Mobile Network Testing

EVOLUTION OF MOBILE NETWORK TESTING

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Make ideas real

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TECHNOLOGY EVOLUTION 4G LTE TO 5G NR

LTE LTE Advanced LTE Advanced Pro

| Apr 2019
1st 5G NR networks (FR1, FR2) launched; focus: eMBB

| Oct 2018
Proprietary 5G standard for FWA launched in USA

| June 2018
1st 5G New Radio specs (3GPP Rel-15) approved

| Jun 2016
Pre-5G standards published

| Feb 2018
1st demo of 5G using proprietary 5G standard

| March 2017
Start standardization

| Sep 2015
5G workshop

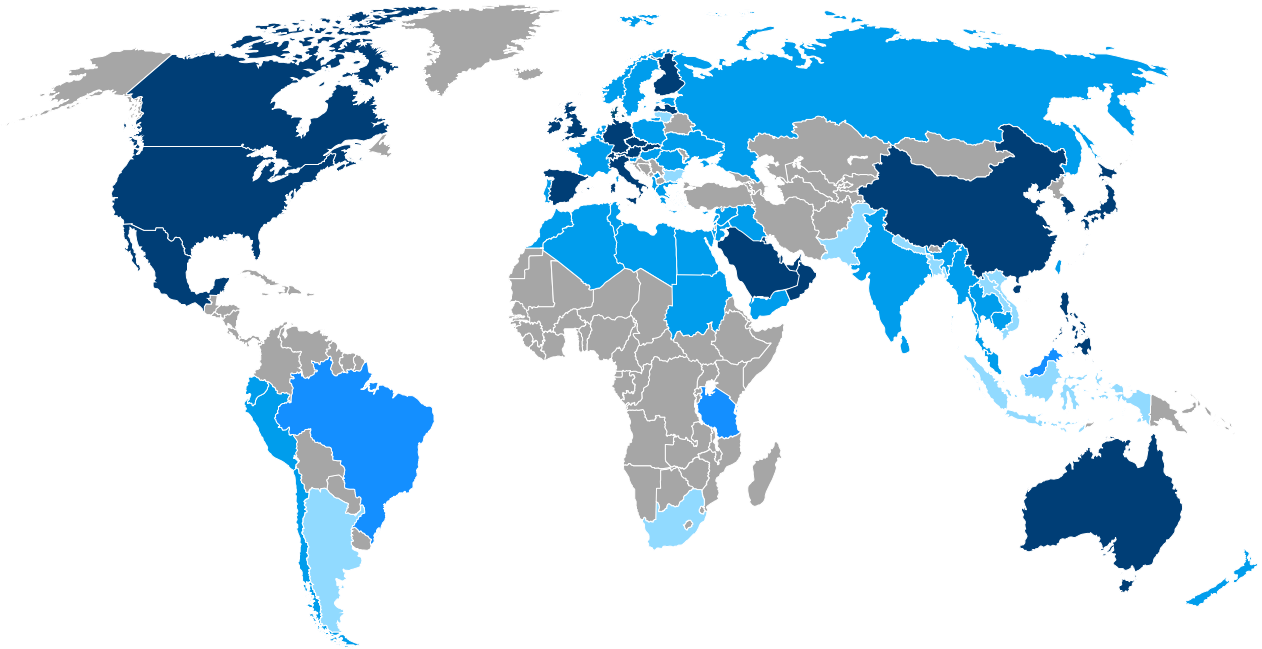
3GPP A GLOBAL INITIATIVE

2016 2018 2020 2022 2024

FWA: Fixed Wireless Access
eMBB: enhanced Mobile Broadband
URLLC: Ultra-Reliable Low Latency Communication
mMTC: massive Machine Type Communication

5G OVERVIEW

FR1 GLOBAL SPECTRUM ALLOCATION



Assigned

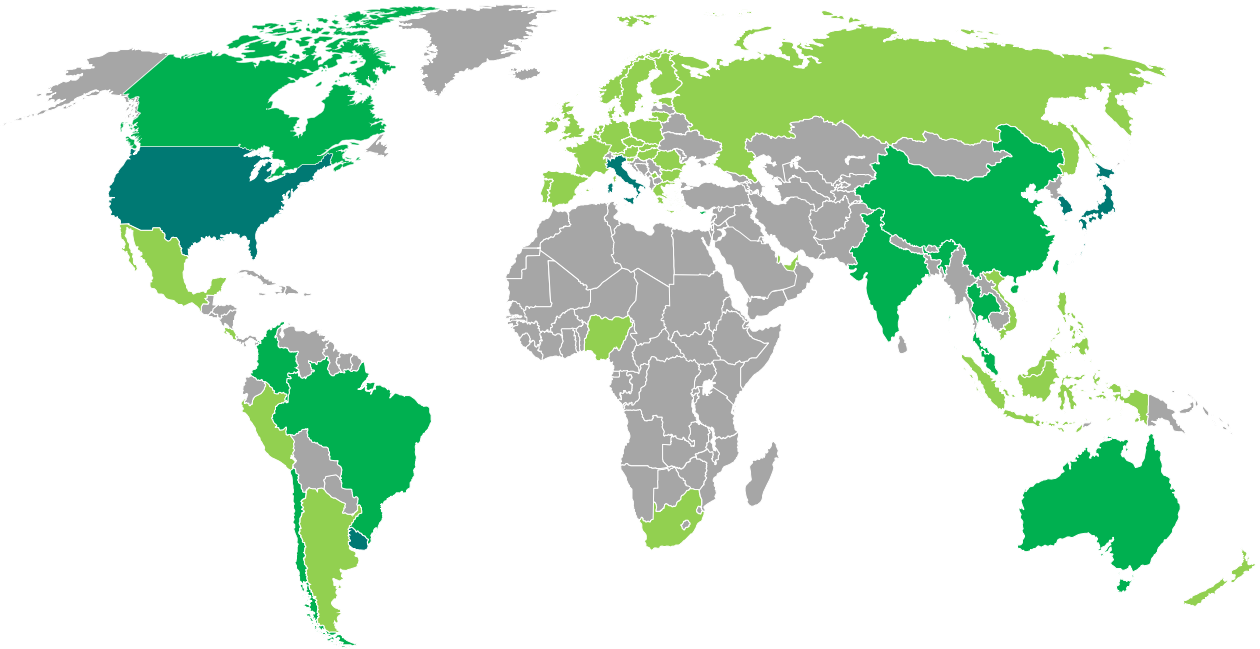
Planned

Ongoing/Considered

Sources: 5G Spectrum Report – GSA (Feb. 2020)

5G OVERVIEW

FR2 GLOBAL SPECTRUM ALLOCATION



Assigned

Planned

Ongoing/Considered

Sources: 5G Spectrum Report – GSA (Feb. 2020)

5G CHALLENGE

- Building the 5G network before customer growth has challenges
  - Initially there is a tiny user traffic load that is un-evenly spread
- How do I learn if the planned and rolled-out network :
  - Meet requirements on Coverage and Quality?
  - Will run into problems when 5G gets mature and 5G customer traffic starts to grow?
- Solution is Drive Test!

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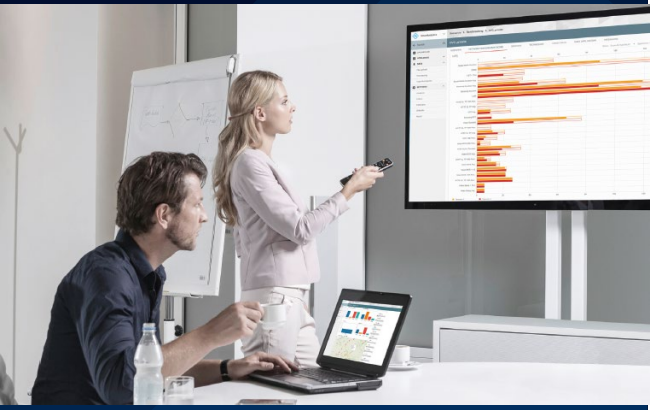
USE CASES

USE CASES ANSWERING QUESTIONS

WORKSPACE OBJECTIVE, 5G-NR



5G-NR Coverage Analysis

- High level coverage situation analysis and visualization; focus on 5G-NR and LTE (NSA)
- Both Scanner and UE visualization
- Easy transition to drill-down options

5G-NR Benchmarking

- Dedicated 5G-NR, QoE and QoS Benchmarking complete visualizations
- Both Scanner and UE visualization
- Easy transition to drill-down options

5G-NR Troubleshooting

- 5G-NR troubleshooting and problem solving visualizations
- Both Scanner and UE visualization
- Easy transition to drill-down options

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SMARTANALYTICS ENTRY USE CASES

5G-NR Coverage Analysis

- What was the RF Coverage of each RAT; how good ?
- What was the RF Coverage of each Band; how good?
- 5G-NR Availability - Where is the LTE coverage with 5G enabled for Dual Connectivity?
- Best cell coverage - Where was each Cell providing the best RF Coverage, how good was the coverage, what was the cell isolation?
- Best SSB beam coverage - Where was each SSB beam providing the best RF Coverage, how good was the coverage, what was the SSB beam isolation?
- What was the average difference between LTE and 5G serving cell coverage (Master Cell vs Secondary cell)?
- Which UEs and Home Operators have been used?
- Where has the UE been connected to LTE only, to EN-DC LTE-5G and eventually legacy RATs?
- What is the RAT and Data Technology distribution?

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SMARTANALYTICS ENTRY USE CASES

5G-NR Benchmarking

- Campaign overview – Where and when do I have measurements? What type of tests? What RAT and Bands have been measured? What is the distribution per Operator?
- 5G-NR Coverage & Quality - What was the RF Coverage of each RAT; how good? What was the RF Coverage for each Band; how good? What was the interference/quality level? How do I compare with the other Operators? And regionally?
- 5G-NR Availability - Where is the LTE coverage with 5G enabled for Dual Connectivity? Comparison between Operators?
- Where (in which regions) am I worst in terms of 5G-NR coverage?
- 5G-NR Network Access – What is the success rate of 5G-NR (secondary cell group) cell activation? To what extent is LTE and 5G-NR Carrier Aggregation used? (secondary cell activation). What is the distribution of CA carriers? Per Operator?
- What is my Network Performance Score considering 5G-NR? How do I compare with the other Operators? And regionally?
- 5G-NR Mobility - What is the success rate of Master Node (MN) LTE handovers? What is the success rate of Secondary Node (SN) cell changes? Per Operator? And regionally?
- 5G-NR Physical Layer - What is the 5G Physical layer throughputs? What is the Modulation [illegible] Operator? And regionally?

SMARTANALYTICS ENTRY USE CASES

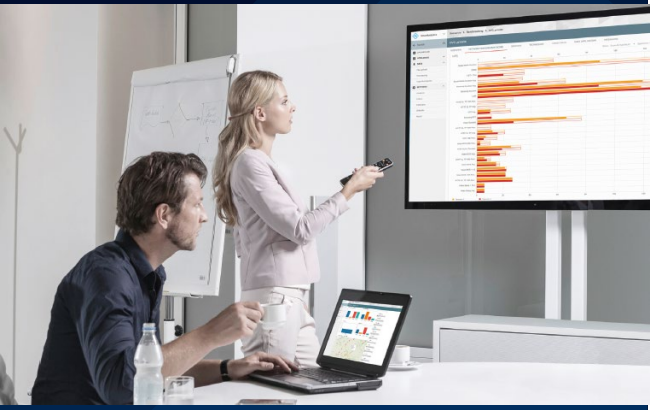
5G-NR Troubleshooting

- Coverage
  - Where are the 5G-NR Coverage problems? What are the worst areas? In terms of…high inter-cell interference?, high inter-cell SSB Beam interference?, Poor inter-cell Beam dominance?, Poor intra-cell SSB Beamforming gain?
  - What are the worst cells in terms of coverage?
  - What are the worst cells in terms of inter-cell interference?
  - What are the worst cells in terms of SINR?
  - What are the worst cells in terms of inter-cell SSB Beam interference?
  - What are the worst cells in terms of intra-cell SSB Beamforming gains?
  - Where are the No coverage areas?
  - Where and to what extent (duration) has the UE been connected to EN-DC enabled LTE cells without having 5G Secondary cells assigned?
- Network Access – Where do I have RACH Fail statistics?
- Mobility – Where do I have SCG Failures?

SMARTANALYTICS ENTRY USE CASES

R&S MNT'S ANALYTICS TRANSVERSAL SOLUTION

ENTRY USE CASES AND FULLY CUSTOMIZABLE WORKSPACES



Data analysis

Data services overview
HTTP & Capacity
DL/UL
HTTP Browsing
Video
Ping
App testing & interactivity test

Network Performance Score & Quality Benchmarking

Overview Network Performance Score
Voice NPS
Data NPS

Voice analysis

Voice overview
Fail/Drop calls
Call Setup Time
Speech Quality
VoLTE
CSFB
SRVCC/IRAT
Handovers

Guided optimization

Call Stability Score
Time-based Anomaly Detection

Coverage analysis

Overview 5G-NR/4G/3G/2G Scanner
5G-NR/4G/3G/2G UE coverage

5G-NR

5G-NR Coverage analysis
5G-NR Benchmarking
5G-NR Troubleshooting

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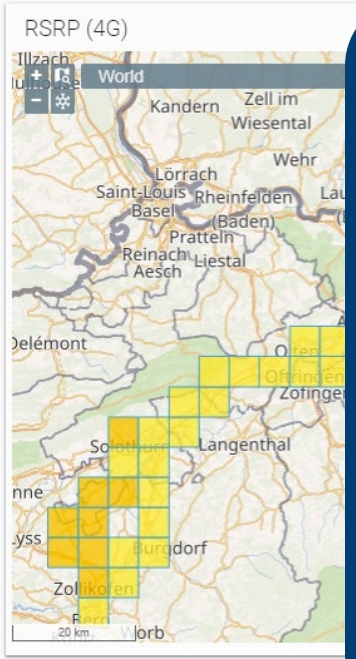
NETWORK PLAN ANALYSIS

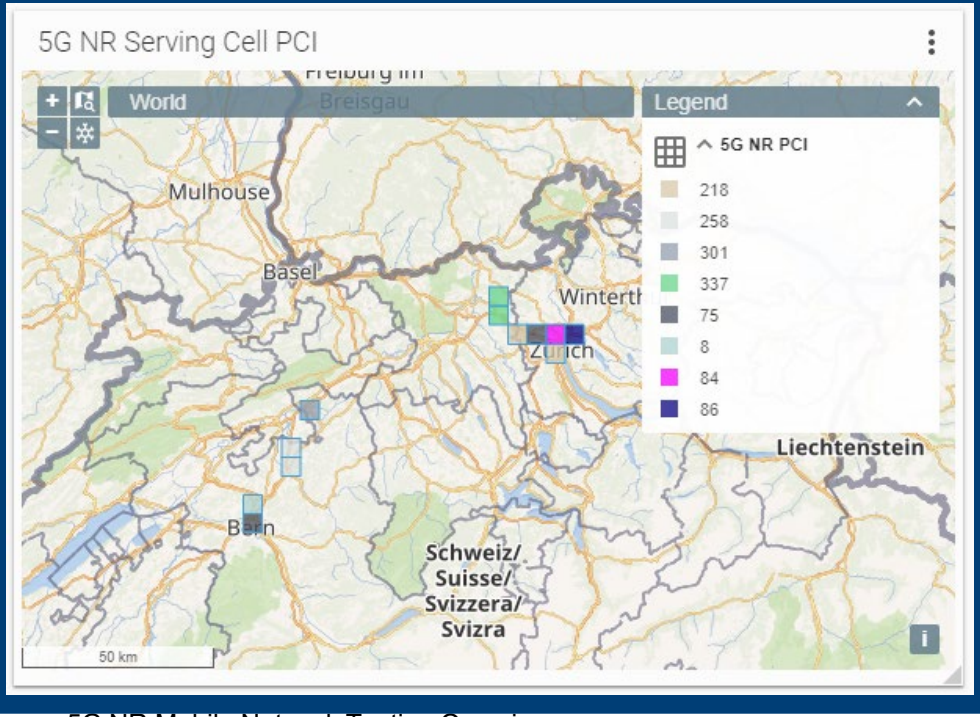
- R&S has introduced new Key Performance Indicators based on Geometry Factors to assess the quality and performance of unloaded 5G NR networks
- The GF KPIs are calculated on R&S®TSMx6 RF Scanner measurements
  - To ensure necessary 5G NR measurement speed, sensitivity and dynamic range
- Geometry Factor based KPIs are:
  - Inter cell based
    - Cell Geometry Factor (CGF) - Measure of Cell isolation / Inter-cell interference
      - For FR1 networks with Cell sector and single SSB index
    - Beam Geometry Factor Inter-Cell (BGF Inter) - Measure of Beam isolation between cells / Inter-cell beam interference
      - For FR1 and FR2 networks with SSB beamforming
  - Intra cell based
    - Beam Geometry Factor Intra-Cell (BGF Intra) – Measure of Beam forming gain vs Single sector

WHAT IS 5G COVERAGE?

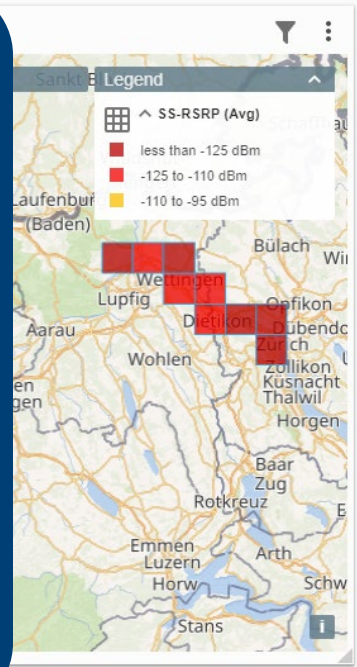
LTE Anchor Cell Coverage



Result 5G Service Coverage



5G NR Carrier Coverage



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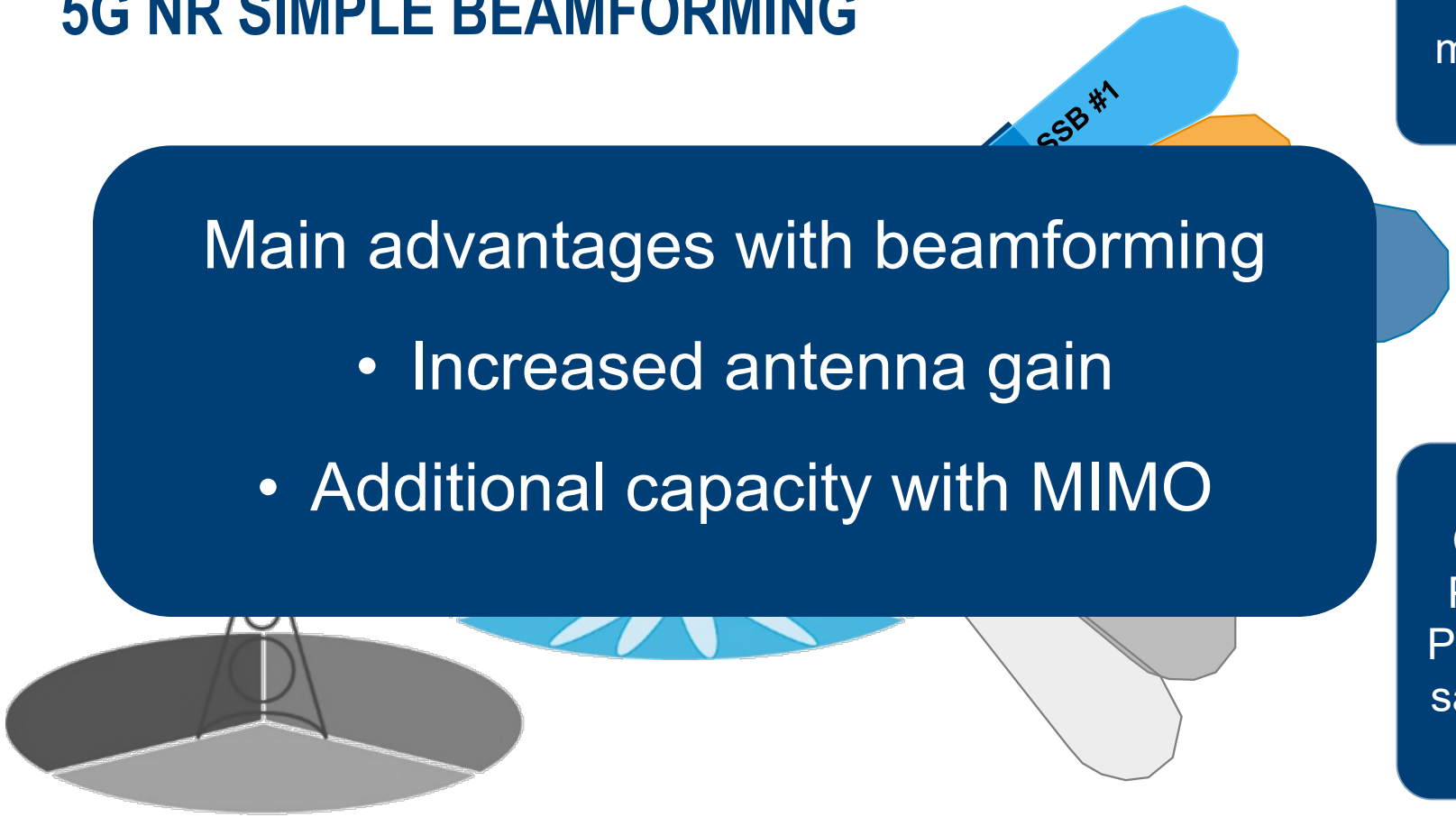
5G NR SIMPLE BEAMFORMING

SSBs mapped on „static“



Main advantages with beamforming

- Increased antenna gain
- Additional capacity with MIMO

UE Data Channels PDSCH & PUSCH use same beam shapes

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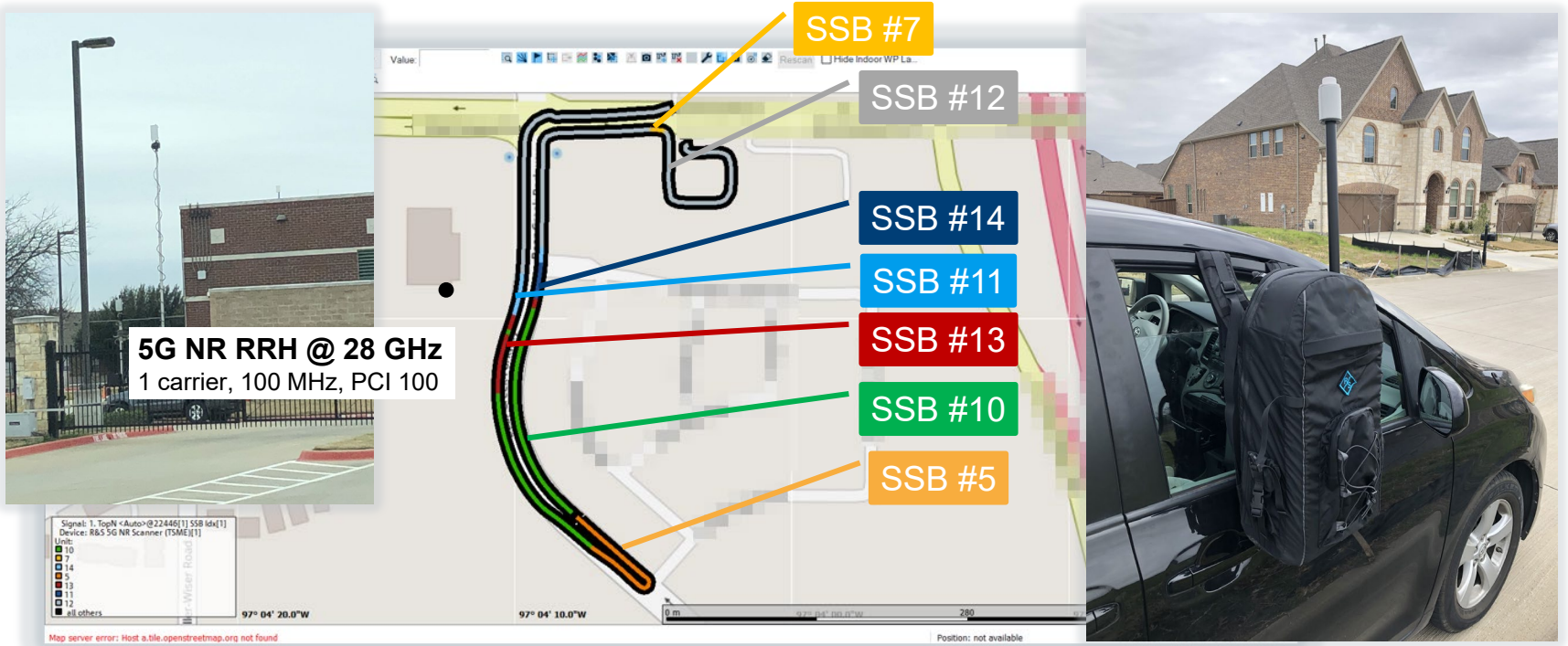
5G SCANNER SSB MEASUREMENT AT A TRIAL SITE



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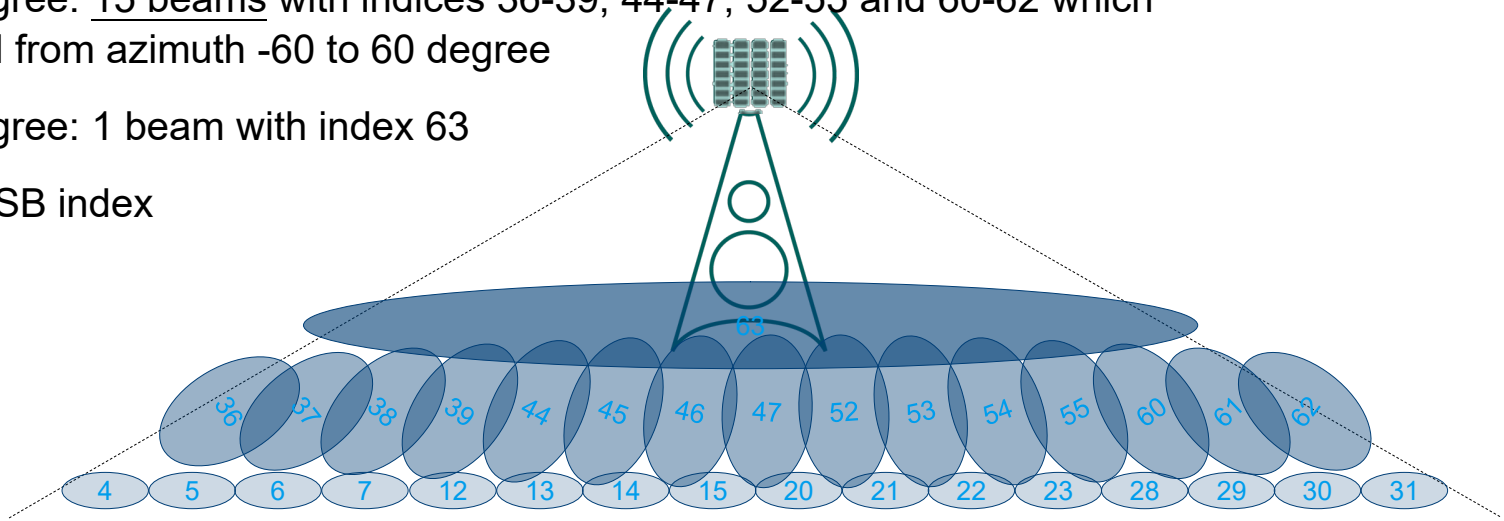
ADVANCED SSB BEAMFORMING FOR MILLIMETER WAVE

- 5G NR gNB Advanced Antenna System configuration
  - Tilt of 0 degree: 16 beams with indices 4-7, 12-15, 20-23 and 28-31 which are spread from azimuth -60 to 60 degree
  - Tilt -10 degree: 15 beams with indices 36-39, 44-47, 52-55 and 60-62 which are spread from azimuth -60 to 60 degree
  - Tilt -25 degree: 1 beam with index 63
- Total of 32 SSB index



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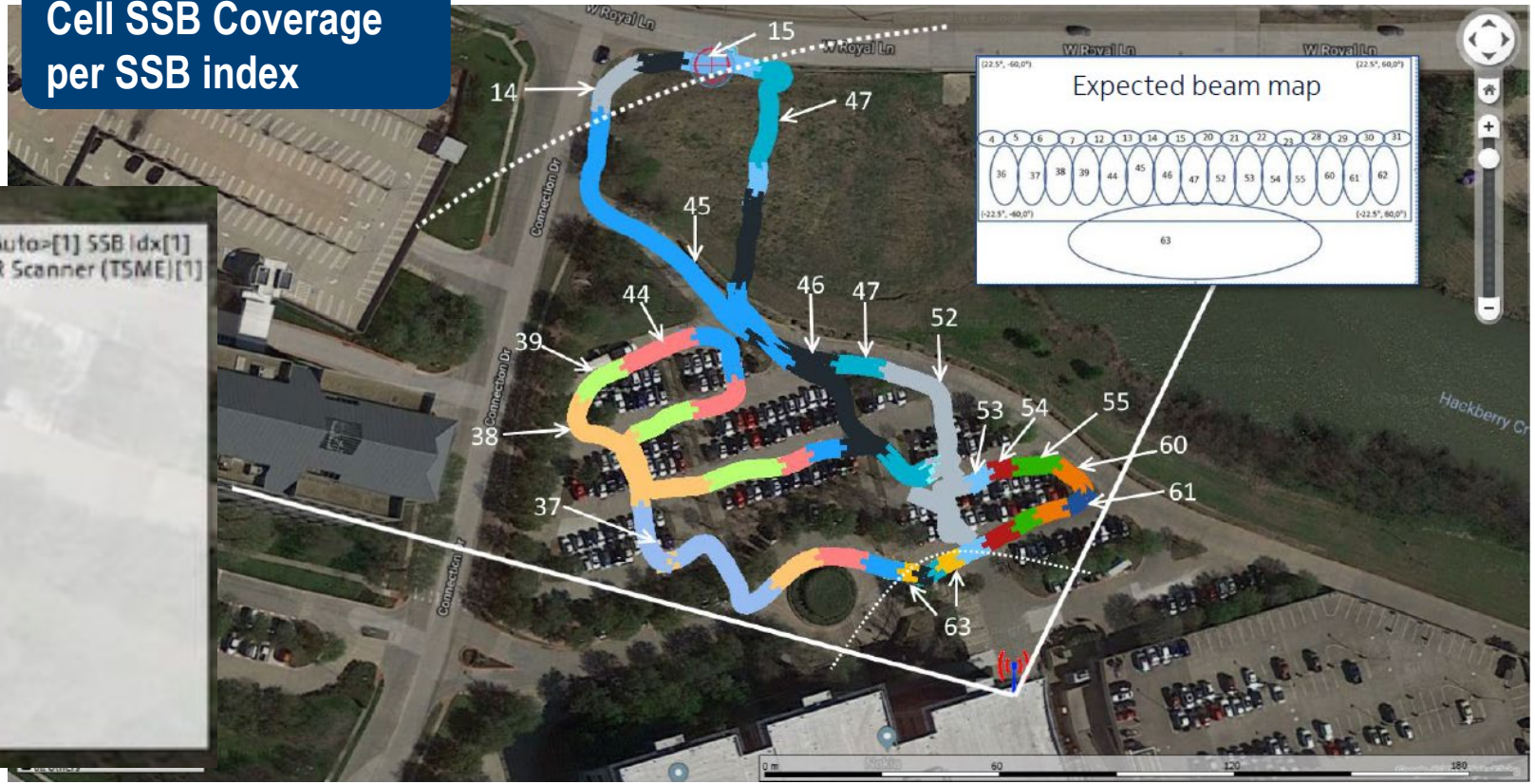
ADVANCED SSB BEAMFORMING COVERAGE ANALYSIS

Cell SSB Coverage per SSB index

SSB Colors



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Mobile Network Testing

UNATTENDED TESTING

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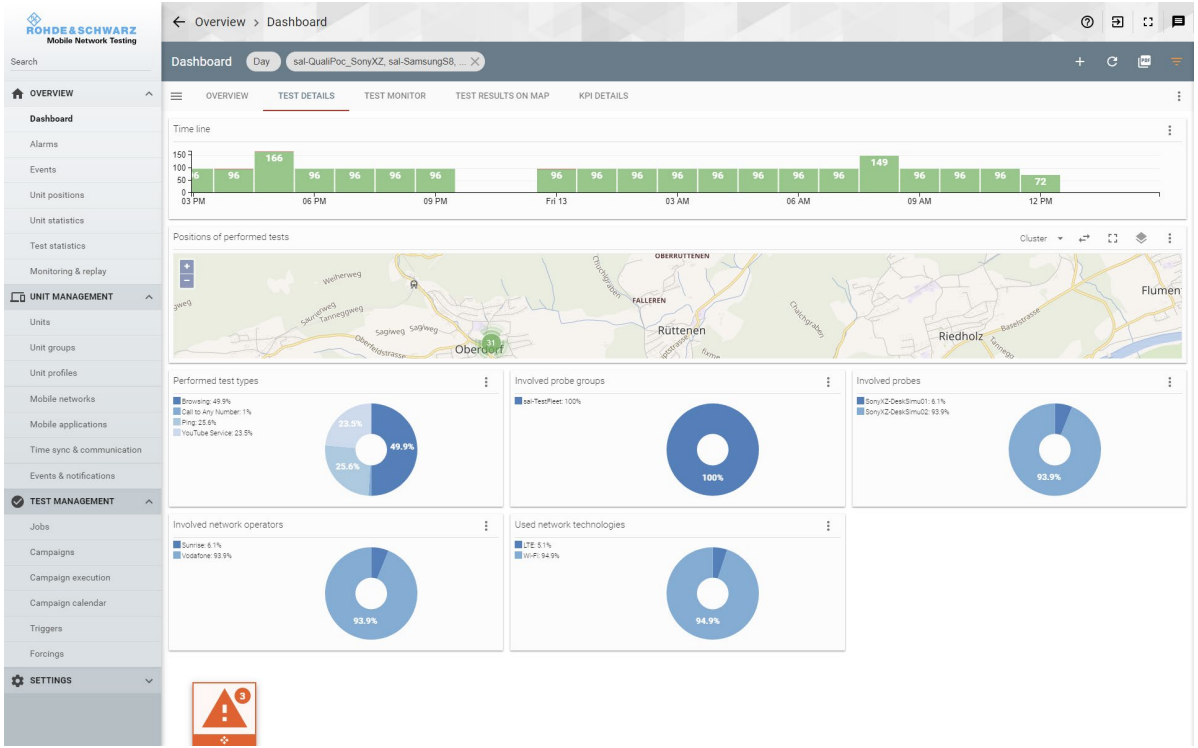
SERVICE QUALITY MONITORING MARKET TRENDS

- More unattended drive tests, data collection and monitoring.
- Monitor and detect network service instabilities, errors or service drops in real time
- QoE based optimization
- The RAN is more dynamic (e.g. C-RAN) so also optimization must be more versatile and more real time.

SMARTMONITOR
FLEET MANAGEMENT & REAL TIME MONITORING

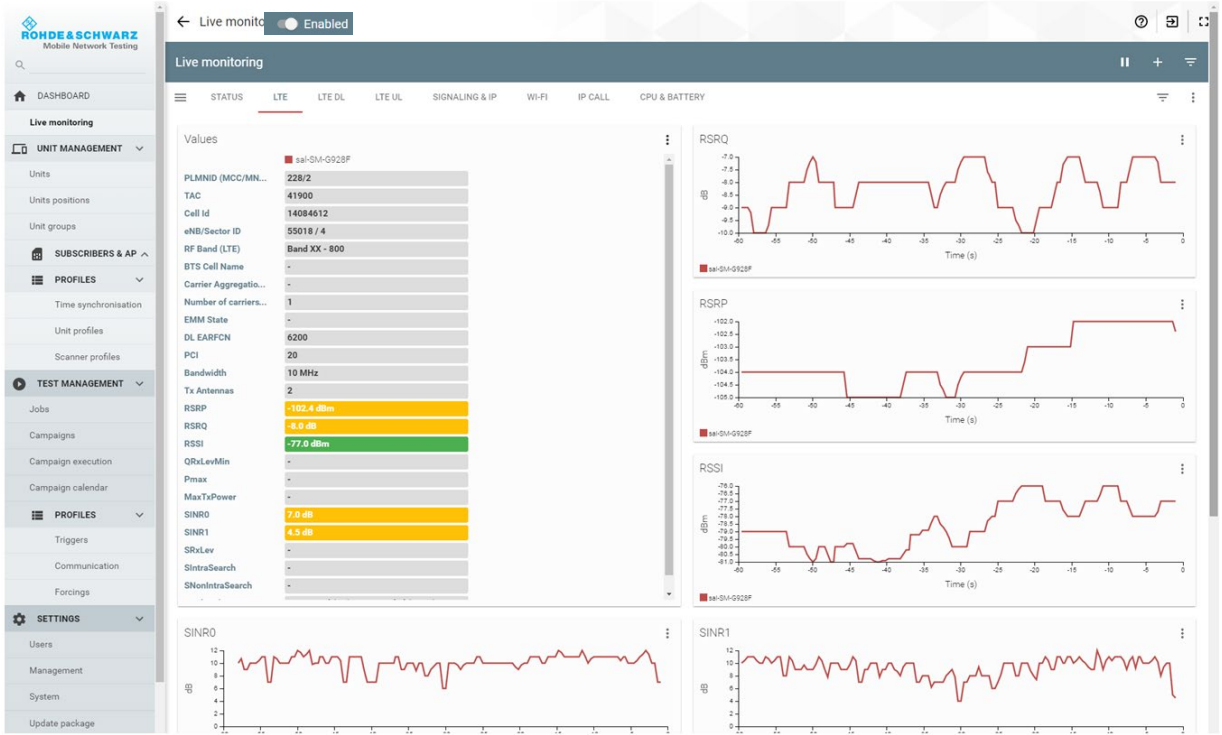
SmartMonitor is a web-based application for:

- **Managing** a fleet of QualiPoc Android Probes
- **Configuring** tests and campaigns
- **Monitoring** status of service quality in real time



SMARTMONITOR LIVE MONITORING

Live Monitoring displays RF parameters and device information from the QualiPoc Android directly to SmartMonitor in real time



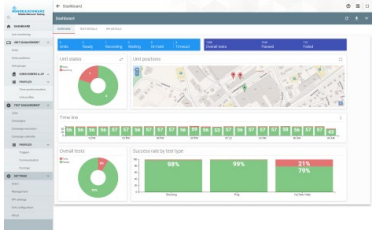
QUALIPOC ANDROID PROBE SUPPORTING 5G NR

► QualiPoc monitors supporting 5G NR with all important parameters:

- 5G NR band
- SSB NR ARFCN
- SS-RSRP, SSRSRQ, SS-SINR
- PDSCH parameters
- PUSCH parameters

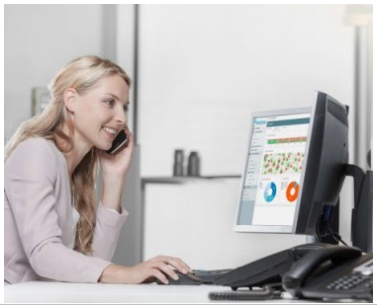
SMARTMONITOR – CONCLUSION

Real time monitoring



- Unattended, 24/7 service quality monitoring from end user perspective
- Dashboard shows test results and statistics in real time

Easy and intuitive to operate



- Drag & drop job and campaign configuration
- Alarming interface
- Tailored roles and access rights
- Access SmartMonitor from everywhere

QualiPoc Android Probe - Rich set of service tests

- Active, systematic data collection
- Voice quality incl. VoLTE and VoWi-Fi, data, video quality and app service tests (Dropbox, Facebook, WhatsApp IM & IP call, Ookla, etc.)
- Reliable operation due to watchdog & self recovering functions

Mobile Network Testing

REAL-TIME SERVICE TESTING

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MEASURING QOS AND QOE OF 5G APPLICATIONS

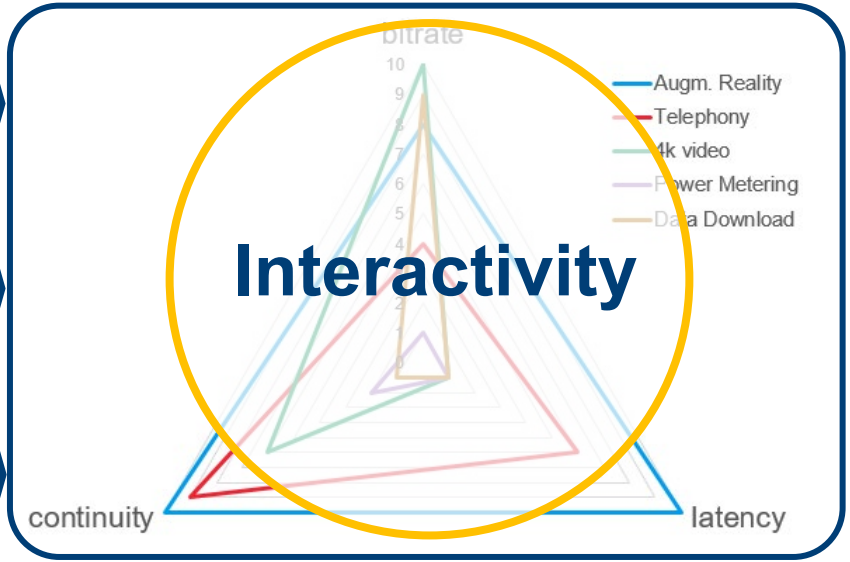
5G

GBs in a second | 3D Video UHD | Cloud Work & Play | AR/VR | Industry Automation | Mission Critical | Self-Driving Vehicles | Smart City

The number of application and use cases will increase by folds in 5G.

Good Performance and QOE

- *Minimum amount of data rate* → **CAPACITY**
- *Minimum response time* → **LATENCY**
- *Maximum length of interruptions* → **CONTINUITY**



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MEASURING QOS AND QOE OF 5G APPLICATIONS

Interactivity

More than Bitrate,
Continuity and Latency are key

Continuity

Interruptions

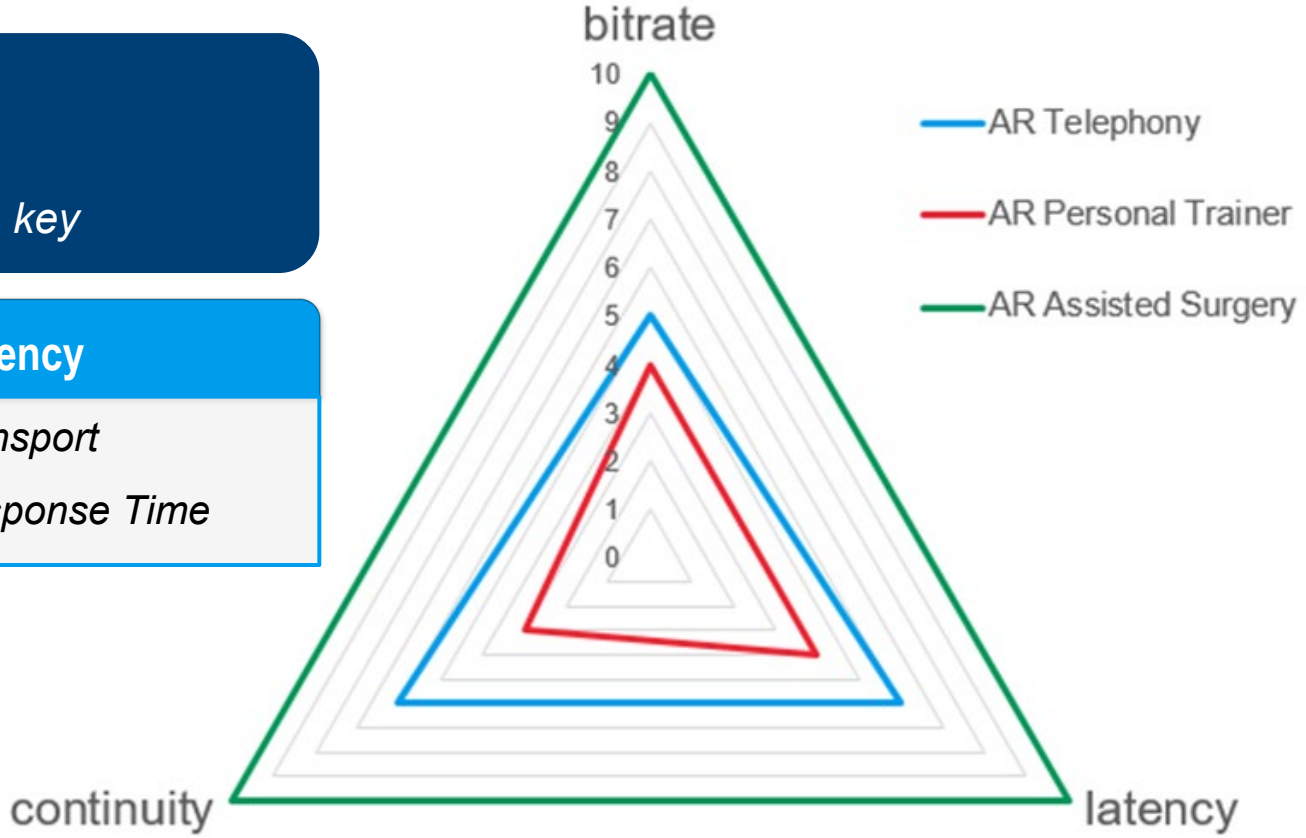
Undercuts of required data rate

Indirectly packet loss

Latency

Transport

Response Time



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INTERACTIVITY TEST

Frequency and size of packets controlled

Measured
Latency (RTT)
Jitter
Packet Loss
Corruption
Ratio

Device sends unique packets to server

Server sends back packets as responses

Continuous Packet Flow
Packet Rates of 100 to 1500 per second

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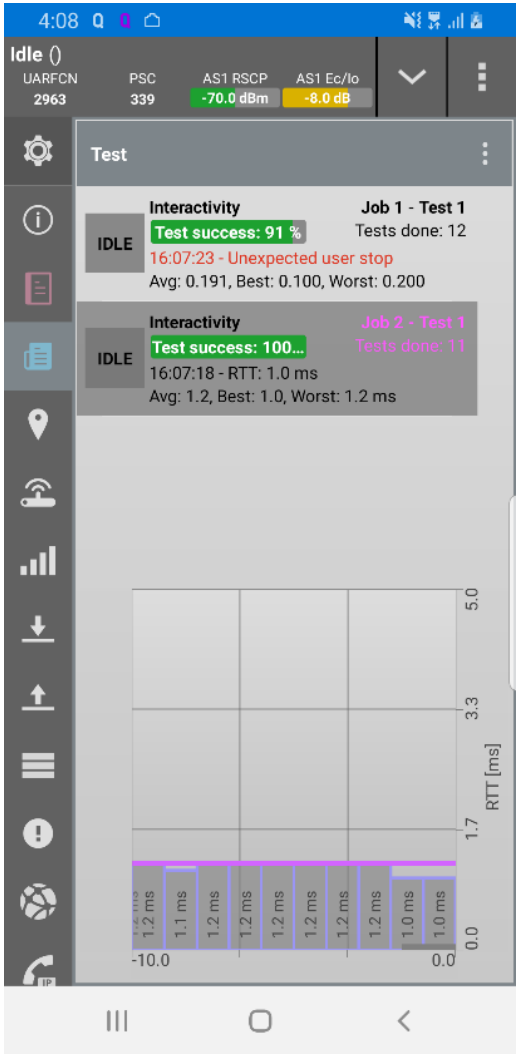

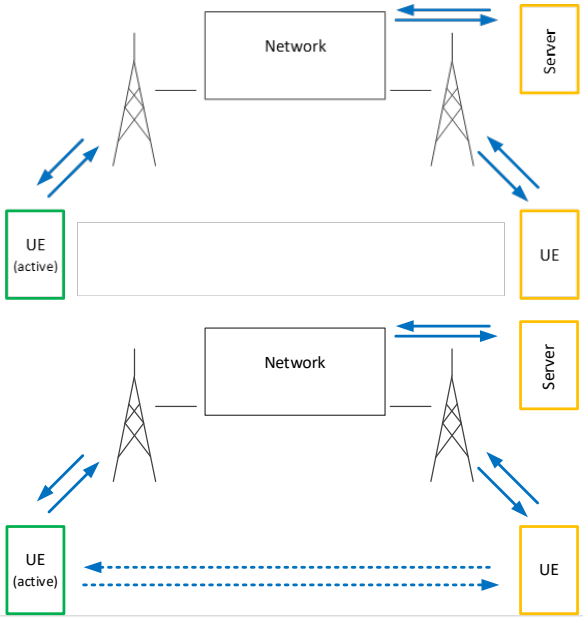

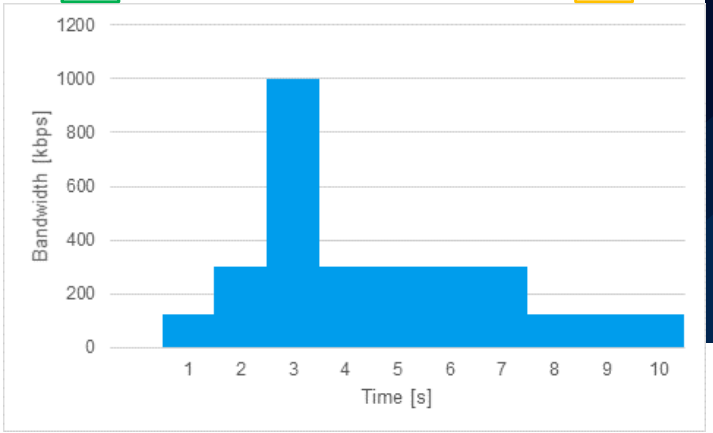

CONTINUOUS EVOLUTION

- **INTERACTIVITY TEST**
- **Traffic Pattern to emulate applications**
  - Constant rate
  - eGaming real-time
- **Technical Results**
  - Latency
  - Packet Delay Variation
  - Packet Error Rate
  - Connectivity

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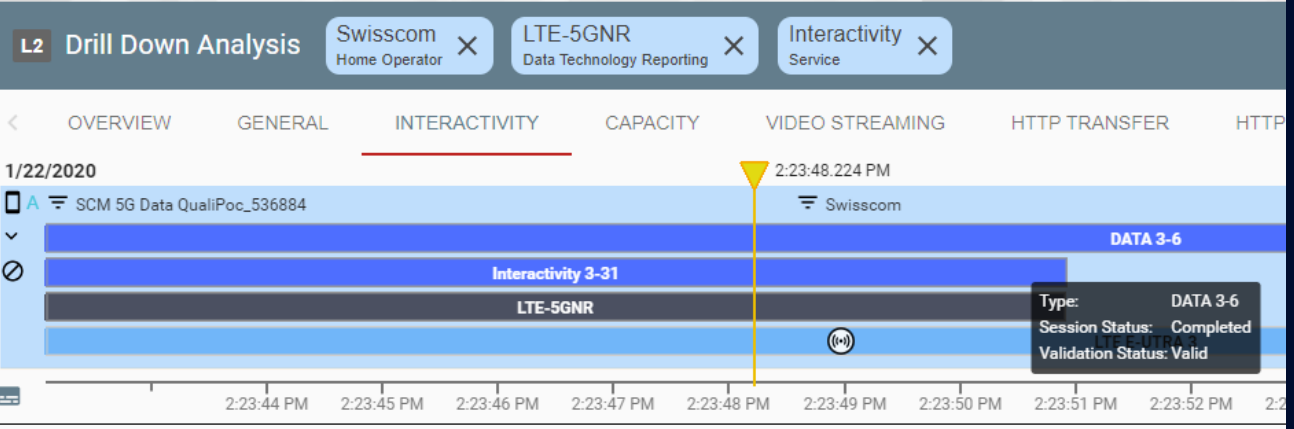

Parameters

	SCM 5G Data QualiPoc_536884
Host	18.195.112.184
Port	862
Pattern Name	eGaming real-time
Configured Test Duration	10 s
Packet Delay Budget	100 ms
Packet Size	100 bytes
Number Of Packets To Send	3625

Test Results

	SCM 5G Data QualiPoc_536884
Home Operator	-
Status	-
Interactivity Score	72.6 %
Channel QoS 3GPP	5.62 %
Packets Sent	3625
Packets Not Sent Rate	0 %
Packets Lost Rate	3.56 %
Total Packet Error Rate	3.56 %
Round-trip latency (median)	31.56 ms
Round-trip latency (10th pe...	25.38 ms
Packet Delay Variation (m...	13.5 ms
Packet Delay Variation (99....	76.8 ms
Throughput	0.284 Mbps

INTERACTIVITY ANALYSIS

- R&S®SmartAnalytics
- Interactivity Tests results
  - Interactivity Score
  - Channel QoS 3GPP
  - Packet statistics
  - Latency statistics
  - Throughput

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THANK YOU!

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