

Wireless innovation day 2023

Look into 5G Fixed Wireless Access (FWA)

Utilizing both FR1 and FR2 frequencies for maximum effectiveness

ROHDE & SCHWARZ

Make ideas real



THE STATE OF THE 5G GLOBAL ECOSYSTEM

Q4CY2022 SNAPSHOT



94

Chipsets
out of which



1696

Devices
out of which



502

Operators
out of which



990M

Connections

Commercial 88

mmW **45**
SA **11**

Announced 6

mmW **4** (FWA)
SA **3**

Commercial 1431

mmW **128**
FWA CPE **203** mmW 26
SA **1222** Indoor 122
Outdoor 81

Announced 265

mmW **38**
FWA CPE **71** mmW 26
SA **22**

Commercial 228

5G SA **32**
mmW **59**
5G FWA **99**

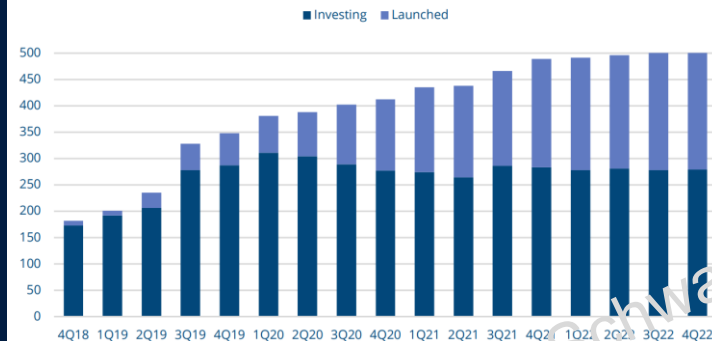
Investing 281

Deploying SA **21**
5G FWA investing **52**

5G private 193

Deploying/trialing/investing

Count of operators investing in 5G, and operating commercial 5G networks



THE STATE OF

5G users vs. 4G users

- use 40 GB of data every month
- stream 2x more video
- spend 1.5x more time on social media
- play mobile games 3x more often
- eMBB is the most common use case

FUTURE SERVICES

FWA

fixed wireless brings broadband connectivity at home, so users can enjoy the same ultra-fast and reliable 5G experience in the place they spend much of their time across an ecosystem of devices.

(I)IoT

pushes 5G to other use cases and device types. For example connectivity in 5G smart factories is enabled with 5G routers and other peripheral sensor-based devices based on NR-Light/RedCap.

NTN

brings connectivity to areas where there is no service at all today, especially for mission critical messaging

XR

extended reality services are in the making by the biggest companies of the world. The possibility of these devices are endless fueled by 5G and low latency.



5G IS MAKING FWA COMPETITIVE**

FWB technologies

Download speeds

**ADSL/
ADSL2**
24 Mbps

**GEO
satellites**
12 – 50 Mbps

**LTE
FWA**
up to 100 Mbps

**LEO
satellites**
50 – 500 Mbps

**FTTC/
VDSL2**
200 Mbps

G.Fast
100 Mbps
– 1 Gbps

HFC
10 Gbps

5G FWA
1 – 10 Gbps*

FTTH/B
2.4 – 40 Gbps



<100 Mbps

<1 Gbps

<40 Gbps

21%

of FBB connections are VDSL
and between 2024 and 2025 this technology will not suffice
and can not offer more than 100 Mbps, in contrast FWA can
offer more for less

THE FWA VALUE PROPOSITION

FWA Positioning



FWA TCO

10 years TCO FWA
vs. FTTH

When new ducts/poles
are needed

In rural
up to 65% costs saving

In suburban
up to 45% cost saving

In urban
up to 25% cost savings

FBB and FWA Strategy

1. Fiber where viable
2. FWA where viable
3. Leo as last resort



FWA GROWTH

Rohde & Schwarz

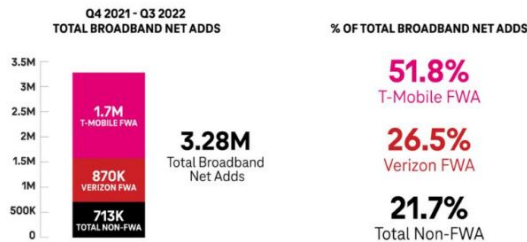
USA: 3.7M reported
T-Mobile: 7-8M ambition
Verizon: 4-5M ambition

Growth Regions:

- USA
- Europe
- South East Asia
- Middle East
- South Africa
- India

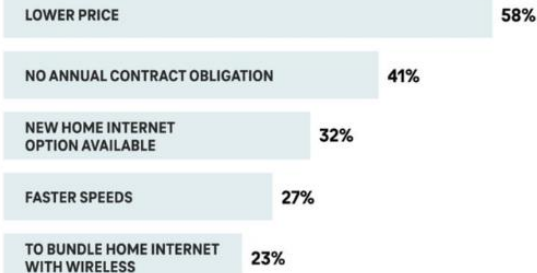
Rohde & Schwarz

SUBSCRIBER GROWTH



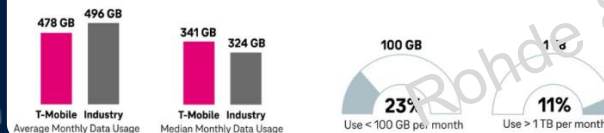
Sources: T-Mobile, OpenVault, Leichtman Research

WHY CUSTOMERS SWITCH



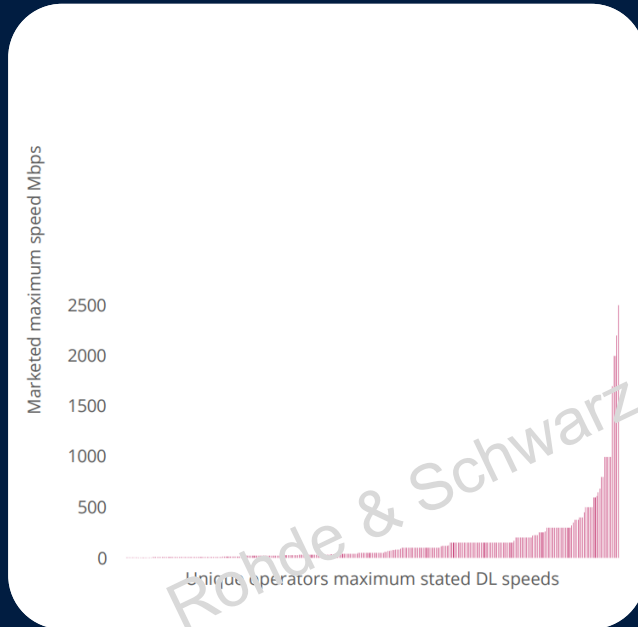
Sources: T-Mobile, Institute for Local Self-Reliance

USAGE TRENDS

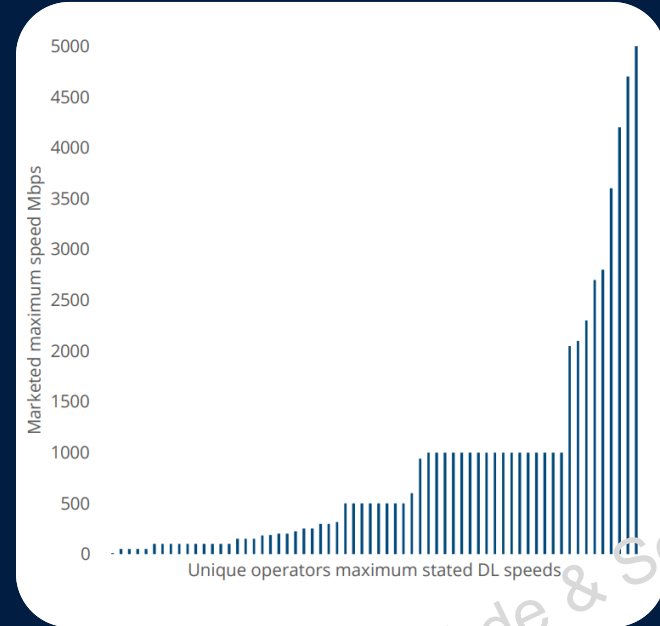


5G OFFERS SIGNIFICANTLY FASTER DL SPEEDS

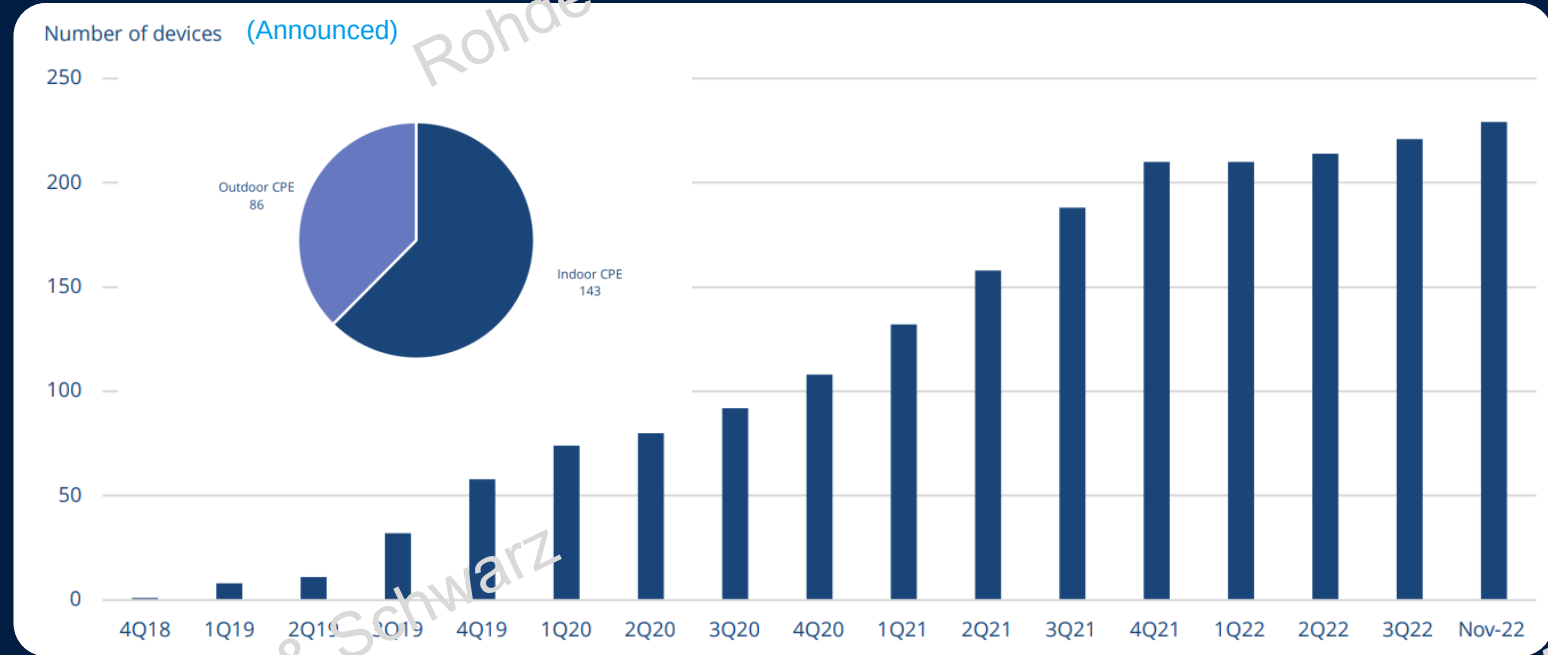
LTE FWA max. DL speeds



5G FWA max. DL speeds



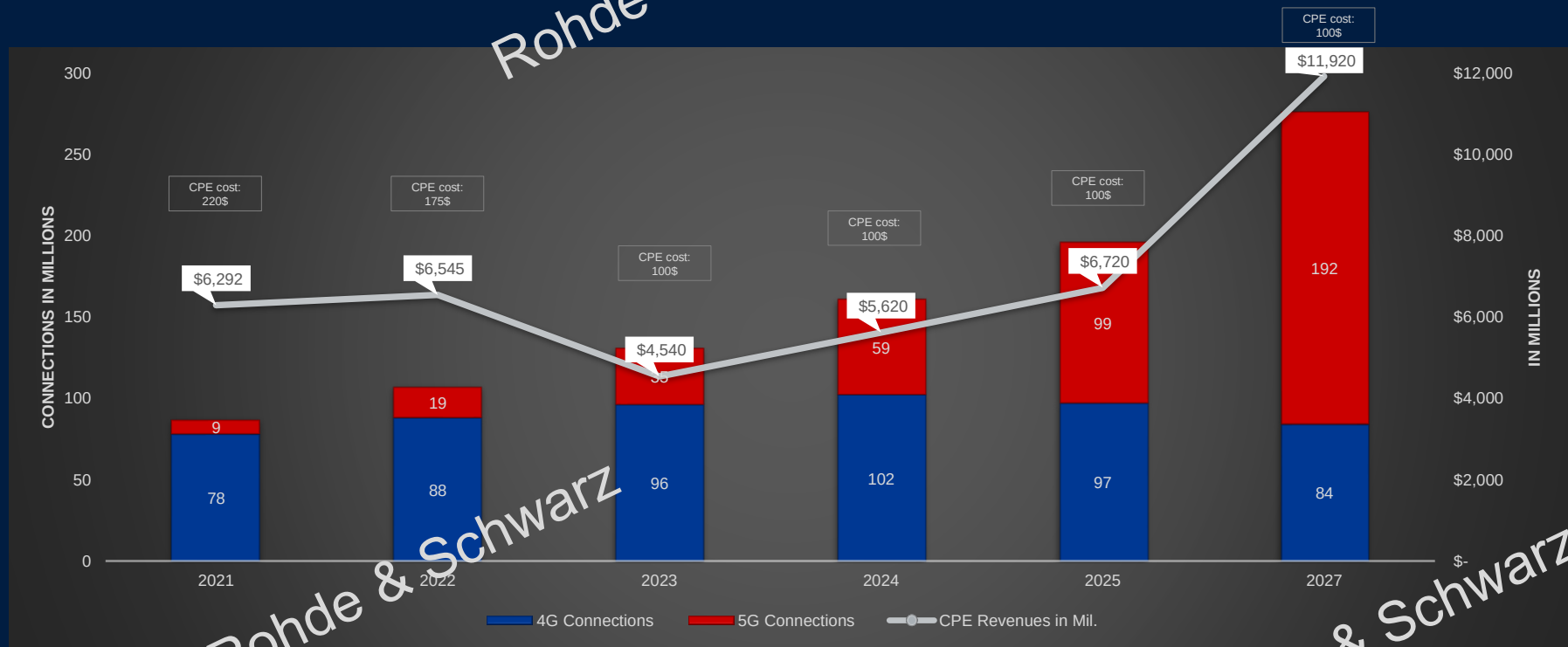
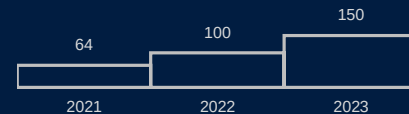
FWA 5G CPE SHIPMENTS ON THE RISE



FWA ESTIMATE ON CPE REVENUES*

Rohde & Schwarz

5G CPE Vendors Estimate



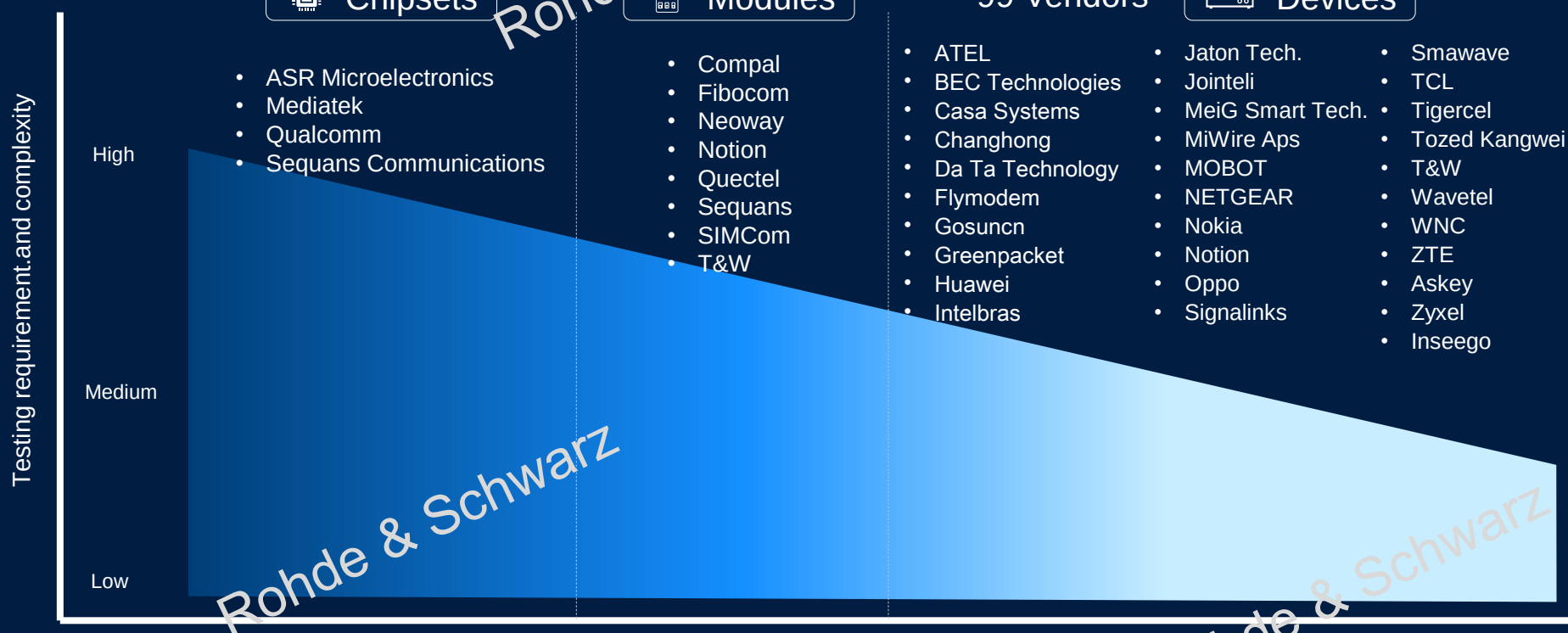
*Source: ABI Research, Dell'oro, and Ericsson Mobility report 2022



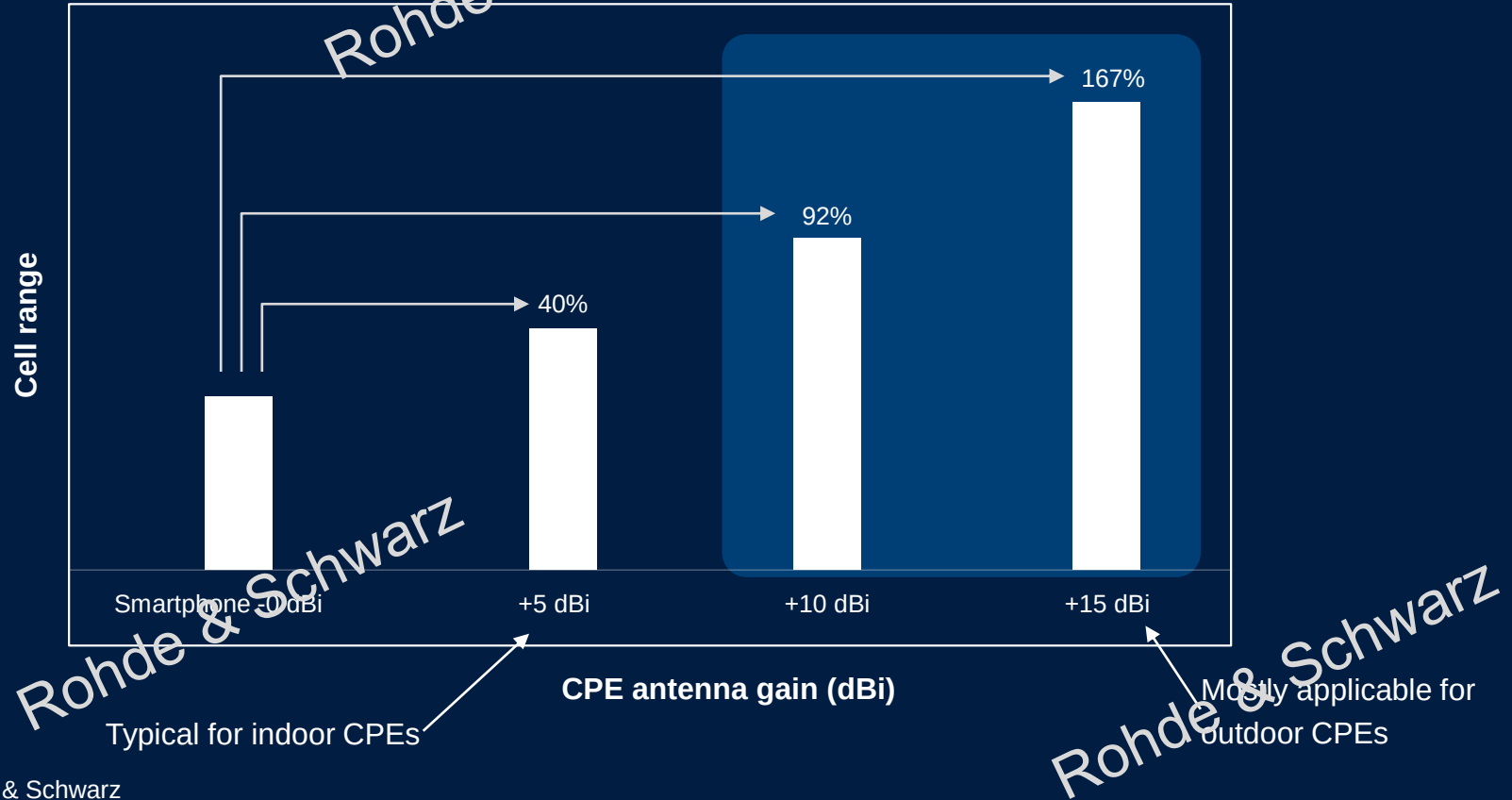
Rohde & Schwarz

Rohde & Schwarz

5G FWA ECOSYSTEM*



IMPACT ON CELL RADIUS W.R.T CPE ANTENNA GAIN



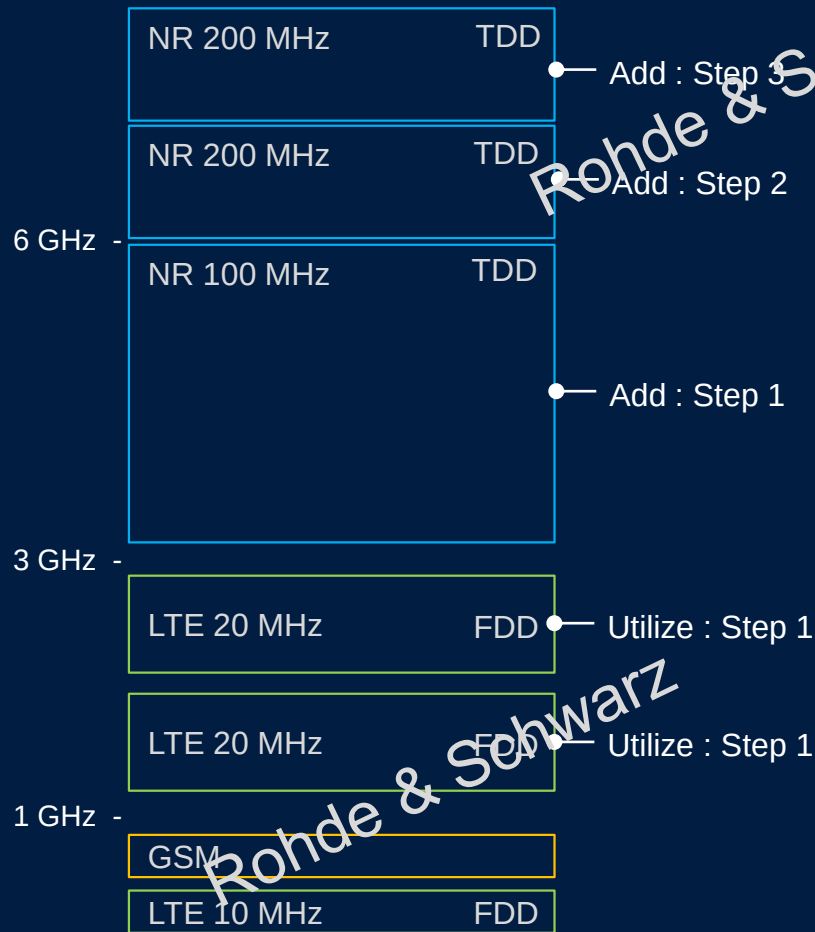
CPE POWER CLASSES FOR 5G NR

FR1 UE Power Classes

Classes	Max RF Output Power	Applicable Bands
Power Class 1	3 dBm	N14
Power Class 1.5	29 dBm	N41
Power Class 2	26 dBm	N41, n77, n78, n79
Power Class 3	23 dBm	All other FR1 bands

FR2 UE Power Classes

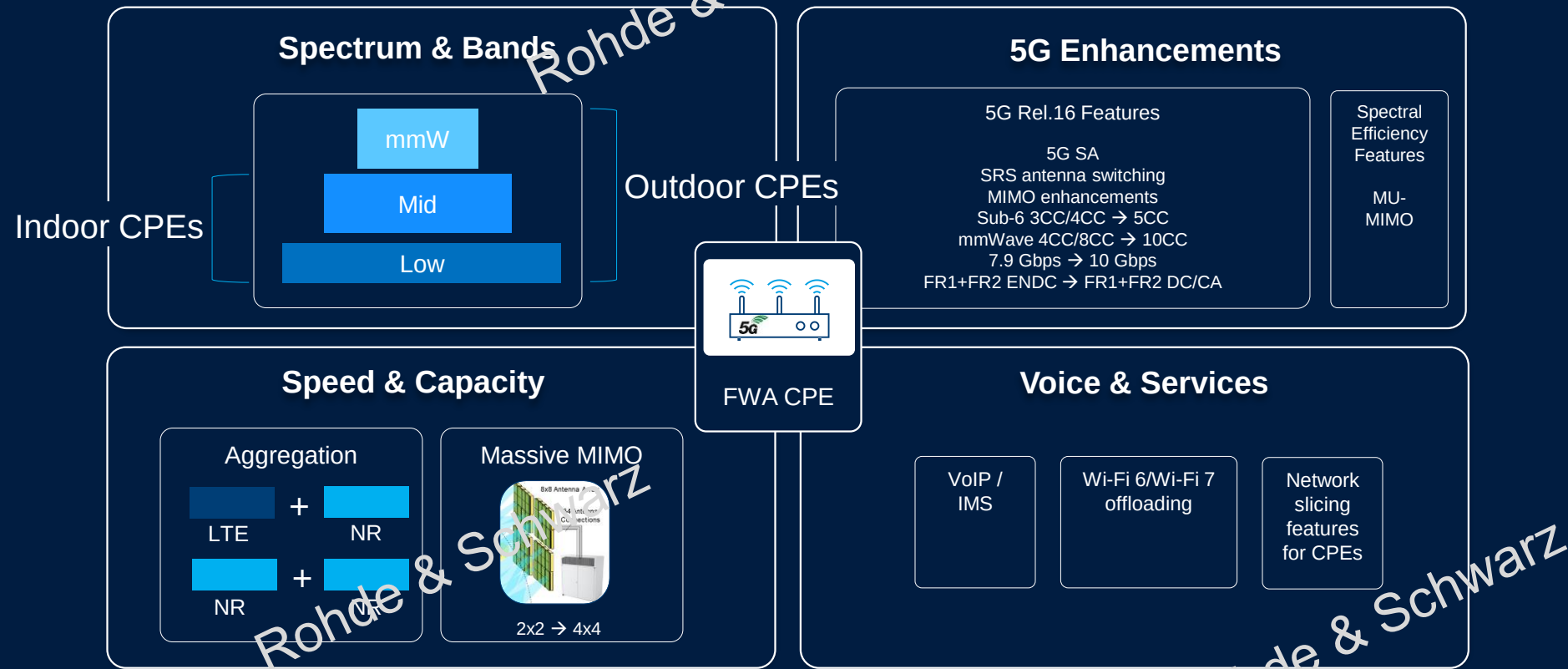
Classes	Max TRP	Min/Max EIRP	Notes
Power Class 1	35 dBm	40 dBm/55 dBm	FWA UEs n260 min is 38 dBm
Power Class 2	23 dBm	29 dBm/43 dBm	Automotive applications (radar, etc)
Power Class 3	23 dBm	22.4 dBm/43 dBm	Handheld UEs n260 min is 20.6 dBm
Power Class 4	23 dBm	34 dBm/43 dBm	Non-handheld UEs n260 min is 31 dBm



OVERALL OPERATOR SOLUTION EXAMPLE

- **Utilize** existing macro sites, baseband and transport
- **Utilize** available spare capacity on deployed sub-3 GHz bands for LTE
- **Add** NR in TDD mid band
- **Add** NR in TDD mmWave band with mmW extended range support
- **Add** baseband and transport capacity.
Use all LTE carriers above 1 GHz for MBB and FWA
-Add QOS/slice separation
- Outdoor CPE focus to maximize performance
-Indoor CPE as complement

5G CPE REQUIREMENTS – OPERATOR PERSPECTIVE Rel.16



5G FWA UE TEST REQUIREMENTS AND SOLUTIONS

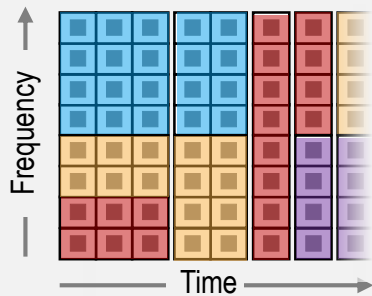
Test Types	Indicators	Goal
RF parametric	NR: 3GPP RF TRx test specification Output power, EVM, OBW, receiver sensitivity level BLER, band permutations and CAs etc.	Checks RF TRX performance in accordance with common test specifications Mostly required by operators
Functional	E2E max. throughput DL/UL per band CA/ENDC/DC combos 24/7 long duration tests NSA/SA attach; Different modulations <1024QAM Operational stability during long connection and throughput Latency SMS USIM/eSIM authentication FW versioning	Tests to improve customer satisfaction Tests device behavior to check: Battery life, thermal status Firmware regression Benchmark for selecting wireless module CPE under heavy load Generally, end-device vendor-specific parameters (as well as RF parametric, operator acceptance, OTA tests)
Operator acceptance	Operator-specific test criteria	Verifies whether device meets with operator's test criteria
Conformance	RF/RRM/PCT	GCF/PCTRB certification
OTA	CTIA OTA test specification	Verifies antenna performance, required by operators
Coexistence	WLAN coexistence testing with Wi-Fi signaling	Ensuring there is no impact between different radios
Security	TCP/IP application message flows	SW vulnerability testing
Regulatory	RF output power, emission mask, spurious emissions etc.	CE/FCC certification



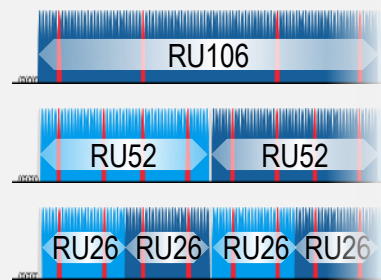
The 7th generation of Wi-Fi for
Extreme High Throughput (EHT) at home, offices and factories

A short recap: Technology cornerstones of the Wi-Fi 6 (802.11ax) revolution

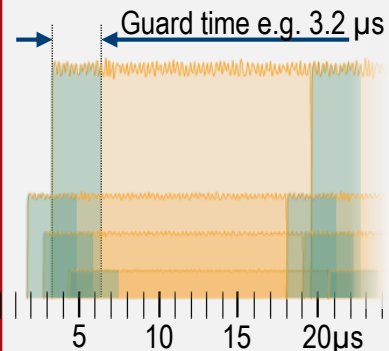
OFDMA



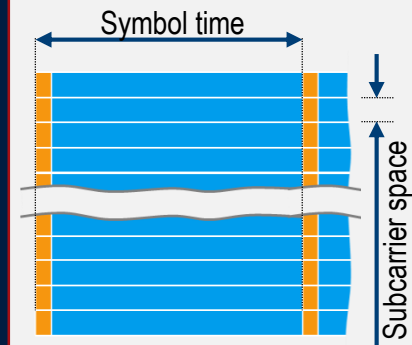
Resource units



Long guard interval



Long symbol time



- ◆ Efficient use of available spectrum
- ◆ Multi-user operation and latency reduction

- ◆ Avoiding inter-symbol interferences
- ◆ More efficient use of available resources

Over two generations a six fold increase of max throughput

	Wi-Fi 5 (802.11ac) <i>Very High Throughput (VHT)</i>	Wi-Fi 6E (802.11ax) <i>High Efficiency (HE)</i>	Wi-Fi 7 (802.11be) <i>Extreme High Throughput (EHT)</i>
Supported bands	5 GHz	2 GHz, 5 GHz, <u>6 GHz</u>	2 GHz, 5 GHz, 6 GHz
Channel bandwidth (MHz)	20, 40, 80, 80+80, 160	20, 40, 80, 80+80, 160	20, 40, 80, 160, <u>320</u>
Transmission scheme	OFDM	OFDM, <u>OFDMA</u>	OFDM, OFDMA
Subcarrier spacing	312.5 kHz	<u>78.125 kHz</u>	78.125 kHz
Guard interval	0.4 μ s, 0.8 μ s	0.8 μ s, <u>1.6 μs</u> , 3.2 μ s	0.8 μ s, 1.6 μ s, 3.2 μ s
Spatial streams	8x8 (incl. DL-MU-MIMO)	8x8 (incl. MU-MIMO)	<u>16x16</u> (incl. MU-MIMO)
Modulation (highest)	256QAM (8 bit)	<u>1024QAM</u> (10 bit)	<u>4096QAM</u> (12 bit)

* dependent on configuration and incl. signaling overhead

Rohde & Schwarz

rethink 5G testing

Rohde & Schwarz

Rohde & Schwarz

Rohde & Schwarz



Rohde & Schwarz

Rohde & Schwarz



Rohde & Schwarz

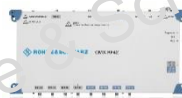
OBT - the best compromise

- ▶ Up to 32 NR Layers
- ▶ Up to 32 LTE Layers
- ▶ 48 layers on air simultaneously
- ▶ Extensive Fading support
- ▶ 10 GHz RF DL iBW
- ▶ Sub8: 400 MHz - 8 GHz
- ▶ mmW: 22 - 50 GHz



NEW IN FR2 SIGNALING

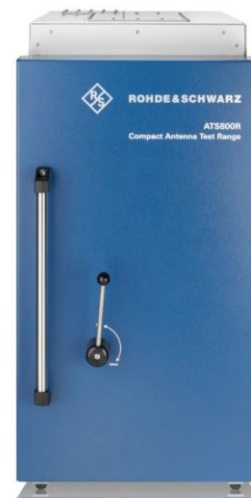
New CMX-RF42



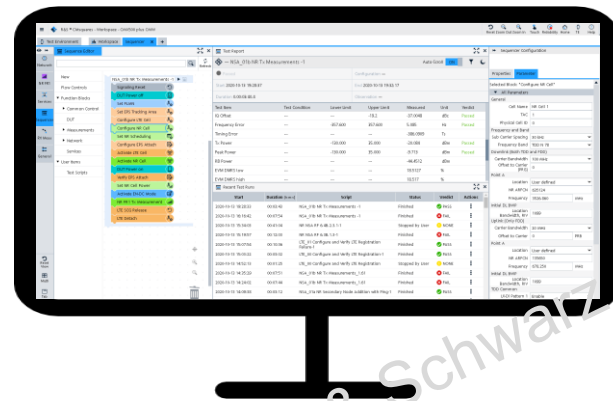
New CMXHEAD50



New
ATS800R



New FR2 Specialist



* Free use of selected Contest RF performance test cases until summer 2023

R&S CMX500 ONE-BOX TEST SETUP FOR APPLICATION TESTING

Unique integrated solution – Simplify your test setup!



SERVER FUNCTIONALITY

Integrated web services

DNS

FTP

IMS

ePDG

HTTP

Video

INTERNET/ USER BACKEND

IPv4/IPv6



APPLICATIONS

Measurements and tools



Iperf



Ping



IP tune



IP analysis



IP logging



DNS monitor



QoS



COMMON GRAPHICAL USER INTERFACE

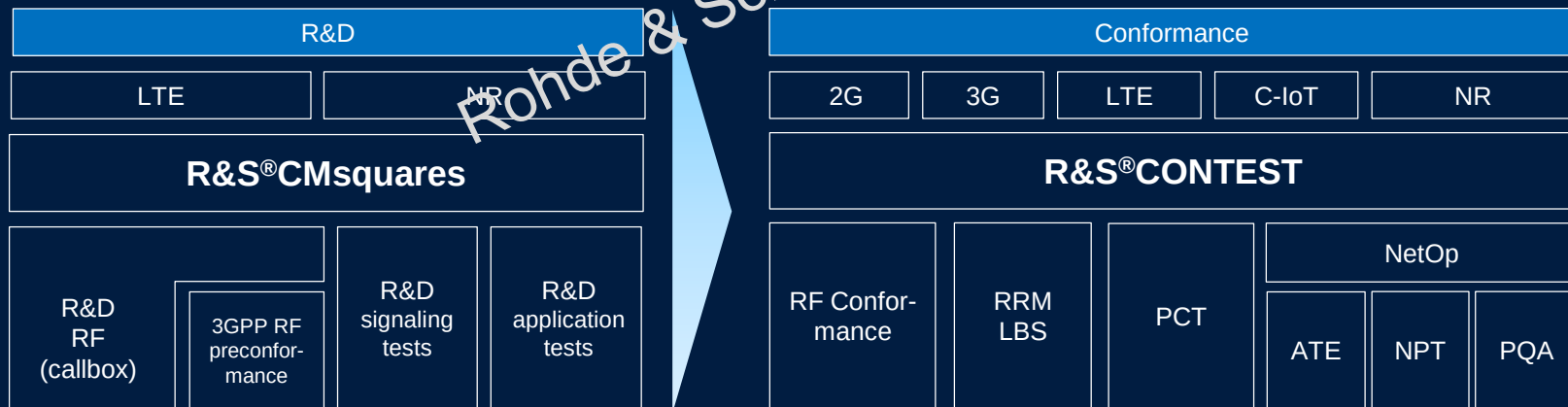
R&S[®]CMXsquares

- All R&S[®]CMX500 services are integrated in R&S[®]CMXsquares, the common graphical user interface
- It has a dashboard where all application types can be accessed
- This unique user interface is controlled via web GUI
- The standardized GUI provides a uniform user experience for all Rohde & Schwarz 5G radio communication testers
- All measurements can be manually operated in workspaces or built as test sequences in the integrated R&S[®]CMSequencer graphical scripting interface
- Test routines can be remotely controlled via XLAPI and SCPI interfaces



Rohde & Schwarz

CMX500 TOOLCHAIN: CMSQUARES & CONTEST



R&S[®]CMSquares



R&S[®]CMX500



R&S[®]ATS CATR



R&S[®]NGM200



R&S[®]TS8980



Rohde & Schwarz

Thank you for your attention!

Rohde & Schwarz

*"If you want to go fast, go alone.
If you want to go far, go together!"*

African proverb

#THINKSIX 6G

https://www.rohde-schwarz.com/us/knowledge-center/videos/-thinksix-main-6g-research-areas-video-detailpage_251220-1043073.html

Rohde & Schwarz



Rohde & Schwarz

