Mobile Test Summit Korea 2024

5G WIFI OFFLOADING AND VONR VOWIFI AUDIO TESTING REDCAP REL. 17 & REL. 18 UPDATE AND MARKET TREND UPDATE

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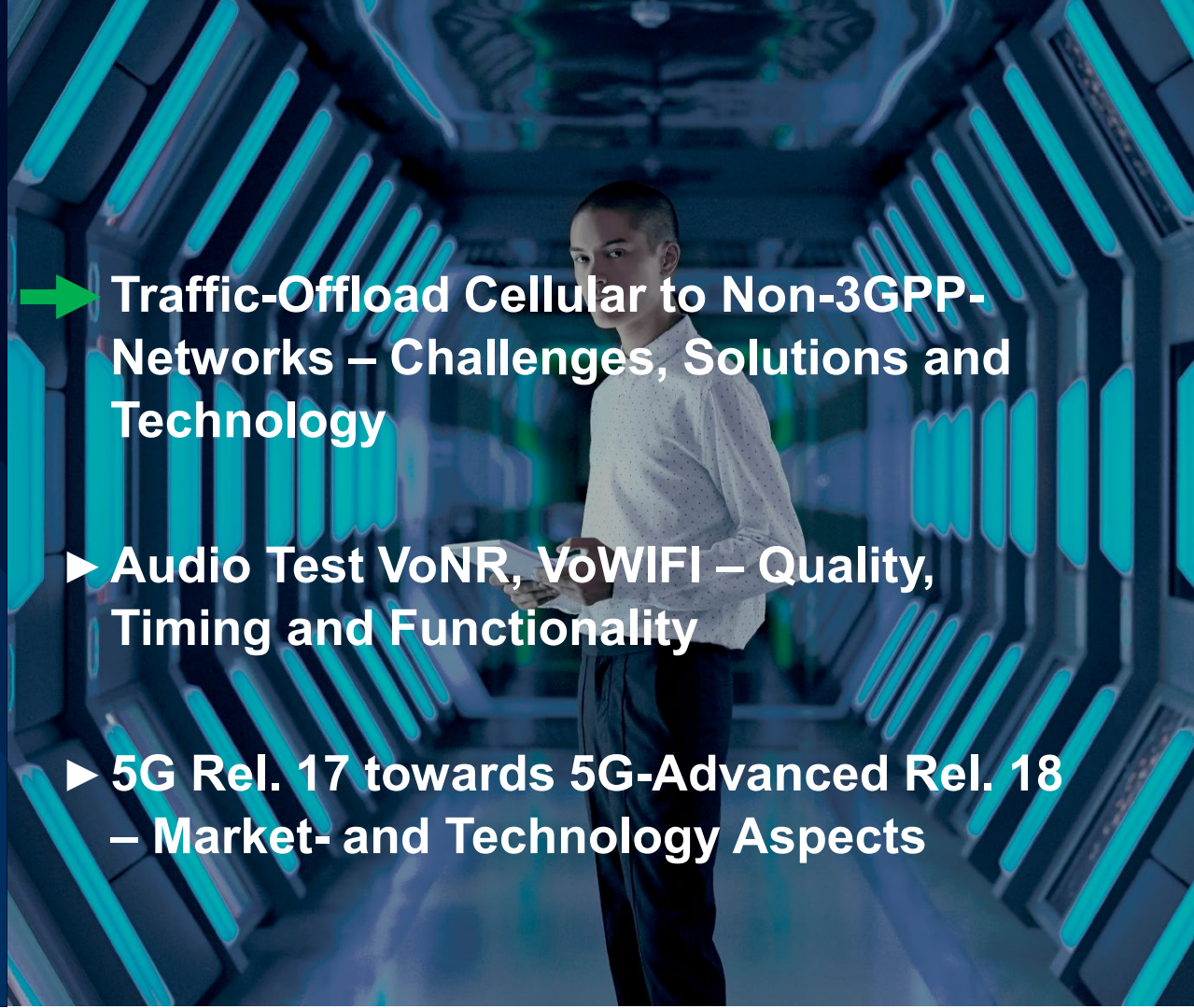
ROHDE&SCHWARZ
Make ideas real

MOBILE TEST SUMMIT KOREA 2024

- 5G WiFi offloading and VoNR VoWifi audio testing
- RedCap Rel. 17 & Rel. 18 update and market trend update



- Traffic-Offload Cellular to Non-3GPP-Networks – Challenges, Solutions and Technology
- Audio Test VoNR, VoWIFI – Quality, Timing and Functionality
- 5G Rel. 17 towards 5G-Advanced Rel. 18 – Market- and Technology Aspects

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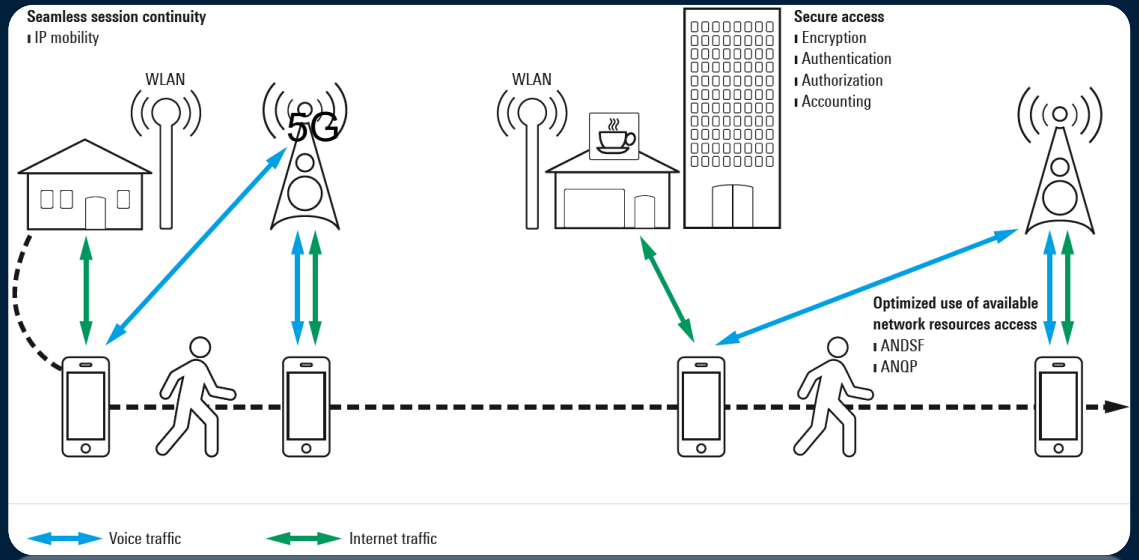
WLAN OFFLOADING

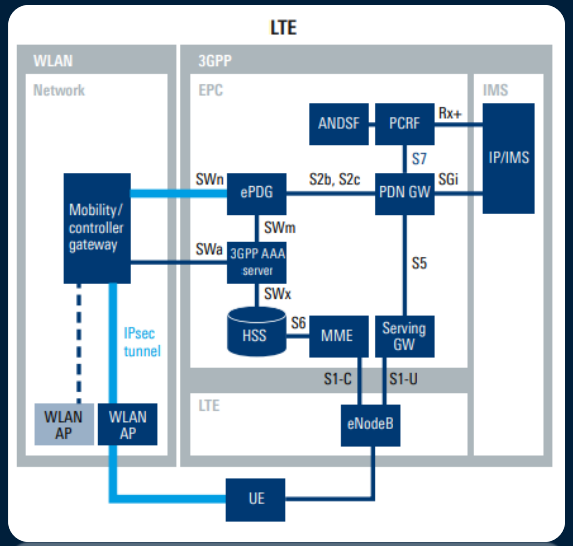
WLAN OFFLOADING – PRINCIPLE & CHALLENGES



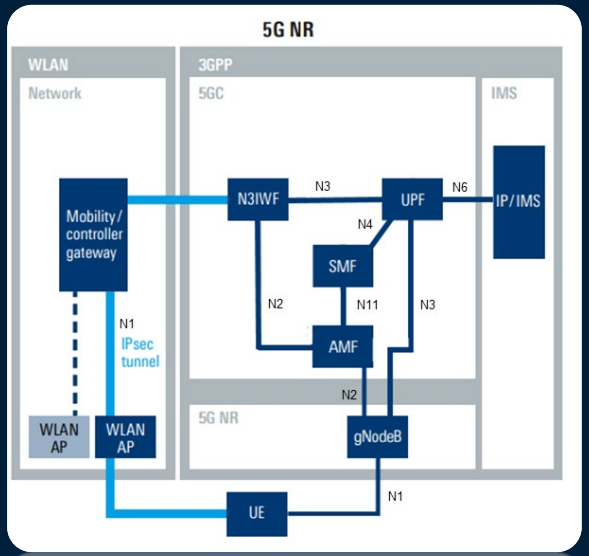
- WLAN offloading describes the procedure to delivering data originally targeted for cellular networks e.g. 4G/5G over WLAN.
- Offloading traffic from mobile networks to WLAN is the perfect solution for bandwidth-intensive applications, helps to reduce the amount of data being carried on the cellular bands and to ensure QoS for the end users.
- It is also used to ensure service continuity where insufficient cellular coverage is given but a WLAN hotspot is available to take over the connection. Example: Voice over WLAN
- Achieving **seamless switching between 5G and WLAN** is challenging due to the complexity of network components involved.

ePDG vs. N3IWF

ePDG
(4G)



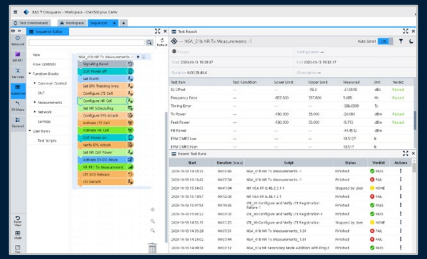
N3IWF
(5G)

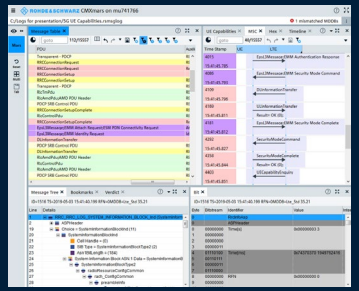


- N3IWF – Non-3GPP Inter-Working Function successor of ePDG – evolved Packed Data Gateway
- Provides a secure gateway for non-3GPP Access → i.e. WLAN to 5GC
- UE & N3IWF establish IPSec tunnels and N3IWF connects to 5GC via N2/N3
- Gateway used to integrate untrusted non-3GPP networks (i.e. public hotspots) to 5GC and the network for C-plane & U-plane traffic

NR / WLAN OFFLOADING TEST CHALLENGES

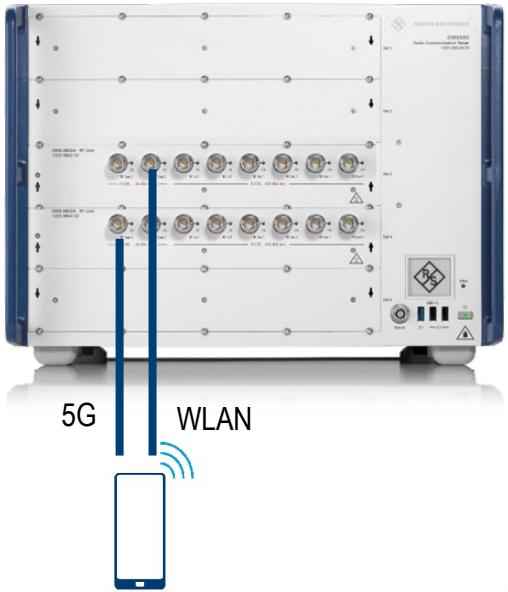
- LTE / NR and WLAN in one single integrated Testbed
- Full control of the NR cell and the WLAN access point incl. Power Level etc.
- Integrated ePDG, N3IWF Gateway, DNS and IMS Support
- Parallel Delay-, Throughput- and Speech Quality Measurements
- UE and network message flow analysis on all layers 5G, WiFi, IMS, U-Plane
- Scripts for automated testing





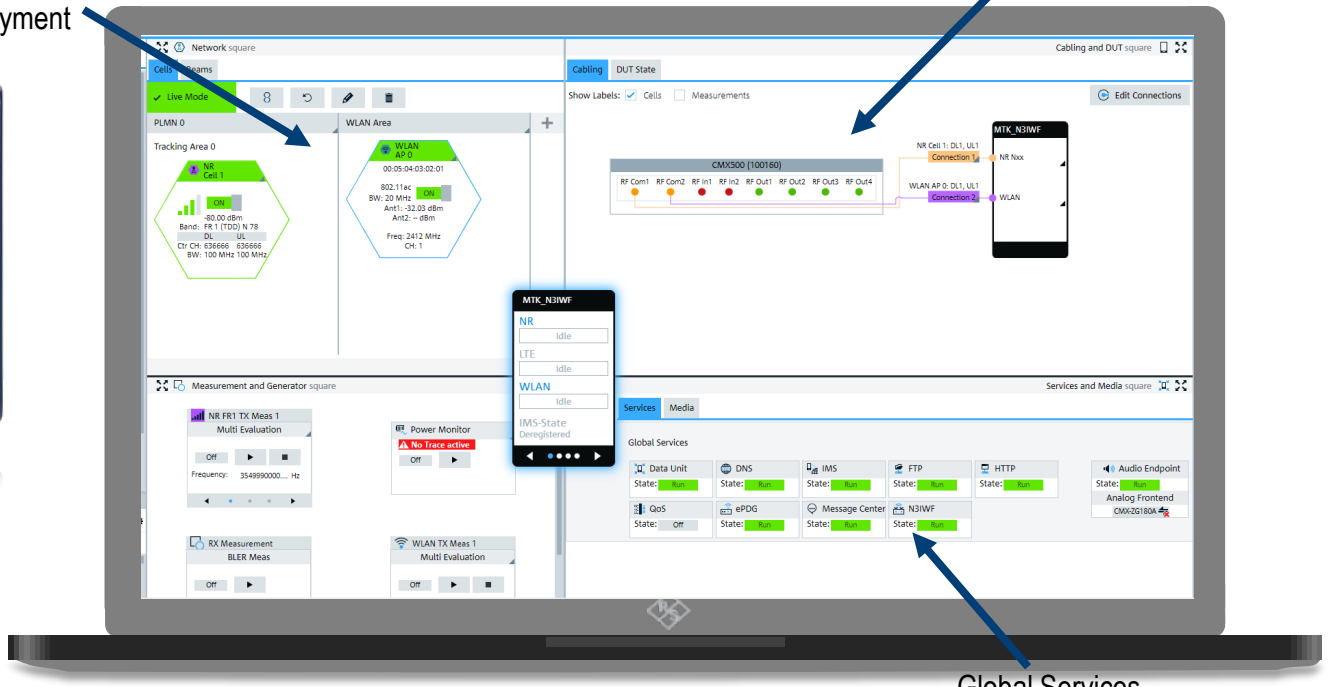
CMX500 - WLAN OFFLOADING TEST ENVIRONMENT

Test setup



Network deployment

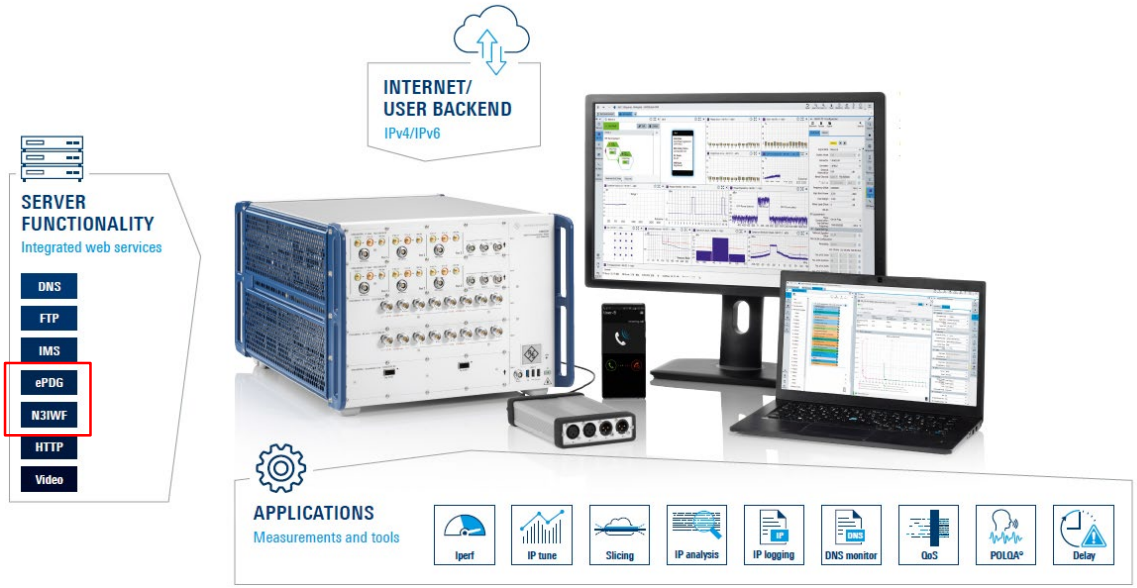
Cabling



Global Services
ePDG or N3IWF

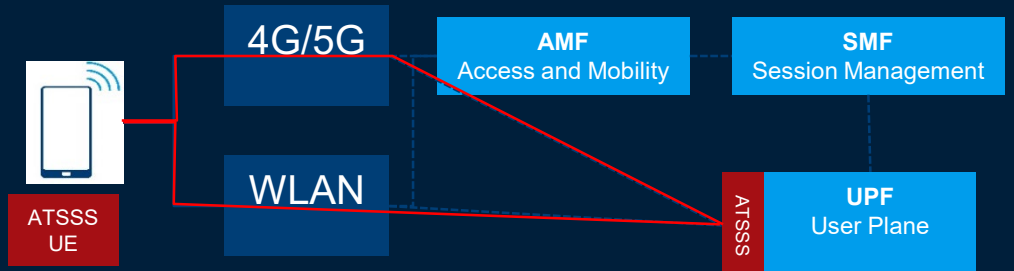
APPLICATION TEST

- Fully integrated IPv4/6 infrastructure
- Integrated servers to test most common protocols out of the box
- Comprehensive IP measurements and tools
  - IP Throughput
  - IP Tune
  - IP Analysis
  - Speech Quality Measurement
  - Internal Delay
- Backend Service Testing for Third-Party and OTT Applications



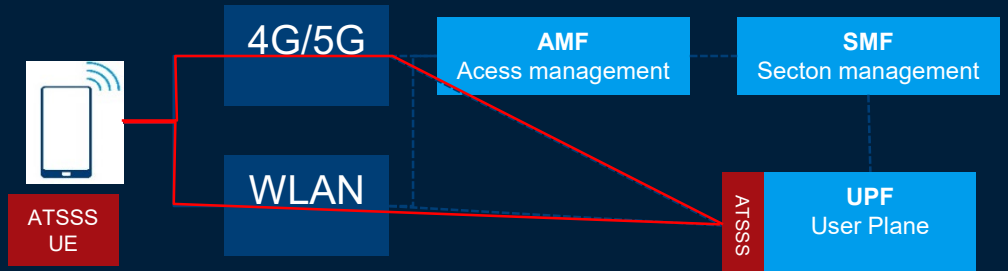
ATSSS - ACCESS TRAFFIC STEERING, SWITCHING, AND SPLITTING

ATSSS – INTRODUCTION



- **Use cases:**
  - **Increase the data rate** and throughput by aggregating the bandwidth of multiple networks.
  - **Enhancing the reliability and resilience** by switching to the best available network.
  - **Improving the user experience and quality of service** by steering the traffic according to the service requirements.

ATSSS – INTRODUCTION



ATSSS uses several kinds of rules:

- **URSP (UE Route Selection Policy)**, see TS 24.526
  - Originally introduced for Network Slicing and now expanded for ATSSS usage to create multi-access PDU sessions.
  - URSP rules for ATSSS are **provided by the network to the UE** and tell the UE if to request an MA PDU (Multi Access PDU) or an ordinary PDU session for a new connection

- **ATSSS rules** (see TS 24.193 clause 6) describe UE behavior specific to ATSSS, e.g., how much traffic each access has to carry in case of the Load Balancing Steering Mode

- **N4 rules** govern the network behavior regarding DL traffic

ATSSS – TESTING ASPECTS

- **ATSSS - Conceivable testability scenarios**
  - Check if UE obeys URSP and ATSSS rules
  - Check how quickly and how exactly the UE reacts
  - Measure the access quality upon which the UE changes access
  - Data throughput scenarios
  - QoS POLQA scenarios
  - Run a campaign to observe decision making of the UE
  - …

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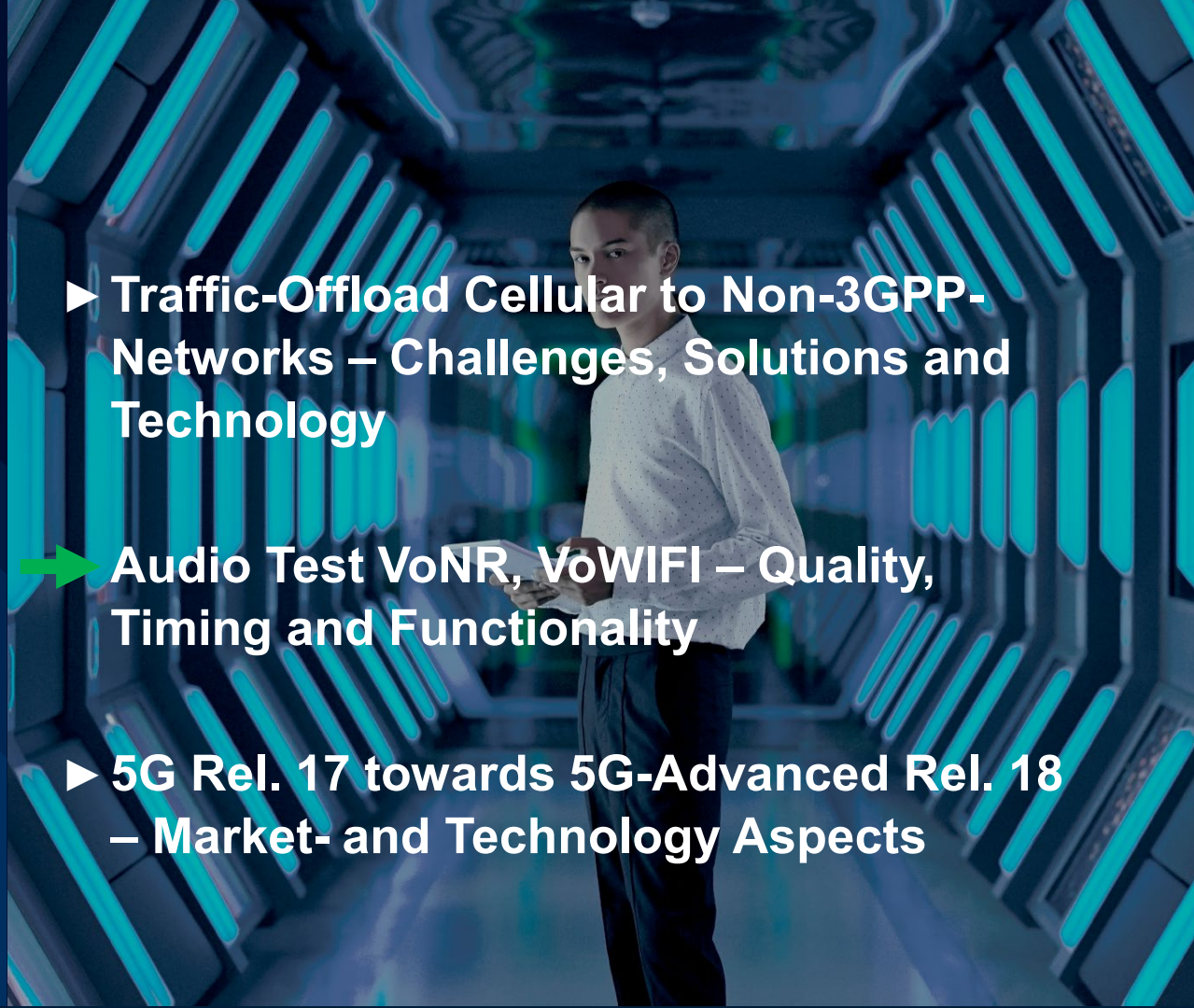

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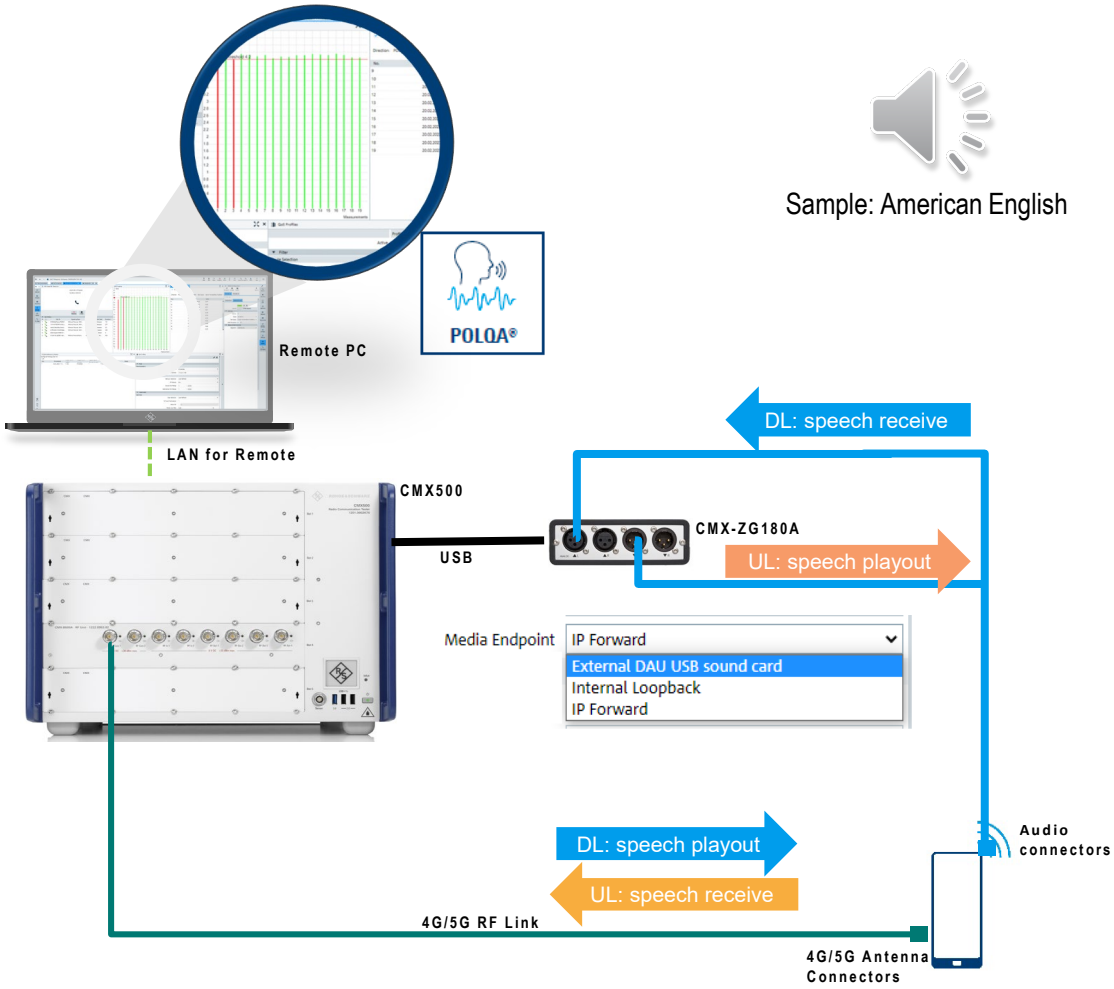
SPEECH QUALITY TEST

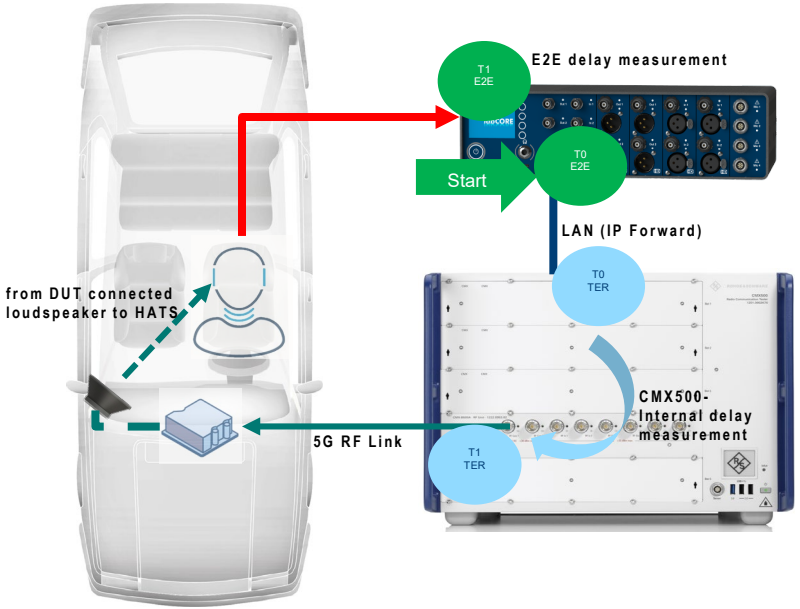
CMX500 – Integrated Speech Quality Analysis

- One box for Audio Quality (Internal POLQA Analysis – no need for Audio Analyzer)
  - Golden Standard KPI for speech quality measurement
  - Evaluates the subjective speech quality
  - MOS (Mean Opinion Score):
    - 1 (worst) … 5 (best)
- VoWiFi, VoNR and VoLTE in the same box
- Support for AT&T VoNR Audio Quality test plan
- Speech samples files in multiple languages provided
  - ITU-T Rec. P.863 (2011)

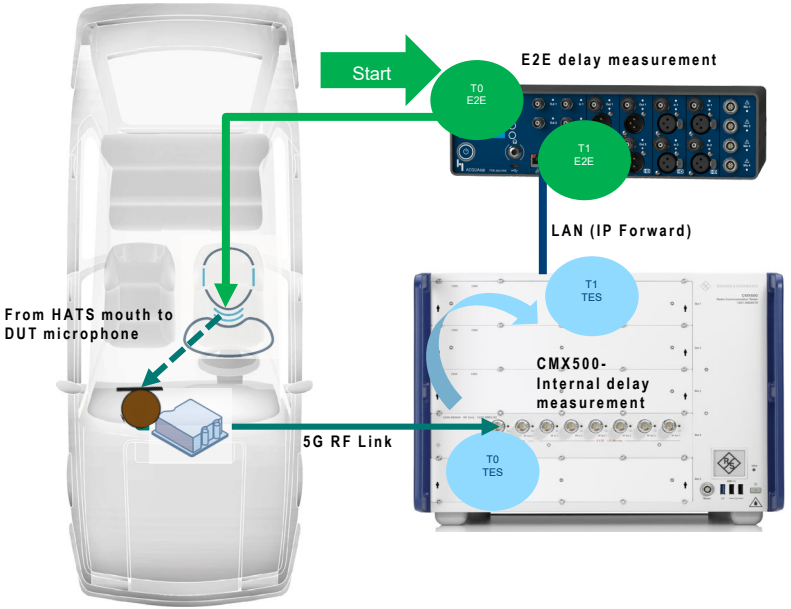


Precise delay measurements with CMX500 & HEAD acoustics labCORE

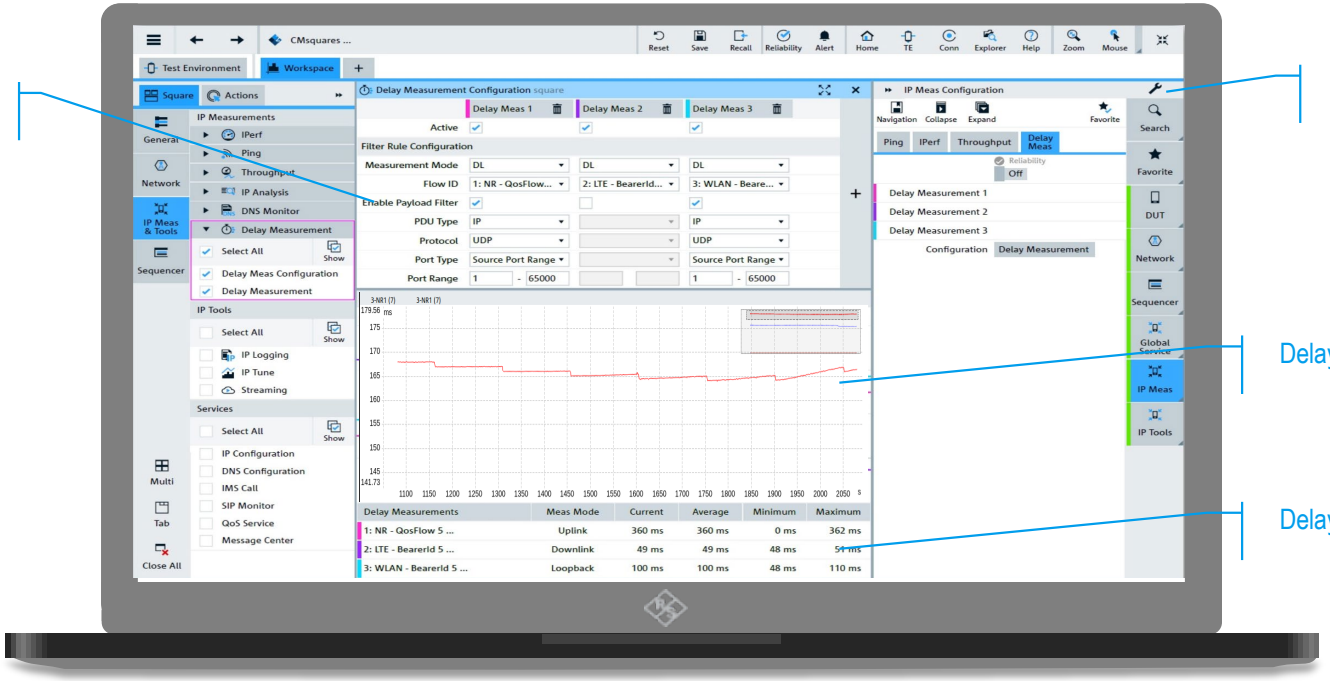
Downlink delay measurement (IP Forward)



Uplink delay measurement (IP Forward)



CMX500 Internal Delay Measurement



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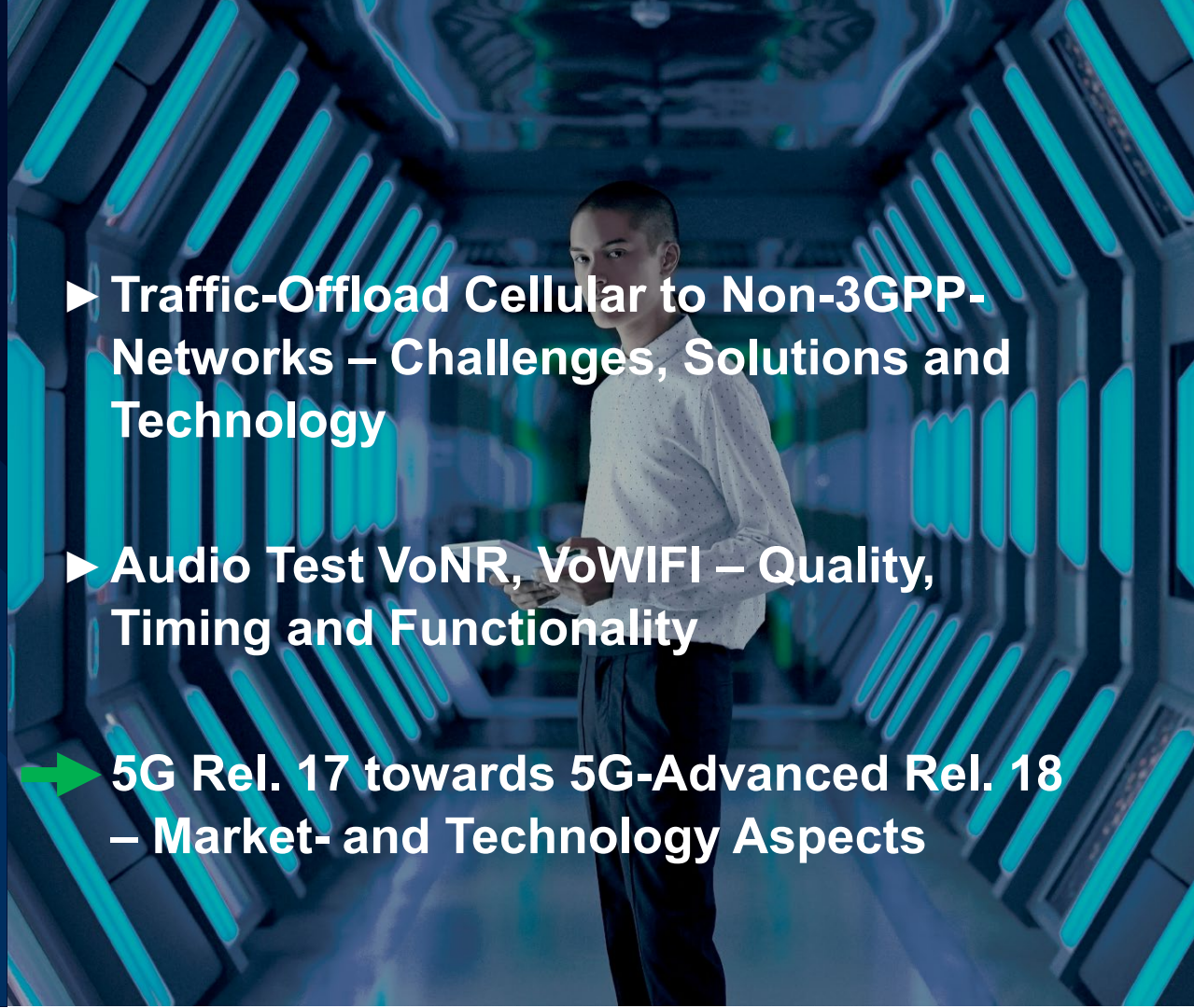

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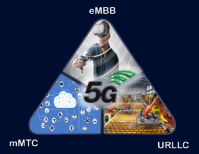
3GPP 5G ADVANCED EVOLUTION



5G NR Advanced
Release 18

5G NR
| Release 15
| Release 16
| Release 17
Release 19
Release 20

6G workshop
March 2025

Release 18
5G Adv.

Release 19
5G Adv

Release 20 6G
Studies

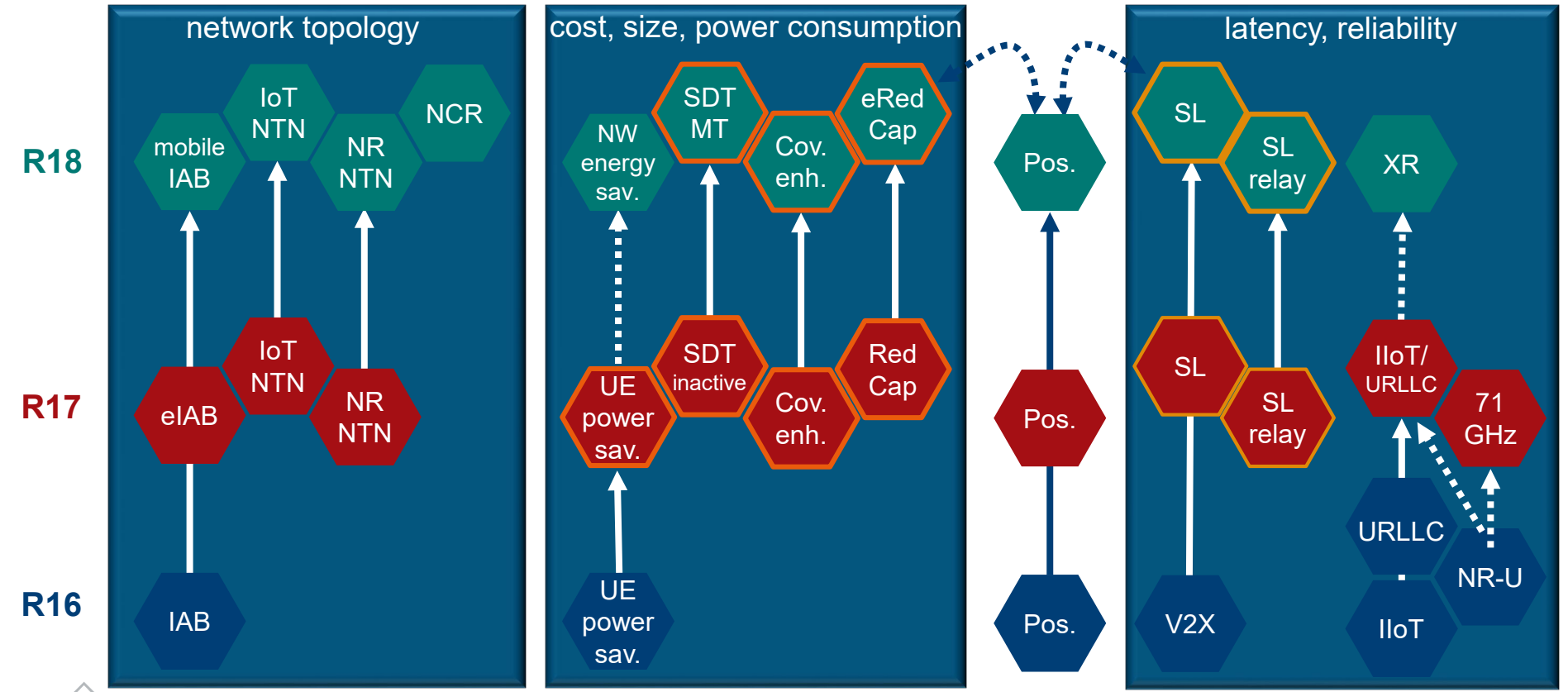
Release 21
6G Normative

Duration open

6G research kick off

2018 2020 2022 2024 2026 2028 2030

3GPP REL-16 TO REL-18 TOPICS AND RELATIONS

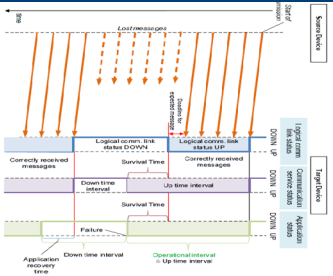


INDUSTRIAL IoT & NON-PUBLIC NETWORKS (NPN)

5G TIME SENSITIVE NETWORKS (TSN) - INTEGRATION

Deterministic network: 5G measures ingress-egress latency and sync with external networks.

New KPI: Survival time



5G or PTP external as time reference

5GS Bridge

Control plane

UDM NEF AMF SMF PCF TSN AF

TSN based application

TSN bridge

DS-TSN translator

UE

DS-TSN translator

UE

UPF

NW-TSN translator

TSN bridge

TSN based application

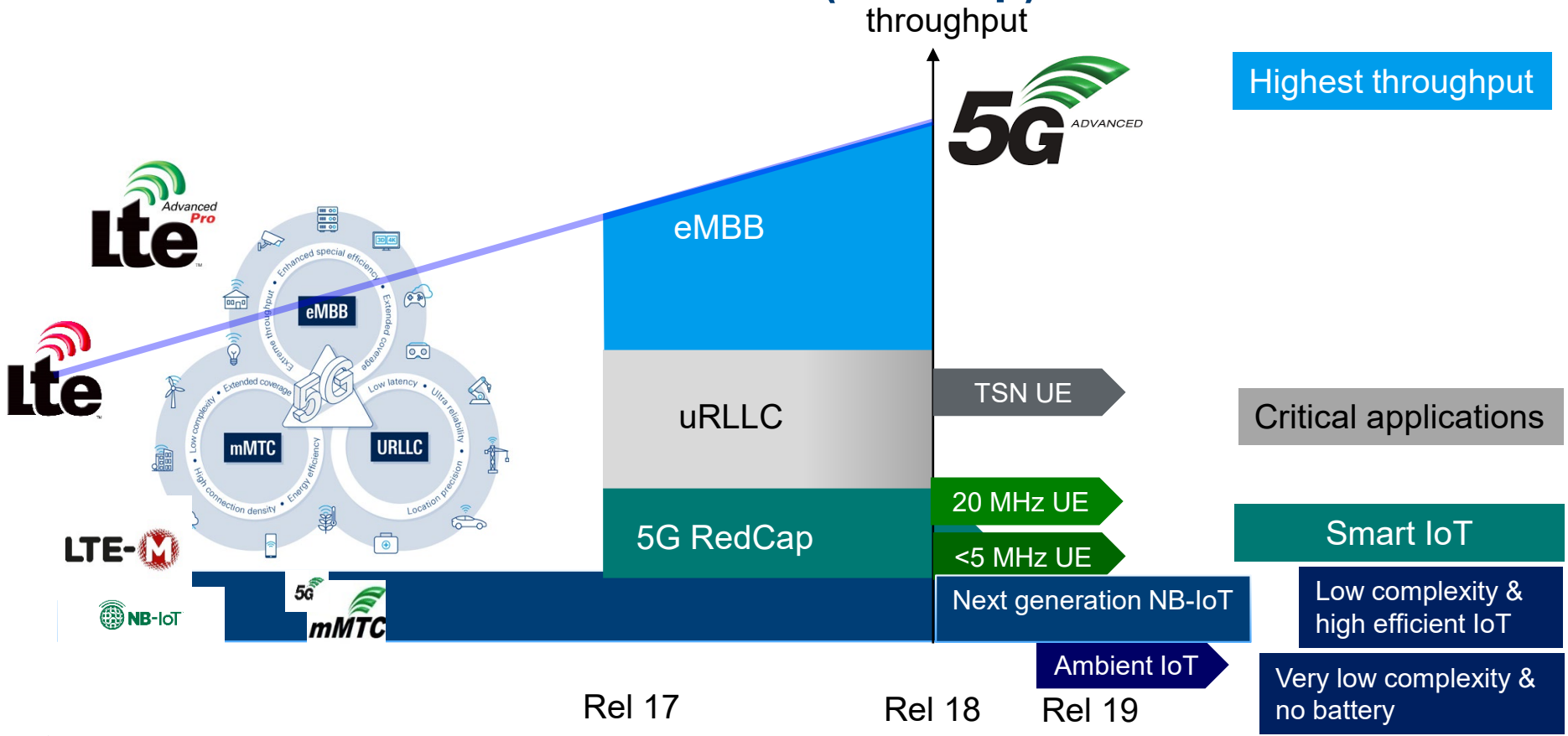
5GS time synchronization

TSN time synchronization

Enhancements on time error budget estimation to reduce uncertainty

REDUCED CAPABILITY (RedCap) + POWER SAVING ASPECTS

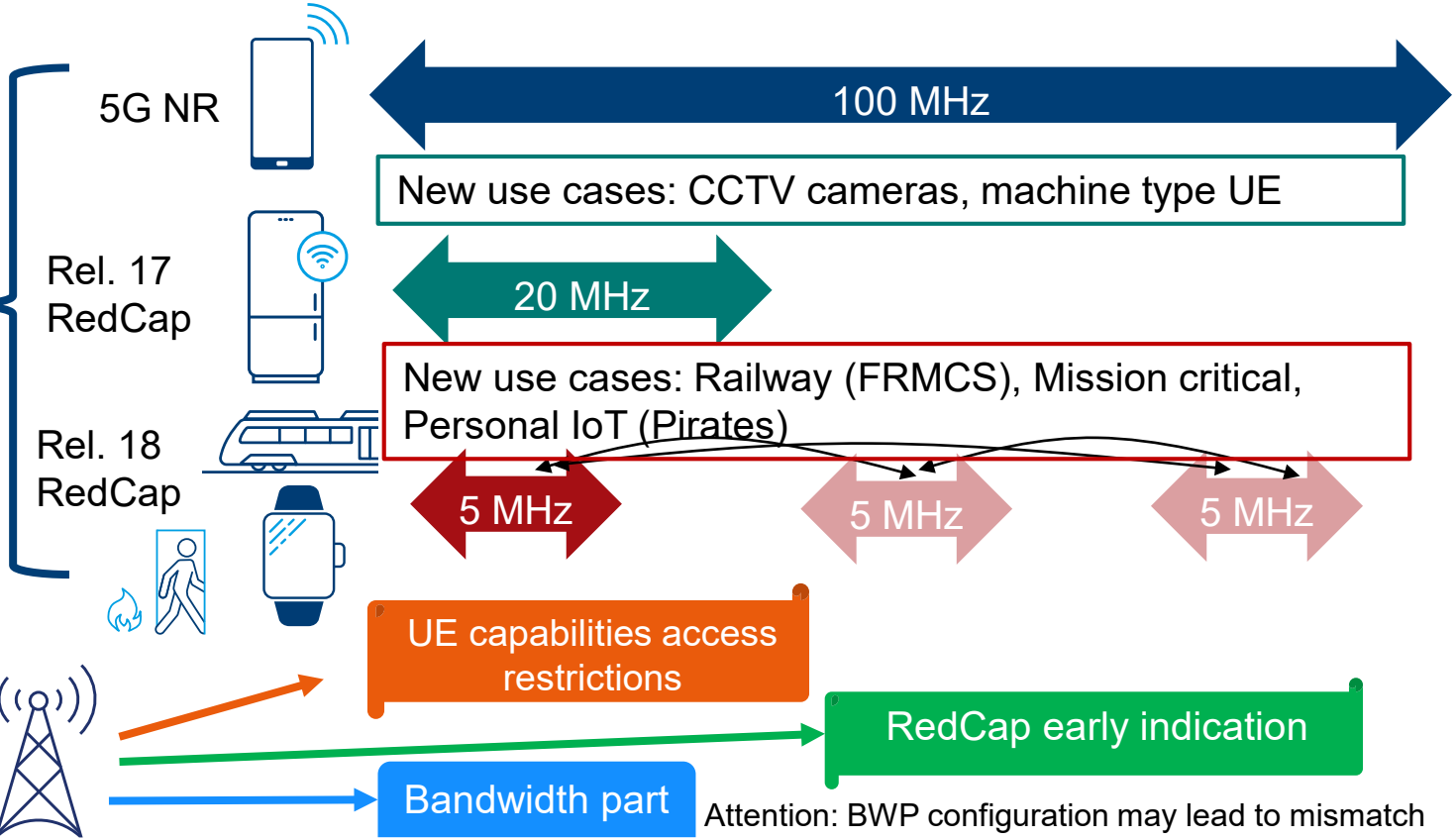
5G NR: REDUCED CAPABILITIES (RedCap)



REDUCED CAPABILITIES ASPECTS & EVOLUTION

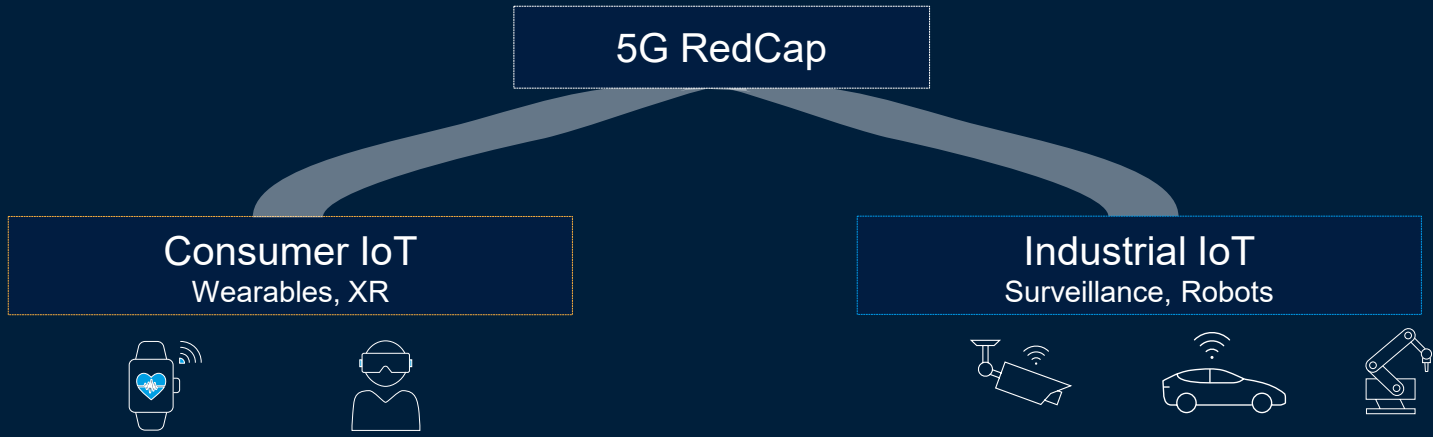
- 20MHz bandwidth
- Half-duplex
- 1 antenna
- 256QAM optional
- No dual connectivity

Coexistence



Network must operate in standalone 5G (SA)

5G RedCap MAIN USE CASES AND STAKEHOLDERS



End User	MNOs	Infra/Chipset/Device OEM	Test Houses
• IoT – better price performance for different use cases, especially smart IoT, IIoT • XR, Drones, AI chat bots • More performant wearables • Future proof	• Future proof IoT 5G technology • Allow EoF life for other techno like LTE cat4 • New revenue streams/usecases XR, Drones • Expansion of 5G devices	• Driver for SA deployments and upgrades • New use case creation: XR, Drones • Mainly a SW upgrade in the core • Enable 5G adoption • Scale IoT and Wearable Chipset platforms • Enter new usecases	• New Device Types • More Testing • GCF/PTCRB • CE/FCC

5G DEVICE EXPANSION WITH RedCap – SMART IoT

Full 5G is too complex and power-hungry to fit into a smartwatch or similar

high

Device complexity

low

eMTC/NB-IoT – 3GPP R15/16/LTE
Lowest complexity
and delay tolerance

Low end
wearables

Sensors:
agriculture,
smart city

Utility
meter

RedCap - 3GPP R17
Lower complexity
and power

Surveillance
cameras

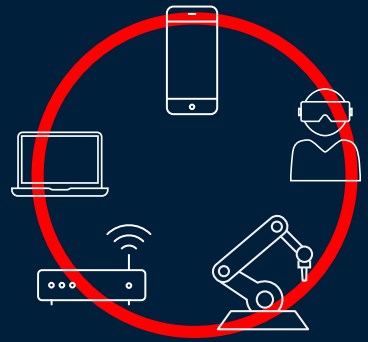
High end
logistic

High end
wearables

High end
industrial
sensors

SMART IoT

eMBB/URLLC - 3GPP R15/16/LTE
Highest performance

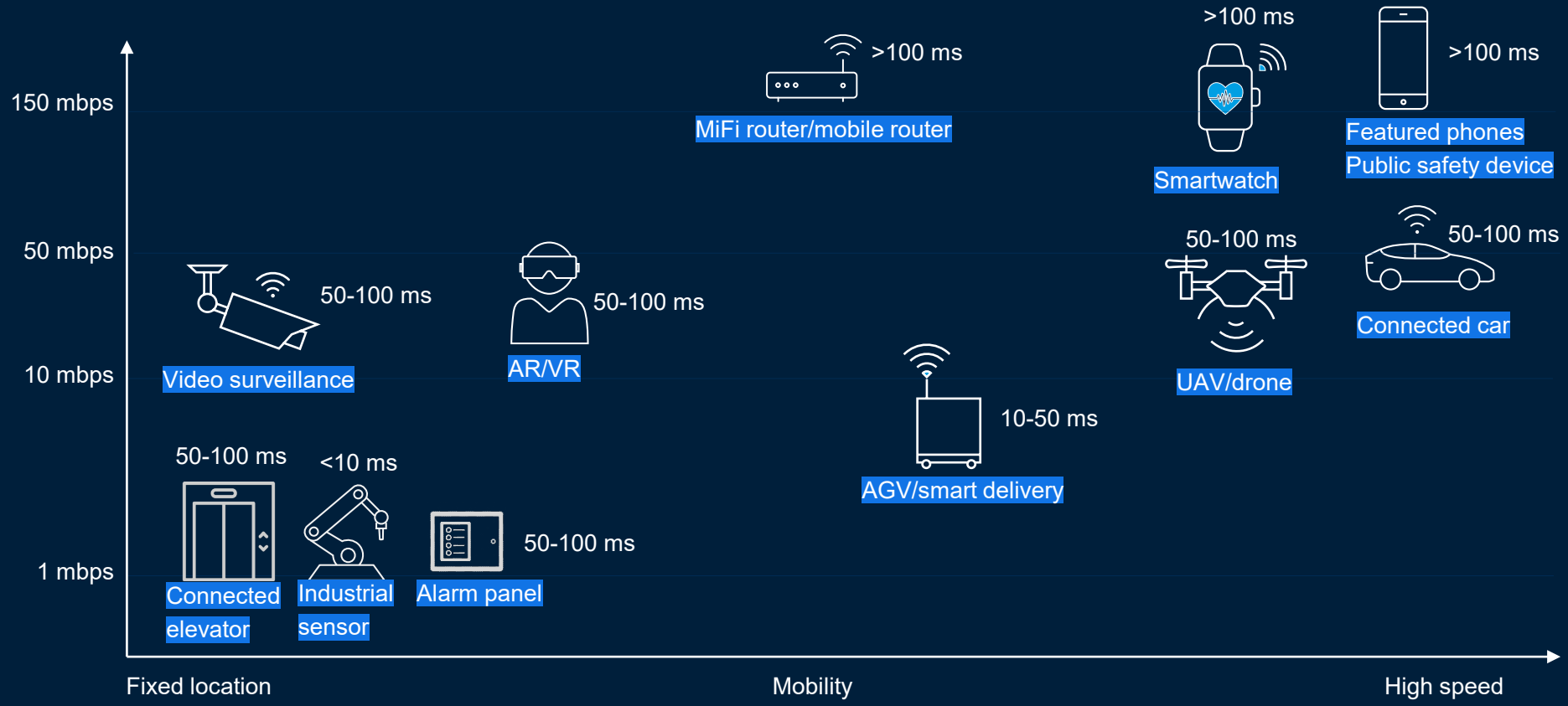


*size of bubble indicates device cost

Device performance

high

5G DEVICE EXPANSION WITH RedCap CONTD.



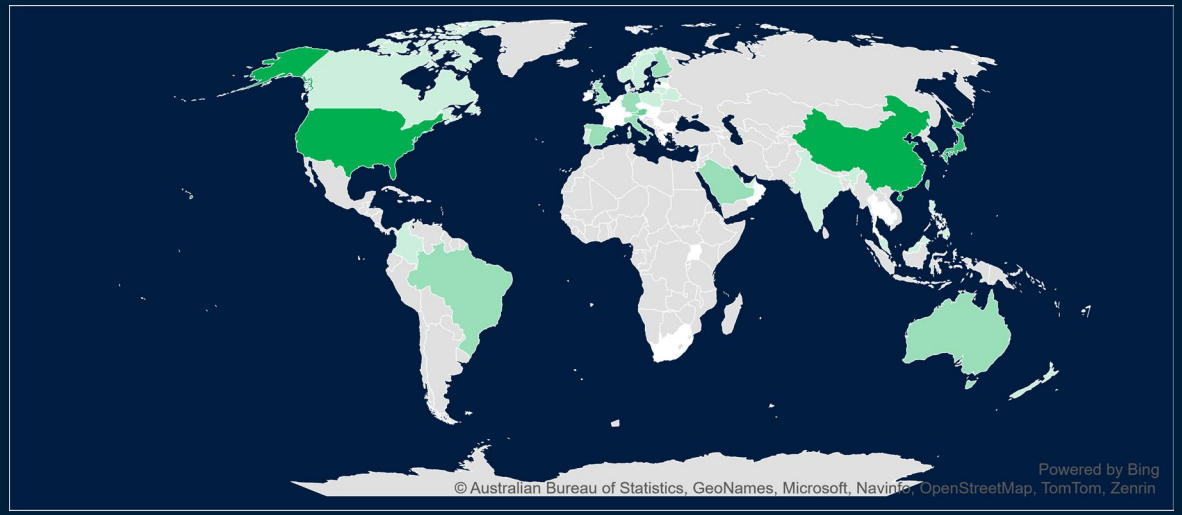
RedCap DEVICE WORKS ONLY OVER 5G SA NW

578
5G Operators
out of which

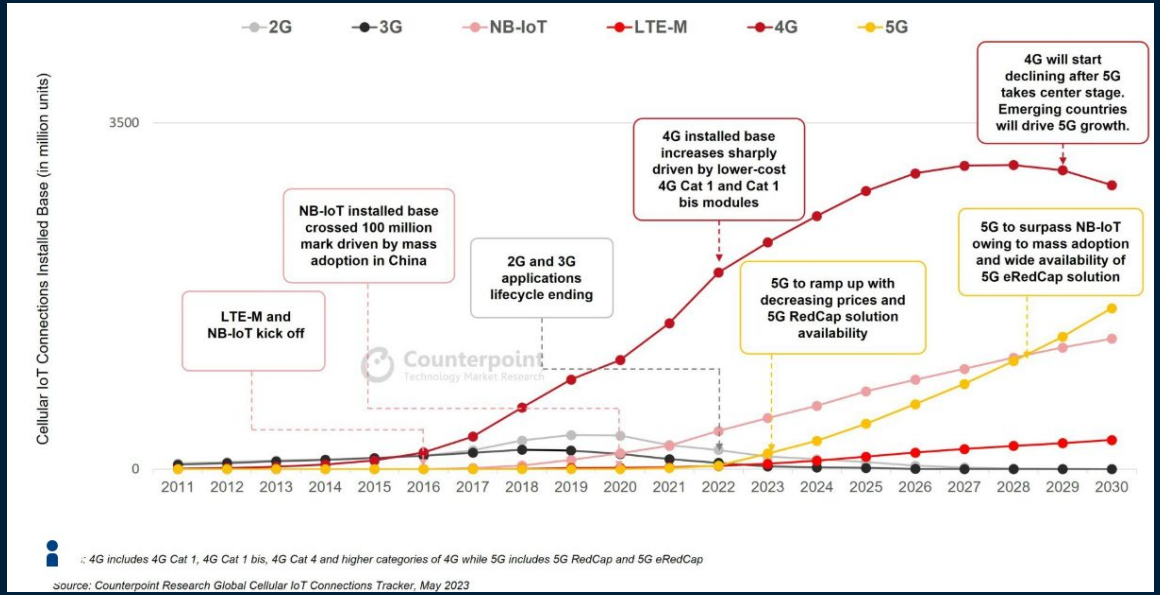
- Commercial **299**
  - 5G SA **43**
    - mmW **59**
    - 5G FWA **152**
- Investing **277**
  - Deploying SA **75**
  - 5G FWA investing **45**
- 5G private **1148**
  Deploying/trialing/investing

4G: 2,500

Global status of 5G SA deployments (41 launched, 75 deploying investing)



THE RedCap CONNECTIONS ARE EXPECTED TO EXCEED 100 MILLION IN THE NEXT THREE YEARS



The global cellular IoT connections installed base is expected to surpass 6 billion by 2030 with a CAGR of 10.8%. The growth will be mainly driven by cellular connectivity adoption across various sectors such as utilities, automotive, industrial, retail and healthcare.

Unlike the previous decade, where consumer devices like smartphones and PCs played a significant role in driving cellular connections, this decade will see a shift towards cellular connections propelled by the digital transformation initiatives undertaken by enterprise IoT payers.

Highlights of cellular IoT connections installed base:

- Global cellular IoT connections grew 29% YoY to reach 2.7 billion in 2022 with 4G continuing to grow its majority share.
- China held over two-thirds of cellular IoT connections in 2022, followed by Europe and North America.
- NB-IoT dominates in China, while LTE-M is preferred in Australia, Japan and North America; Europe supports both.
- 4G and NB-IoT are the most preferred cellular IoT applications technologies.
- 5G is nascent as module prices and breadth of applications reflect early-stage dynamics.
- IoT growth drivers are shifting, with the enterprise and transformation initiatives key in propelling IoT connections forward.

Features		5G NR	5G RedCap (1T2R)	5G RedCap (1T1R)	Cat 4	Cat 1/Cat 1bis
Throughput		UL: 175 Mbps	UL: 50 Mbps	UL: 50 Mbps	UL: 50 Mbps	UL: 5 Mbps @16QAM
	FDD	DL: 350 Mbps @256QAM/2T4R/100M	DL: 150 Mbps @64QAM/1T2R	DL: 85 Mbps @64QAM/1T1R	DL: 150 Mbps @64QAM/1T2R	DL: 10 Mbps @64QAM/1T1R
		UL: 250 Mbps	UL: 22 Mbps	UL: 22 Mbps	UL: 15 Mbps	UL: 1 Mbps @16QAM
	TDD	DL: 1.7 Gbps @256QAM/2T4R/100M	DL: 124 Mbps @64QAM/1T2R	DL: 62 Mbps @64QAM/1T1R	DL: 110 Mbps @64QAM/1T2R	DL: 7.4 Mbps @64QAM/1T1R
URLLC		1 ms support URLLC	5~10 ms@99.99% support URLLC	5~10 ms@99.99% support URLLC	>100 ms	>100 ms
Power consumption		100 mA~3 A	Working: 120~160 mA Idle:12~22 mA	Working: 120~160 mA Idle:12~22 mA	Working: 120~160 mA Idle:12~22 mA	<100 mA
Network Slicing/URLLC						

DEPLOYMENT SCENARIOS – CHALLENGES IOT

Dense urban	Nomadic/Mobile	Industrial sites / Private Networks	Rural
• Reflective environment with multiple paths • Small cells / hot spots • Frequent Handover • Highly dynamic • Varying network load over day time • Low mobility	• Varying network load over day time • Frequent handover • Roaming • Voice • High mobility + velocity	• Reflective environment with multiple paths • Private networks • High reliability • Long Term stability • Stationary	• Coverage scenario • Large cells • Low Mobility • Stationary
→ Challenge is dynamic environment	→ Challenge is mobility	→ Challenge is the specific use case	→ Challenge is coverage

A CLOSER LOOK AT FALLBACK FOR RedCap DEVICES

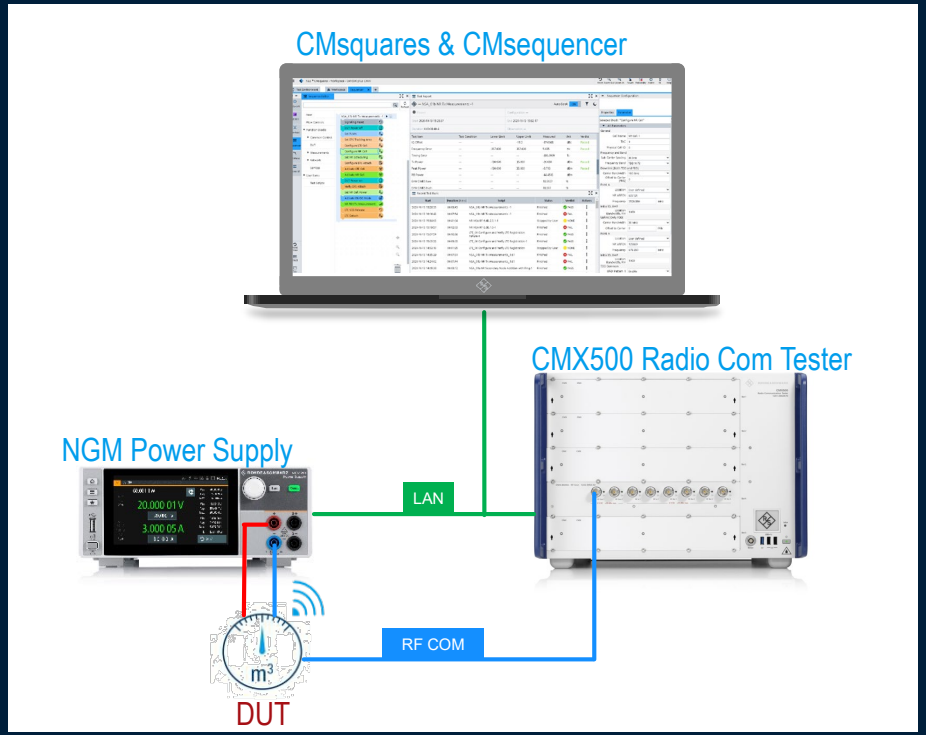
NR RedCap will be introduced with LTE fallback

- REDCAP/eRedCap is non backwards compatible, it requires 5G SA of Rel. 17/18
- Especially in early phase REDCAP will often operate in fallback mode, due to absence of NR SA network
  - LTE category depending on UE/HW configuration
  - Simple eMBB device „band restricted“
- Need for fallback will also impact REDCAP configuration
- Operating in fallback mode has implications on customer deployments due to availability / non-availability of certain features

Resulting Challenges

- Impact on test
  - LTE fallback needs to be considered on all test setups - Availability
  - Test solution as close as possible to customer scenario – Remote/Mobile solutions

R&S®CMX500 – POWER CONSUMPTION TESTING



The R&S®CMX500 Battery Life Testing solution offers seamless power consumption measurements in parallel to:

- RF measurements: power consumption vs. max. RF Power (FR1, FR2, multiple CC combinations)
- Protocol testing: power consumption vs. Power saving features (c-DRX, PDCCH WUS, etc.)
- Application testing: power consumption vs. E2E TP testing, web browsing, video streaming, gaming, etc.
- Multi-technology solution for all standards supported by the R&S®CMX platform
  - LTE, 5G FR1/FR2 incl. RedCap