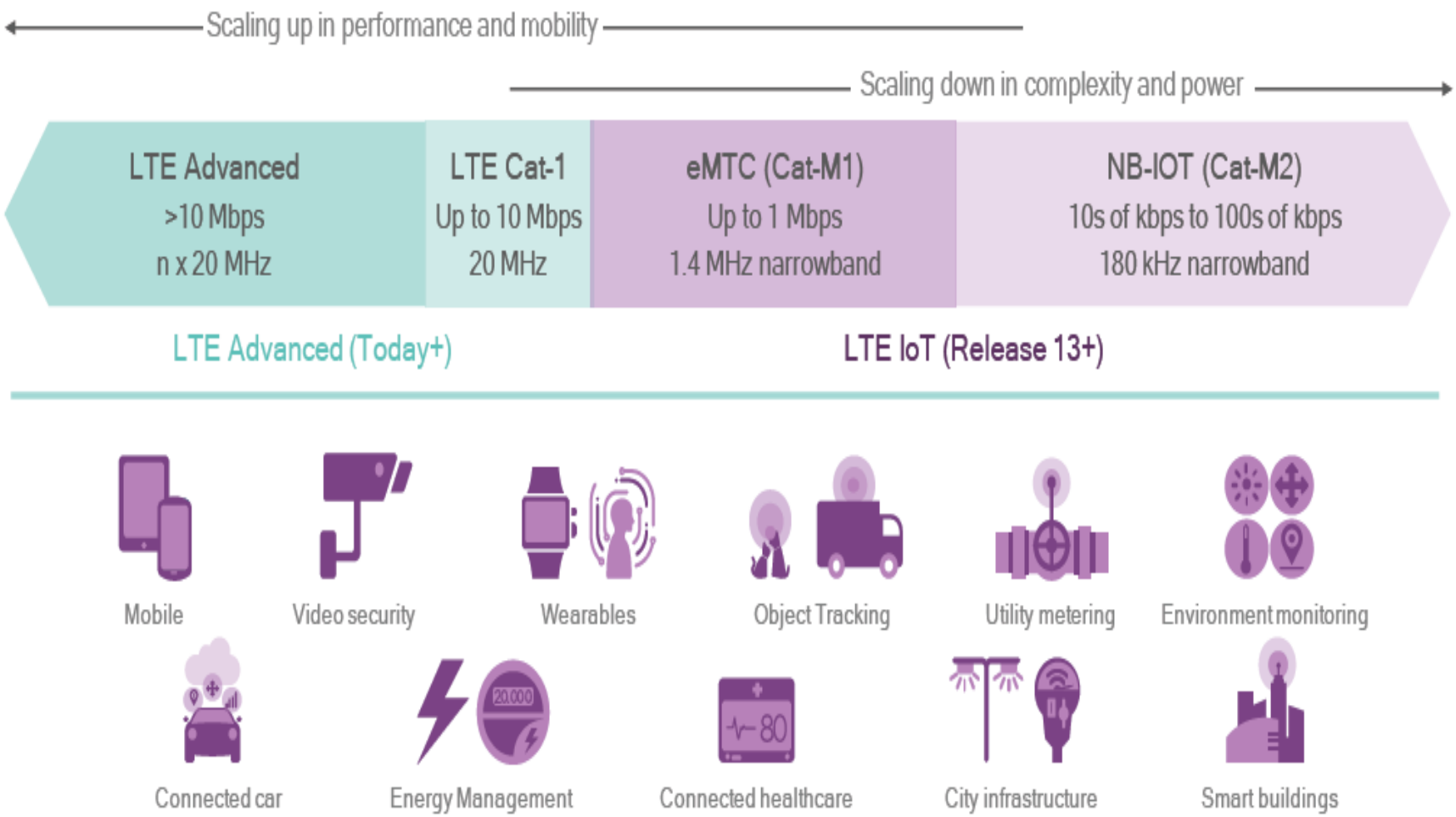
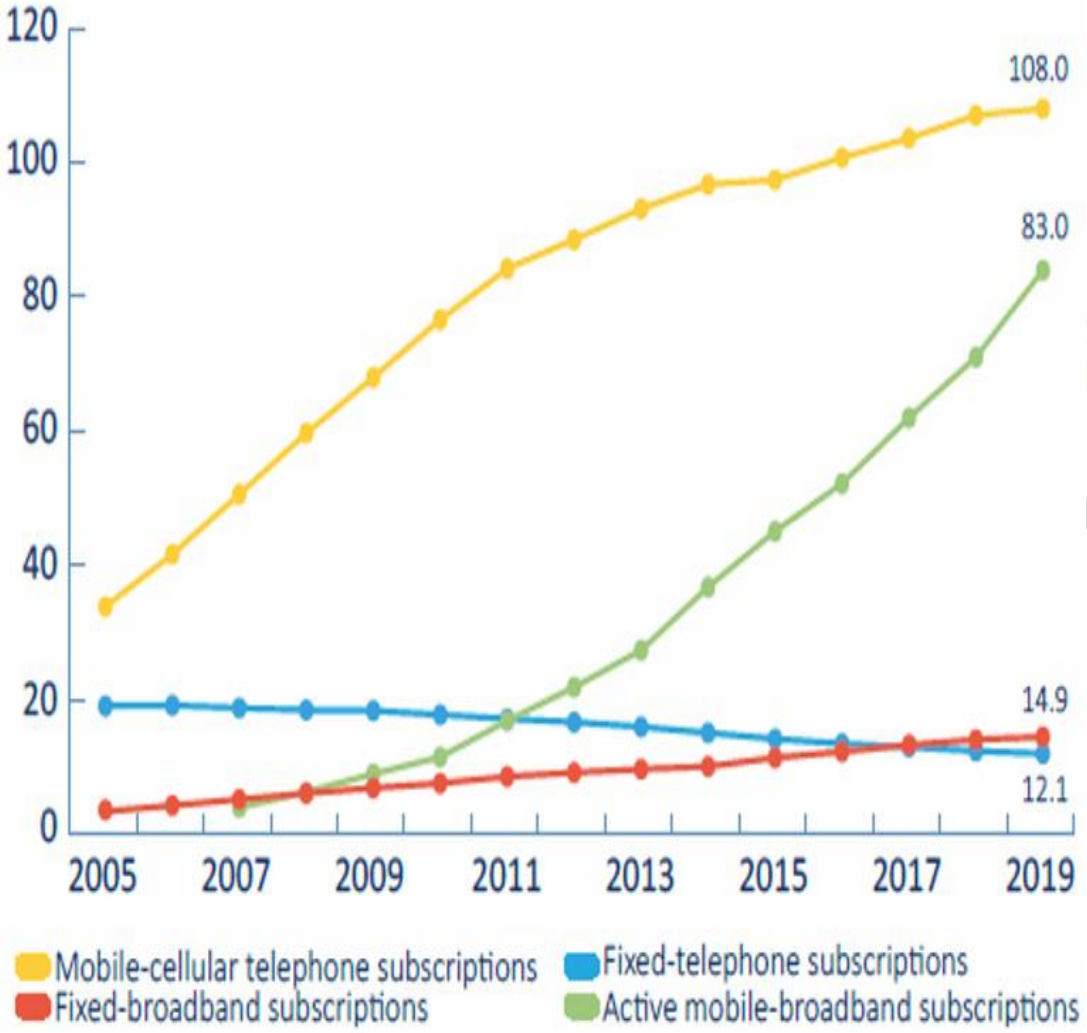
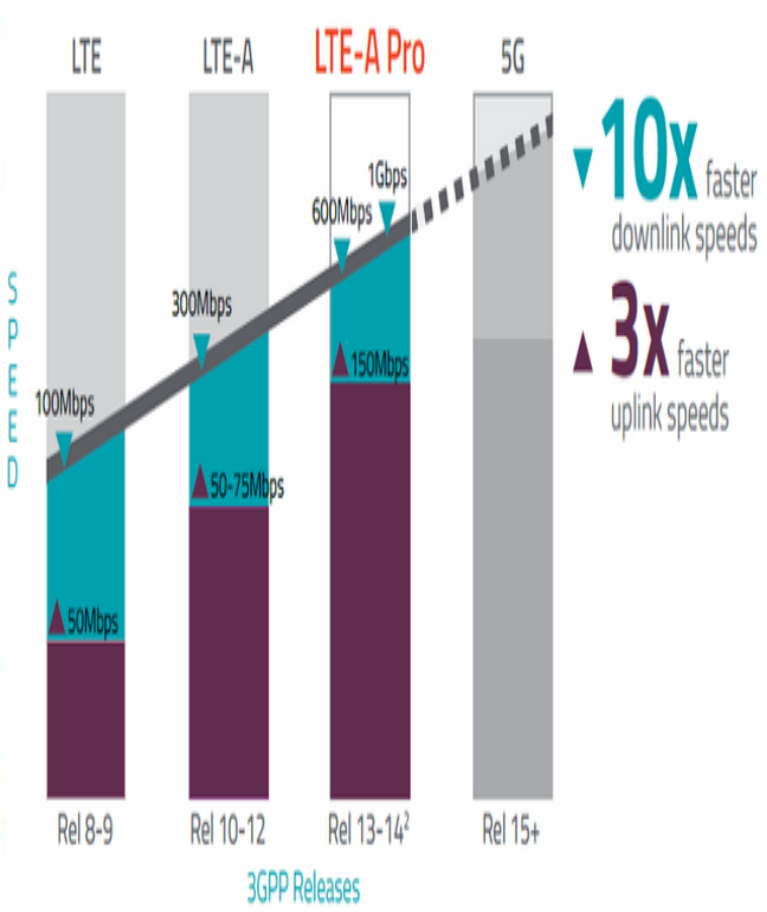


Illustration how the LTE (and LTE-A Pro) is scaling to connect the IoT

Effects of Evolutions



Note: * ITU estimate. Source: ITU.

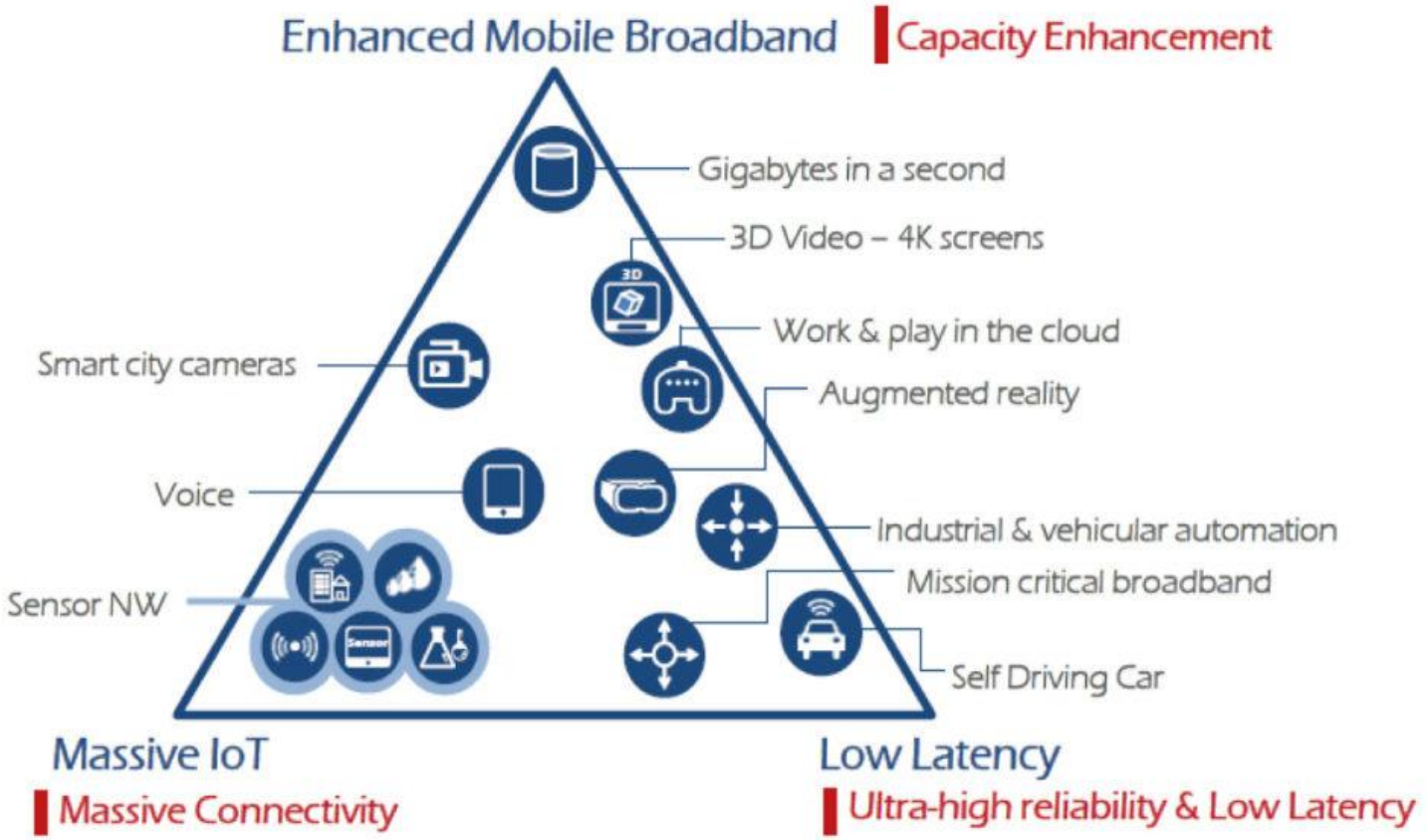


What is 5G?

WIRELESS CONNECTIVITY BETWEEN PEOPLE AND DEVICES

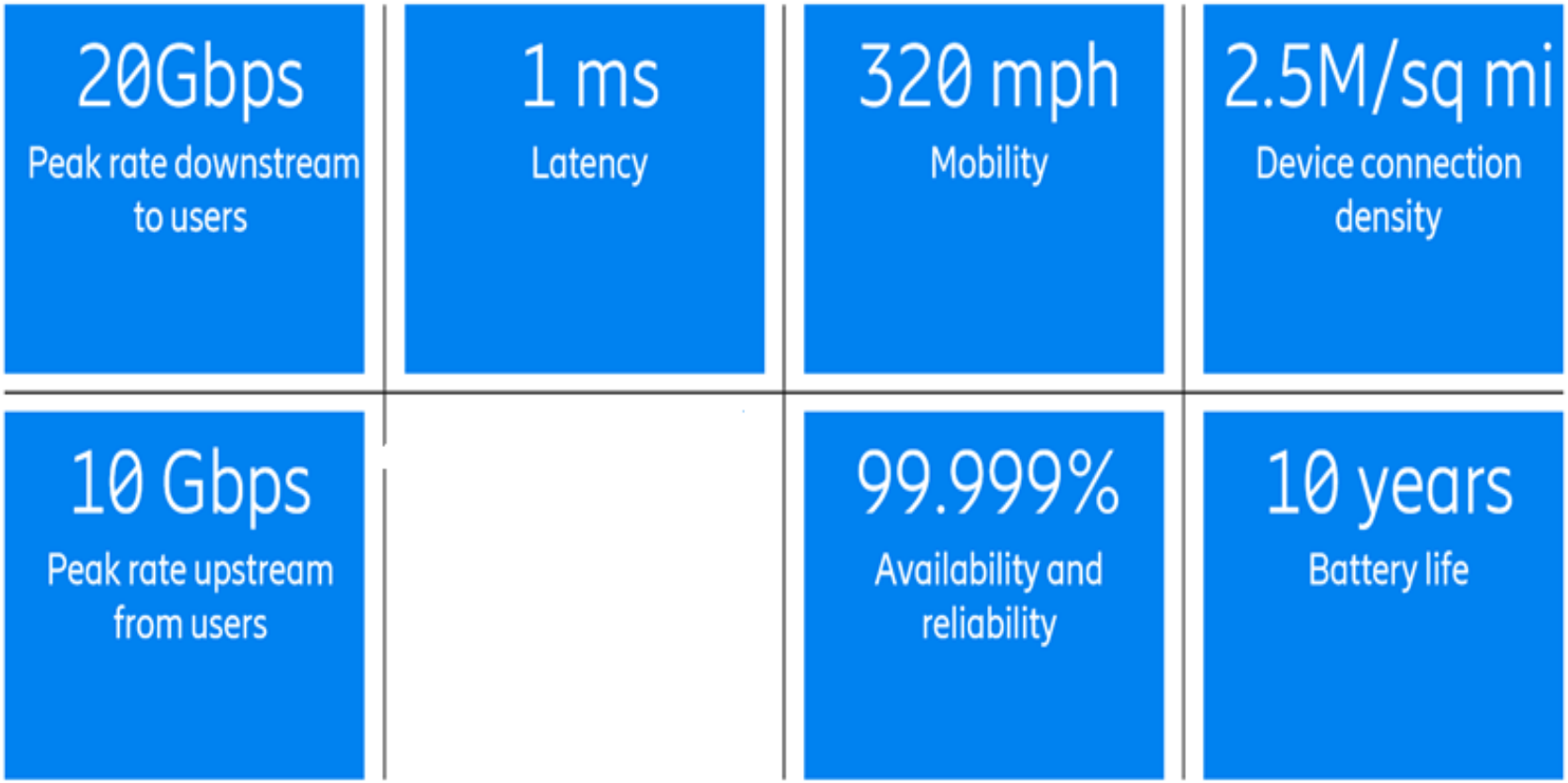
- **Technical Requirements: Capacity & Energy efficiencies, Latency, Reliability, Connectivity**
  - Speed is not the only differentiator between 5G and previous generations

Why 5G?



(Source: ETRI graphic, from ITU-R IMT 2020 requirements)

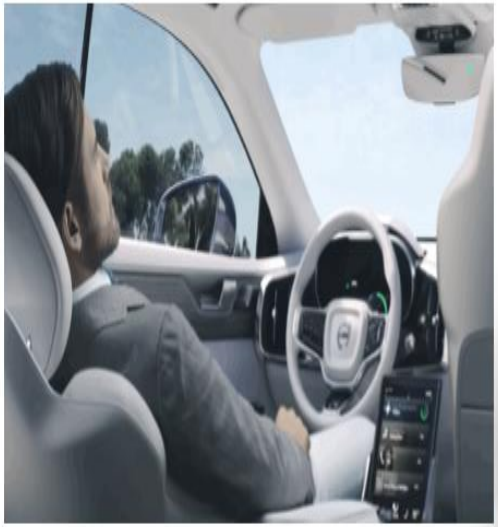
5G Requirements

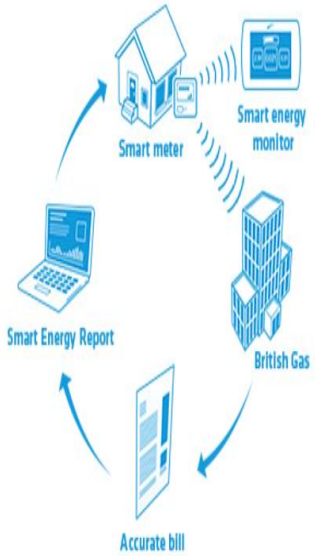


Use Cases of 5G

Examples:

- Video streaming
- File Downloading
- Online Gaming





- Smart meters

Examples:

- Autonomous driving
- Remote surgery
- ...

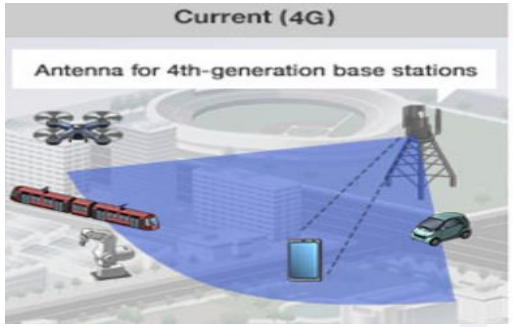
LTE-A vs. IMT 2020

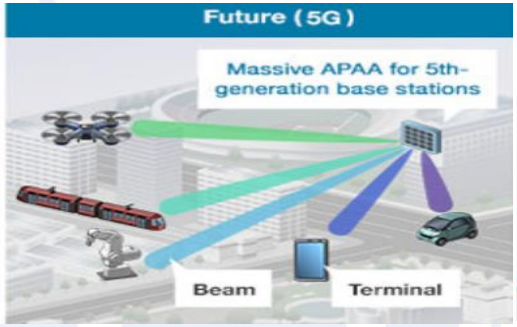
	IMT-Advanced	IMT-2020
Minimum peak bitrate	Downlink: 1 Gbit/s Uplink: 0.05 Gbit/s	Downlink: 20 Gbit/s Uplink: 10 Gbit/s
Bitrate experienced by individual mobile device	10 Mbit/s	100 Mbit/s
Peak spectral efficiency	Downlink: 15 bit/s/Hz Uplink: 6.75 bit/s/Hz	Downlink: 30 bit/s/Hz Uplink: 15 bit/s/Hz
Mobility	350 km/h	500 km/h
User plane latency	10 msec	1 msec
Connection density	100 thousand devices per square kilometer	1 million devices per square kilometer
Traffic capacity	0.1 Mbit/s/sq. m.	10 Mbit/s/sq. m. in hot spots
Frequency bandwidth	Up to 20 MHz/carrier (up to 100 MHz aggregated)	Up to 1 GHz (single or multiple frequency carriers)

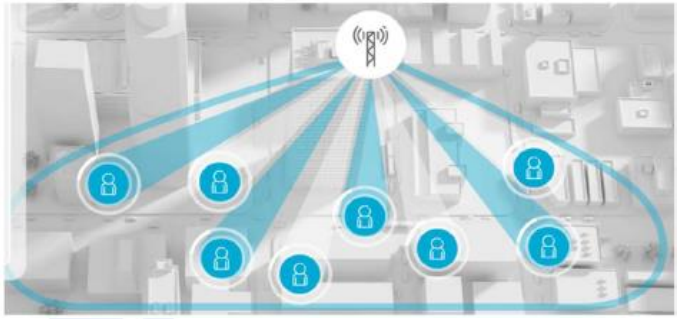
Question is “How can it be done”

5G Air interface Candidate Techniques

Advance Antenna Technology (powerful tools for improving end-user experience, capacity and coverage)



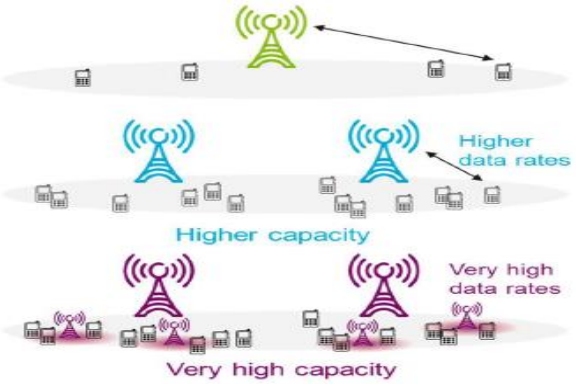




- Beamforming and MIMO (Multiple Input Multiple Output)
- Full Dimension MIMO (FD-MIMO)
- Massive MIMO, which is considered as key enabler for 5G
- Millimeterwave Communications

Other Technical Techniques

- **Carrier Aggregation** enables faster data speeds by increasing the bandwidth available to devices by using more than one carrier (channel)
- **Network Densification/Small Cell Deployment**
- **Multi Cell Joint Processing**
- **Radio Access Network Slicing**



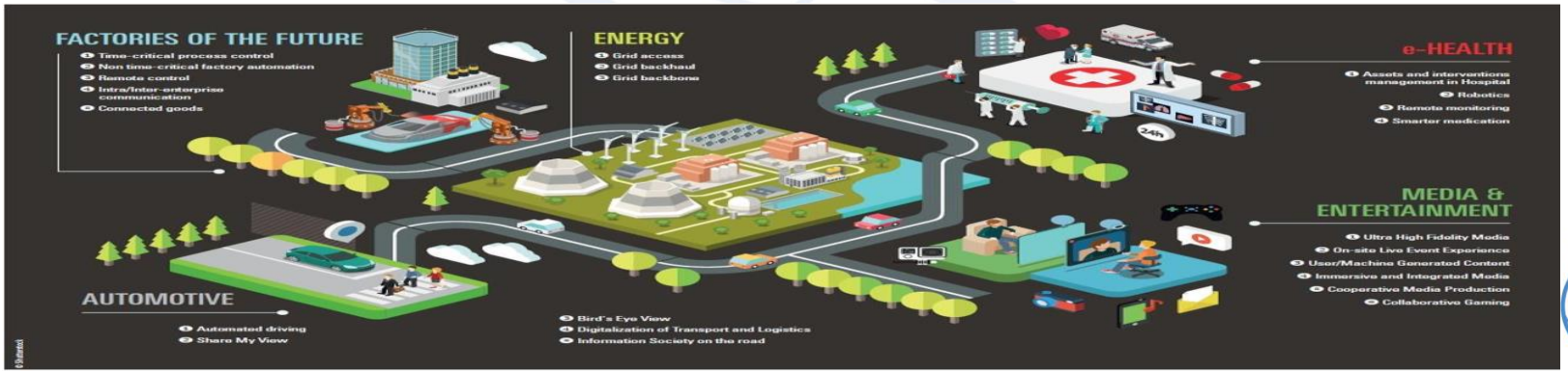
Regulatory view point;

❖Spectrum Management is also key to 5G

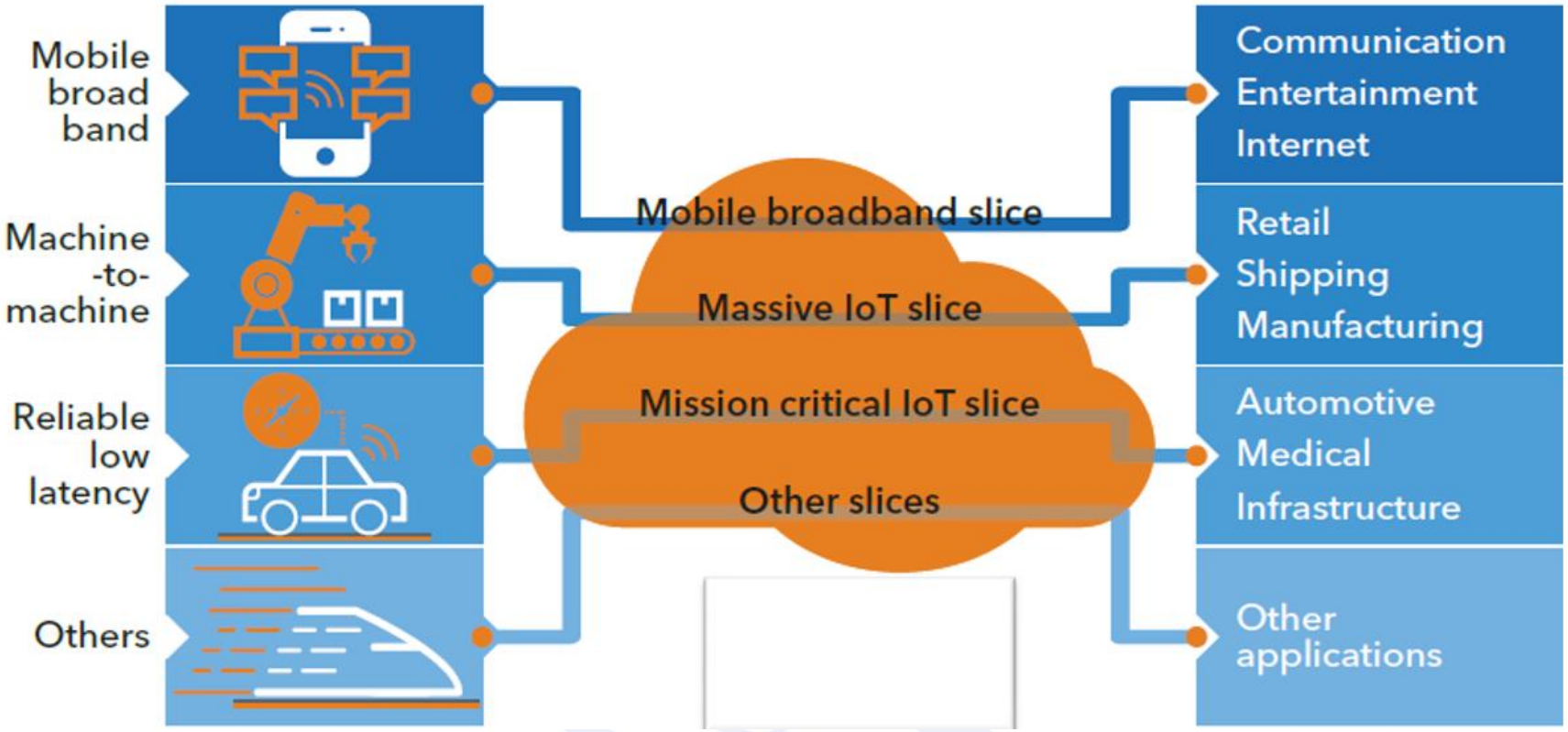
Addressing the Issues

- Different 5G use cases/verticals have extremely diverse and conflicting technical requirements.

- **Question: What is the best strategy to support all the use cases/verticals in 5G**

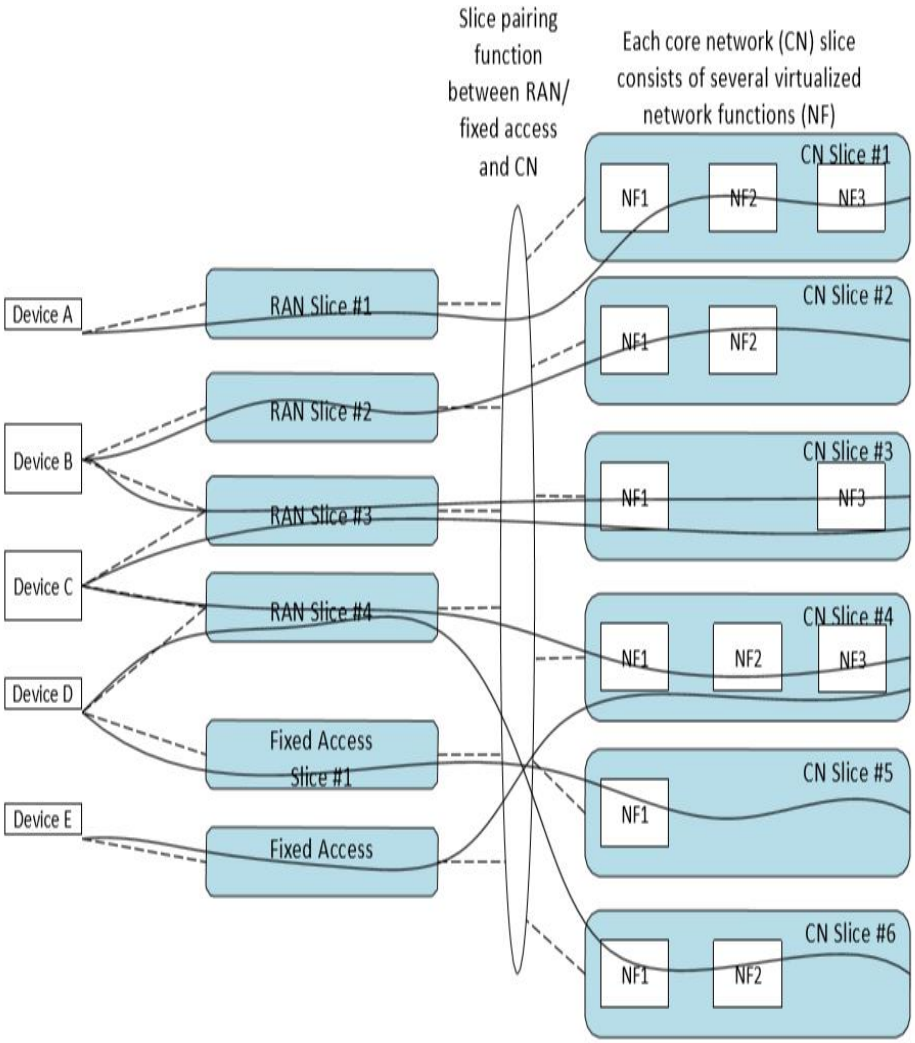


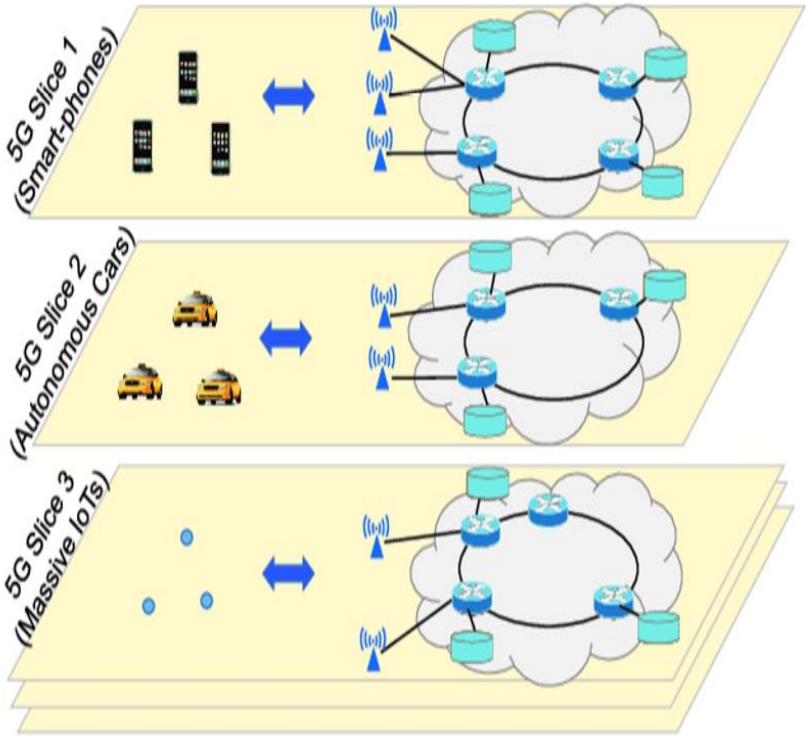
Network Slicing



Network slicing offers an effective way to meet the requirements of all use cases and enables individual design, deployment, customization, and optimization of different network slices on a common infrastructure

Network Slicing System Architecture





'With Network Slicing QoS will be assured for every service'

QoS requirements

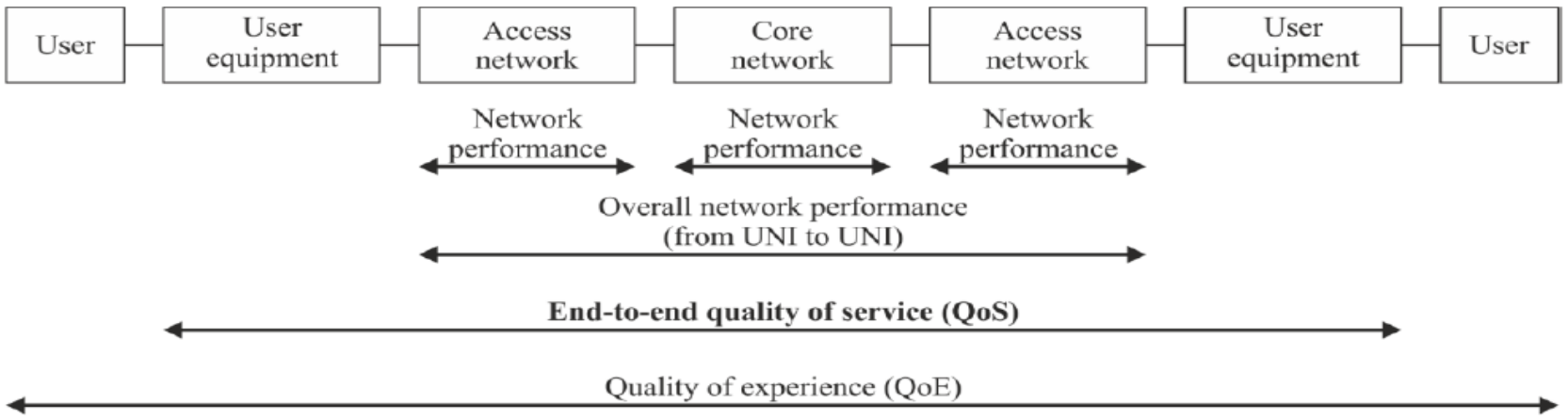
Performance Metrics	mMTC	URLLC	eMBB
Availability	Regular	Very High	Regular
E2E latency	Not highly sensitive	Extremely sensitive	Not highly sensitive
Data Rate	Low	Low/med/high	High
Connection Density	High	Medium	Medium
Network coverage	Full	Localized	Full
Energy Efficiency	High	Low/medium	High
Uniform User Experience	Not required	Required	Required

The challenge: Different 5G use cases/verticals have extremely diverse and conflicting technical requirements.

Question: What is the best strategy to support all the use cases/ verticals in 5G

What is QoS?

- Quality of Service (QoS) support in mobile broadband networks is based on definition of QoS classes and QoS parameters and their mapping on defined bearers.
- Satisfying the QoS requirements of the various applications and services entails quantifying these requirements in terms of parameters that identify target performance levels
- Parameters include Throughput (downlink and uplink), Delay, Jitter, and Packet loss



Some Key Performance Indicators

The major quantitative parameters:

- **Throughput**: Characterized through the guaranteed bit rate, maximum bit rate, and aggregate maximum bit rate.

- **Area Traffic Capacity**: Total traffic throughput served per geographic area (in Mbit/s/m^2). IMT-2020 is expected to support 10 Mbit/s/m^2 area traffic capacity, for example in hot spots.

- **Latency**: The contribution by the radio network to the time from when the source sends a packet to when the destination receives it (in ms). IMT-2020 would be able to provide 1 ms over-the-air latency, capable of supporting services with very low latency requirements.

- **Peak data rate**: Maximum achievable data rate under ideal conditions per user/device (in Gbit/s). The peak data rate of IMT-2020 for enhanced Mobile Broadband is expected to reach 10 Gbit/s. However under certain conditions and scenarios IMT-2020 would support up to 20 Gbit/s peak data rate.

Voice over 5G NR (VoNR)

The mobile voice is a legacy service which continues to exist in each new mobile generation.

Two main types of voice services that will be available over 5G mobile networks;

Carrier-Grade Voice Service which have strict QoS support and do not belong to the public Internet Voice over New Radio (VoNR) or Vo5G.

OTT Voice Services: will continue to exist in 5G networks and they will continue to be provided through the mobile Internet access on the best effort principle by using the network neutrality (e.g., Viber, WhatsApp, Skype, and others).

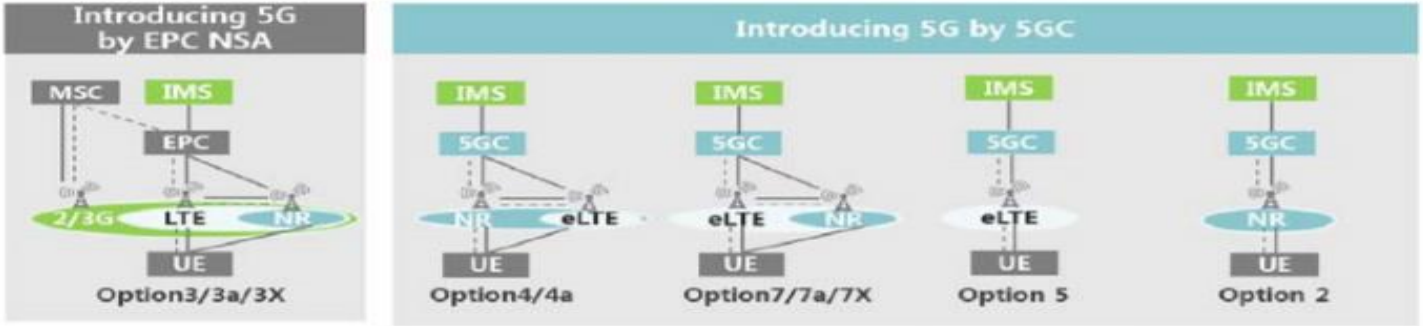
What is happening in VoLTE ?

KPI	VoLTE - VoLTE in the same LTE network	VoLTE – VoLTE between interconnected LTE networks	VoLTE - 3G	VoLTE - PSTN
Registration success rate	99.9%	99.9%	99.9%	99.9%
Service availability	99%	99%	98%	99%
Post dialing Delay (PDD)	LTE-LTE: 3.5 s CSFB: 6 s	LTE-LTE: 4 s CSFB: 6 s	4.5 s CSFB: not defined	4 s CSFB: not defined
Voice QoE (MOS grade)	4	4 (HD voice) 2.8 (otherwise)	3.8 (HD voice) 2.8 (otherwise)	3.1
Mouth-to-ear delay	400 ms	400 ms	400 ms	400 ms
Call drop rate	2 %	2 %	3 %	2 %

ITU-T G.1028 specifies All target values for managed VoIP for the different scenarios

What Happens to VoNR ?

3GPP has specified that 5G uses the 4G voice/video communication architecture and still provides voice/ video communication services based on the IMS. One may note that VoLTE and VoNR are different access modes for IMS (IP Multimedia Subsystem) voice/video communication services

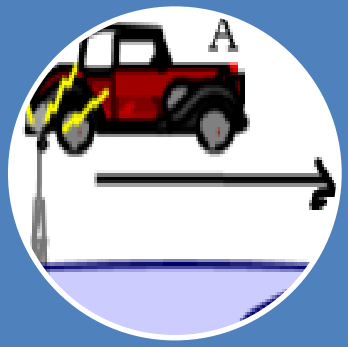


Optional Voice/Video Communication Solution	CSFB->VoLTE->VoNR	EPS FB or RAT FB or VoLTE->VoNR	VoeLTE->VoNR	VoeLTE	EPS FB or RAT FB or VoLTE->VoNR

Typical Scenario

In VoNR;

UEs camp on the 5G NR network, and voice/video communication and data services are carried on the 5G NR network.



When a UE moves to the area where the NR signal coverage is poor, a coverage-based handover needs to be initiated to implement the interworking with the 4G network.

Then, the UE handovers to the LTE network and the VoLTE service is provided.

Food for Thought

How soon is coming to us?

When can we start feeling it?

Is really going to revolutionize anything?

Etc?

Me I can't wait!!!

References

[b-3GPP TS 22.261]3GPP TS 22.261(2018), 3rd Generation Partnership Project, *Service requirements for the 5G system, Stage 1,(Release 16).*

Recommendation ITU-T Y.3106 (formerly Y.IMT2020-qos-req): "QoS functional requirements for the IMT-2020 network”

Thank you