

Wireless Communication

Unlocking the ultimate Wi-Fi 7 experience

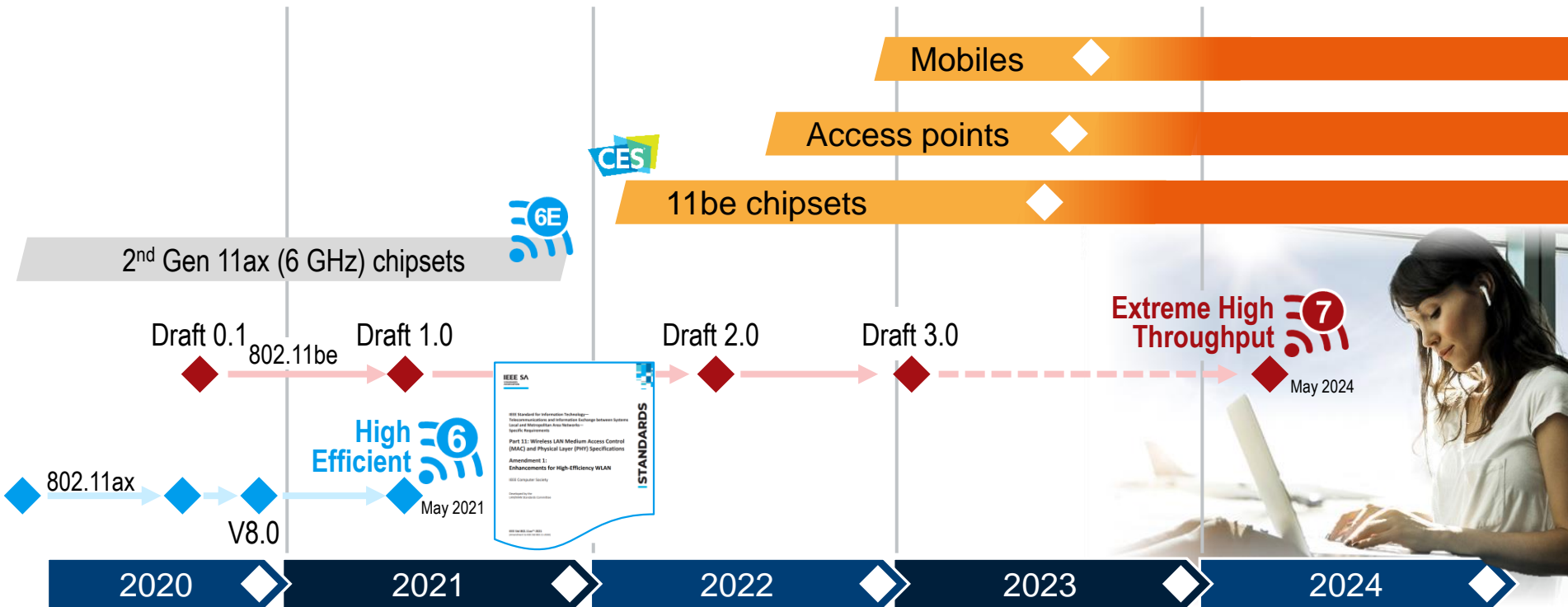
Jörg Köpp, Market Segment Manager
Hagen Heggenberger, Product Manager

ROHDE & SCHWARZ

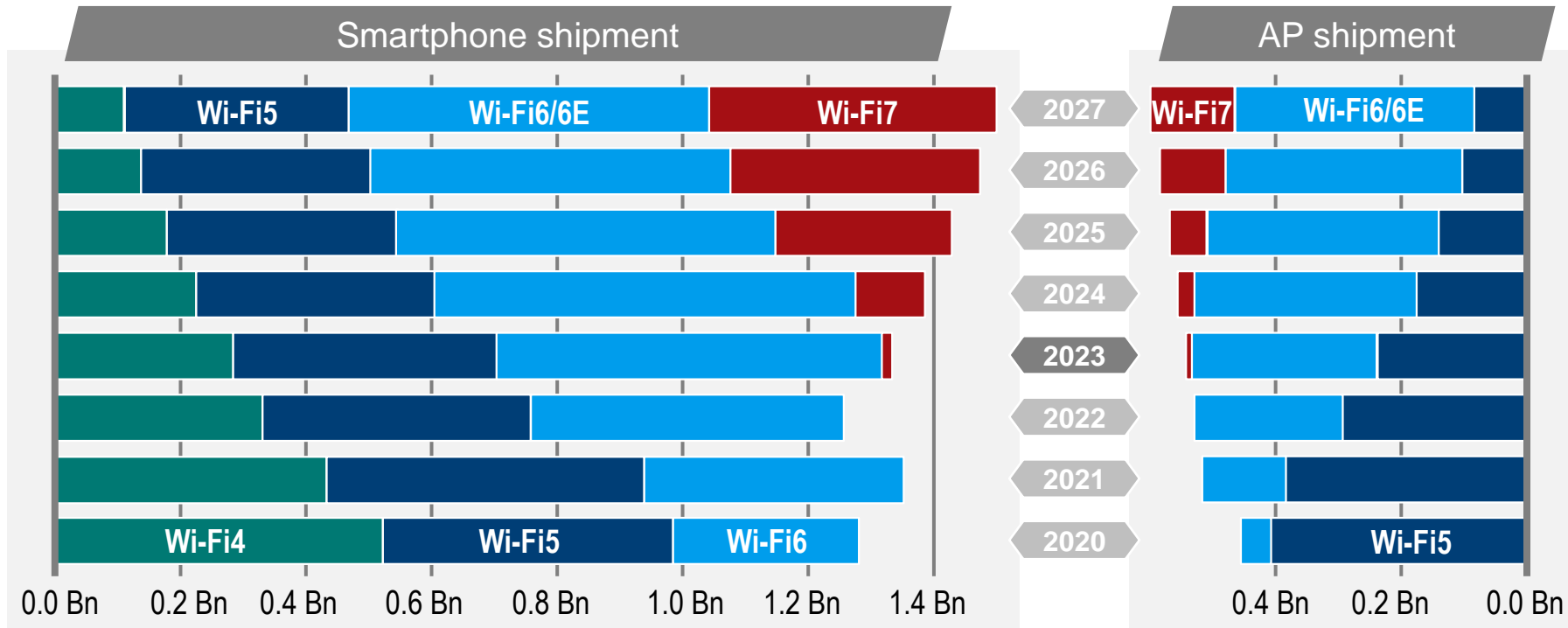
Make ideas real



Extreme high throughput WLAN (EHT – IEEE 802.11be – Wi-Fi7) is entering the market with amazing speed



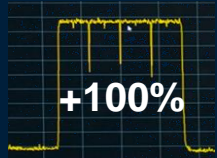
1st mobile Wi-Fi7 devices expected to be released in 2H2023



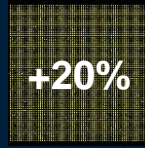
Source: Techno System Research, 2022 Wireless connectivity market analysis, summary report, June 2022
<https://iotbusinessnews.com/download/2022-TSR-Wireless-Connectivity-Market-Report-Summary.pdf>



The four cornerstones of IEEE 802.11be to achieve extreme high throughput



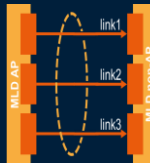
**320 MHz
channel**



**4096QAM
modulation**



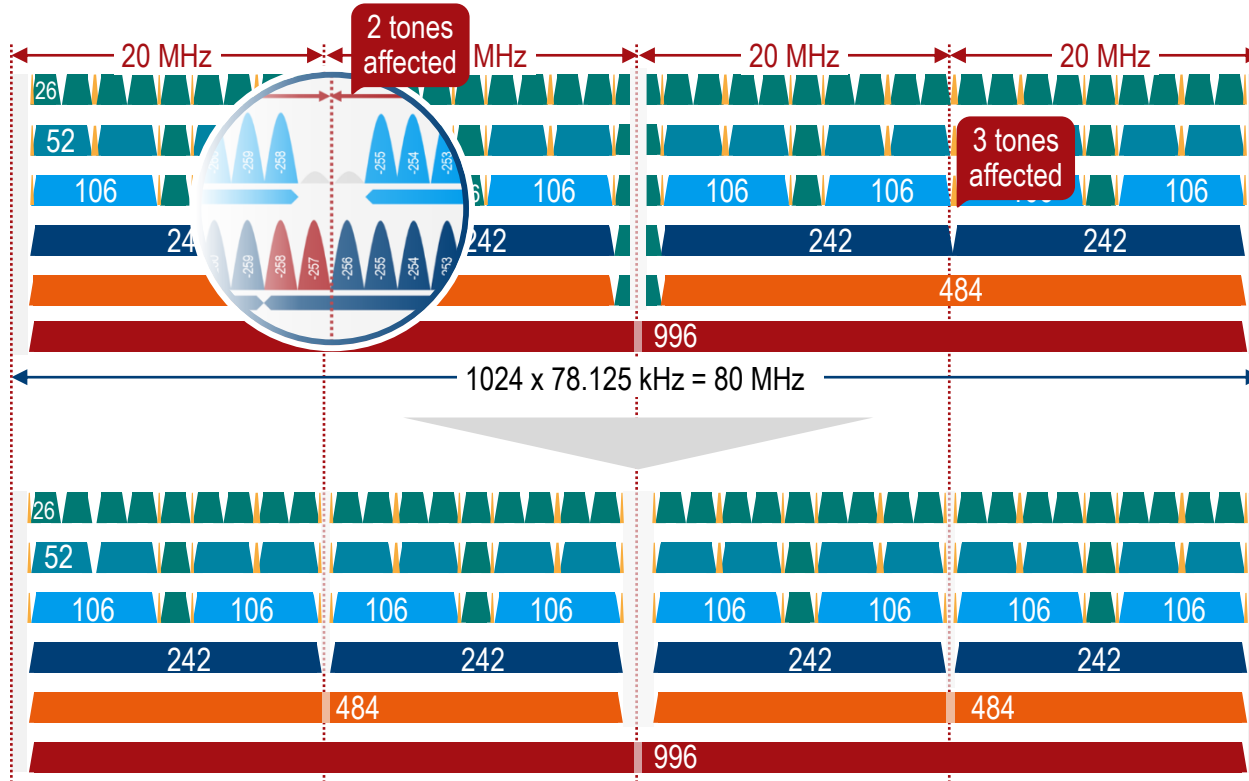
**16x16
MIMO**



**Multi-link
operation**



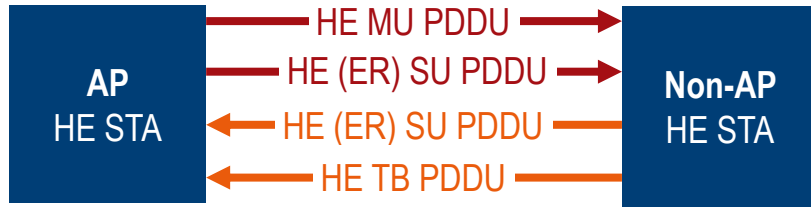
Please be aware of a modified tone-plan ≥ 80 MHz



- 802.11be tone plan is based on 20/40 MHz PPDU 11ax tone plan
- 802.11be modifies the HE 80 MHz OFDMA tone plan to fix the problems with regulation and puncturing (20 MHz boundary)
- The 80 MHz OFDMA design applies to any RU < 996 for all modes of transmission, SU, DL MU, TB PPDU, with and without puncturing.

New physical layer protocol data unit (PDDU) formats

IEEE 802.11ax – Wi-Fi6/6E



HE MU PDDU

Downlink: non-MU-MIMO, MU-MIMO

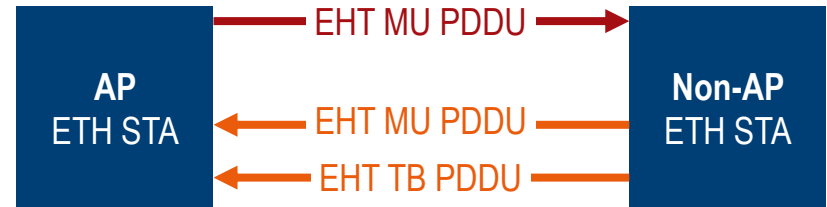
HE (ER) SU PDDU

Downlink: SU transmission, sounding NDP
Uplink: SU transmission, sounding NDP

HE TB PDDU

Uplink: MU-MIMO

IEEE 802.11be – Wi-Fi7



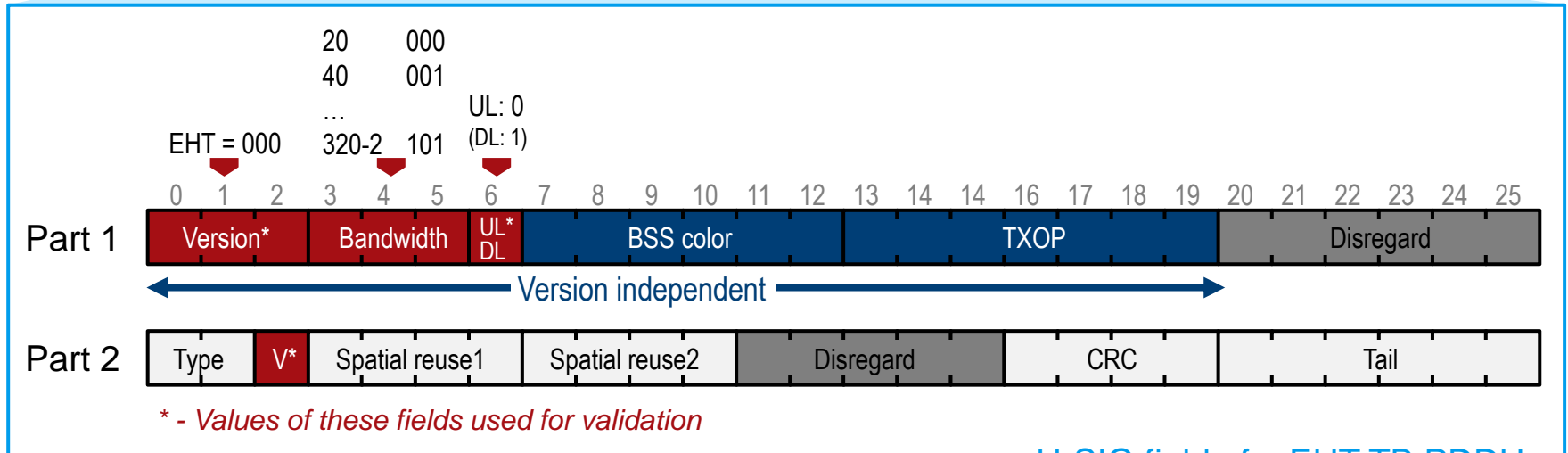
EHT MU PDDU

Downlink: non-MU-MIMO, MU-MIMO
Downlink: SU transmission, sounding NDP
Uplink: SU transmission, sounding NDP

EHT TB PDDU

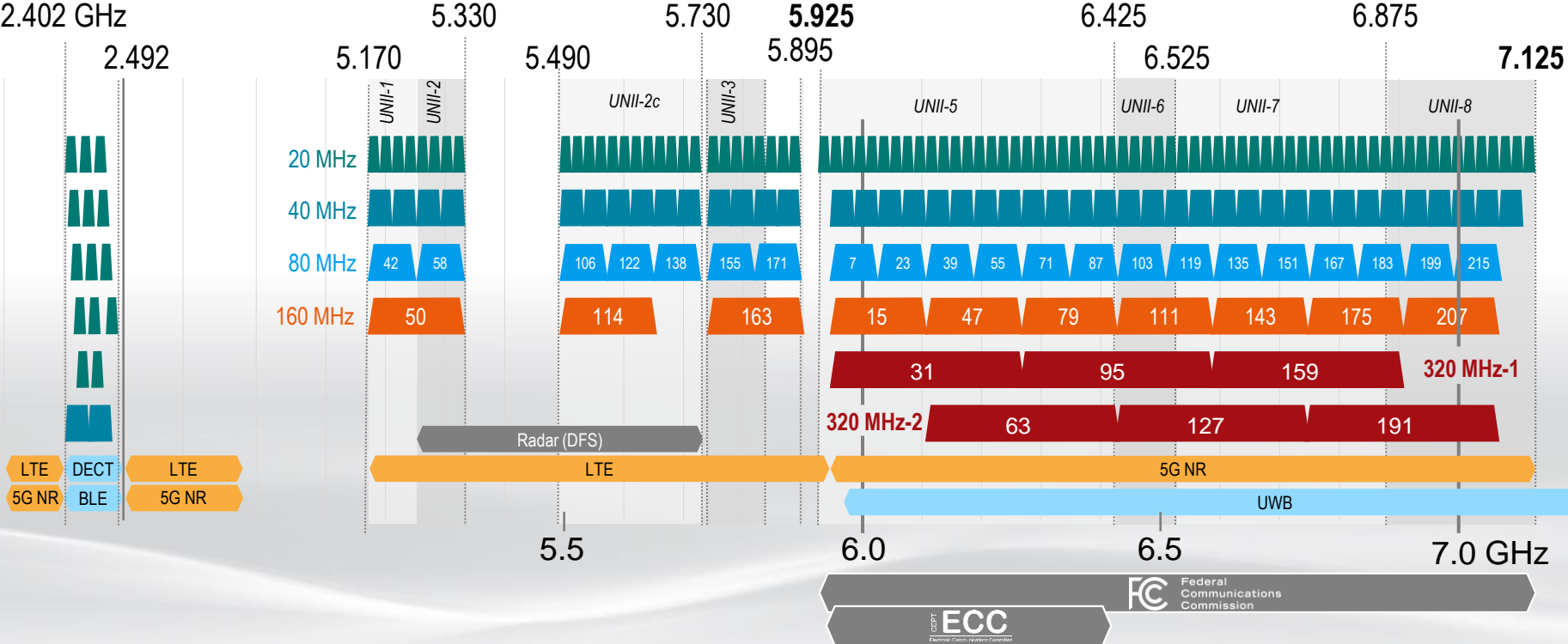
Uplink: MU-MIMO

EHT preamble designed for the future (example EHT TB PDDU)

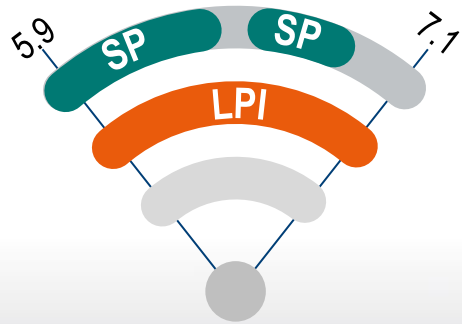


U-SIG field of a EHT TB PDDU

New spectrum allocation allows more and wider channels in a (still) less congested 6 GHz band



6 GHz band regulation in a nutshell, based on FCC and CEPT



FCC Federal Communications Commission

CEPT ECC Electronic Communications Committee

Standard Power
AP: EIRP: 36 dBm (AFC)
UE: EIRP: 30 dBm

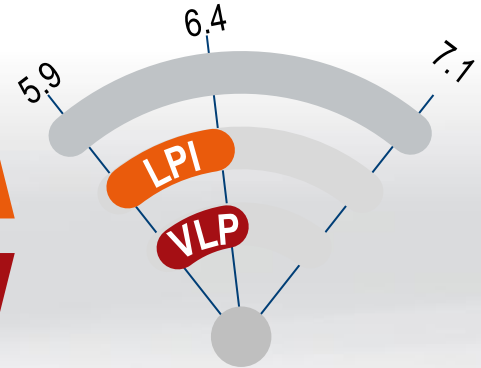
~~Standard Power~~

Low Power Indoor
AP: EIRP: 30 dBm
UE: EIRP: 24 dBm

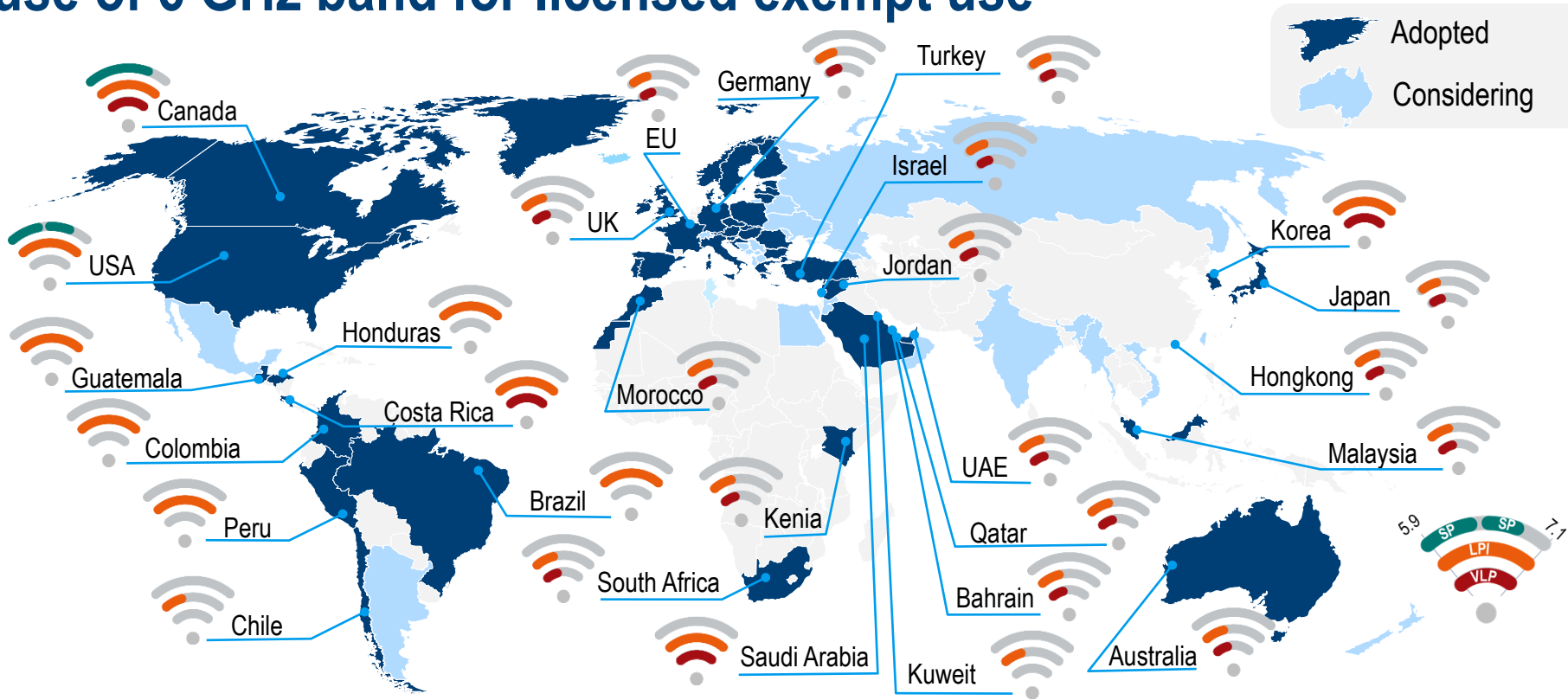
Low Power Indoor
AP: EIRP: 23 dBm
UE: EIRP: 23 dBm

~~Very Low Power~~

Very Low Power
AP: EIRP: 14 dBm
UE: EIRP: 14 dBm

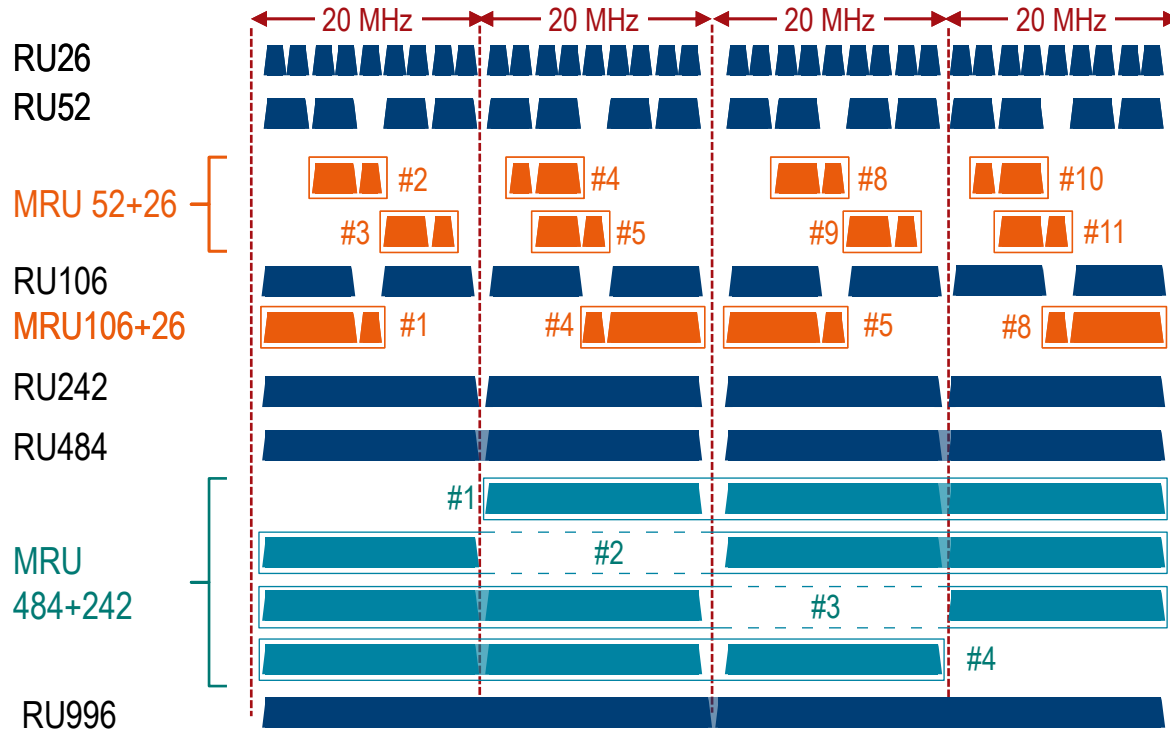


More and more countries allow or consider to allow use of 6 GHz band for licensed exempt use



Multiple resource units (MRU) per user for efficiency

Example 80 MHz channel



A small size MRU (i.e. 26, 52, 106 tone) can only be combined for efficiency with another small size RU to form an MRU. RUs in the MRU need to be contiguous and within a 20 MHz channel boundary

The permitted large size MRU combinations (i.e. 242, 484, 996 tone) allow additional aggregated bandwidth options (e.g. 60 MHz) per user that don't need to be continuous.

Extended use of preamble puncturing in IEEE 802.11be defined for EHT MU PDDU (UL/DL) and EHT TB PPDU (UL)

Non-OFDMA¹⁾ preamble puncturing

80 MHz	20 MHz
160 MHz	20 or 40 MHz
320 MHz	40 and/or 80 MHz

80 MHz: 484+242-tone MRU 2



160 MHz: 996+484-tone MRU 2



160 MHz: 996+484+242-tone MRU 4



320 MHz: 3x 996-tone MRU 2



320 MHz: 2x 996+484-tone MRU 3



¹⁾ An EHT PPDU that is transmitted using a single RU or MRU that occupies all the non-punctured 20 MHz channels within the PPDU bandwidth.

OFDMA preamble puncturing

80 MHz	0..4 20 MHz
160 MHz	in 80 MHz
320 MHz	sub blocks

80 MHz: 484-tone RU + 242-tone RU



160 MHz: 3x 242-tone RUs + 484-tone RU



160 MHz: 2x 242-tone RUs + 484+242-tone MRU



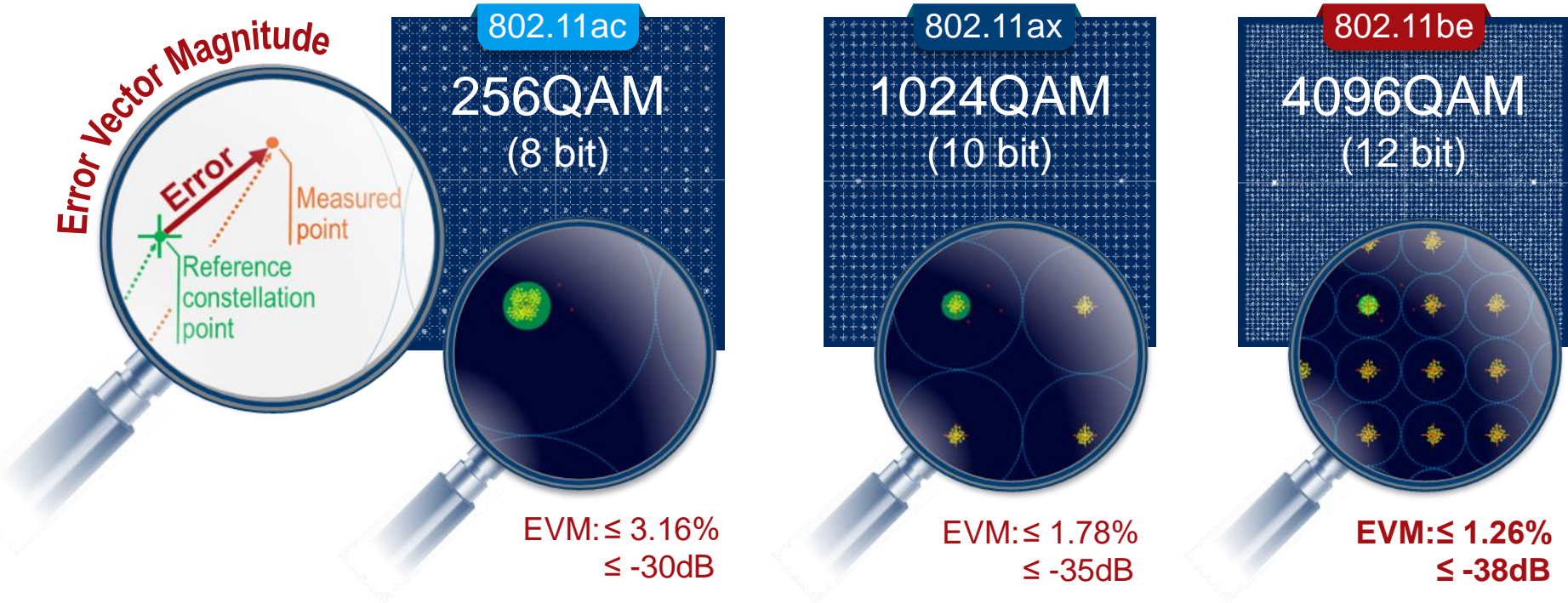
320 MHz: 2x 969-tone RUs + 2x 484-tone RUs



320 MHz: 2x 484+242-tone MRUs + 242-tone RU + 2x 484-tone RUs



Wi-Fi7 pushes RF performance requirements and test equipment quality to the next level



Receiver and transmitter requirement based on IEEE 802.11be

Spectral flatness

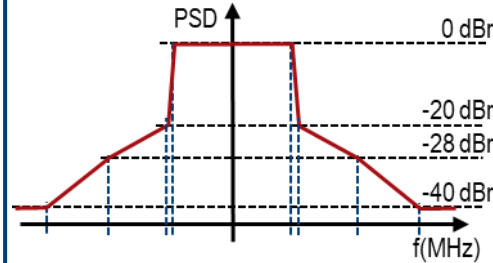
Center freq. leakage

Min. input sensitivity

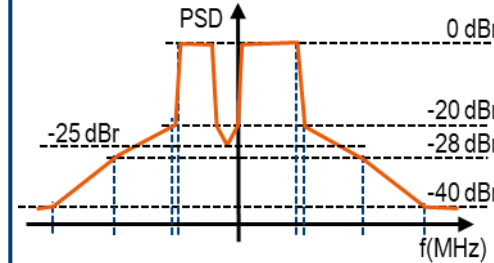
Channel rejection

Maximum input level

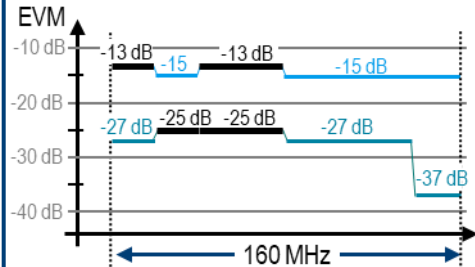
320 MHz spectrum mask



Punctured spectrum mask



MRU unused tone error



Transmitter constellation error

MCS	Mod.	Coding	Error Vector Magnitude of		
			EHT MU PDDU	EHT TB PDDU	
			P > MCS7	P ≤ MCS7	
12	4096-QAM	3/4	-38 dB	-38 dB	-38 dB
13	4096-QAM	5/6	-38 dB	-38 dB	-38 dB

Absolut power accuracy

Relative power accuracy

RSSI meas. accuracy

Carrier frequency offset

Timing drift



High-performance radio communication tester R&S®CMP180 for R&D and production purposes with very high accuracy

Excellent RF performance

- ◆ 400 MHz up to 8 GHz
- ◆ Up to 500 MHz bandwidth
- ◆ High output power
- ◆ Extraordinary EVM value

Compact design (2 HU x 19")

- ◆ 2x 8 RF (in/out) ports
- ◆ up to two channels (VSA/VSG)
- ◆ Build-in controller
- ◆ Common platform (CMP200)

High-degree of flexibility

- ◆ up to 6 or 8 GHz
- ◆ 250 or 500 MHz bandwidth
- ◆ 1 or 2 channels in a box
- ◆ Stackable to get more channels



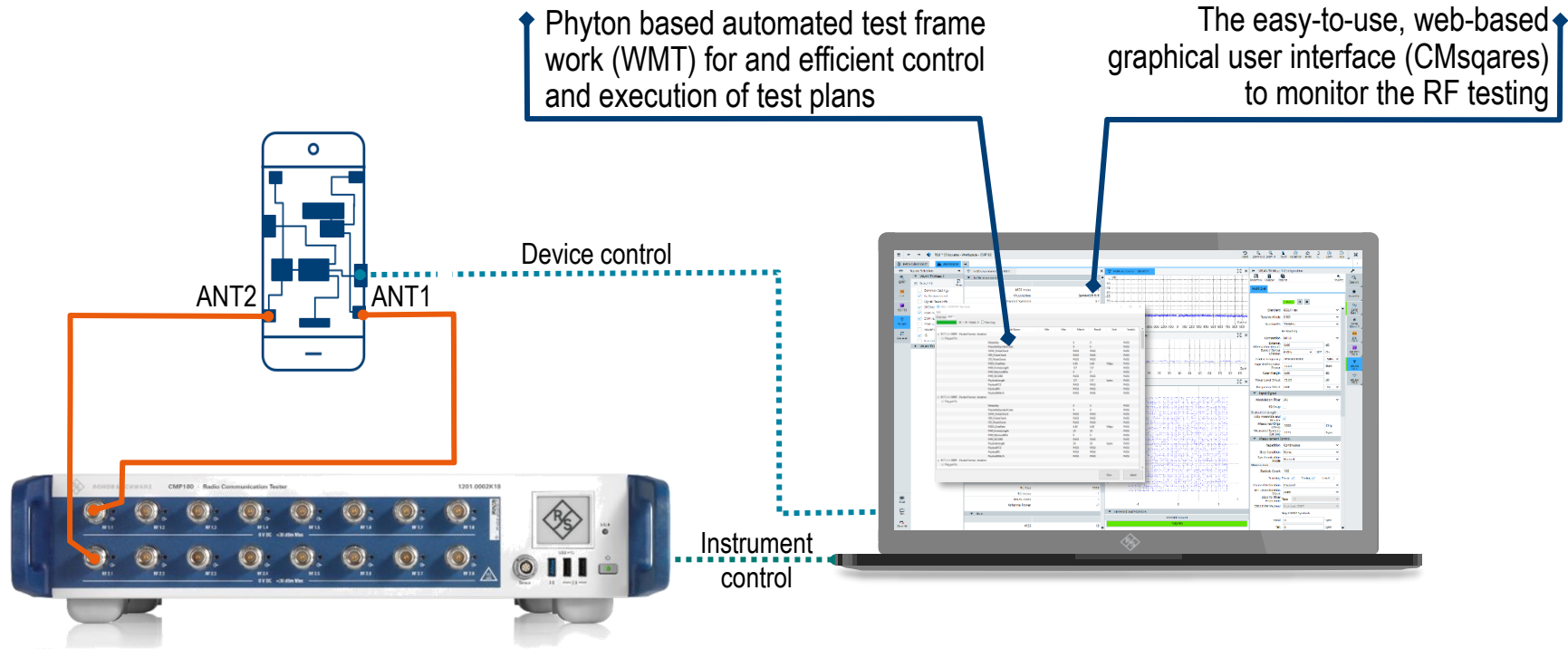
R&S®CMP180 supports RF testing of the primary wireless communication technologies

Technology	RF generator	RF analyzer
5G NR FR1	◆	◆
LTE-A	◆	◆
WCDMA/HSPA+	◆	◆
GSM/GPRS/EGPRS	◆	◆
eMTC	◆	◆
NB-IoT	◆	◆
C-V2X	◆	◆
CDMA2000, 1xRTT	◆	◆

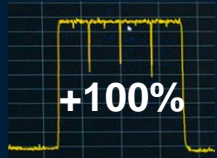
Technology	RF generator	RF analyzer
IEEE802.11a/b/g/n/ac/ax/be	◆	◆
Bluetooth® BR, EDR	◆	◆
Bluetooth® Low Energy	◆	◆
Low Power IoT		
802.15.4 (Zigbee, Thread)	◆	◆
LoRa®	◆	(-)
SigFox	◆	(-)
GNSS	◆	(-)



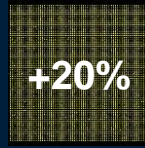
2x2 MIMO testing in 6 GHz Band with 320 MHz channel



The four cornerstones of IEEE 802.11be to achieve extreme high throughput



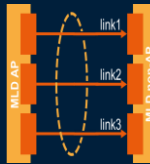
**320 MHz
channel**



**4096QAM
modulation**



**16x16
MIMO**

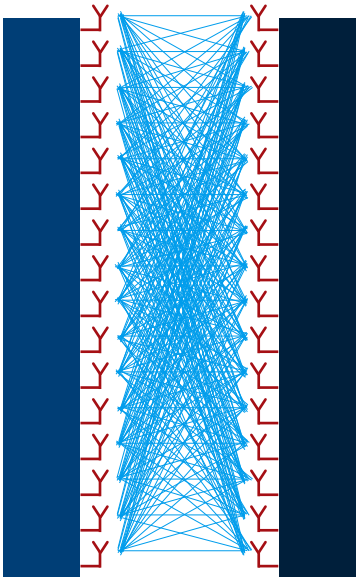


**Multi-link
operation**

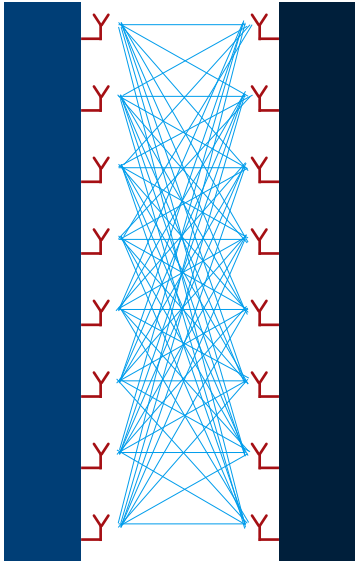


MIMO accounts for almost 50% of the Wi-Fi shipments: 2x2, 3x3 and 4x4 stay mainstream – 8x8 for “geeks”

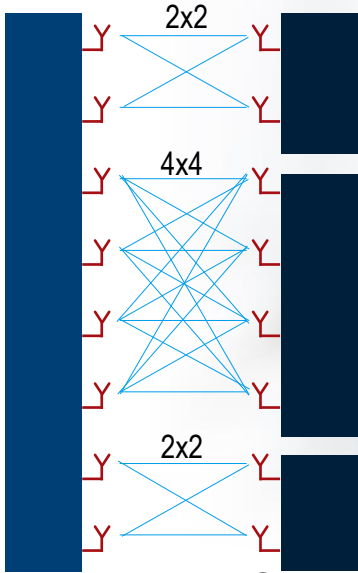
802.11be vision
(max $N_{SS} = 16$)



802.11be Draft 0.3
(max NSS = 8)



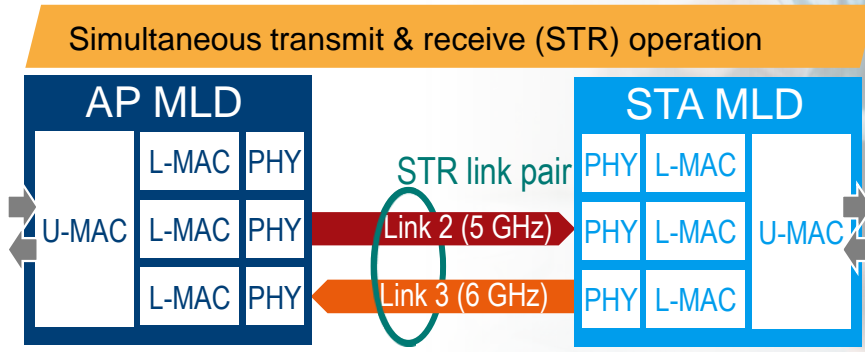
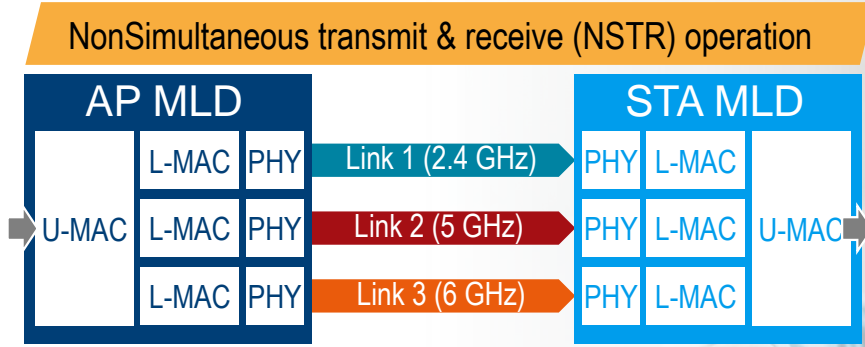
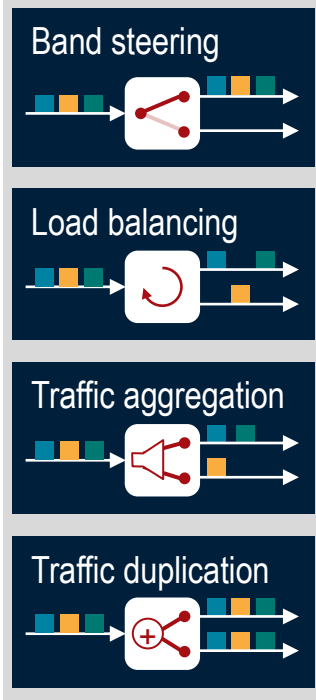
SU-MIMO
 ≤ 8 streams in total



MU-MIMO
 ≤ 8 users per RU (≥ 248)
 ≤ 4 streams per user
 ≤ 8 streams in total



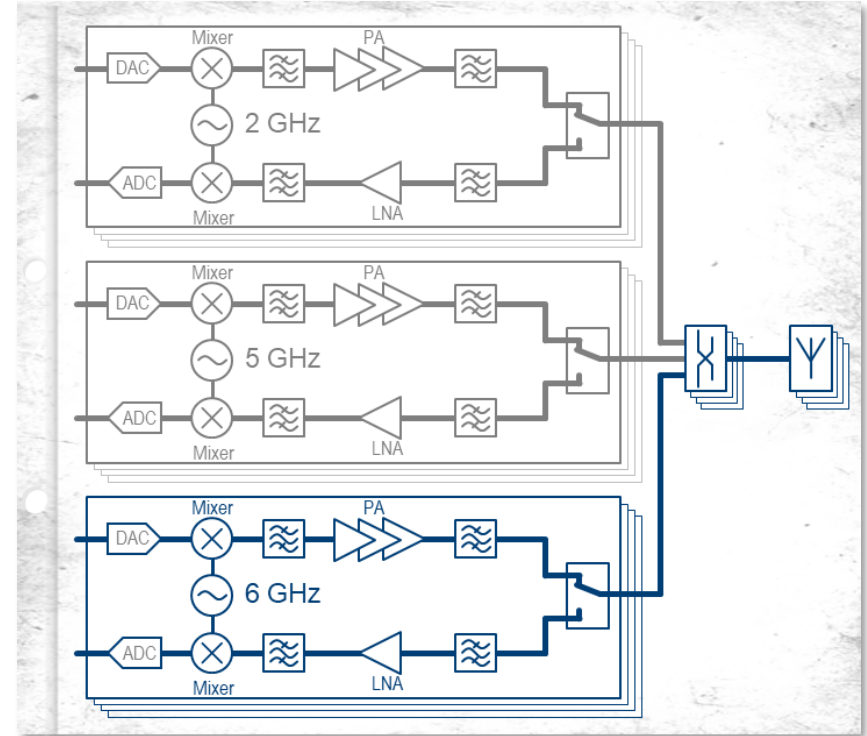
Further improve throughput, latency and efficiency with introducing **multi-link operation (MLO)**



High demand for efficient and easy-to-use multi channel testing

Rising demand for multi channel testing

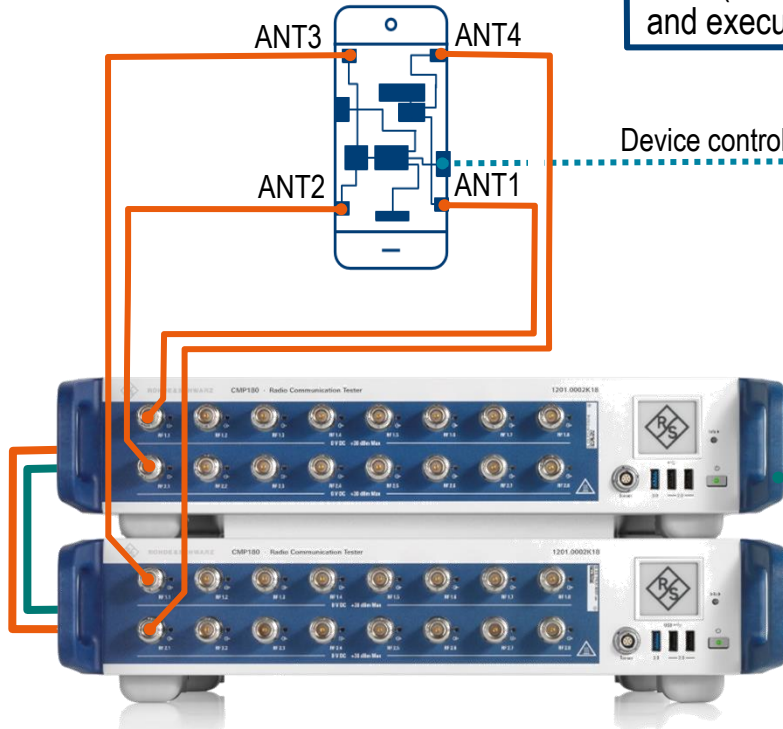
- ◆ 2x2, 4x4 MIMO, ...
- ◆ Dualband, Tripleband, Quadband ...
- ◆ Multi-link operation (NSTR, STR)
- ◆ Multi-technology (Wi-Fi, Bluetooth, Thread)



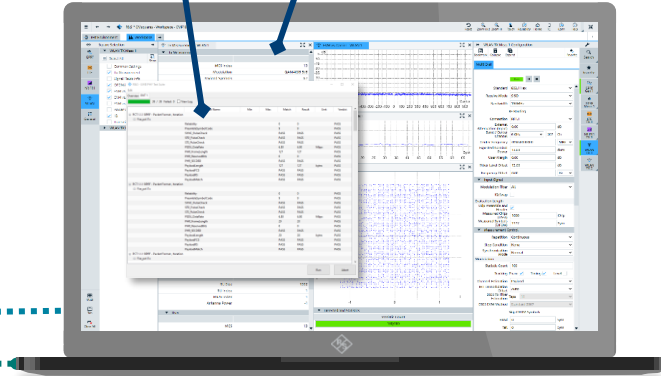
4x4 MIMO testing in 6 GHz Band with 320 MHz channel

Phyton based automated test frame work (WMT) for and efficient control and execution of test plans

The easy-to-use, web-based graphical user interface (CMSquares) to monitor the RF testing



Instrument control



- CMPflexx makes it easy to scale up two single instruments to a powerful system for ultimate flexibility and extreme performance.
- The primary CMP180 controls the secondary instrument to build a system using a common software.



The critical role of test-automation in R&D and production



Performance & scalability matter

Fast and efficient test execution incl. accurate run of vendor specific procedures like calibration



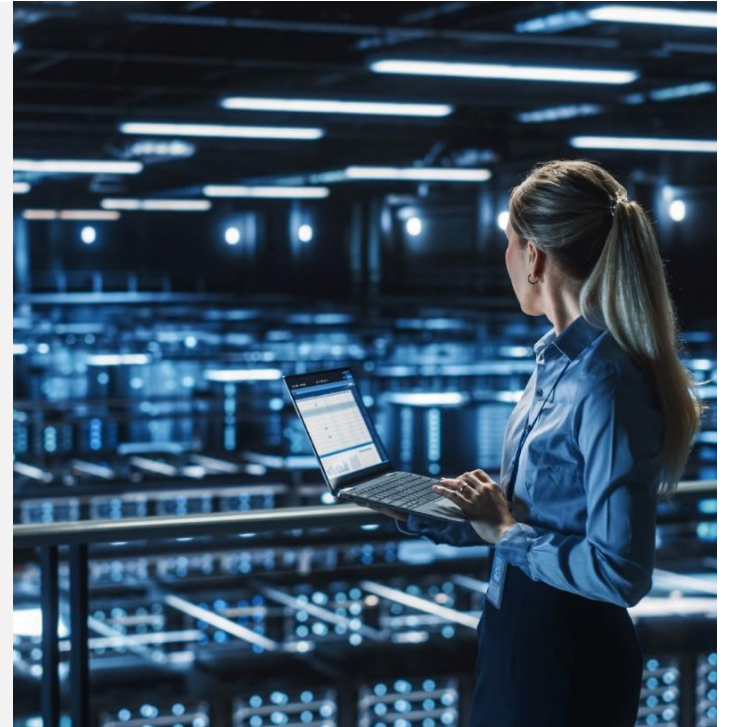
Integration & support make the difference

Easy integration of test solutions into their very specific automated test environment in R&D or production

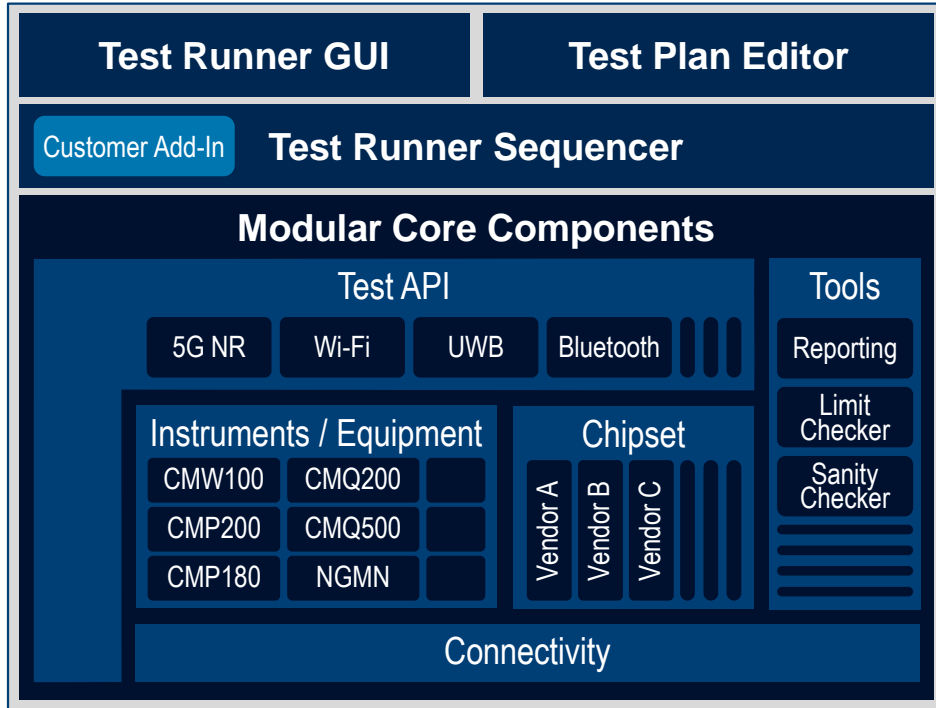


Test intelligence becomes fundamental

Data about performance, usage and health of the automatic test equipment system are of high interest



Ready to integrate wireless test automation framework which makes non-signaling testing fast, accurate & easy

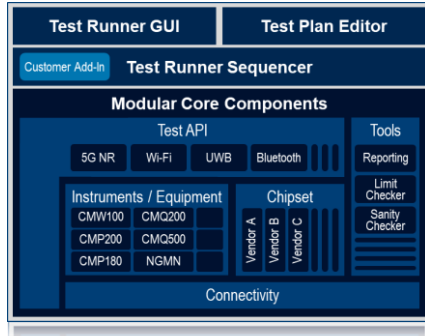


Tailored for production testing and non-signaling R&D applications

- Flexible integration into any automated testing environment
- Fully customizable from a basic test tool to a full-blown turnkey solution incl. Python based customer add-ins.
- Field-proven speed of test execution
- High efficiency by broadcasting and interleaving (smart channel)
- Insightful and easy customizable GUI for sequencing and test plan creation



Our offering to provide a customized automated test solution



Python-based framework



Customization & integration



Automated test solution

Wi-Fi test solutions for today and tomorrow



Conformance



R&S®TS8997

RF performance



R&S®CMW500/270

R&S®CMP180

Production



R&S®TS7124



R&S®DST200



Make ideas real



R&S®CMW100



R&S®CMP180



R&S®ZNA



R&S®FSW



R&S®SMM100A



R&S®VSE

RF design and compliance



R&S®NGU

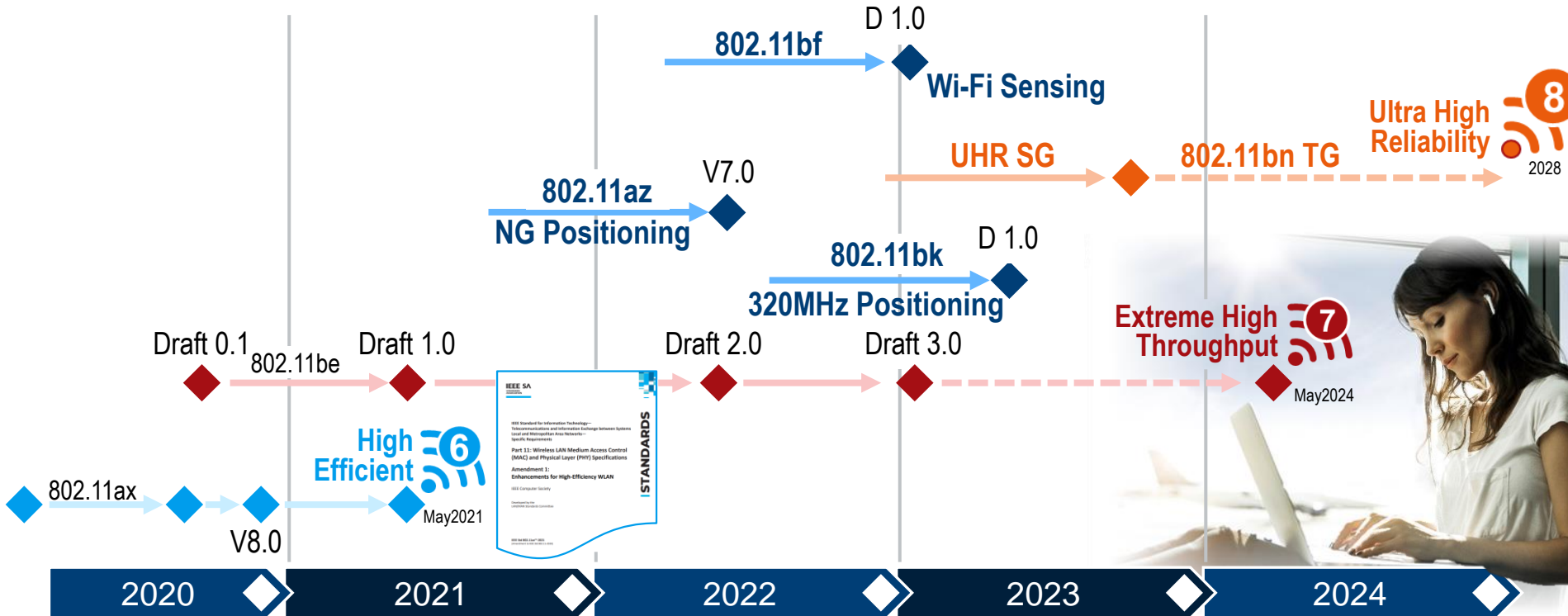


R&S®RTP

Embedded design & power

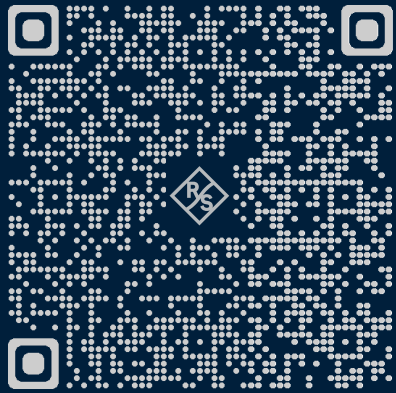


What else and what next in Wi-Fi?



Find out more

www.rohde-schwarz.com/wlan/11be



thank
YOU
😊

ROHDE & SCHWARZ

Make ideas real

