

SEAMLESS CONNECTIVITY WITH Wi-Fi AND 5G CONVERGENCE



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ROHDE & SCHWARZ

Make ideas real



Connecting the dots: the vibrant state of Wi-Fi today

6 GHz rocks

More than 60 countries have designated portions of the 6 GHz band for Wi-Fi, and discussions are ongoing in several additional countries.

Wi-Fi 7 take off

The Wi-Fi market is bouncing back with the launch of Wi-Fi 7, which is already supported by over 30 mobile handsets.

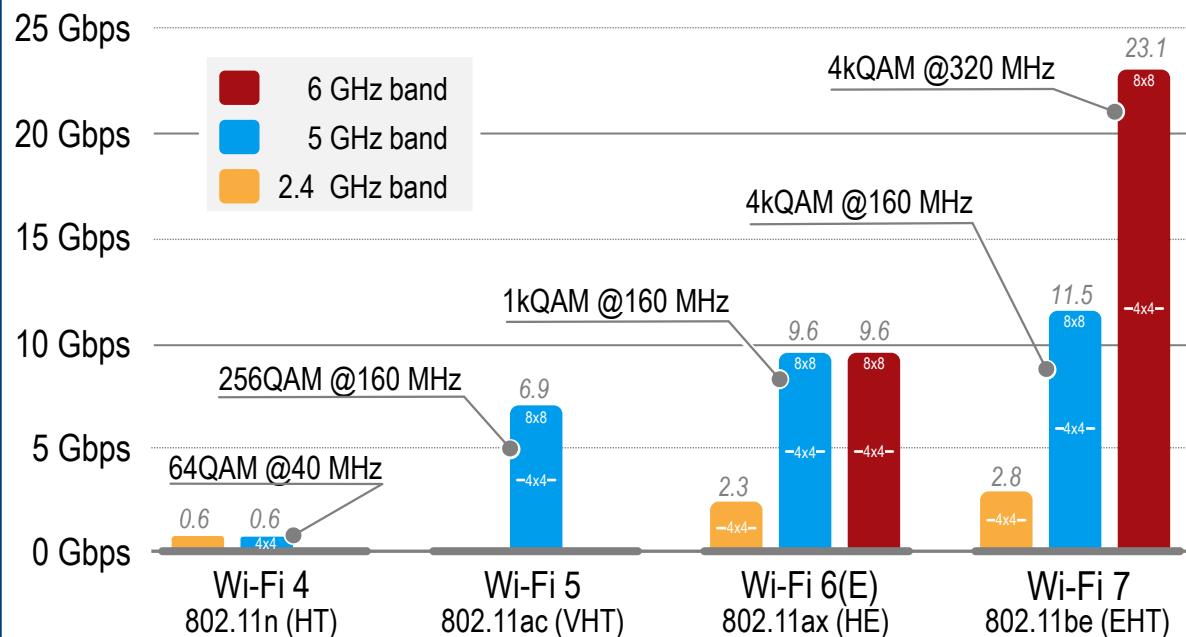
Convergence counts

3GPP's 6G will be designed for seamless integration and interoperability with a range of access technologies, including Wi-Fi.



Wi-Fi 7 is all about delivering extreme high throughput

Evolution of maximum achievable throughput per single link in all bands



Wi-Fi 7 key enabler

4kQAM modulation

can enhance throughput by 20%, provided that the conditions are optimal.

320 MHz channels

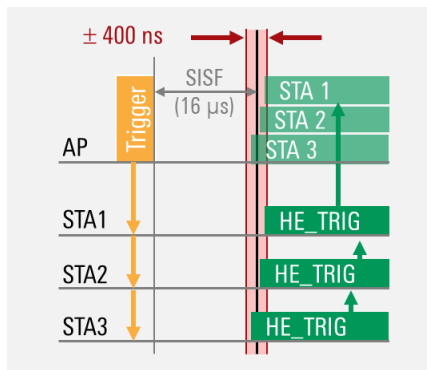
can double the maximum throughput if the 6 GHz band is available.

Multi-link operation

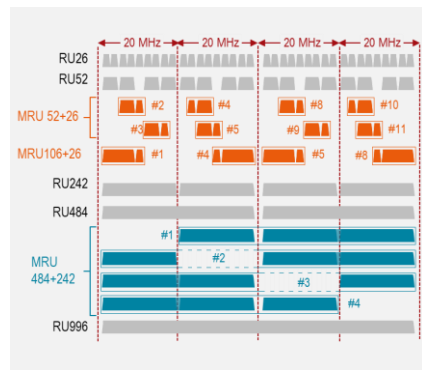
has the potential to enhance latency, throughput, and reliability.

Navigating the challenges of Wi-Fi 6/7 testing: Increased complexity and a wide range of variations

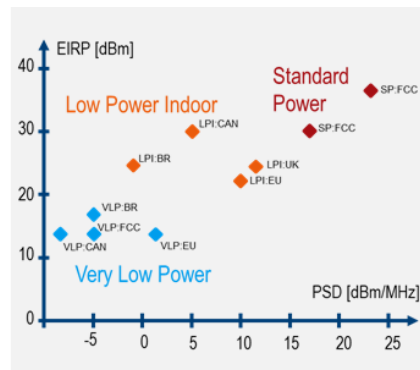
Trigger based (OFDMA)



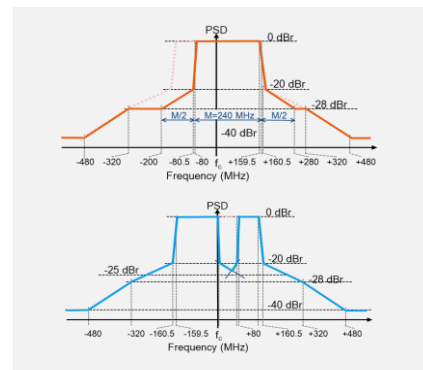
Resource units (RU/MRU)



Spectrum regulation



Preamble puncturing



Multi-link operation (MLO) – introduced in Wi-Fi 7 – asks for new measurements (interference, timing, power save) in all different MLO modes and possible channel/band combinations.

CMX500

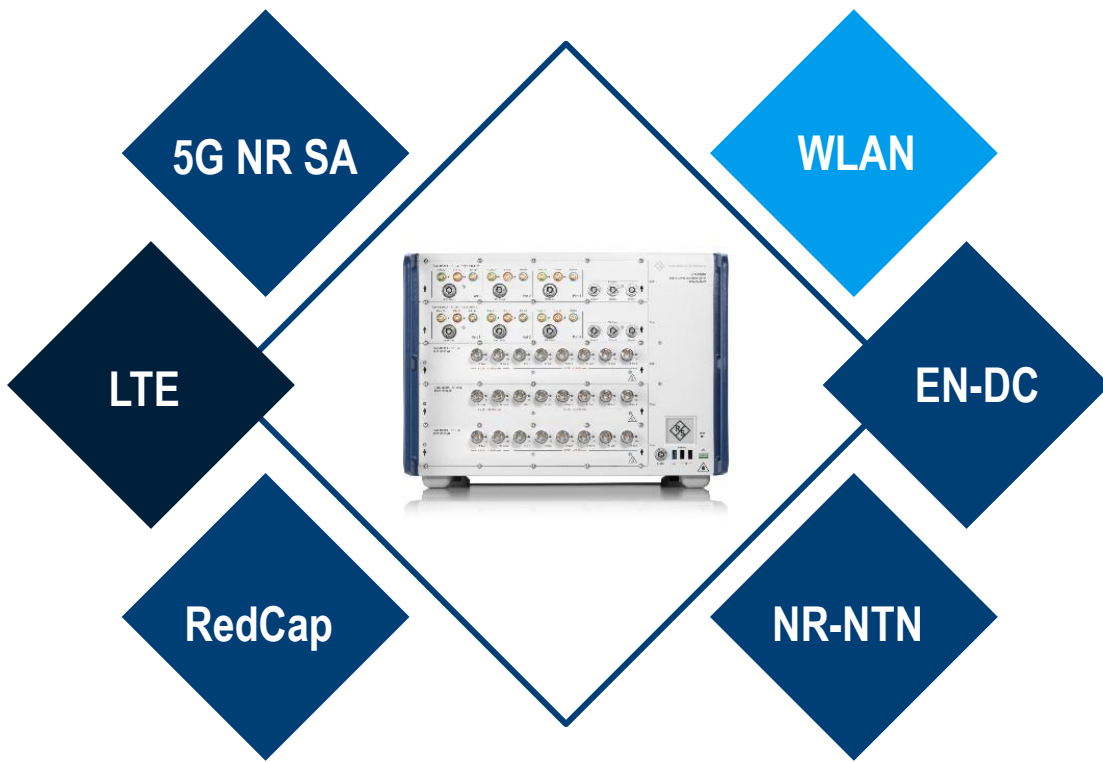
MULTI TECHNOLOGY, MULTI RADIO ONE BOX TESTER



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Multi Technology

- ▶ CMX500 supports cellular and non-cellular technologies
- ▶ Capabilities to test technology interworking (wanted and unwanted)



Multi Radio

- ▶ CMX500 supports multiple frequency ranges – multiple times
- ▶ Many radio interfaces - many use cases

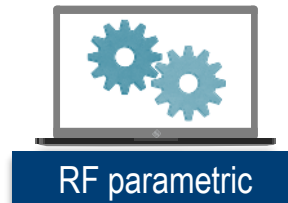
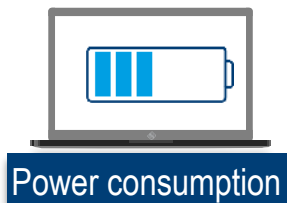
Up to 4 IF-boards for mmW frequencies in combination with remote radio heads



Up to 4 RF-boards for sub8 GHz bands, each with multiple TX and RX and wide bandwidth

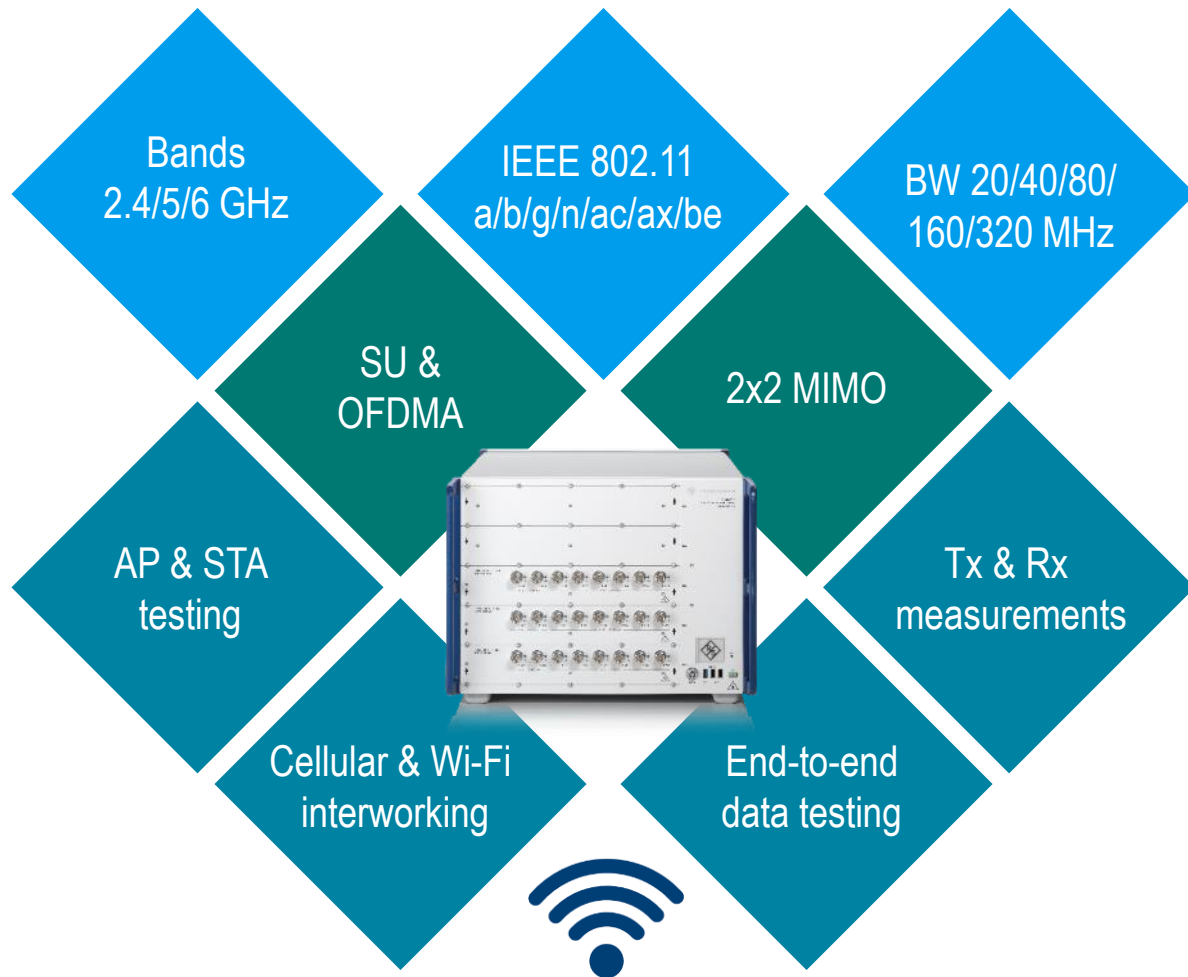
One Box Tester

- ▶ Parametric RF testing
- ▶ Multitude of additional services and features
- ▶ Support for huge amount of test needs and use cases



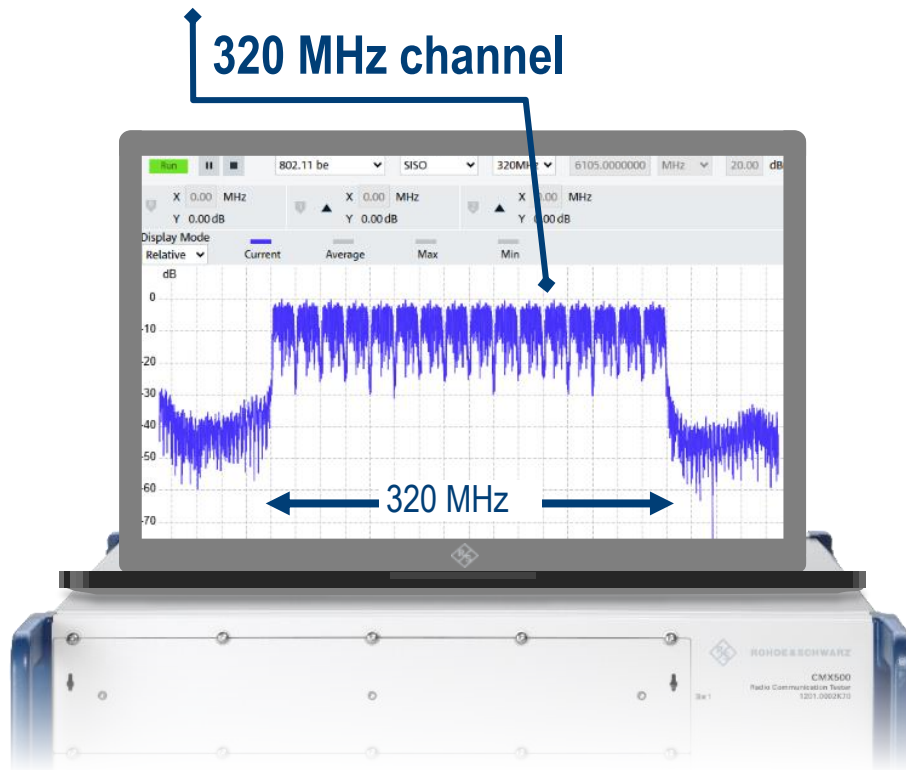
WLAN / Wi-Fi

- ▶ Support of all WLAN/Wi-Fi generations
- ▶ Support of all WLAN/Wi-Fi bandwidth and modulations
- ▶ Support of a wide range of WLAN/Wi-Fi measurements and functionalities

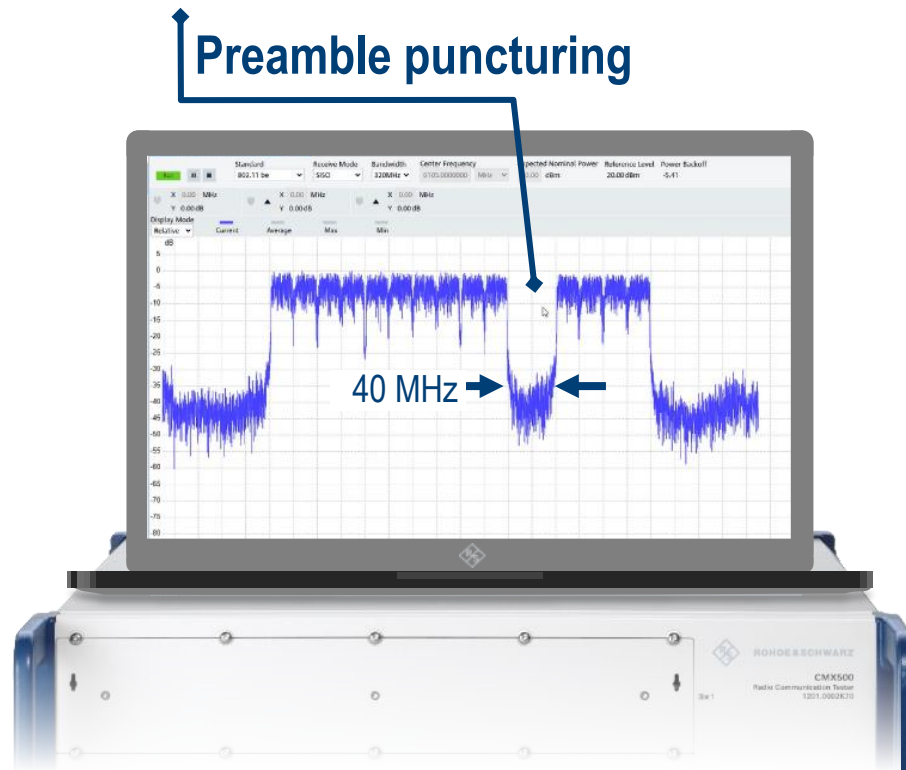


Wi-Fi 7 testing on the CMX500 – two examples

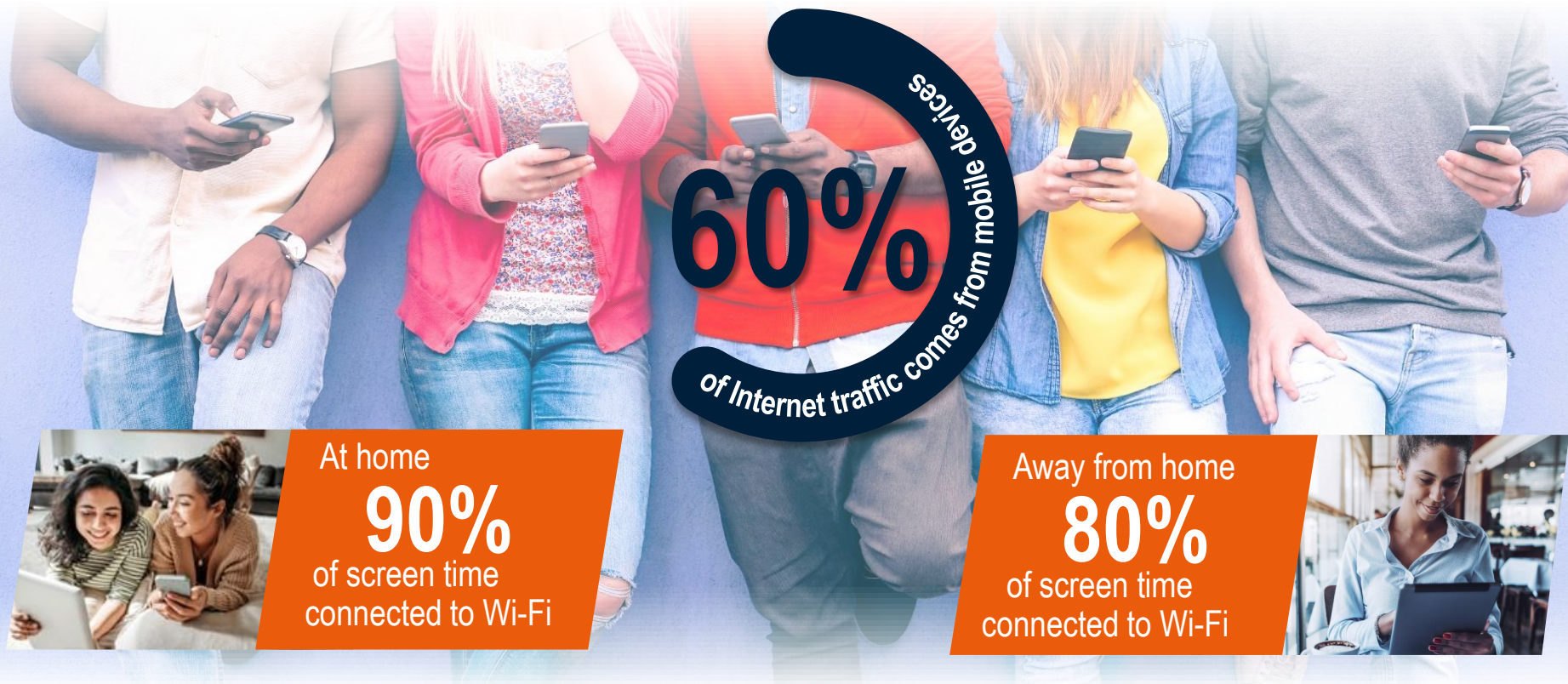
320 MHz channel



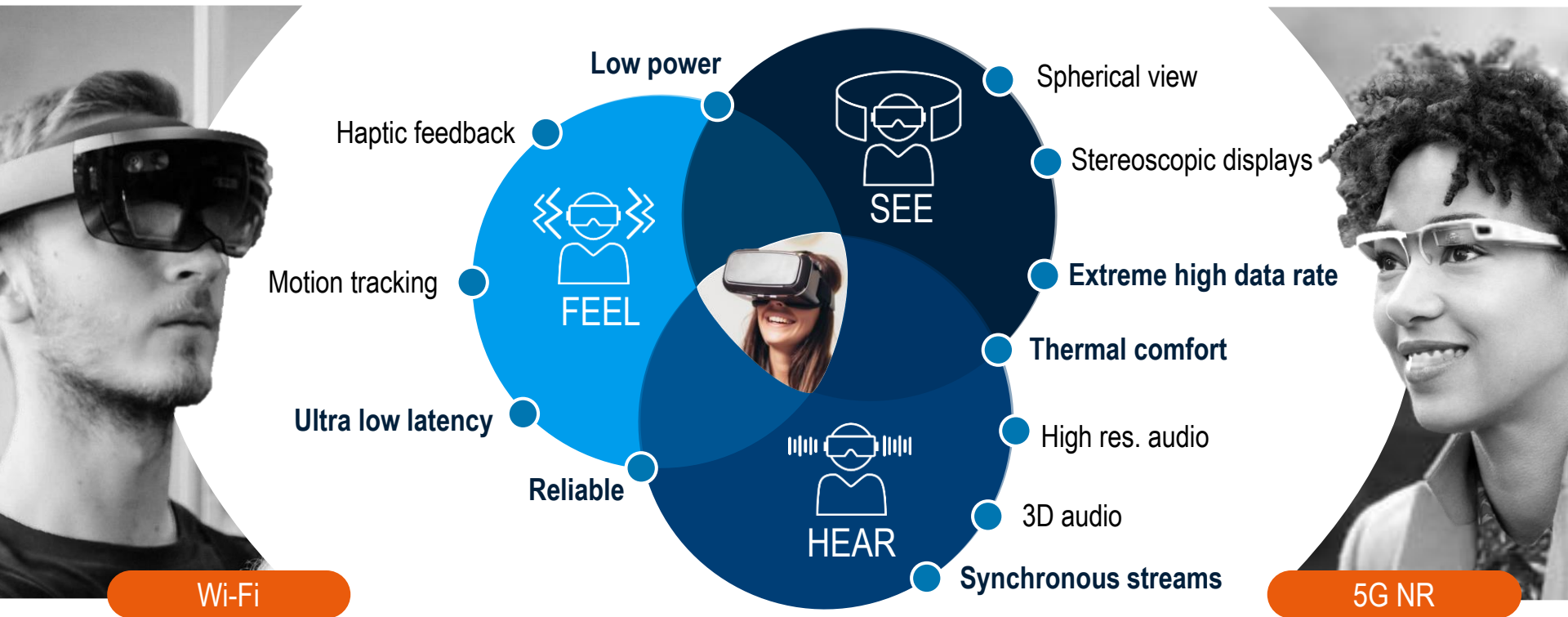
Preamble puncturing



Wireless-mobile convergence is central to the user experience



The ultimate goal: provide an immersive and interactive user experience in homes, offices, factories, and on the go.



Different concepts and solutions to deliver convergence

Allow secure and seamless Wi-Fi access & roaming

Make Wi-Fi a part of the mobile network



Institute of Electrical &
Electronics Engineers
802.11u

Wi-Fi Alliance
Passpoint

Wireless Broadband
Alliance
OpenRoaming

3GPP 5G NR
Wi-Fi offload

3GPP 5G NR
ATSSS



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Wi-Fi Alliance Passpoint® – the well-established standard for secure and seamless Wi-Fi network access & roaming



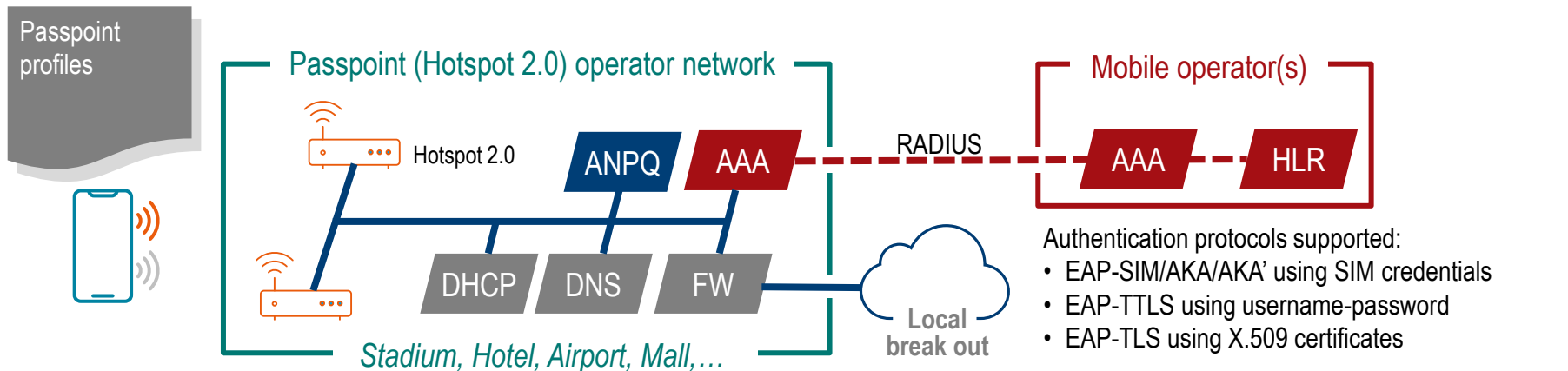
Automatic network discovery,
selection and authentication



Security based on
802.11u, EAP & WPA2/3

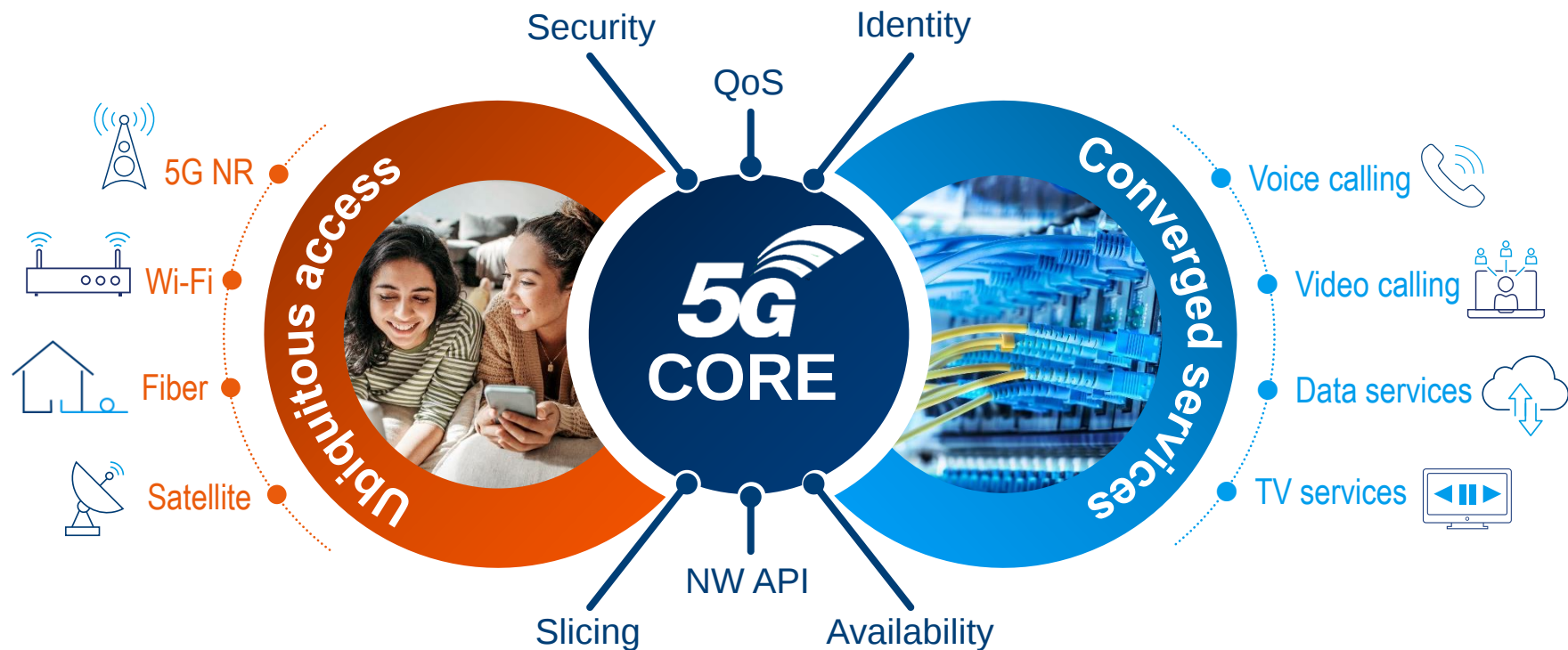


Seamless roaming between
wireless networks



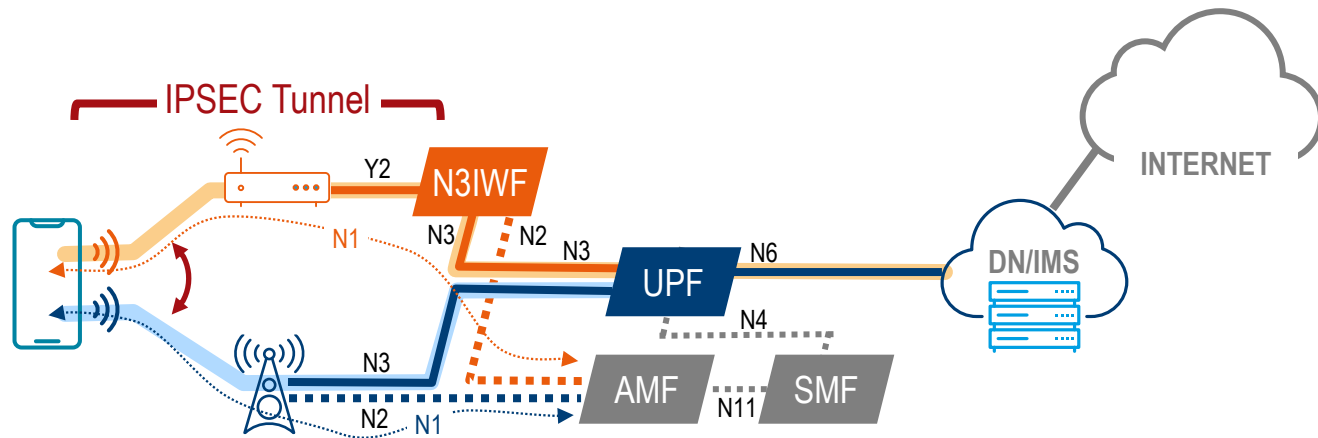
AAA	Authentication, authorization and accounting
ANQP	Access network query protocol
EAP	Extensible authentication protocol
WPA	Wi-Fi protected access

Mobile operators aim to provide **converged services** supported by **ubiquitous access** and coverage everywhere



3GPP 5G NR Wi-Fi offload: Non-trusted access via non-3GPP interworking function (N3IWF) specified in 3GPP Rel.15

- Access network discovery & selection policy (ANDSP)
WLAN selection policy (WLANSF)
- N3AN node configuration

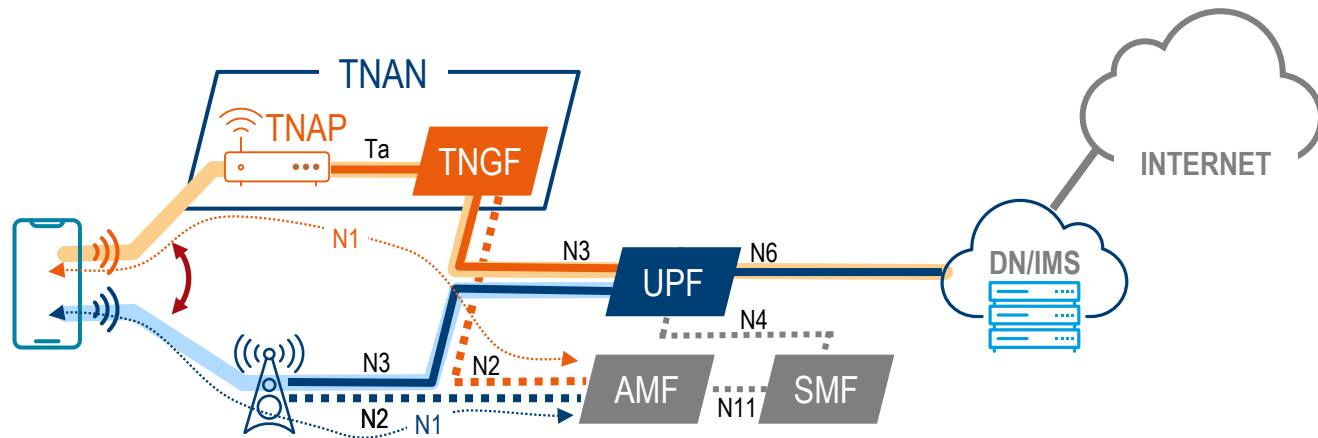


1. The UE selects and connects with a non-3GPP access network
 2. The UE selects a PLMN and an N3IWF in this PLMN
- ⇒ PLMN/N3IWF selection and non-3GPP access selection are independent

AMF	Access and mobility management function
DN	Data network
N3AN	Non-3GPP access network
N3IWF	Non-3GPP interworking function
SMF	Session management function
UPF	User plane function

Trusted access via trusted non-3GPP AP (TNAP) and trusted gateway function (TNGF) specified in 3GPP Rel.16

- Access network discovery & selection policy (ANDSP)
- WLAN selection policy (WLANSF)
- N3AN node configuration

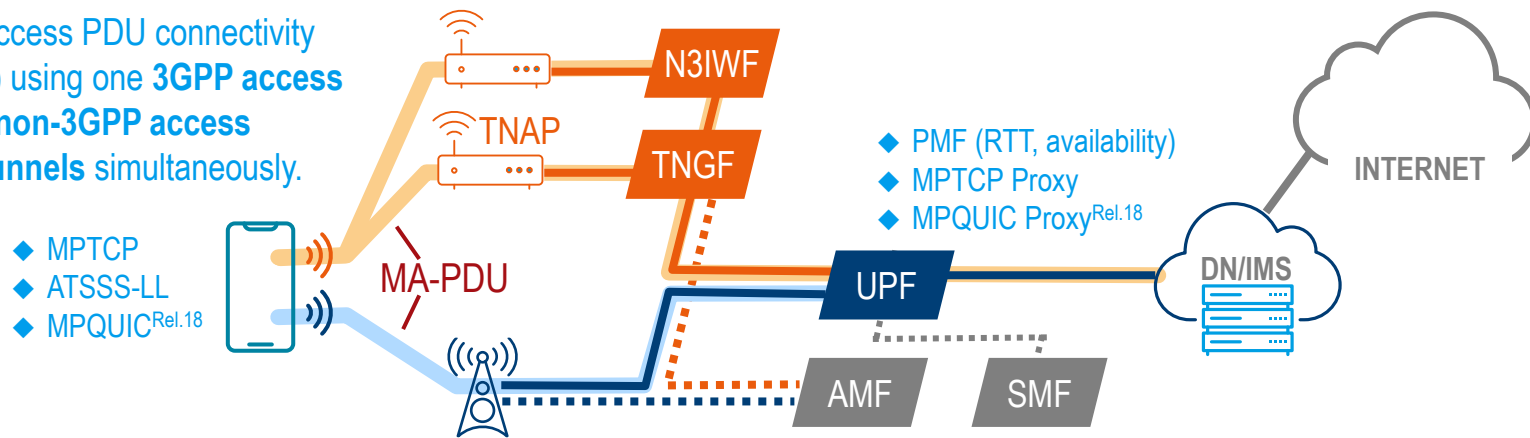


1. The UE selects a PLMN
 2. The UE selects a trusted non-3GPP access network (TNAN) that supports trusted connectivity to the selected PLMN
- ⇒ The non-3GPP access network selection is affected by the PLMN selection

AMF	Access and mobility management function
DN	Data network
TANF	Trusted non-3GPP access point
TNGF	Trusted non-3GPP gateway function
SMF	Session management function
UPF	User plane function

Extended architecture to support access traffic steering, switching, and splitting (ATSSS, AT3S)

Enables a multi-access PDU connectivity service (MA PDU) using one **3GPP** access network and one **non-3GPP** access network by **two tunnels** simultaneously.

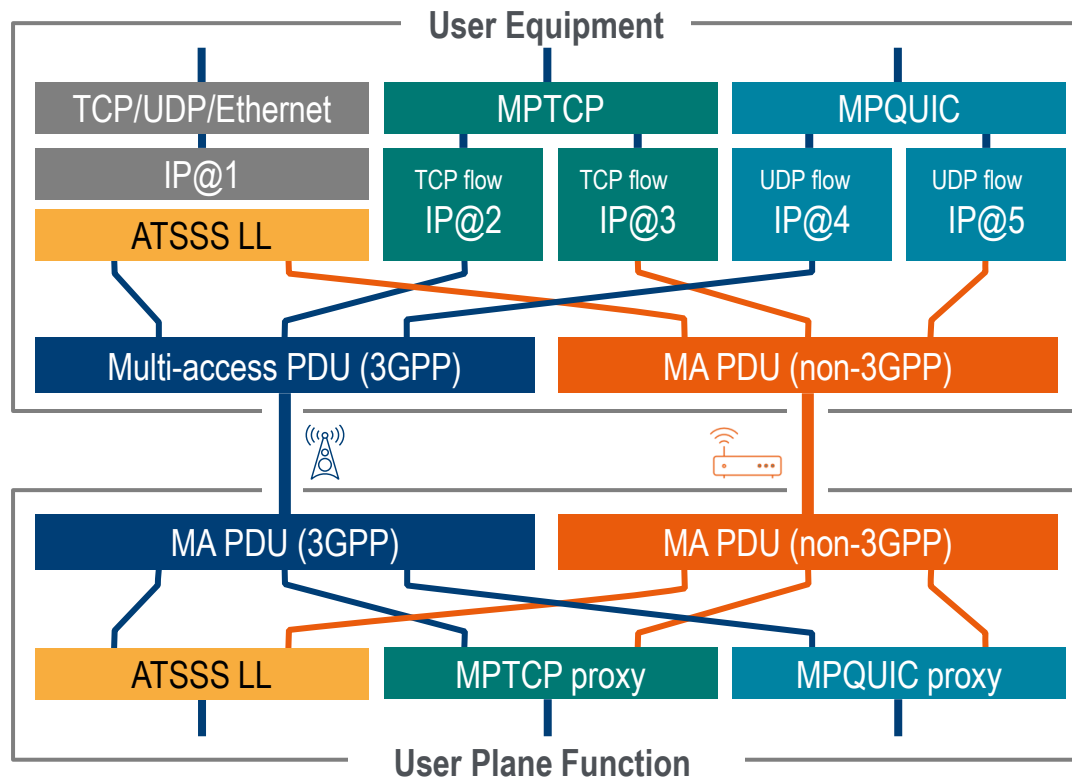


After the establishment of a MA PDU session (types IPv4, IPv6, IPv4v6, or Ethernet):

- The UE applies network-provided policy (i.e. URSP, ATSSS rules) and considers local conditions for deciding how to distribute the **uplink traffic**
- Similarly, the UPF anchor of the MA PDU session applies network-provided policy (i.e. N4 rules) and feedback information received from the UE for deciding how to distribute the **downlink traffic**

ATSSS	Access traffic steering, switching, splitting
MPTCP	Multipath TCP (RFC 8684)
MPQUIC	Multipath QUIC (RFC 9000)
PMF	Performance measurement function
URSP	UE route selection policy

ATSSS can apply different steering functionalities for different types of traffic

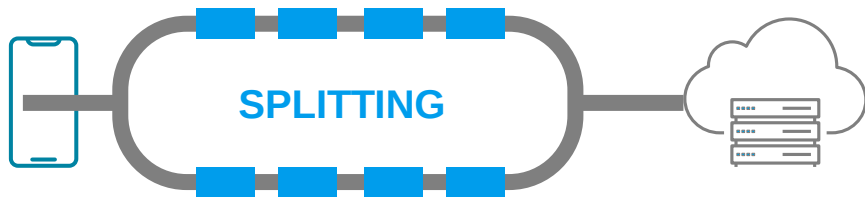
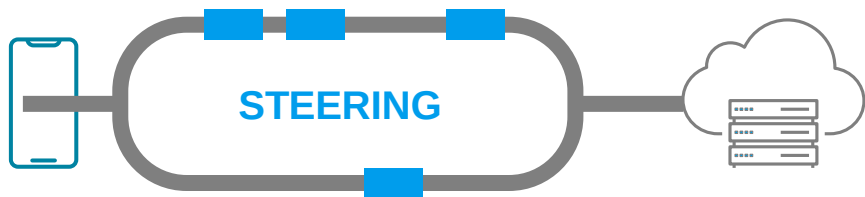


ATSSS-low-layer (ATSS-LL) enables multi-access transport for any kind of traffic flow including UDP, TCP, Ethernet, etc.

Multipath transmission control protocol (MPTCP) combines two TCP connections as defined by IETF in RFC 8684.

MPQUIC as a complementary higher layer steering functionality using UDP connections as defined by IETF in RFC 9000.

Different steering modes and steering functionalities to steer, split and switch traffic across two accesses



Active-Standby

Use the defined active access as long as available, otherwise switch to the standby access

Smallest Delay

Use the access with the lowest delay based on RTT measurements

Load-Balancing

Distributes the traffic across both access based on defined distribution (e.g. 40% vs. 60%) or autonomous, as long as both access are available

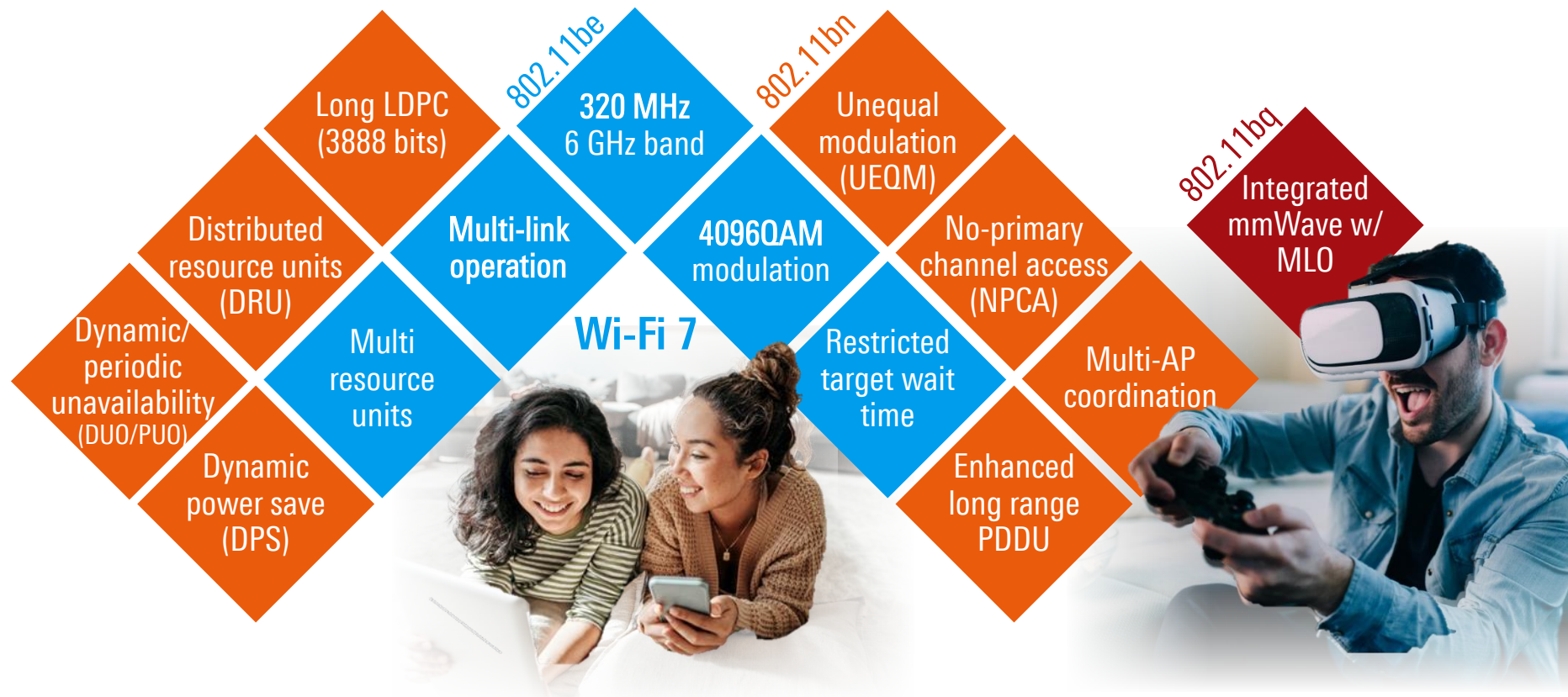
Priority-based

All traffic to the high-priority access as long as not congested and available

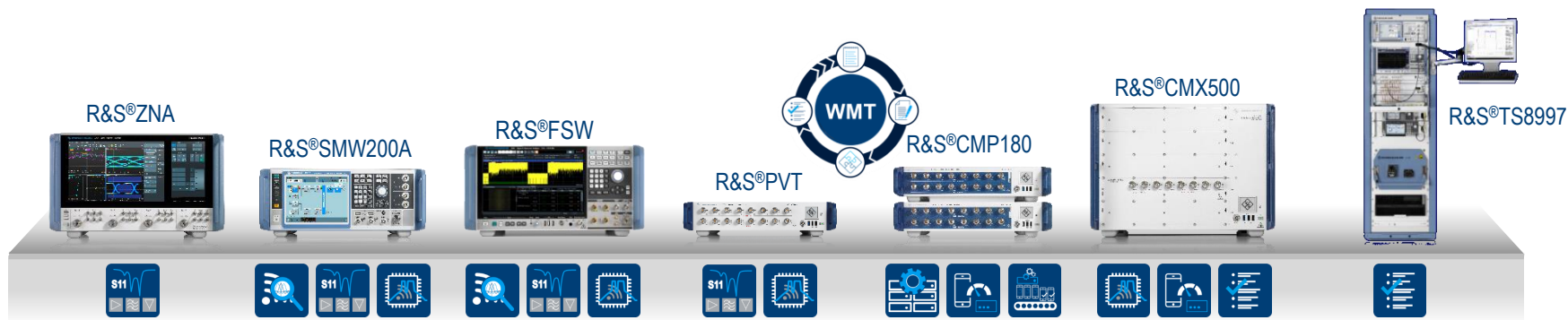
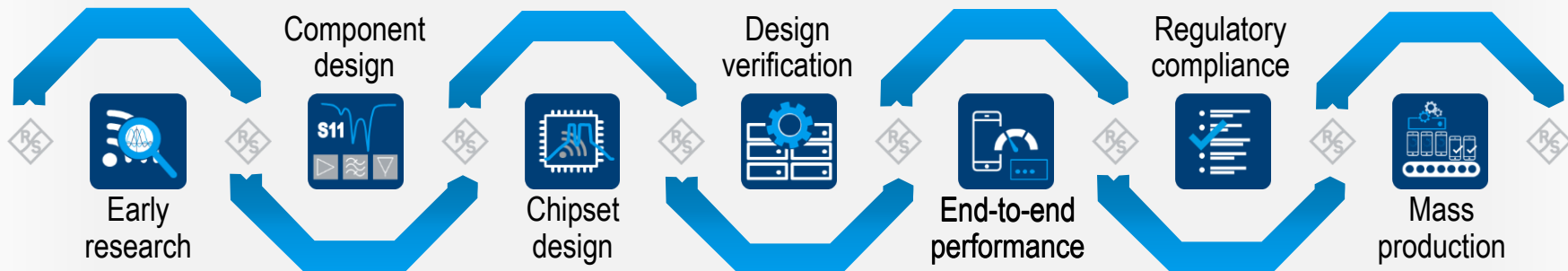
Redundant

Duplicate traffic to both accesses based on actual PER with option to define primary and secondary access

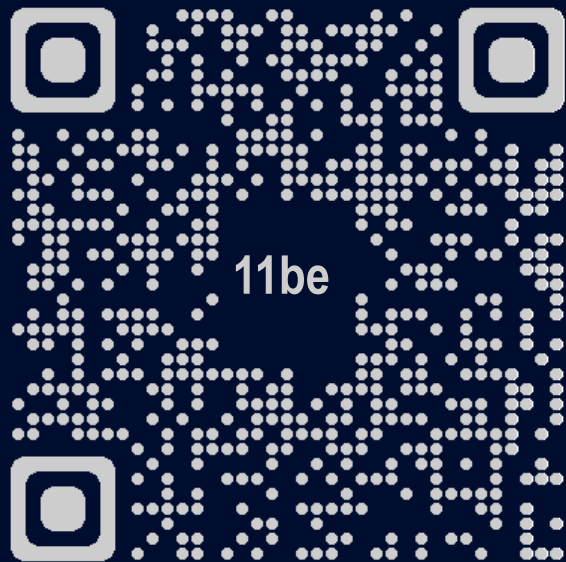
Wi-Fi evolution towards ultra high reliability



Continuous development of the wireless test portfolio to empower the ecosystem at the forefront of technology evolution



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More information

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

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