

**Are you ready
for Wi-Fi 6E/7 testing?**

WE ARE!

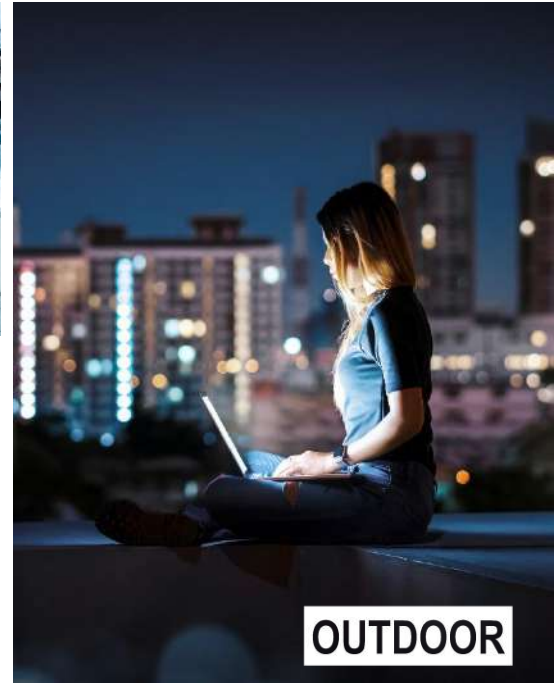
Hagen Heggenberger
Product Manager

Joerg Koepp
Market Segment Manager

ROHDE & SCHWARZ

Make ideas real

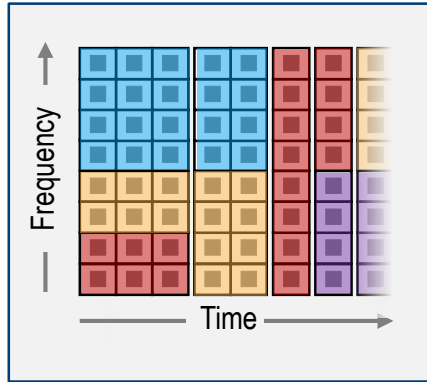




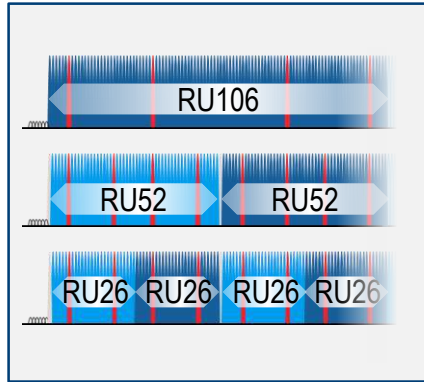
**The 6th generation of Wi-Fi® for high efficiency
in dense areas (indoor and outdoor environments)**

Cornerstones of the Wi-Fi 6 revolution

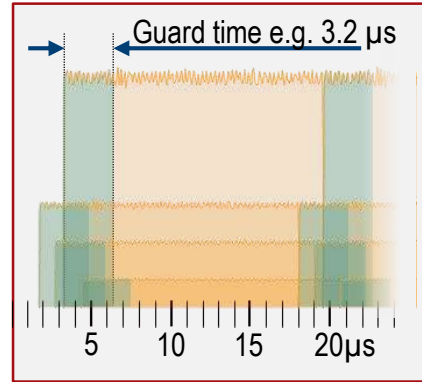
OFDMA



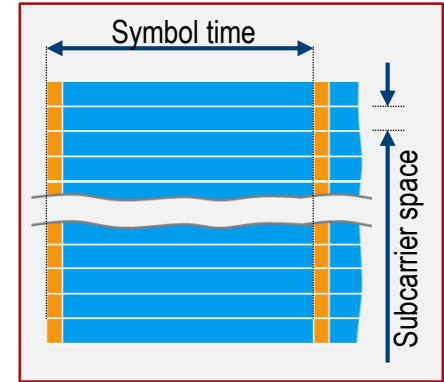
Resource units



Long guard interval



Long symbol time



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

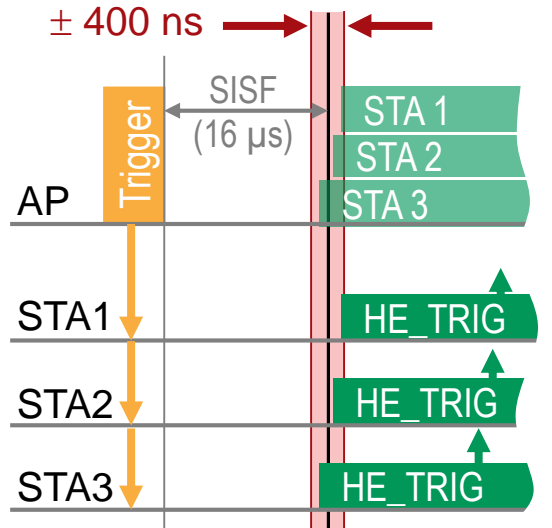
- ◆ Avoiding inter-symbol interferences
- ◆ More efficient use of available resources

What are the main differences?

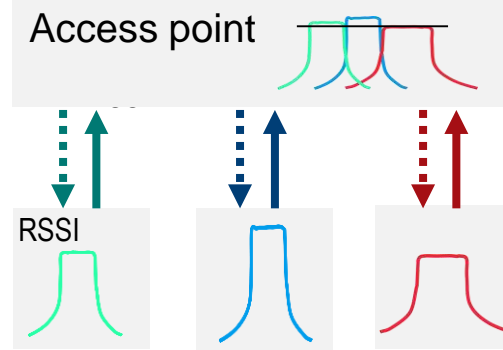
	Wi-Fi 4 (802.11n) <i>High Throughput (HT)</i>	Wi-Fi 5 (802.11ac) <i>Very High Throughput (VHT)</i>	Wi-Fi 6 (802.11ax) <i>High Efficiency (HE)</i>
Supported bands	2 GHz, 5 GHz	5 GHz	2 GHz, 5 GHz
Channel bandwidth (MHz)	20, 40	20, 40, 80, 80+80, 160	20, 40, 80, 80+80, 160
Transmission scheme	OFDM	OFDM	OFDM, OFDMA
Subcarrier spacing	312.5 kHz	312.5 kHz	78.125 kHz
Guard interval	0.4 μ s, 0.8 μ s	0.4 μ s, 0.8 μ s	0.8 μ s, 1.6 μs, 3.2 μs
Spatial streams	4x4 (SU-MIMO only)	8x8 (incl. DL-MU-MIMO)	8x8 (incl. MU-MIMO)
Modulation (highest)	64QAM	256QAM	1024QAM
Max. data rate*	<i>540 Mbps</i>	<i>6.934 Mbps</i>	<i>9.765 Mbps</i>

Wi-Fi 6 test challenges related to OFDMA

Accurate start time



Accurate power control



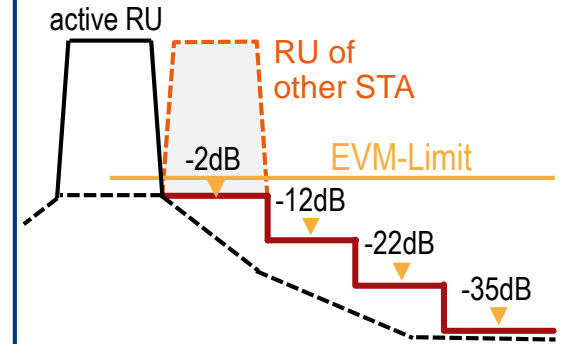
STA RSSI measurement accuracy:

class A: ± 3 dB class B: ± 5 dB

STA transmit power accuracy:

class A: ± 3 dB class B: ± 9 dB

Clean RU spectrum

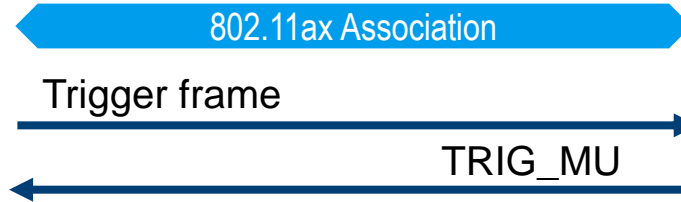


Ensure RU transmit modulation accuracy for the unoccupied subcarriers to avoid interference:

Unused Tone Error

Measurement of timing error in signaling mode

R&S®CMW270/500

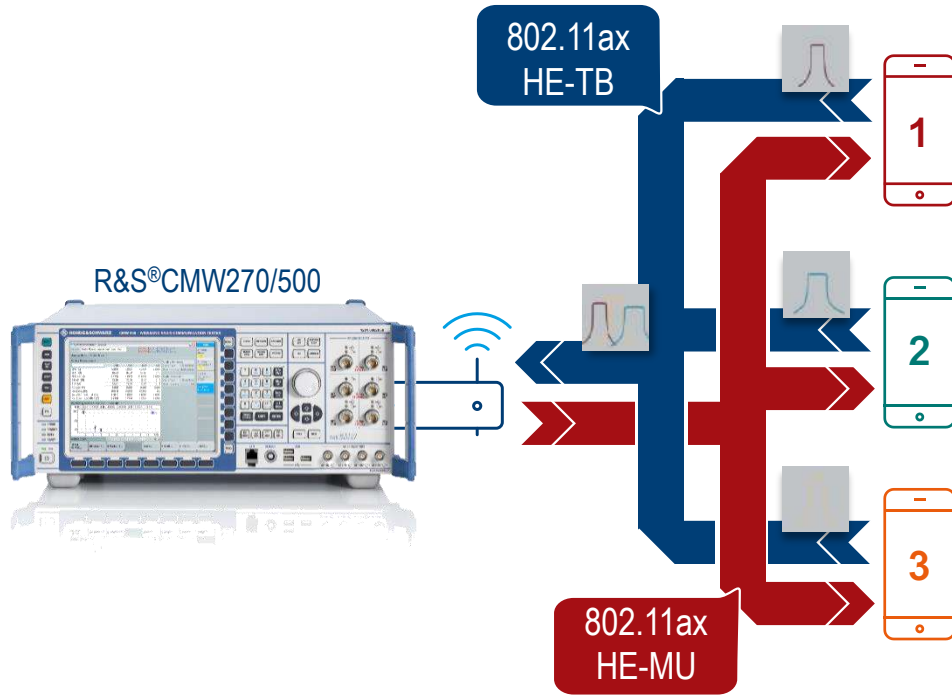


Statistics	Current	Average
Trigger		9.98
Trigger Source	WLAN Sig1: HE_TB Trigger	21.20
Trigger Slope	IF Power	11.23
Trigger Threshold	WLAN Sig1: HE_TB Trigger	-38.99
Trigger Timeout	WLAN Sig1: RXFrameTrigger	-38.97
Limits	WLAN Sig2: HE_TB Trigger	-39.49
Generator Shortcut	WLAN Sig2: RXFrameTrigger	-6.93
	WLAN Sig3: HE_TB Trigger	-0.046
	WLAN Sig3: RXFrameTrigger	-0.029
Symbol Clock Error [ppm]	-0.046	-0.029
Timing Error [us]	-1.350	-1.121
IQ Offset [dB]	-67.97	-69.75
DC Power [dBm]	-58.01	-59.78
Gain Imbalance [dB]	0.00	0.00
Quadrature Error [°]	0.00	0.00

This signaling setup can be used to test and measure a couple of OFDMA & MU-MIMO functionalities such as

- Timing error
- Unused tone error
- Power control etc.

Simultaneous MU OFDMA testing with multiple stations (STAs)



Simultaneous testing of up to 3 stations
TX testing of trigger based multi-user transmission
RX testing of downlink multi-user transmission

Stress/interference testing
of multi-user operation

Speeding up testing of several RU
combinations

The global 6 GHz band race in on

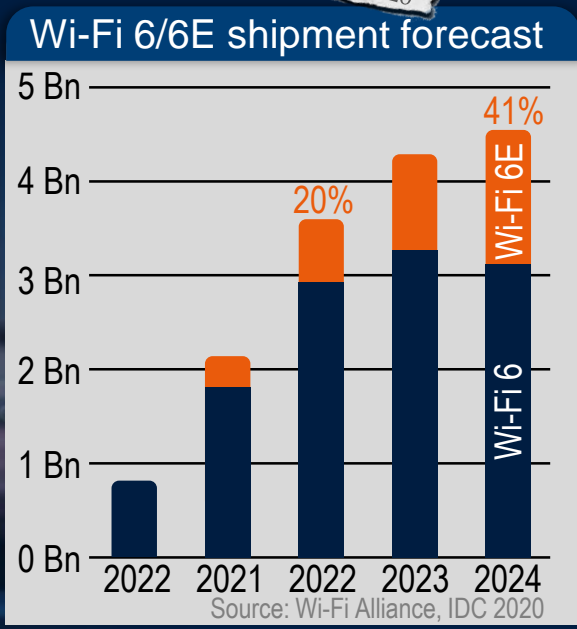
FCC unlocks a massive amount of bandwidth for next-gen Wi-Fi devices cnet April 2020

Korea first country in Asia to release 6 GHz band to Wi-Fi wifinowglobal Oct 2020

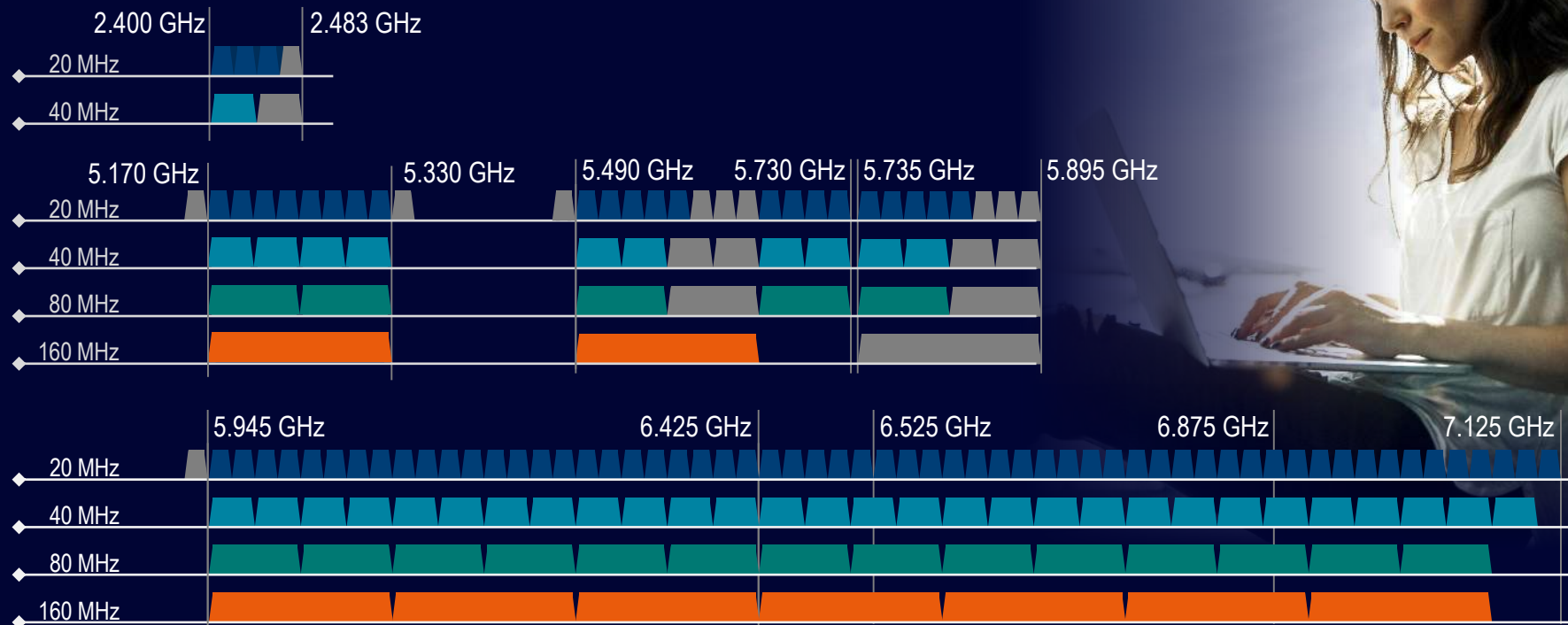
Wi-Fi Alliance® certification for Wi-Fi 6E is now available January 2021

Canada opens 6Ghz band for Wi-Fi, tripling spectrum access Reuters May 2021

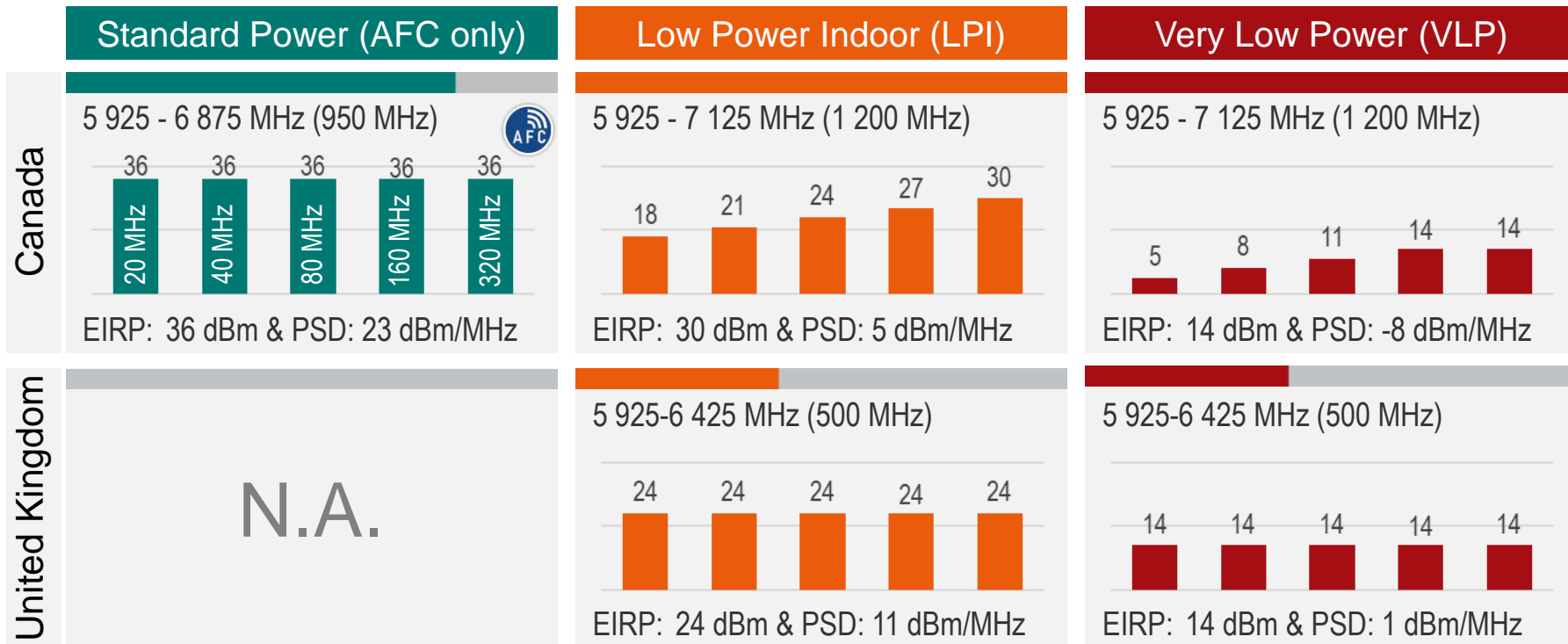
Wi-Fi 6E era begins: Samsung releases world's first 6 GHz Wi-Fi smartphone wifinowglobal Jan 2021



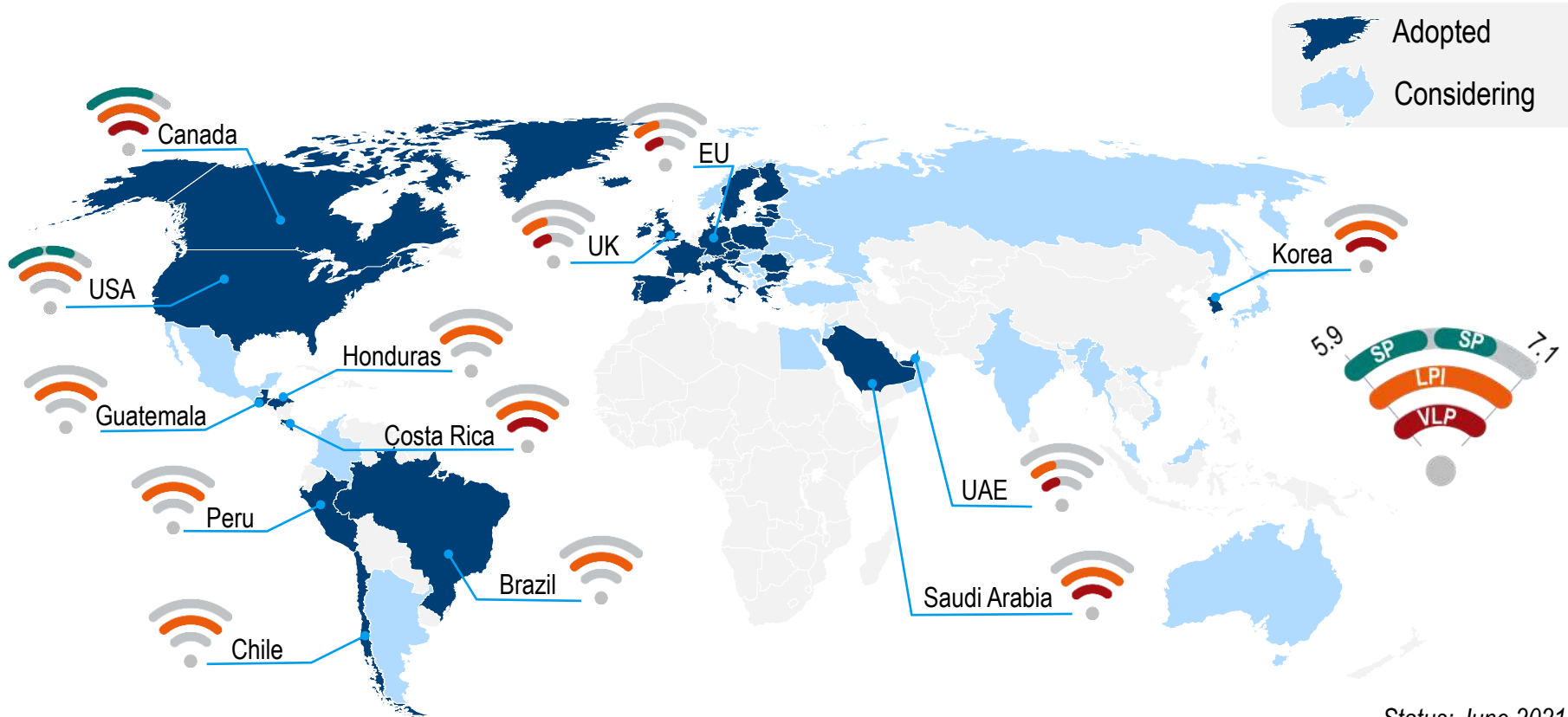
Only the availability of more spectrum (1.2 or 0.5 GHz) will allow Wi-Fi 6 (802.11ax) to unfold its full power



Examples of regulation in 6 GHz band



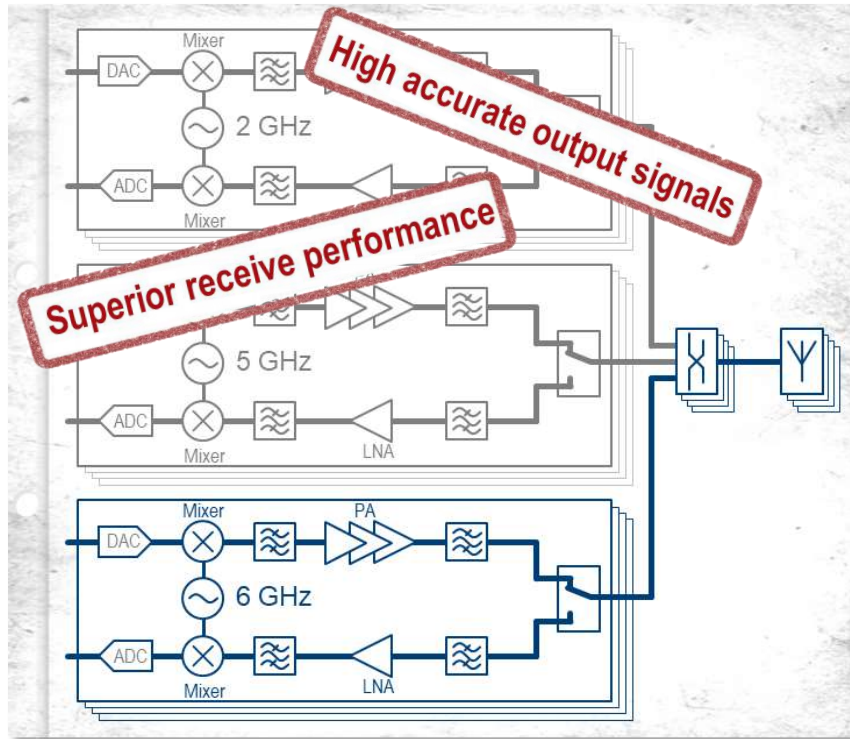
Global 6 GHz band regulation for licensed exempt use



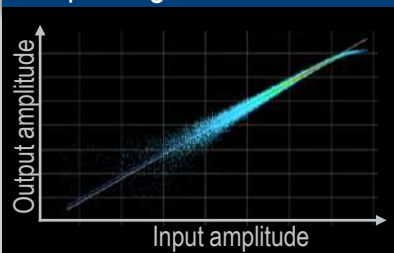
Status: June 2021



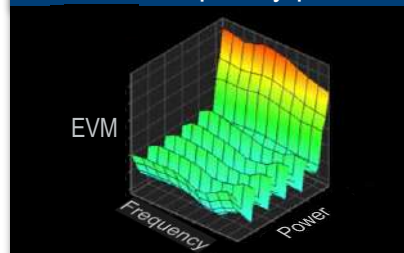
Wi-Fi 6E will drive innovation in RF design to provide highest performance in the most efficient way



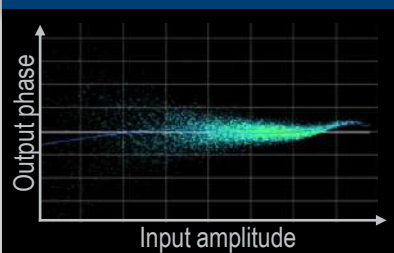
Amplifier gain



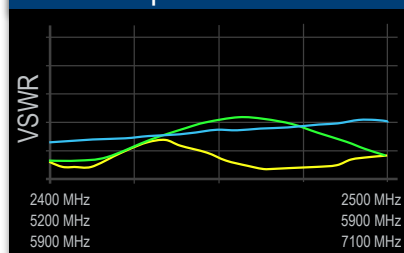
EVM vs. frequency/power



Phase noise



Antenna performance



Power efficiency

Thermal performance



It's time to review your Wi-Fi® test setups



Wi-Fi 6E rings in a new era of Wi-Fi® test setups that need ...

- higher frequencies (> 6 GHz)
- wider bandwidth (> 200 MHz)
- better EVM
- Multi-layer, multi-band support
-

... in order to be ready for the future

R&S®CMP180 - The future integrated.

Enhanced frequency and bandwidth for the next wireless generation

Futureproof design

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

Compact (2 HU x 19")

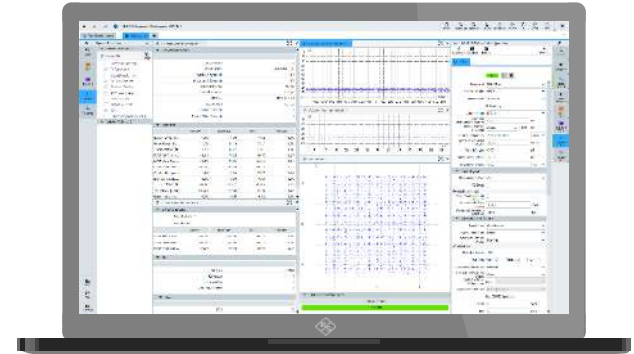
- ◆ 2x 8 RF (in/out) ports
- ◆ 2 VSA + 2 VSG
- ◆ Build-in controller

Advanced testing

- ◆ 5G FR1 devices
- ◆ Wi-Fi 6E/7 STAs & APs
- ◆ BLE and many more

Common platform

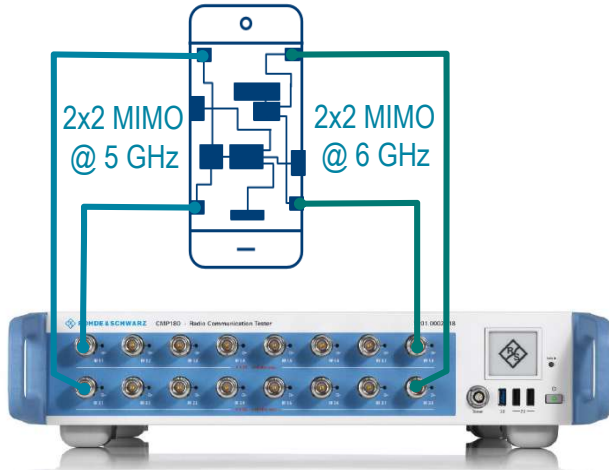
- ◆ Linux OS
- ◆ R&S®CMsquares
- ◆ Systemwide license



The ideal solution for comprehensive RF testing in engineering validation (EVT), design validation (DVT) and prototyping

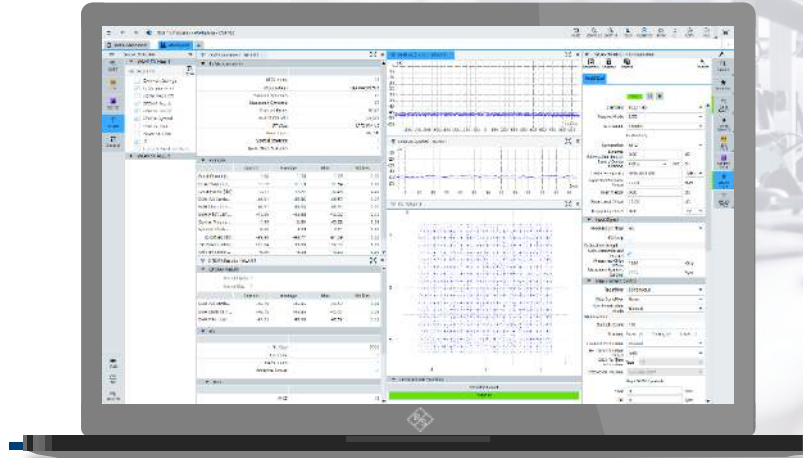
R&S®CMP180

Excellent RF performance combined with flexibility, speed and broad technology support.



R&S®CMSquares

Powerful control center with an intuitive web based user interface and graphical sequencer.



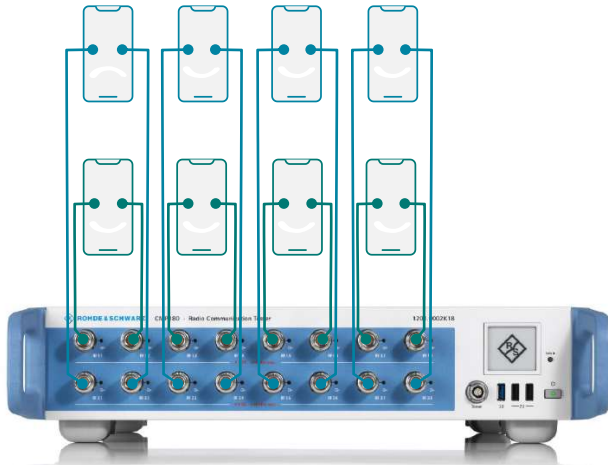
Rohde & Schwarz



After CMW100 and CMP200, this is the next member of the family of wireless device testers for validation and production

R&S®CMP180

Parallel testing on up to 16 RF ports and R&S®SmartChannel support for optimized test performance



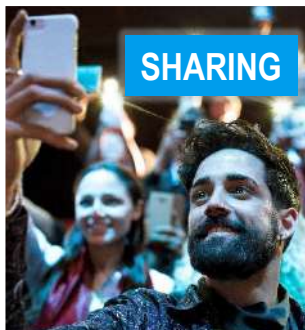
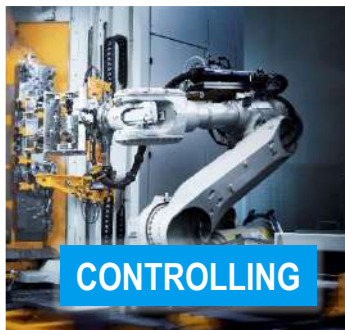
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Wireless Manufacturing Test (WMT)

Modular software framework tailored for high volume production testing and non-signaling R&D applications.

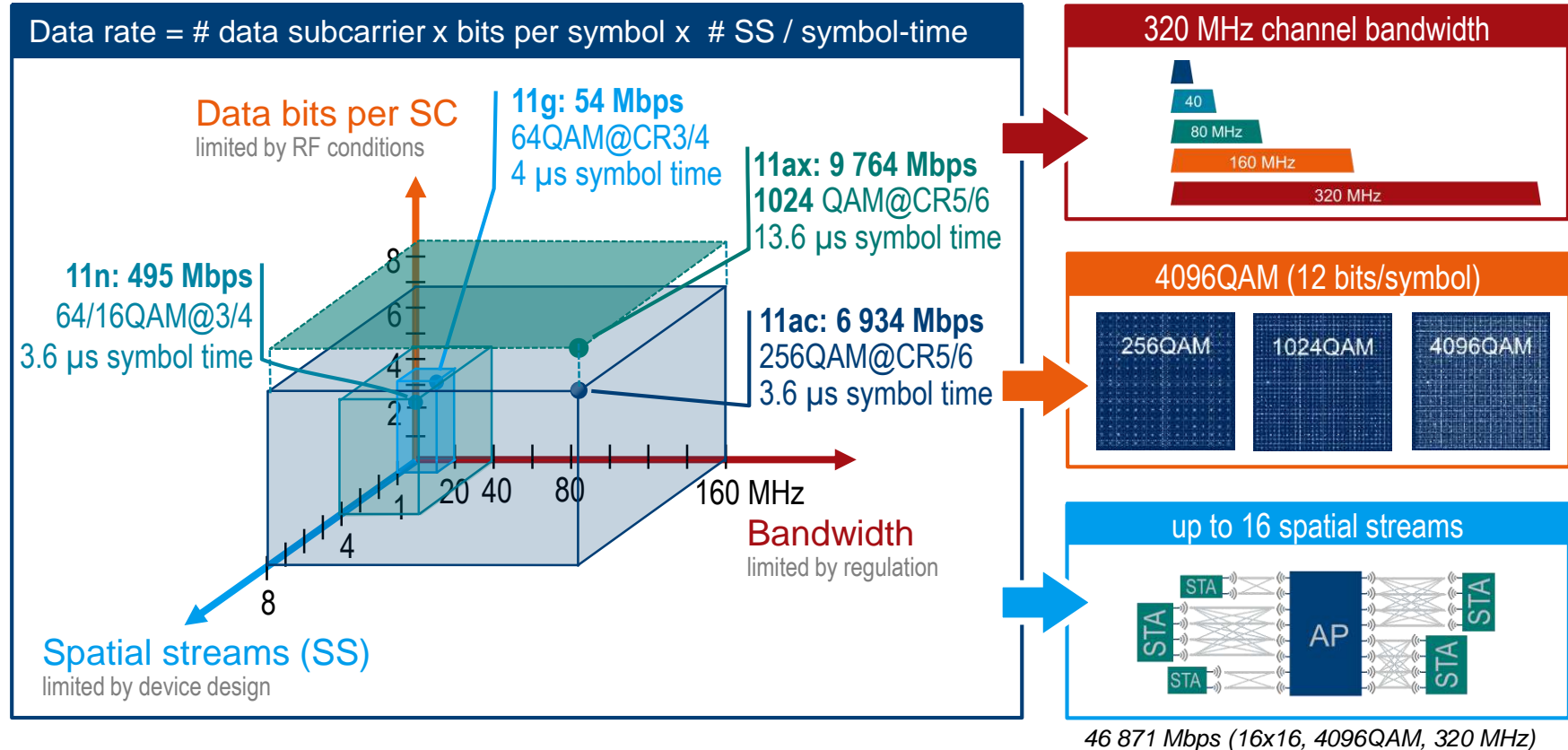


Production

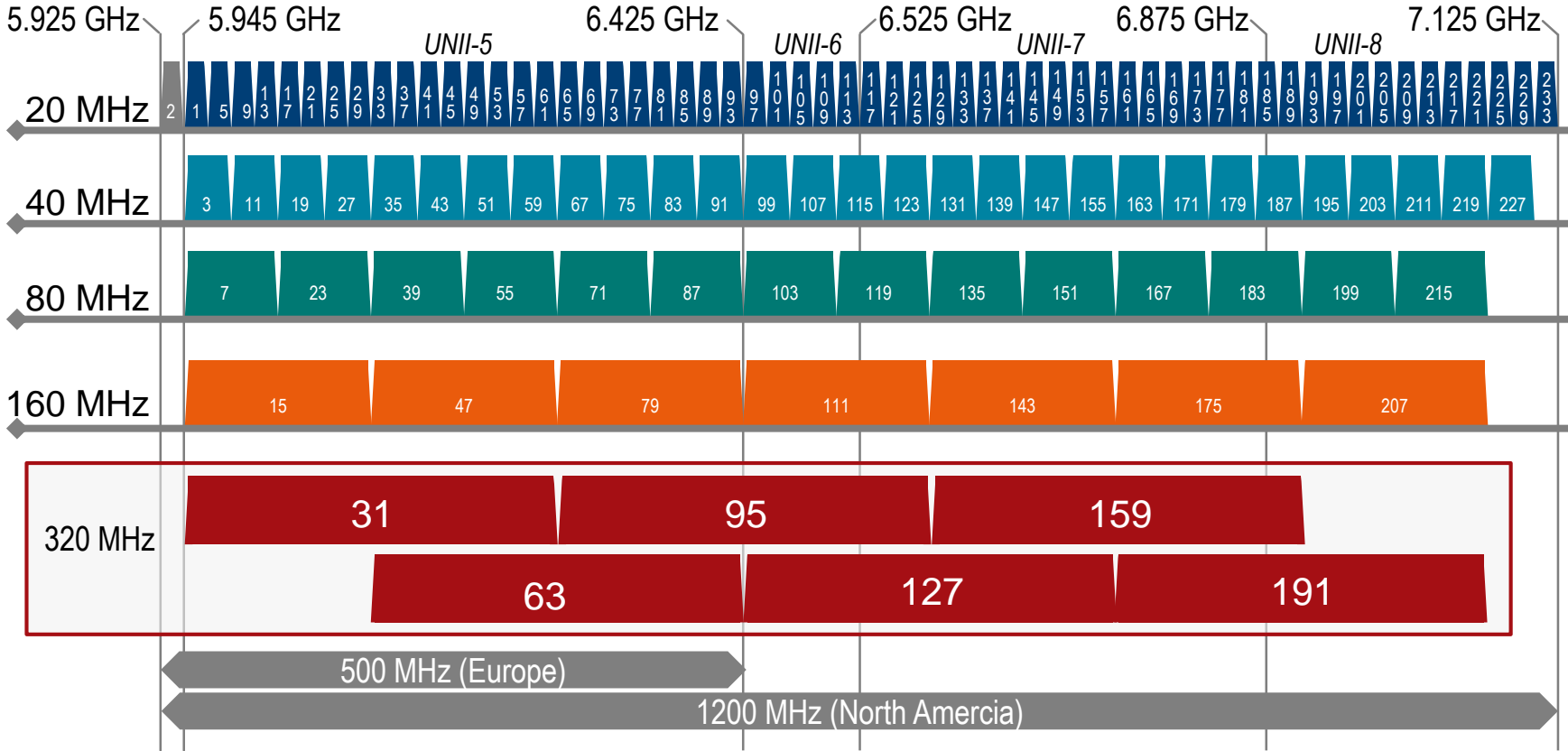


The 7th generation of Wi-Fi® for Extreme High Throughput (EHT) at home, offices and factories

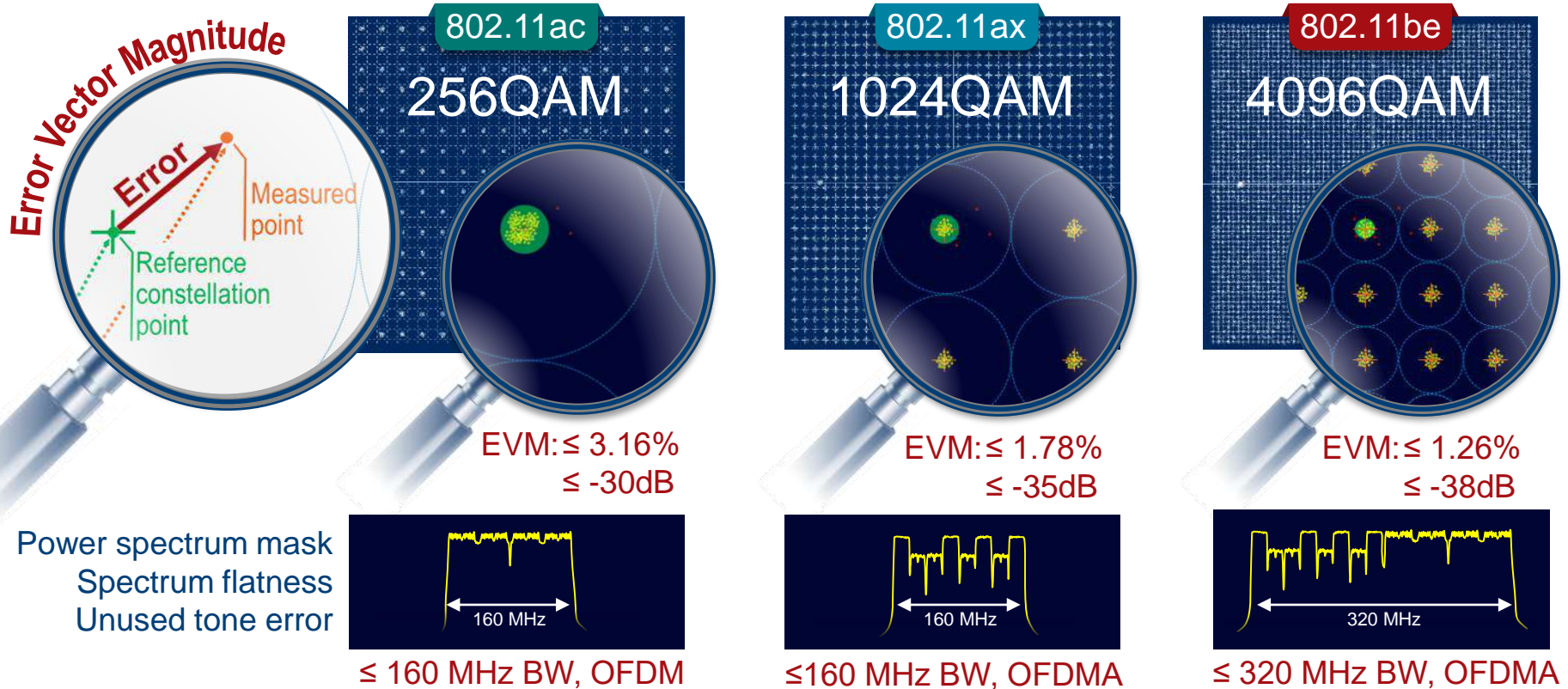
The everlasting demand for higher data rates and its limitations



A few overlapping 320 MHz channels in the 6 GHz band

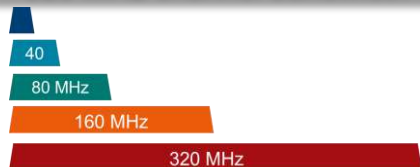


Wi-Fi 7 pushes RF performance requirements to the next level

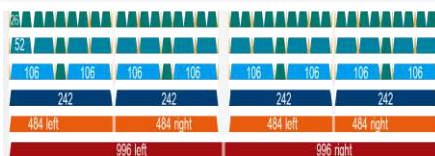


Wi-Fi 7 features that are of importance for test & measurement

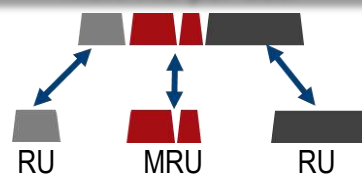
320 MHz channel bandwidth



New channelization/tone plan



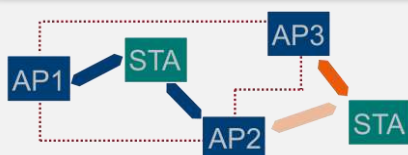
Multi-RU per user



4096QAM



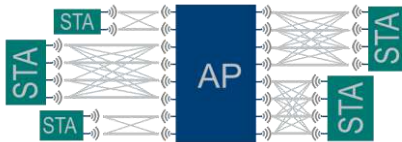
Multi AP coordination



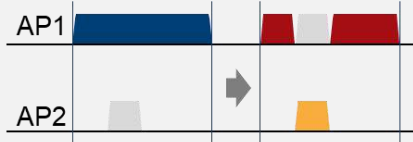
Multi-link operation



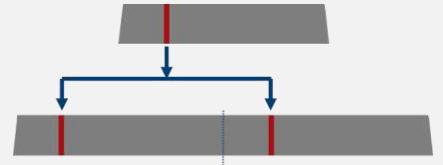
Up to 16 spatial streams



Preamble puncturing*



DCM/DUP*



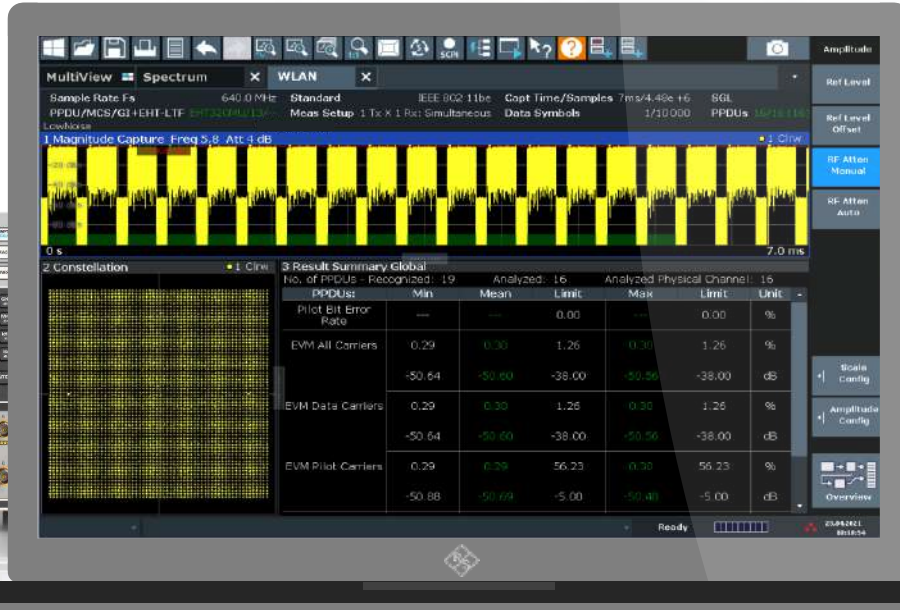
* Wi-Fi 6 features

Measurements* of 802.11be signals with the R&S®FSW signal and spectrum analyzer



Unparalleled low phase noise and best sensitivity on the market

R&S®FSW8



*Based on actual draft specification of IEEE 802.11be



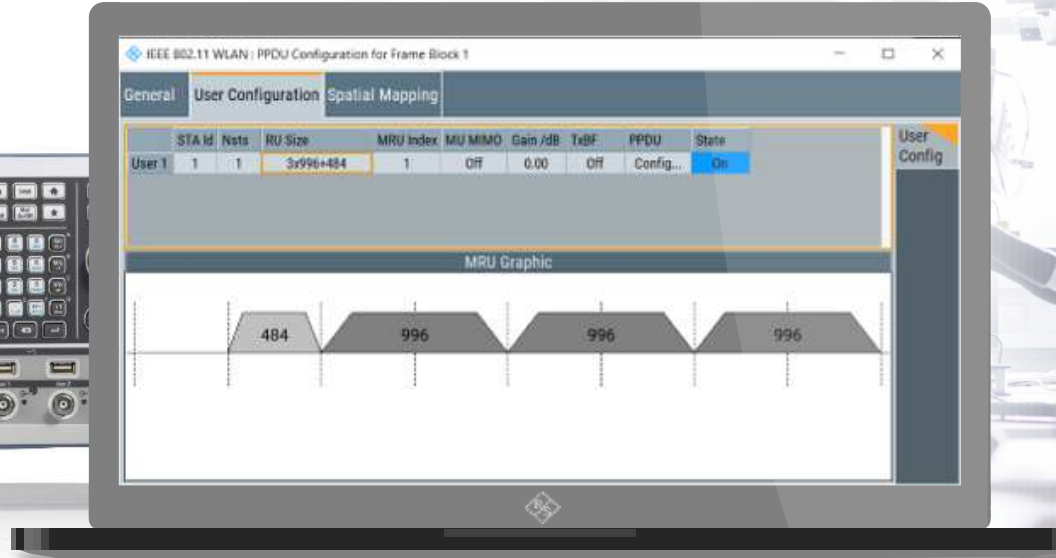
Rohde & Schwarz

Generation* of 802.11be signals with the R&S® SMM100A vector signal generator



Excellent modulation
frequency response,
EVM and ACPR

R&S® SMM100A



*Based on actual draft specification of IEEE 802.11be



Rohde & Schwarz

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



R&S®CMW100



R&S®CMP180



Make ideas real



R&S®ZNA



R&S®FSW



R&S®SMM100A

RF design and compliance



R&S®NGU

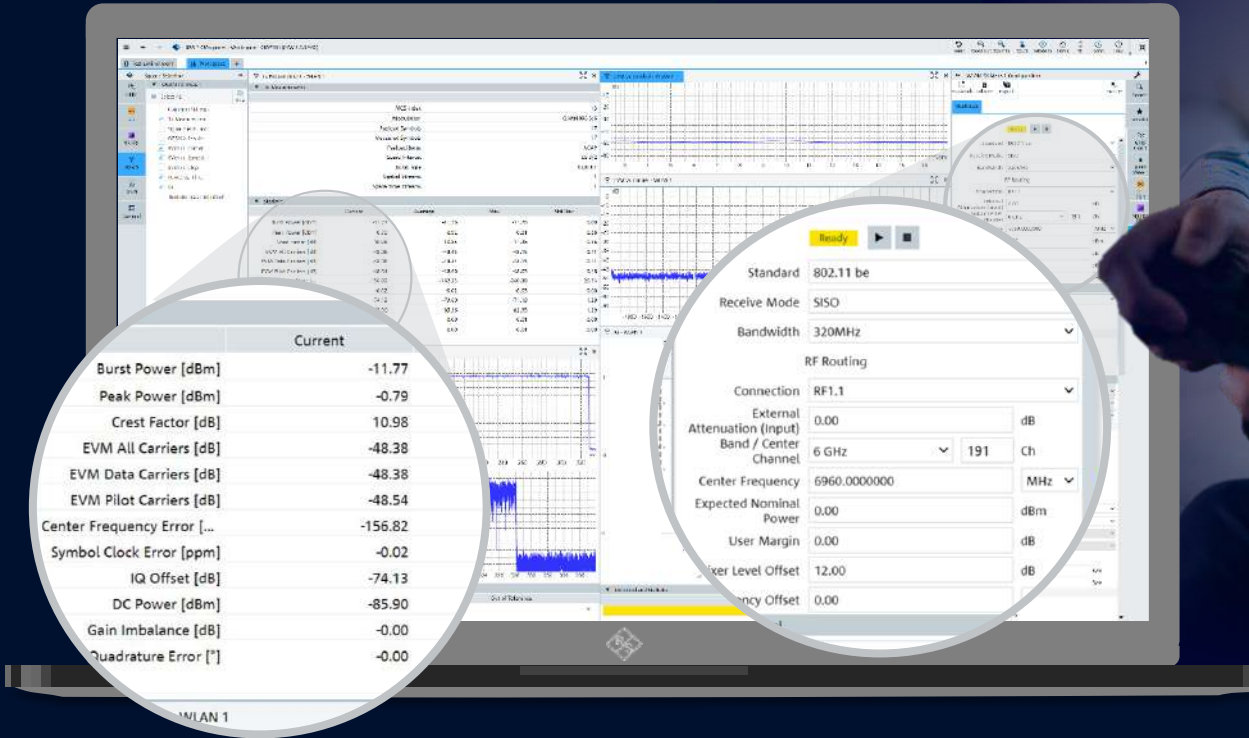


R&S®RTP

Embedded design & power

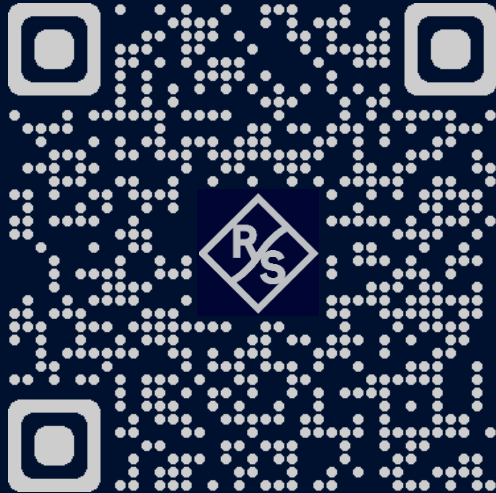


One more thing Wi-Fi 7 on the R&S[®]CMP180



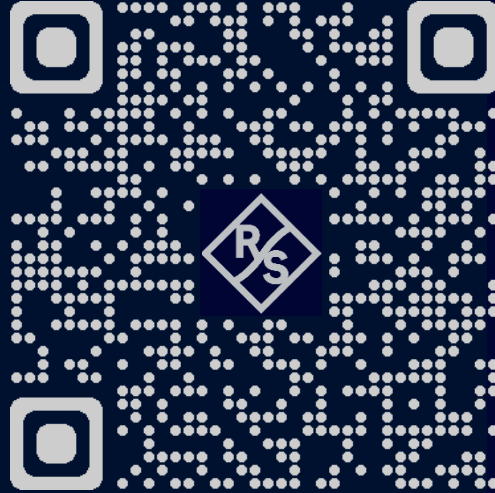
More information

R&S®CMP180



www.rohde-schwarz.com/product/cmp180

Wi-Fi test solutions



www.rohde-schwarz.com/WLAN



The HISTORY and FUTURE of Wi-Fi



WaveLAN, the starting point for Wi-Fi development, was used for wirelessly connecting cashing machines.

802.11 b
Higher speed physical layer achieved. 11 Mbps 2.4 GHz band

Channel capacity	11 Mbps	Modulation	QPSK
Channel bandwidth	20 MHz	Bandwidth	2.4 GHz
Transmission scheme	CSMA/SSSS		

Need for faster speed and better distance coverage.

802.11 g
High speed physical layer in the 2.4 GHz band

Channel capacity	54 Mbps	Modulation	64QAM
Channel bandwidth	20 MHz	Bandwidth	2.4 GHz
Transmission scheme	CSMA/SSSS		



The ability to connect to the internet via mobile devices and the rising number of smartphones on the market required the introduction of features like MIMO.

802.11 n
Faster higher data rate capability

Channel capacity	600 Mbps	Modulation	64QAM
Channel bandwidth	40 MHz	Bandwidth	2.4 GHz
Transmission scheme	CSMA/OFDM		



More and more people wanted Wi-Fi at home and at work. High speed Wi-Fi was therefore required in the 5 GHz spectrum to relieve the overcrowded 2.4 GHz spectrum.

802.11 n
Supports for higher throughput (HT)

Channel capacity	600 Mbps	Modulation	64QAM
Channel bandwidth	40 MHz	Bandwidth	2.4 & 5 GHz
Transmission scheme	CSMA/OFDM		



Designed for in-room/desk network applications requiring very high data rates such as for HD video streaming.

802.11 ac
Delivers multi-gigabit (Gbps) in the 5 GHz band

Channel capacity	1.3 Gbps	Modulation	64QAM
Channel bandwidth	160 MHz	Bandwidth	5 GHz
Transmission scheme	CSMA/OFDM		



Achieves up to 20 Gbps throughput and enables extended distances for enlarged application space.

Enables use of the sub GHz spectrum for IoT and remote internet applications.

802.11 ah
Enables IoT (IoT) in the sub 1 GHz

Channel capacity	100 Mbps	Modulation	64QAM
Channel bandwidth	10 MHz	Bandwidth	1.9 GHz
Transmission scheme	CSMA/OFDM		

The heavy use of Wi-Fi meant that a new approach was required. OFDMA allows multiple devices to communicate simultaneously.

802.11 ac
Enables the high throughput (HT)

Channel capacity	3.5 Gbps	Modulation	256QAM
Channel bandwidth	160 MHz	Bandwidth	5 GHz
Transmission scheme	CSMA/OFDM		



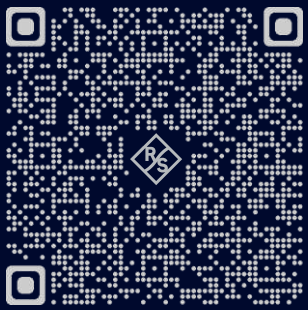
802.11 ax
Enables the high throughput (HT)

Channel capacity	3.0 Gbps	Modulation	256QAM
Channel bandwidth	160 MHz	Bandwidth	5 GHz
Transmission scheme	CSMA/OFDM		

802.11 ah
Sub 1 GHz

Channel capacity	100 Mbps	Modulation	64QAM
Channel bandwidth	10 MHz	Bandwidth	1.9 GHz
Transmission scheme	CSMA/OFDM		

Poster available at rohde-schwarz.com



Provides Wi-Fi based car-to-car communications to enable emerging intelligent traffic services.

802.11 p
Enhances IEEE 802.11p for vehicular environments

Channel capacity	600 Mbps	Modulation	64QAM
Channel bandwidth	10 MHz	Bandwidth	5.8 GHz
Transmission scheme	CSMA/OFDM		

Meet today's and tomorrow's rising demands on V2X communications on the way to fully autonomous vehicles.



802.11 d
Enhancements for next generation vehicular (NGV)

Channel capacity	100 Mbps	Modulation	256QAM
Channel bandwidth	10 MHz	Bandwidth	5.8 GHz
Transmission scheme	CSMA/OFDM		

The advent of home office and schooling as well as industrial applications require improved data throughput, reduced latency and efficiency.

802.11 be
Enhancements for systems 320 throughput (EHT)

Channel capacity	320 Gbps	Modulation	4096QAM
Channel bandwidth	320 MHz	Bandwidth	2.4 & 5 GHz
Transmission scheme	CSMA/OFDM		



thank
YOU
😊

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Make ideas real



www.rohde-schwarz.com/wlan