

# QoS and QoE trends for emerging services

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KEYSIGHT TECHNOLOGIES

Jari Schroderus



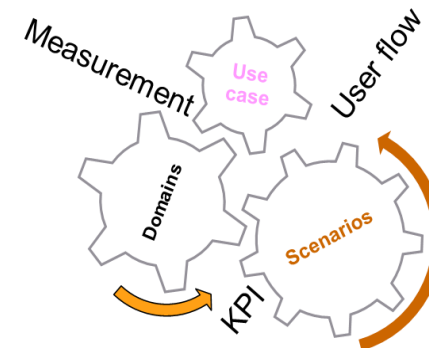
# Many factors matters when you look at QoE

- Environmental: noise, lighting conditions... usually outside of measurement scope
- Human related aspects: be happy, having a bad day... outside of measurement scope..
- Network conditions, battery, crashes: reproducible and measurable: Yes, in focus !
- Statistical confidence and robustness of results
- Collecting data in busy vs. non busy hours may impact NPS scores
- Country and region specific variations in customer application preferences

Restrict QoE influencing factors to:

- What can be “measured” against “Scientific Units”: Time, Data rate, Power...
- What can be automated → statistical relevant
- Model how to map results to use cases, domains and network scenarios

Identifier	Use Case	Application	Mobile device	IoT Device
VR	Virtual Reality	Yes	Yes	
GA	Gaming	Yes	Yes	
AR	Augmented Reality	Yes	Yes	
CS	Content Distribution Streaming Services	Yes	Yes	
LS	Live Streaming Services	Yes	Yes	
SN	Social Networking	Yes	Yes	
HS	High Speed Internet	Yes	Yes	
PM	Patient Monitoring		Yes	Yes
ES	Emergency Services		Yes	Yes
SM	Smart Metering		Yes	Yes
SG	Smart Grids		Yes	Yes
CV	Connected Vehicles		Yes	Yes

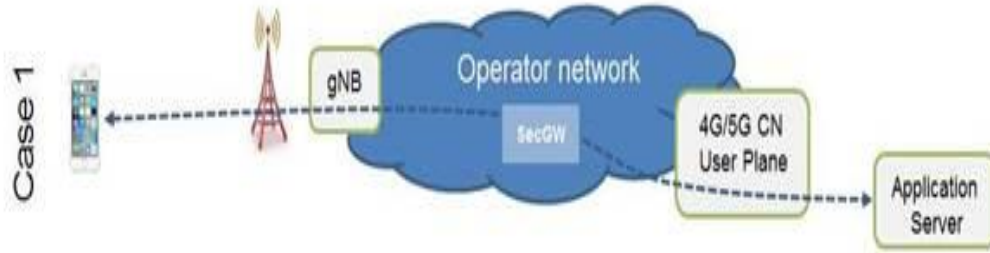


Domain	Application	Mobile device	IoT device
Reliability	Yes		Yes
Network Resources usage	Yes		
User Experience	Yes		
Device Resources usage	Yes		
Network Adaptation	Yes		Yes
Energy Consumption	Yes	Yes	Yes
Data Performance		Yes	Yes
Radio Performance		Yes	Yes
User Experience with Reference Apps		Yes	

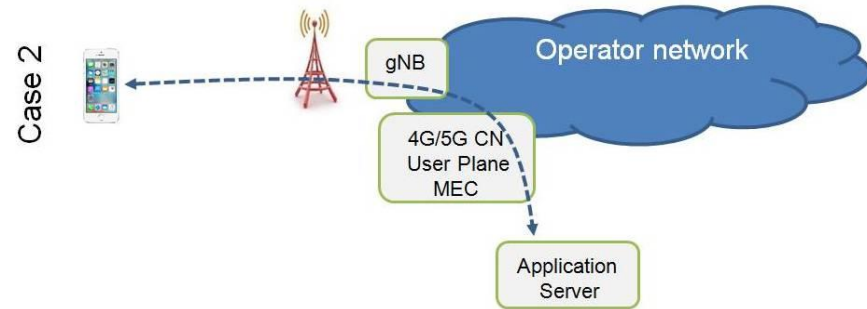
Table 9 - Internet of Things Scenarios Parameters (Warehouse, Outdoor Sensors, Home Sensors)

	OFFICE	URBAN	FESTIVAL
High level scenario description	Very densely sensed area (factory, amazon)		Very sparsely sensed area
Sub-scenario description	Factory scenario (a lot of moving parts)	Warehouse scenario (stationary conditions)	Average sparsely sensed area (Daytime (busy with car traffic, data traffic), Nighttime (no car traffic, little data traffic))
Serving cell	RSRP: -100dBm AWGN: 10dB Channel model: ETU Channel model Doppler: 50 Hz Channel model correlation: Medium	RSRP: -100dBm AWGN: 10dB Channel model: ETU Channel model Doppler: 5 Hz Channel model correlation: Medium	RSRP: -95dBm AWGN: 5dB Channel model: EPA Channel model Doppler: 5Hz Channel model correlation: High
LTE scheduling	Frequency domain (DL): 100% of PRBs Time domain (DL): 20% of subframes Frequency domain (UL): 100% of PRBs Time domain (UL): 20% of subframes	Frequency domain (DL): 100% of PRBs Time domain (DL): 20% of subframes Frequency domain (UL): 100% of PRBs Time domain (UL): 20% of subframes	Frequency domain (DL): 100% of PRBs Time domain (DL): 20% of subframes Frequency domain (UL): 100% of PRBs Time domain (UL): 20% of subframes
Network	Additional each way latency: 0ms	Additional each way latency: 100ms	Additional each way latency: 0ms
Comments	control of robots	thermostat, package tracker	lamppost, floor sensor, wind detector; thermostat, electric plug meter; bad coverage scenario (basement, electric closet, bathroom cabinet)

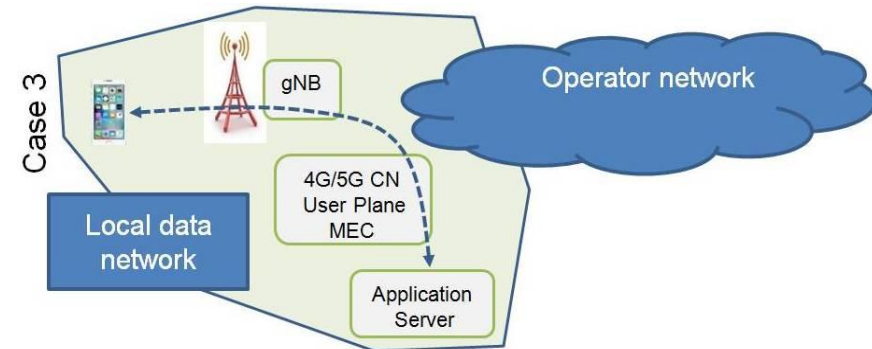
# Architectures for 5G NR eMBB



Case 1: Typical commercial deployment with 200km between 5G NB and NG core user plane



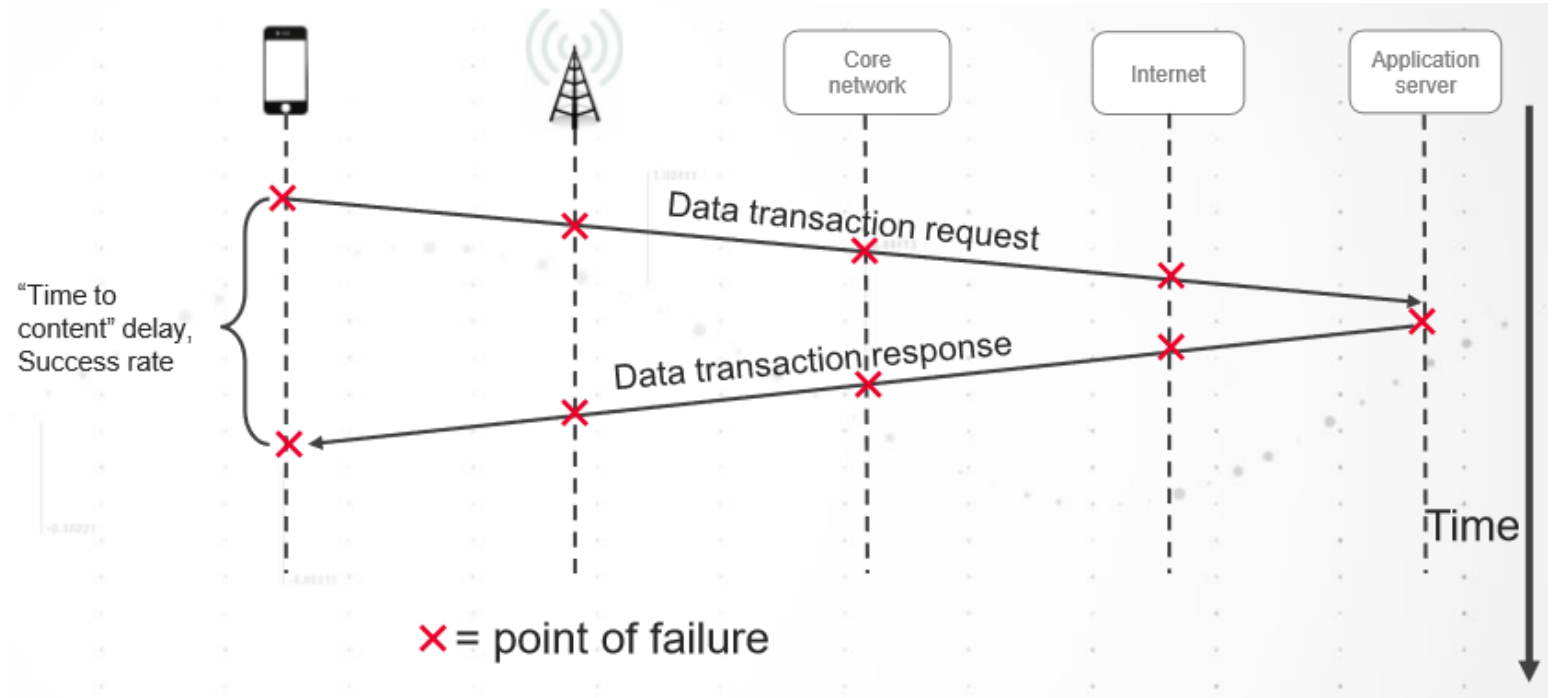
Case 2: Mobile Edge Computing - data steering to local server to reduce the E2E latency down to 1 ms level



Case 3: Data steering to Local Data network

# QoE analysis for data connection require E2E visibility

- Transaction can fail on radio, core, internet, or in the application server
- Active, device-end testing needed for full visibility
- Full QoE assessment possible only from the device end
- Measure transactions, accessibility, retainability, and time to content
- Use the same OTT applications that consumers use and run those in the UE



# 5G NR test cases defined by NGMN

## NGMN

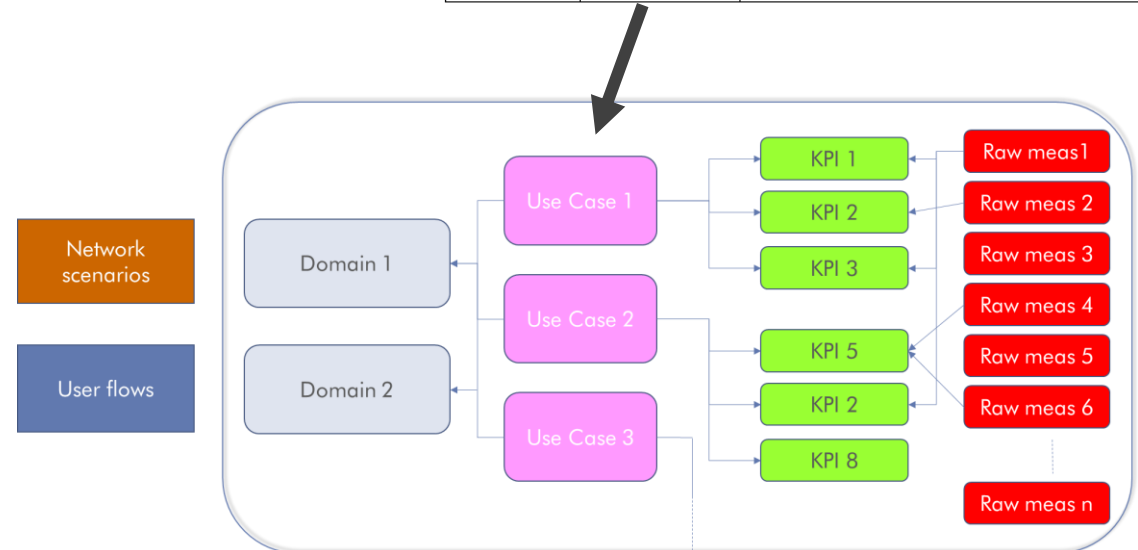
### List of contributing, reviewing and supporting companies



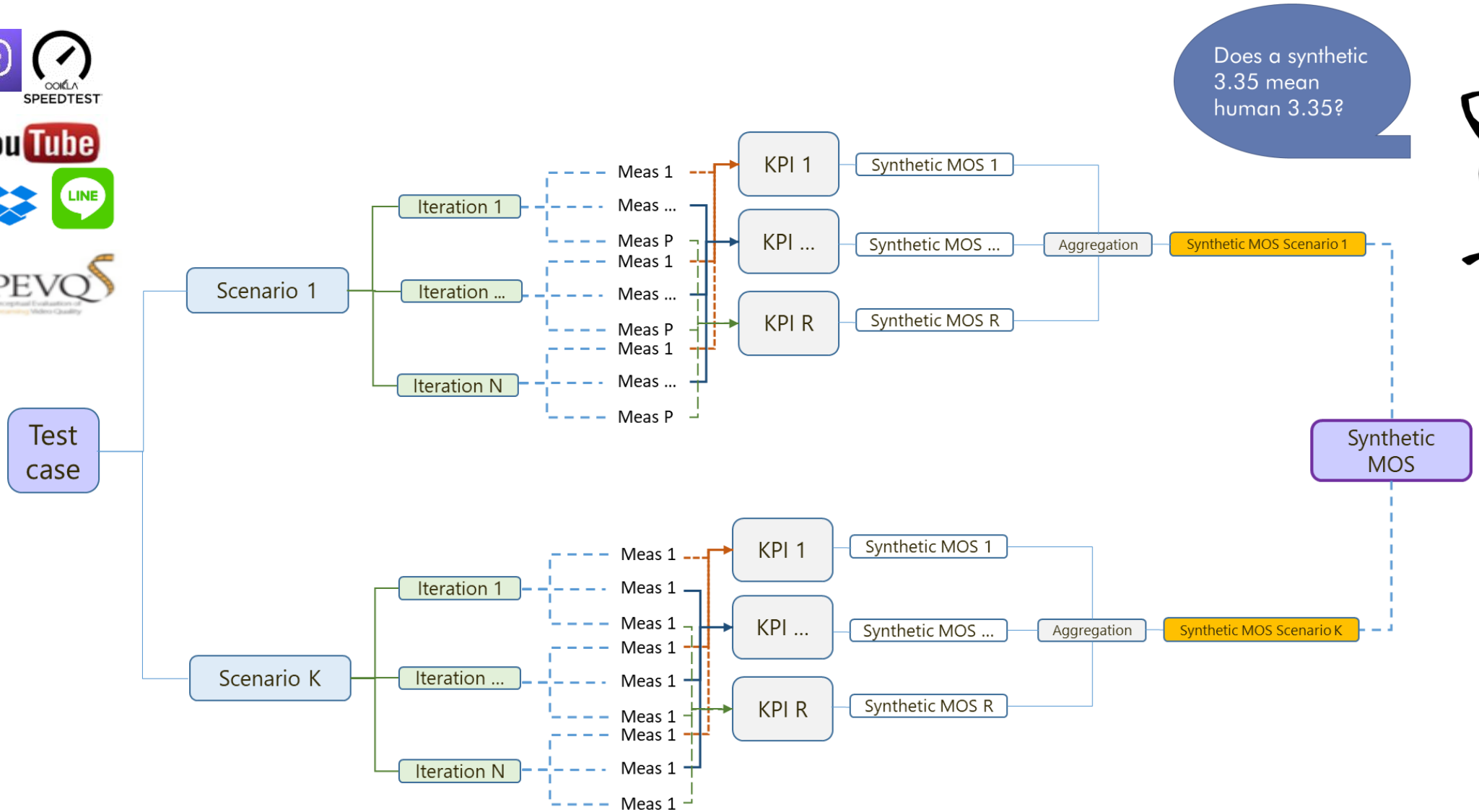
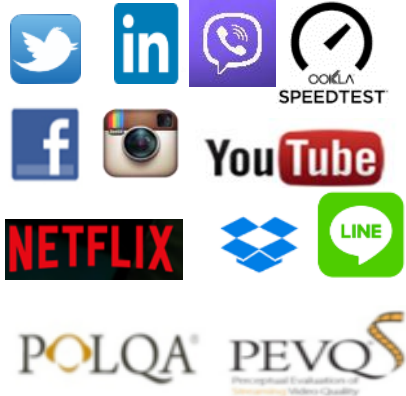
When we talk about voice and video quality, we consider the quality in terms of Mean Opinion Score (MOS) in range 1 (bad) -5 (excellent)

- **Social Networking**
- **High Speed Internet**
- **Content streaming**

Identifier	Use Case	Description
VR	Virtual Reality	Based on mobile phone-based or dedicated VR gear
GA	Gaming	Used in mobile phones or connected consoles
AR	Augmented Reality	For mobile phones or AR glasses/head gear
CS	Content Distribution Streaming Services	Typical streaming service in DL. This includes content on demand as well as live streaming.
LS	Live Streaming Services	Modern user-based streaming in UL. Examples in Facebook live, Periscope
SN	Social Networking	Content posting in online platforms
HS	High Speed Internet	Traditional browsing or files up/download
PM	Patient Monitoring	Transmission of life critical and/or low latency medical data
ES	Emergency Services	Emergency services such as «panic button», communication with emergency dispatch center
SM	Smart Metering	Deployed metering sensors, mostly IoT devices.
SG	Smart Grids	Electricity meters and actuators for grid management
CV	Connected Vehicles	Services for V2X interconnection, road safety, road traffic management and steering



# Aggregating MOS score from measured KPI's



Does a synthetic 3.35 mean human 3.35?



# Need for commonly defined QoE definitions, metrics and methods for new application classes

## High Speed KPIs [NGMN]

KPI	Target	Function		
			min <sub>KPI</sub>	max <sub>KPI</sub>
App Access Time (s)	Average	Type II	10	0.1
App Accessibility (%)	Ratio	Type I	50	100
App Availability (%)	Ratio	Type I	50	100
Feature Availability (%)	Ratio	Type I	50	100
Content Download Throughput (Mbit/s)	Average	Type I	1	1000
Content Upload Throughput (Mbit/s)	Average	Type I	1	1000

## Content Streaming KPIs [NGMN]

KPI	Target	Function		
			min <sub>KPI</sub>	max <sub>KPI</sub>
App Access Time (s)	Average	Type II	10	0.1
App Accessibility (%)	Ratio	Type I	50	100
App Availability (%)	Ratio	Type I	50	100
Content Load Time (s)	Average	Type II	10	0.1
Feature Availability (%)	Ratio	Type I	50	100
Content Stall (%)	Index	Type I	5	0
Content Search Time (s)	Average	Type II	10	0.1
Content Resolution	Mode	Type I	Lowest	Highest
Video Quality MOS	Average	n.a.	n.a.	n.a.

## Social Network KPI [NGMN]

KPI	Target	Function		
			min <sub>KPI</sub>	max <sub>KPI</sub>
App Access Time (s)	Average	Type II	10	0.1
App Accessibility (%)	Ratio	Type I	50	100
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Content Load Time (s)	Average	Type II	10	0.1
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Content Upload Throughput (Mbit/s)	Average	Type I	1	1000
Content Resolution	Mode	Type I	Lowest	Highest

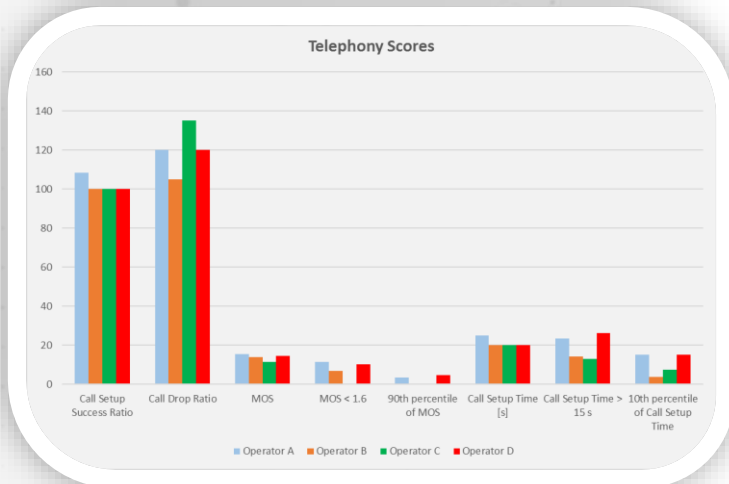
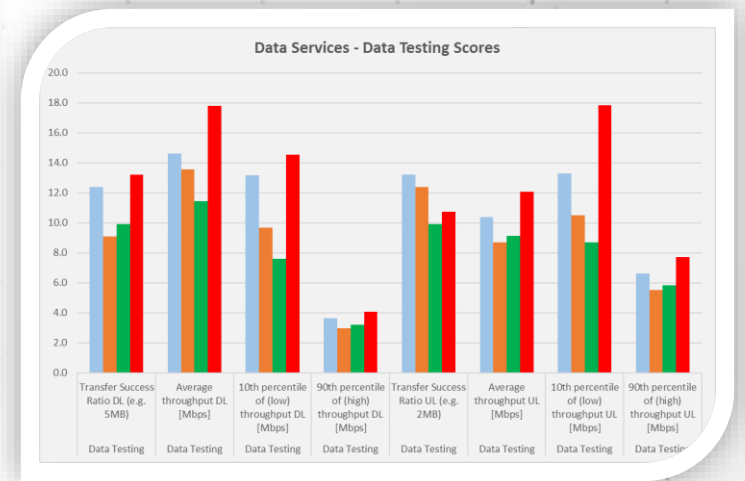
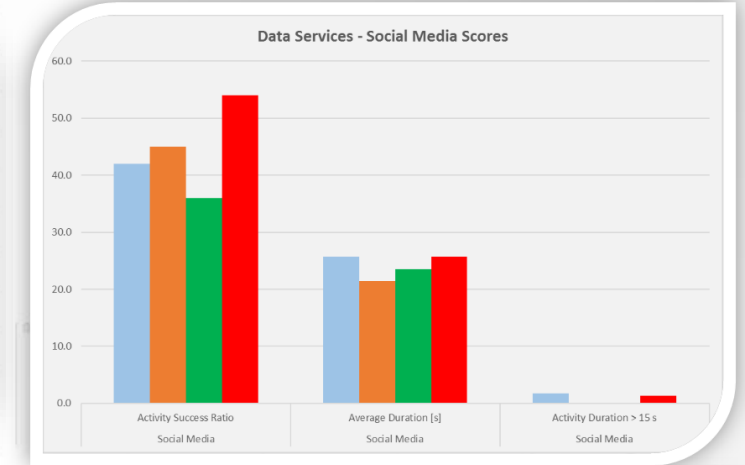
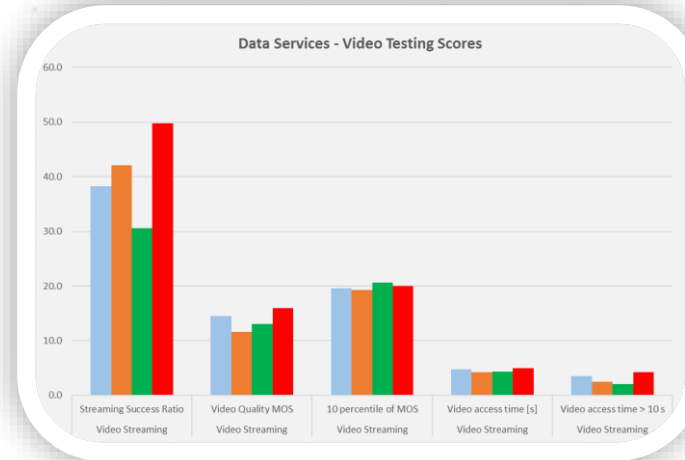
How to calculate MOS for these 3 areas ? Common definition to new areas missing

# NPS examples measured with Keysight Nemo tools

## ETSI TR 103 559, NETWORK PERFORMANCE SCORE

Nemo tools provide NPS scores for

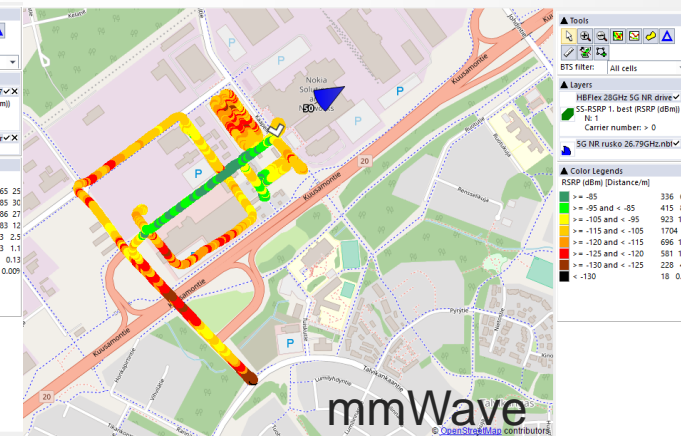
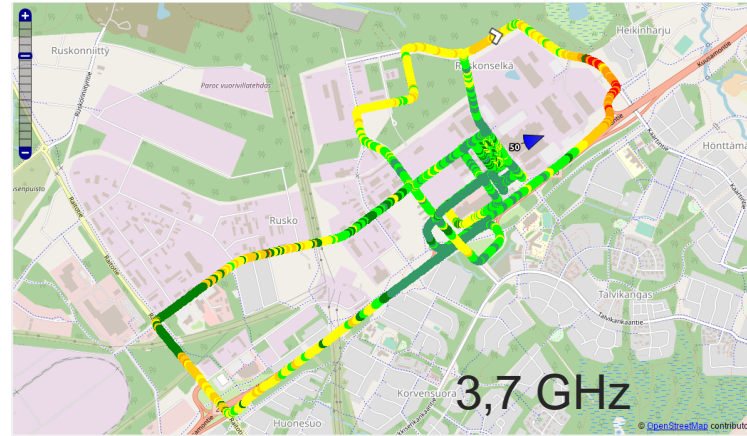
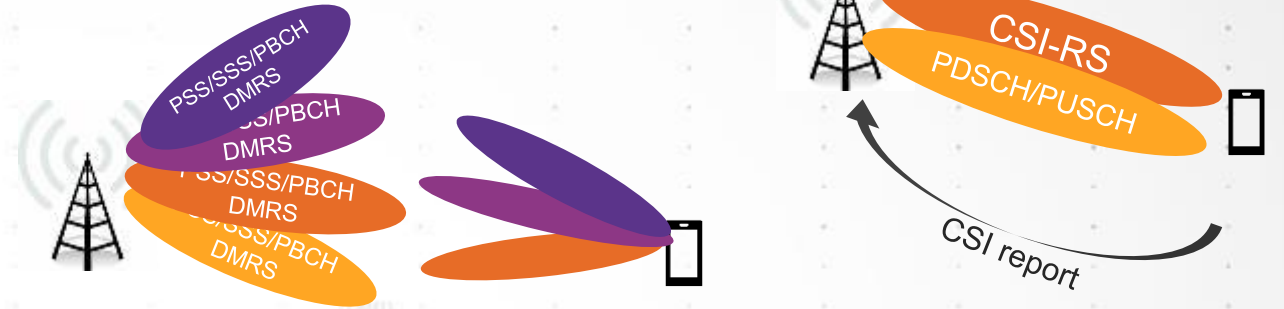
- Data services (60 % weight)
  - Video testing
  - Social media
  - Browsing
  - Data testing
- Telephony scores (40 % weight)





# 5G NR – Beam Based Network Coverage

- Paradigm shift from cell based network coverage to beam based network coverage
- Major challenge for operators and NEMs to verify and understand the network coverage on the field
- Higher frequencies (FR1, FR2) and smaller cell sizes - more demanding in propagation manner and have impact on QoS - accessibility and reliability



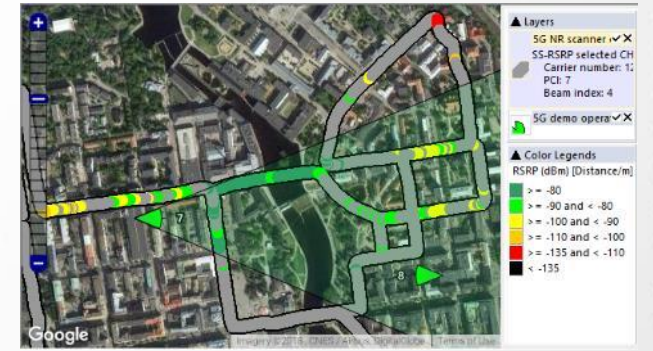
Physical Cell Id 7, beam index 2



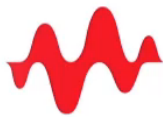
Physical Cell Id 7, beam index 3



Physical Cell Id 7, beam index 4

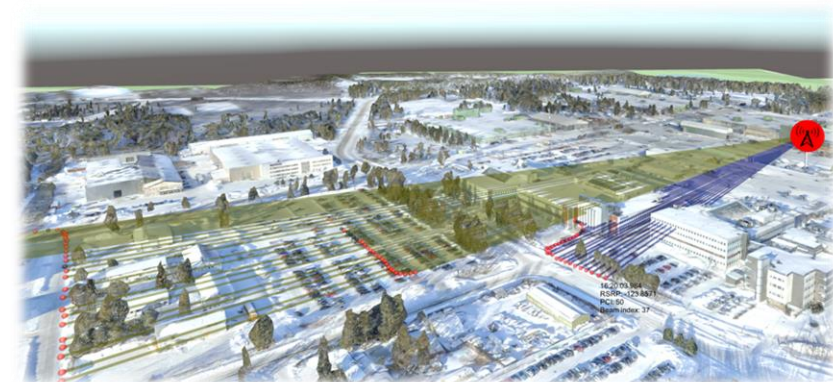
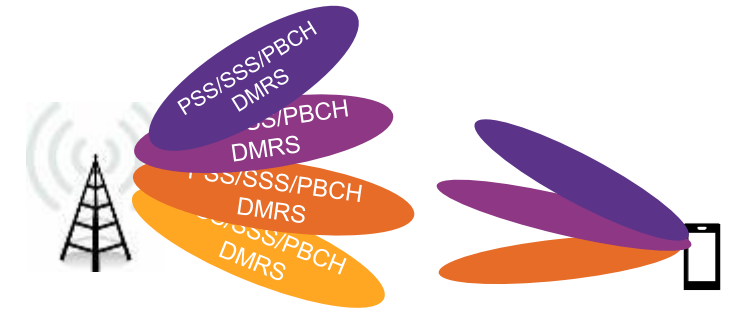


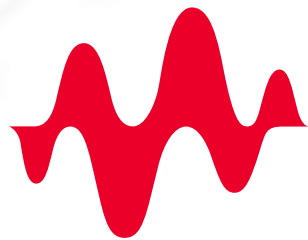
# How to measure 5G NR FR2 beams in practice



# Summary

- 5G means new use cases, environments and network dimensions
  - Higher capacity and peak rates
  - Mission Critical with 1 ms latency
  - Massive Number of Devices and network load scenarios
  - Higher frequencies → more unreliable connection
  - Beam forming changes the network coverage concept
- QoE analysis for data connection require E2E visibility
- 5G creates more demanding test cases for QoS measurements and testing setups
- Need for commonly defined QoE definitions and metrics and methods for new 5G NR enabled use cases
- Focus for test automation to enable repeatability and statistical meaningful results
- Essential to have ability to 3D visualize 5G NR beams based quality and coverage





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