

User Meeting 2025 Taipei

# CMX500 signaling test for 5G

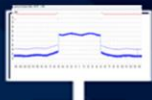
All-in-one 5G signaling tester CMX500 OBT  
Overview

**Christian Dobmeier**  
Director Product Management Mobile Radiocom. Testers



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# CMX500 Use Cases



RF-Callbox



Max. Throughput



Mobility, Failure &  
Reject Scenarios



VoLTE/VoNR/VoWiFi  
Speech Quality



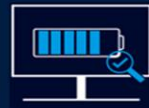
WLAN offloading



Real MNO Config  
Testing



IP Security



Power Consumption



Backend Services



NG eCall



Extended Reality



# NEXT-GEN XR APPLICATION TESTING

## Immersive experience ensured through testing w/ R&S®CMX500

- ◆ Our R&S® CMX500-based eXtended Reality testbed provides a versatile platform for evaluating next generation XR services and applications that can leverage future FR3 data rates
- ◆ The R&S® CMX500's 5G network emulation capabilities enable end-to-end testing of distributed XR application functions such as remote 3D graphics rendering and interactive AI services in addition to audio quality and other core functionality critical to the overall quality of experience (QoE).



R&S®CMX500 OBT



# The future of **DEVICE TESTING** in FR3

## Unlocking the full potential of FR3 for 6G with the R&S®CMX500

- ◆ Rohde & Schwarz and chipset showcase exceptional high-throughput performance with a radio operating at 13 GHz within the considered 6G FR3 frequency range.
- ◆ The **R&S®CMX500** propels 6G development forward by delivering a cutting-edge, future-proof solution for testing devices in the FR3 frequency range, ensuring you're at the forefront of technological innovation!



R&S®CMX500 OBT



# ML-BASED CSI-RS FEEDBACK ENHANCEMENTS

## AI/ML-based CSI Compression testing with R&S®CMX500

- ◆ Demonstrating machine learning (ML)-based channel state information (CSI) feedback enhancement, a critical technology that will also pave the way for AI/ML in 6G with the target to improve spectral efficiency and reducing feedback overhead.
- ◆ The **R&S®CMX500** radiocommunication tester acting as 5G NR base station is interacting with a Qualcomm based device showcasing ML-Based CSI-RS feedback enhancements using a two-sided model



In cooperation with  
**Qualcomm**

R&S®CMX500 OBt



**Onboard**  
Fading &  
Channel  
Emulation  
up to 6 sats

Protocol Testing  
RF Measurements  
Application Testing  
Mobility Testing  
User defined bands



## CMX500 OBT NR-NTN

### Mobility/Handover



NTN ↔ TN handover  
Cell selection  
Inter beam handover  
Inter-satellite handover

## Multiorbit

+/-720kHz doppler



LEO

MEO

GEO/GSO



### E2E Scenario

UE  
emulator

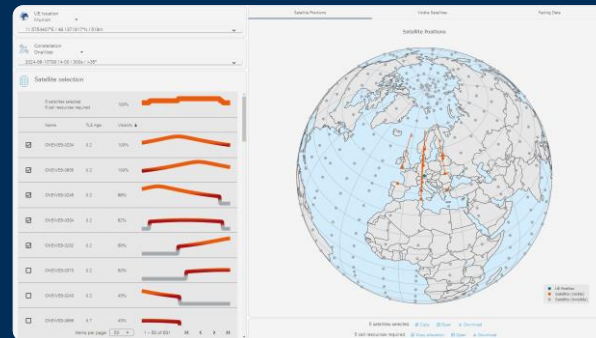


### Multiband

S-Band  
L-Band  
Ku-Band  
Ka-Band

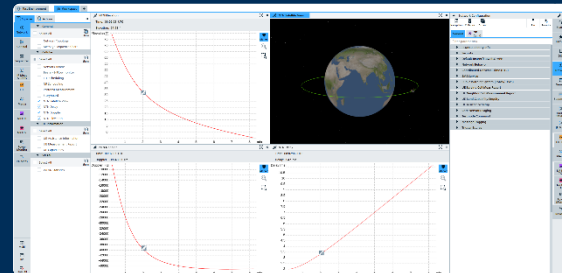
## Constellation Insight Tool

Load, configure, visualize and deploy satellites.



## All-in-one WebGUI

Experience seamless control and visualization



Rohde & Schwarz

COMPANY RESTRICTED



# Band Support

## ► NR-NTN – CMX500

CMX HEAD50



+

CMX500 OBT



**Ka-Band**

**IFU + RRH**

(CMX-B500A + CMX-B73B)

**Ku-Band**

**IFU**

(CMX-B500A)

**L- and S-Band**

**RFU**

(CMX-B600B)

# CMX500 Callbox for today's 5G Testing Challenges



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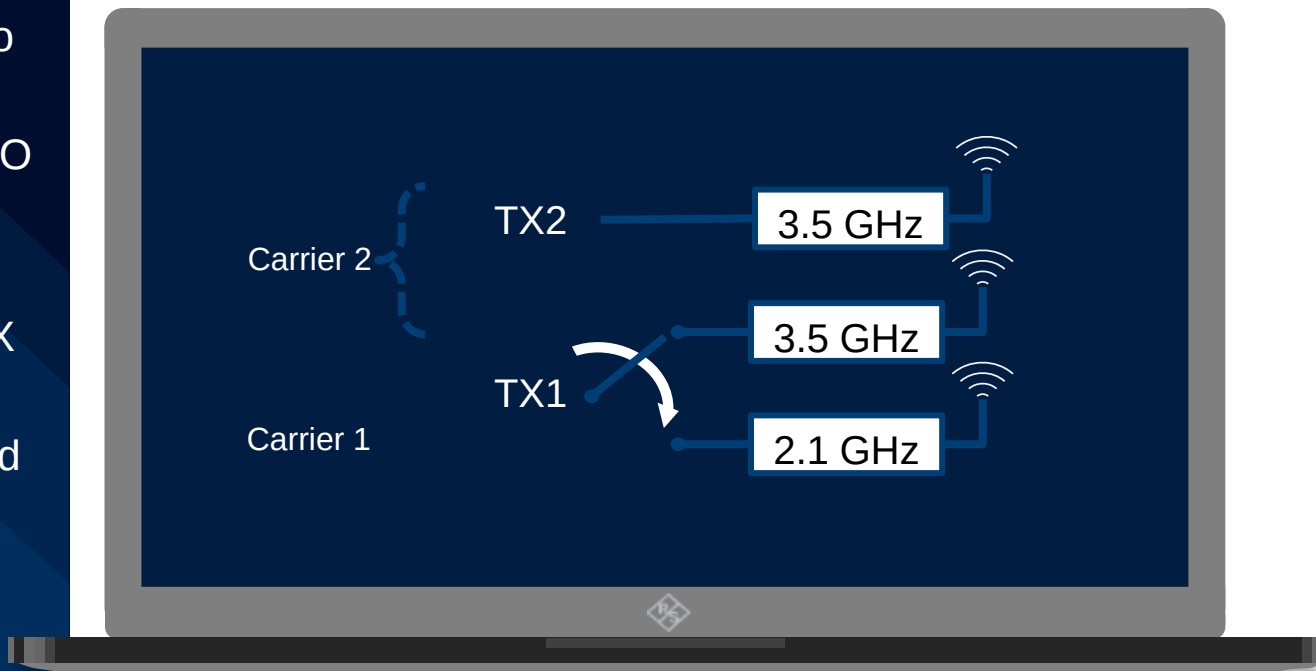


# CALLBOX

## EXAMPLE USE CASES

- ▶ UEs support at most two RF transmitters
  - Prio between UL MIMO or multi-carrier?
- ▶ Dynamic switching of TX between to carriers
  - Enables UL MIMO and CA
- ▶ Applicable to
  - ENDC and SA CA
  - FDD+TDD (rel.16)

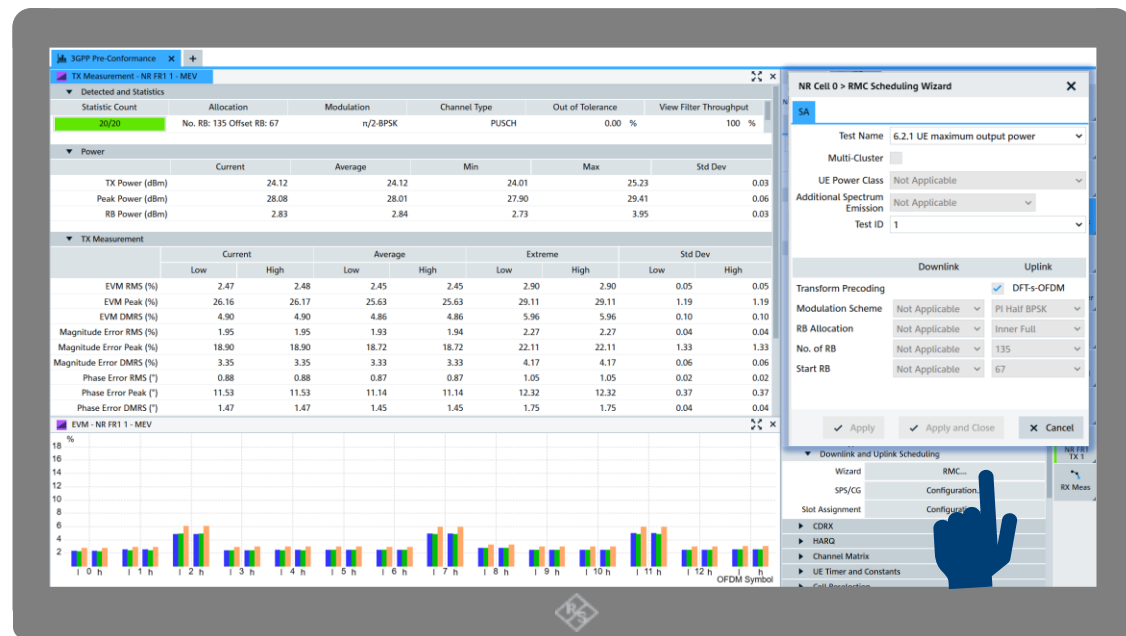
## UL TX SWITCHING



# CALLBOX EXAMPLE USE CASES

- ▶ 3GPP Pre-Conformance
  - Wizzard takes care of 3GPP RMC settings
  - Quick and easy 3GPP pre-conformance in the GUI

## 3GPP 38.521 TEST CASES IN THE GUI



CMX-KS600B NR Signaling, SA/NSA

(NSA/SA)

# Rohde&Schwarz Speech Quality Solutions



- ▶ One box for Audio Quality (Internal POLQA Analysis)
  - no need for Audio Analyzer for R&D Use Cases and Operator testing
- ▶ VoWiFi, VoNR and VoLTE in the same box
- ▶ Support for AT&T VoNR Audio Quality test plan
- ▶ Advanced Internal (One-Box) Audio Quality test capabilities
- ▶ #1 partner of Head Acoustics for more advanced Speech Quality [LINK](#)



# NGECALL R&S TEST SOLUTIONS STATUS UPDATE

## GNSS performance



[EU2017/79 Annex VI](#)

## 4G/5G E2E Conformance



[CEN TS 17240](#)

## Protocol Conformance



[GCF PCT5-KC625 23.24.1](#)

## NGeCall speech quality



ITU-T P.1140 / UN-R144

## Your benefit!



Scalable

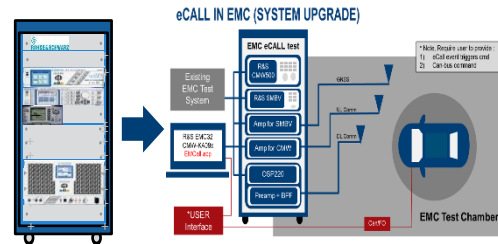


Precise &  
Repeatable



Performance  
optimized

## EMC testing



(UN ECE R10 Rev. 7 verified)

# One box solution to test multi-sim



- ▶ CMX500 support 2 modem context in **ONE BOX**
- ▶ Simplified HW, Cabling & automation
- ▶ **DSDS** for LTE and NR incl. ENDC
- ▶ LTE+LTE, NR+NR, LTE+NR, NR+ENDC
- ▶ Easy to create MSIM tests with **XLAPI** Python interface
- ▶ **Readymade tests** available as test packages
- ▶ **Snippets** used for enabling MSIM on CMseq and webUI

# CMX500 – Ready for REDCAP

## Rel.17 RedCap capability

- Co-existence of RedCap & non-RedCap devices
- FD-FDD & TDD
- CMX OBT Lite

## Callbox for RedCap

- RF Tx & Rx Meas
- E2E Measurements

## 3GPP Pre-conf RedCap

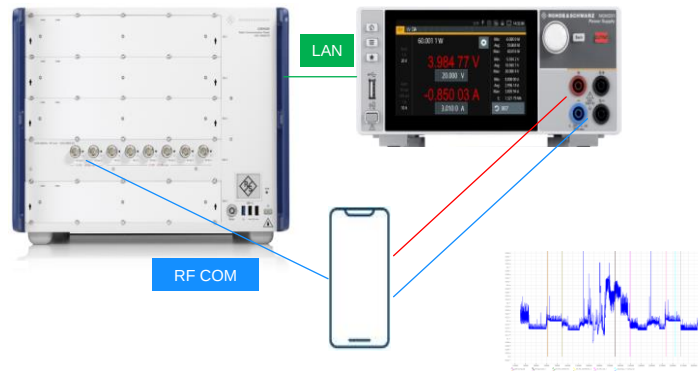
- CMseq RF automation
- 3GPP Pre-conf tests
- CMX-KC664B license needed

## Power Consumption tests

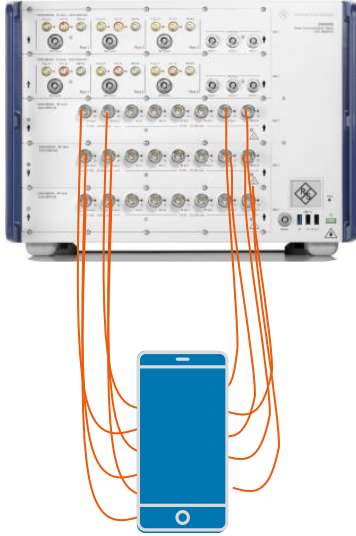
- Rel.17 Power saving features
- Power consumption graph in CMXmars
- Export Power consumption data to .csv

NR FR1 3GPP Composite RedCap

| CMX-KC664B      | SA RedCap 3GPP RF                                 |
|-----------------|---------------------------------------------------|
| <b>Tx Tests</b> |                                                   |
| 6.2.1.1         | UE Maximum Output Power for RedCap                |
| 6.2.2           | UE maximum output power reduction                 |
| 6.2.3           | Additional Maximum Output Power Reduction (a-MPR) |
| 6.2.4           | Configured transmitted power                      |
| 6.3.1           | Minimum Output Power                              |
| 6.3.3.2         | General ON/OFF time mask                          |
| 6.3.3.4         | PRACH Time Mask                                   |
| 6.3.3.6         | SRS time mask                                     |
| 6.3.4.2         | Absolute Power Tolerance                          |
| 6.3.4.3         | Relative power tolerance                          |
| 6.3.4.4         | Aggregate power tolerance                         |
| 6.4.1           | Frequency Error                                   |
| 6.4.2.1         | Error Vector Magnitude (EVM)                      |
| 6.4.2.2         | Carrier Leakage                                   |
| 6.4.2.3         | In-band emissions                                 |
| 6.4.2.4         | EVM equalizer spectrum flatness                   |
| 6.4.2.5         | EVM equalizer spectrum flatness for Pi/2 BPSK     |
| 6.5.1           | Occupied Bandwidth                                |
| 6.5.2.2         | Spectrum Emission Mask                            |
| 6.5.2.3         | Additional Spectrum emissions mask                |
| 6.5.2.4.1       | NR ACLR                                           |
| 6.5.2.4.2       | UTRA ACLR                                         |
| <b>Rx Tests</b> |                                                   |
| 7.3.12          | Reference Sensitivity Power Level                 |
| 7.4             | Maximum Input Level                               |



# BAND COMBO TESTING WITHOUT RECABLING



Can this cabling cover  
all DUT band combos?

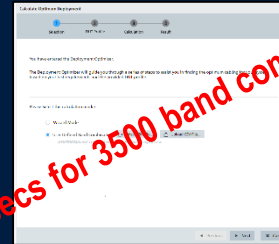
## Points to consider

- ▶ Dynamic Antenna Switching in DUT
- ▶ Combiners & Splitters
- ▶ 1000s of band combos
- ▶ What's best cabling to cover all band combos

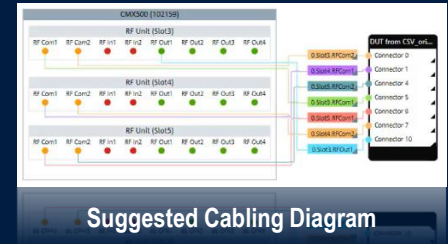
Cabling  
Optimizer  
Service



DUT Band combo csv



COS Wizard





# CMX OBT - Fading Overview

**Internal Fader (no external equipment required):**

- LTE
- NR FR1
- NR FR2

**Powerful fading engine which allows fading in a single box for:**

- up to 12 4x4 MIMO LTE CC
- up to 6 4x4 MIMO 5G NR CC / 12 2x2 MIMO 5G NR CC

(depending on signaling requirement)



R&S AI Workplace

# #CMX500\_AI

AI-Powered Solutions for **Efficiency, Usability, and Productivity**



Rohde & Schwarz

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Conformance Test User Meeting 2025

# WLAN ON CMX500 OBT

# WLAN IEEE802.11 EVOLUTION OVER 25 YEARS +

## 802.11a (Non-HT)

- 5GHz band
- 20MHz BW
- SISO
- 64QAM
- 54Mbps

## 802.11g (Non-HT)

- 2.4GHz band
- 20MHz BW
- SISO
- 64QAM
- 54Mbps

## 802.11b (Non-HT)

- 2.4GHz Band
- 22MHz BW
- SISO
- QPSK
- 11Mbps

## 802.11n (HT: Wi-Fi4)

- 2.4/5GHz
- 40MHz BW
- MIMO 4x4
- 64QAM
- 540Mbps

## 802.11ac (VHT: Wi-Fi5)

- 5GHz Band
- 160MHz BW
- MIMO 8x8
- 256QAM
- 6.9Gbps

## 802.11ax (HE: Wi-Fi6/6E)

- 2.4/5/6 GHz
- 160MHz BW
- MIMO 8x8
- 1024QAM
- OFDMA
- 9.6Gbps

## 802.11bn (UHR: Wi-Fi8)

- 2.4/5/6 GHz
- 320MHz BW
- MIMO Mod.
- 4096QAM
- OFDMA
- dRU
- MLO
- ~55Gbps

## 802.11be (EHT: Wi-Fi7)

- 2.4/5/6 GHz
- 320MHz BW
- MIMO 8x8
- 4096QAM
- OFDMA
- mRU
- MLO
- 46Gbps

GSM

UMTS

LTE

5G

6G

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# AVAILABLE R&S SIGNALING TESTER FOR WLAN

## CMW270

wireless connectivity tester



- ▶ WLAN 11 a / b / g / n / ac / ax SISO and MIMO max. 160MHz BW
- ▶ Wi-Fi6e extension for 6GHz Band
- ▶ Bluetooth Low Energy (BLE), Basic Rate and EDR

## CMW500

Multi-RAT signaling tester



- ▶ LTE, WCDMA, GSM, WLAN, Bluetooth
- ▶ Bluetooth and WLAN capability same as CMW270

## CMX500

one-box signaling tester OBT



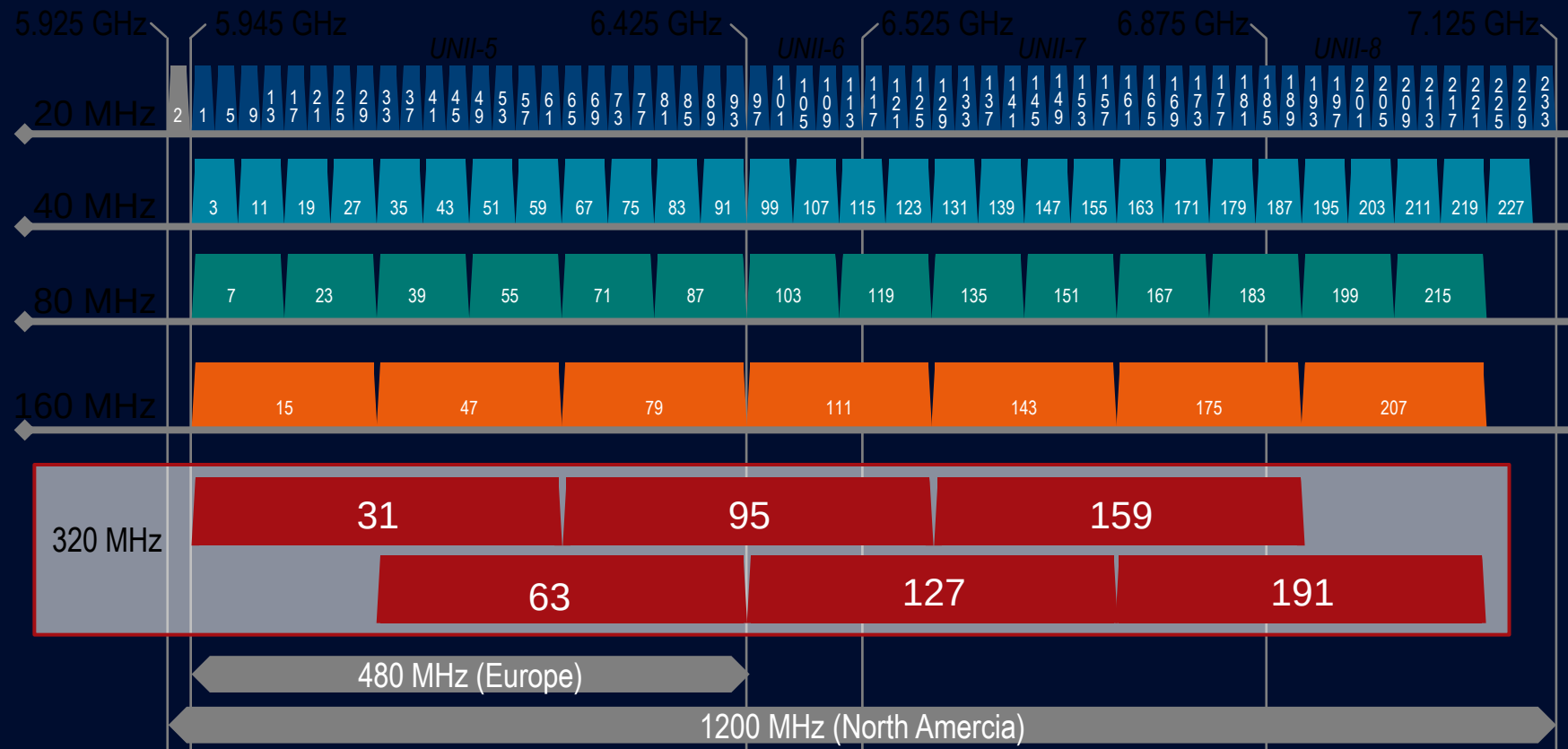
- ▶ LTE, 5G FR1 and FR2 WLAN
- ▶ Frequency range up to **8 GHz**
- ▶ WLAN 11 a / b / g / n / ac / ax / **be** SISO and MIMO

# MAIN NEW FEATURES IN 802.11BE (WIFI 7)

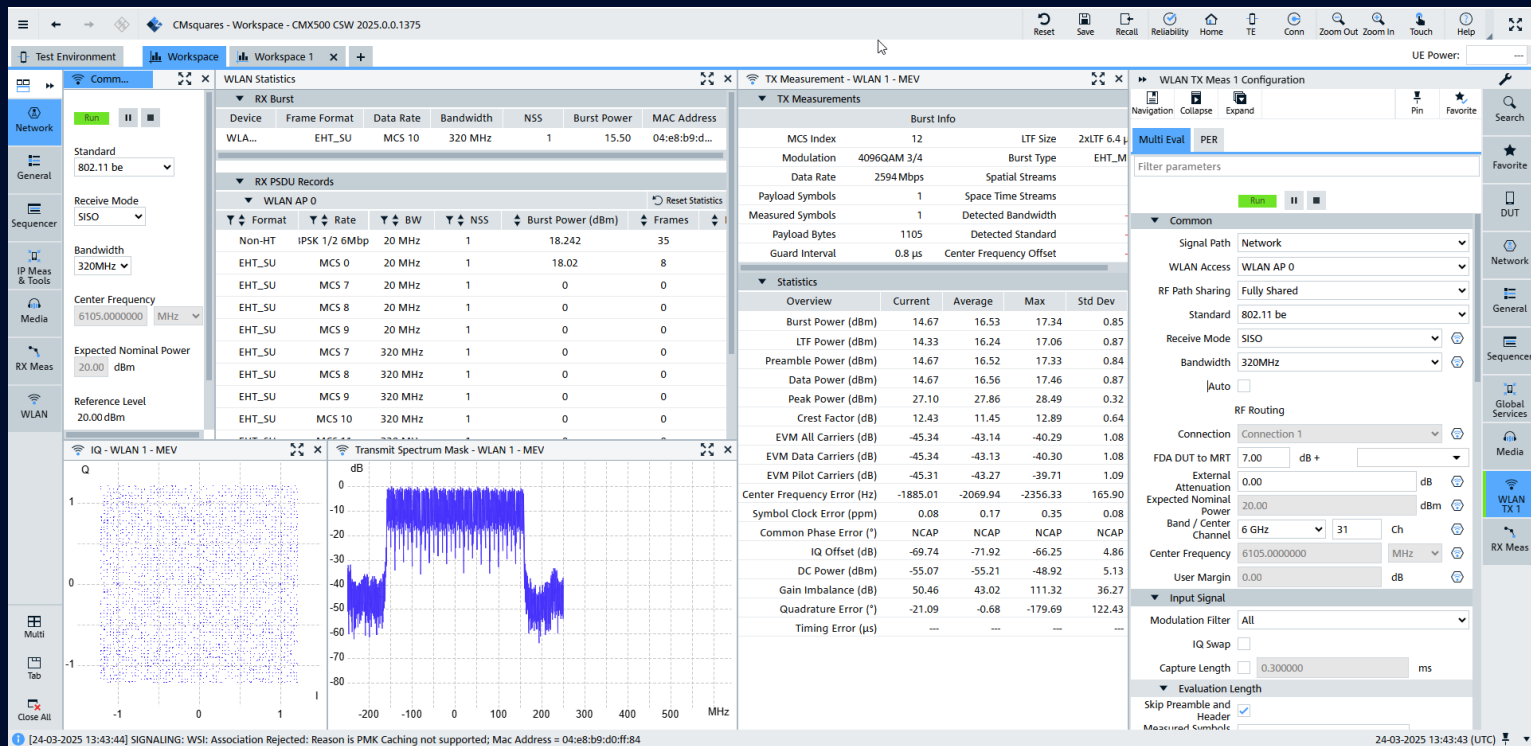
- ▶ 320MHz channel BW in 6GHz band
- ▶ Preamble puncturing
- ▶ 4096QAM modulation (12 bit per symbol)
- ▶ Multiple resource units
- ▶ Multi Link Operation (MLO)



# A few overlapping 320 MHz channels in the 6 GHz band

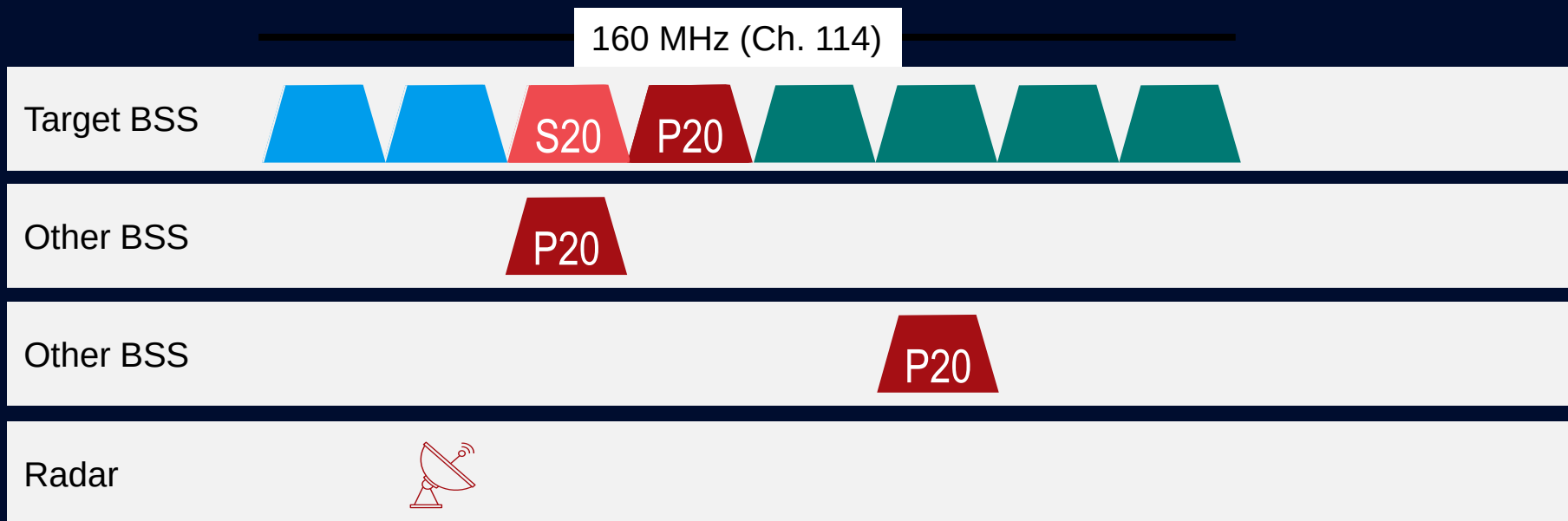


# 802.11BE WIDE CHANNEL BANDWIDTH – INCREASED DATA RATE





# WIDE CHANNELS ARE GREAT, IF AVAILABLE AND NOT „BUSY“



# 80MHZ BW WITH 20 MHZ SEGMENT 3 PUNCTURING ACTIVATED

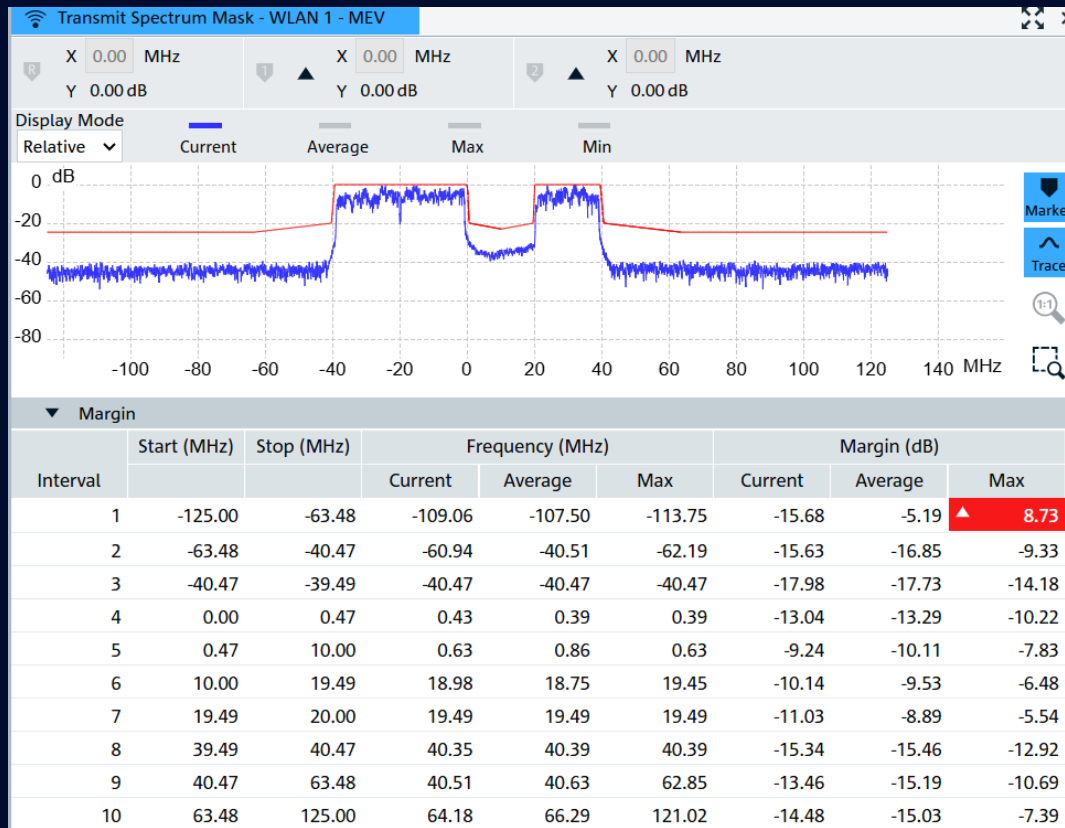
WLAN AP 0 > Preamble Puncturing

Operating Bandwidth: 80 MHz

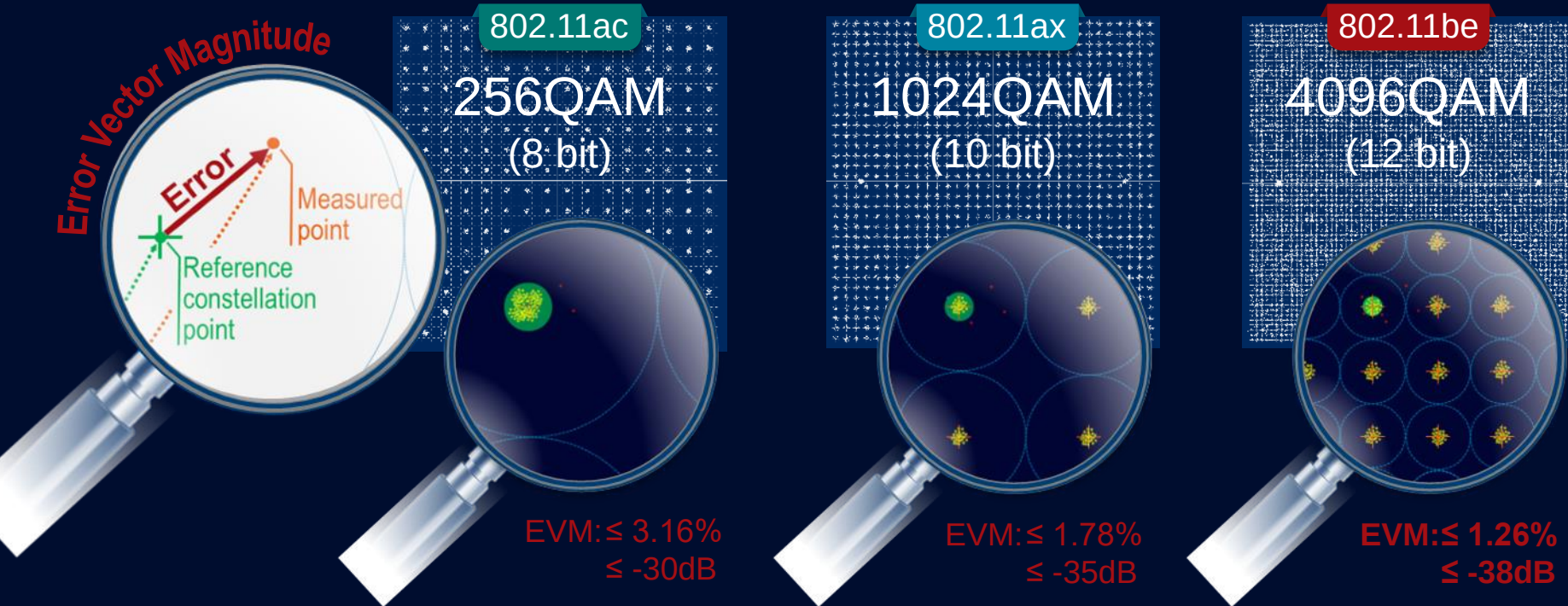
Puncturing Size: 20 MHz

Puncturing Segment: 20 MHz Segment 3

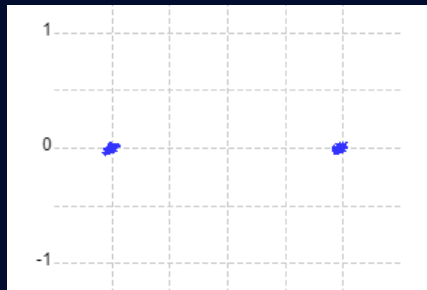
|        |        |        |        |
|--------|--------|--------|--------|
| 1      | 2      | 3      | 4      |
| 20 MHz | 20 MHz | 20 MHz | 20 MHz |



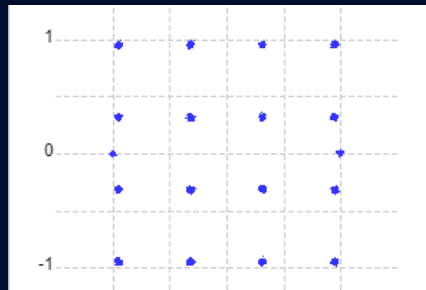
# 802.11be pushes RF performance REQUIREMENTS AND test equipment quality to the next level



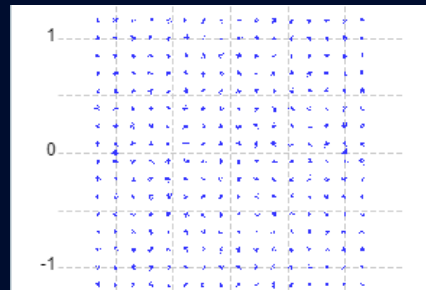
# 802.11BE MODULATION



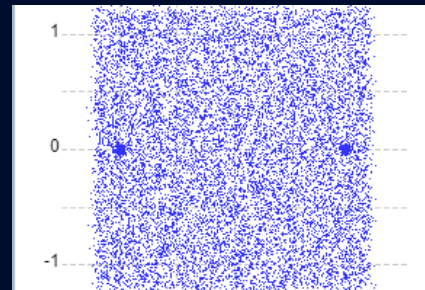
MCS0 - BPSK



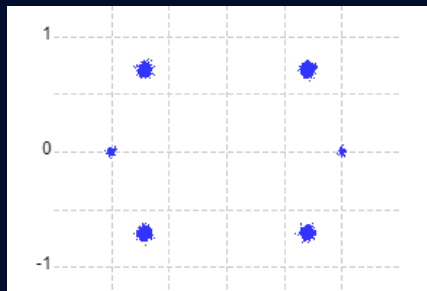
MCS3/4 - 16QAM



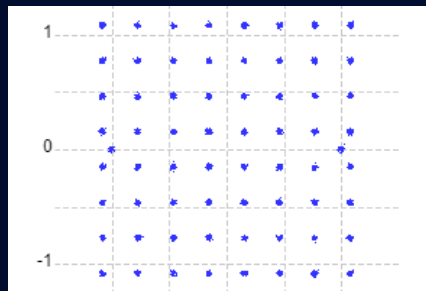
MCS8/9 - 256QAM



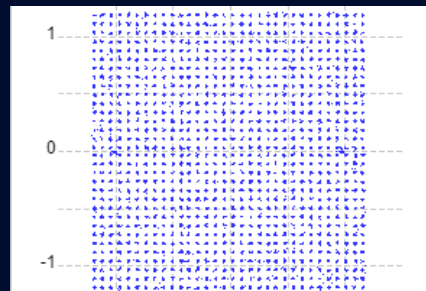
MCS12/13 - 4096QAM



MCS1/2 - QPSK



MCS5/6/7 - 64QAM

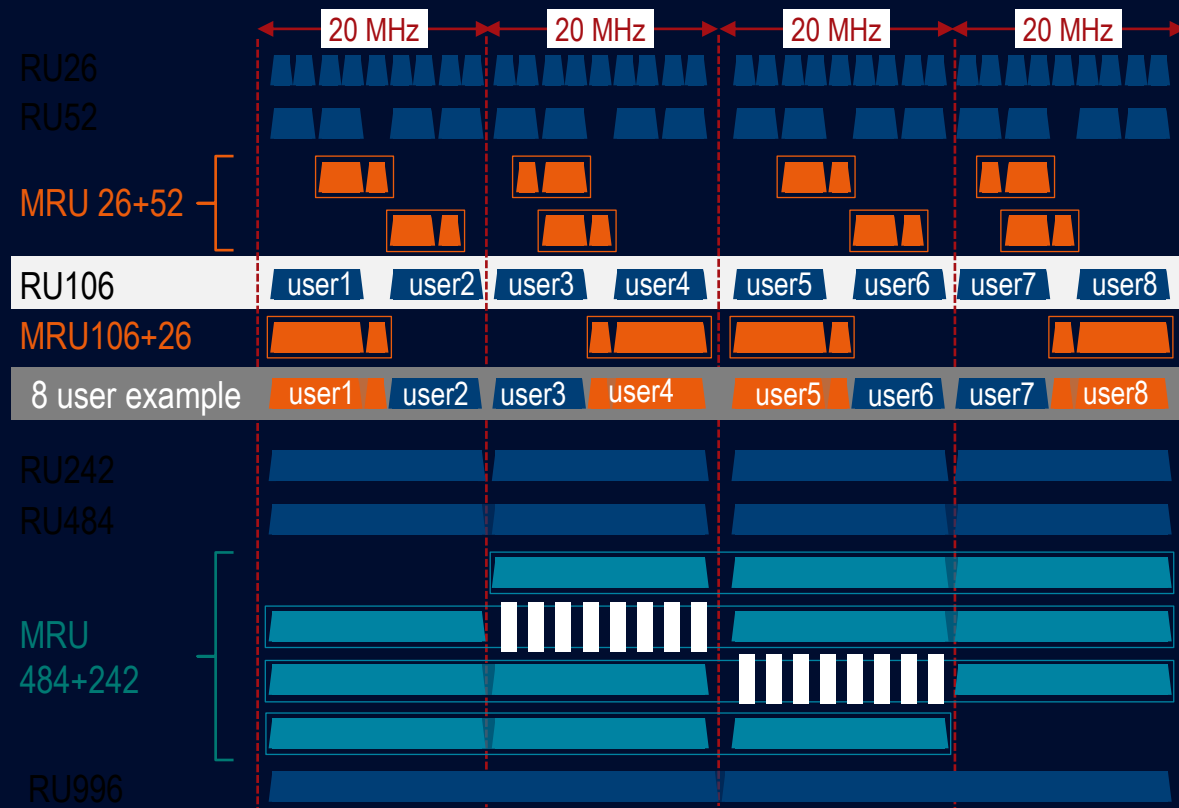


MCS10/11 - 1024QAM

Coming

MCS14/15 - BPSK-DCM

# Multiple Resource Units (MRU) per user for efficiency

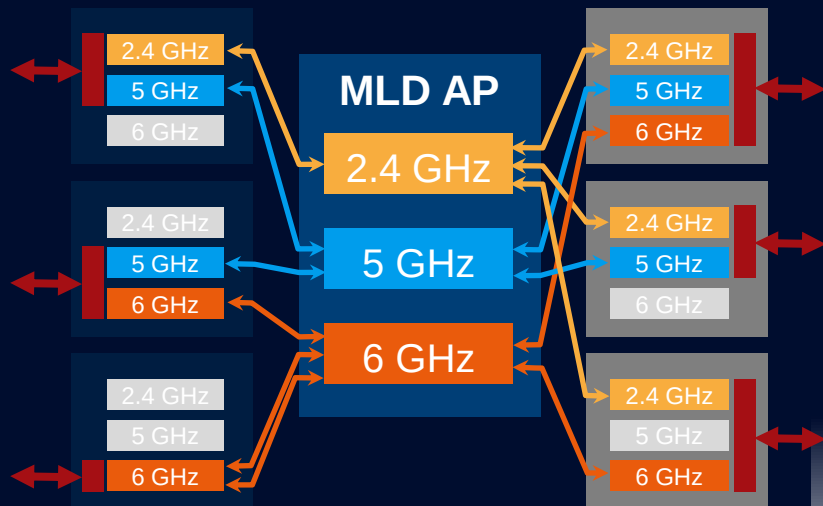


A **small size MRU** (i.e. 26, 52, 106 tone) can only be combined for **efficiency** with another small size RU to form an MRU. RUs in the MRU need to be contiguous and within a 20 MHz channel boundary

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.



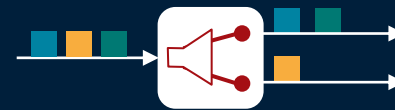
# WI-FI 7 WILL ALLOW MULTI-LINK OPERATION



Band steering



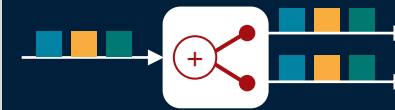
Traffic aggregation



Load balancing



Traffic duplication



# WHAT IS MULTI LINK OPERATION (MLO)?

- ▶ Multi-Link Devices (MLD) allow
  - **concurrent data** transmission and reception
  - in **multiple channels**
  - across a **single or multiple** frequency **bands**
- ▶ MLO helps to achieve
  - Higher throughput (bandwidth aggregation)
  - Lower latency (link switching)
  - Enhanced reliability (interference mitigation)

# MULTI LINK OPERATION (MLO) MODES FOR MLD

## Single-Radio Modes (MLSR = Multi Link Single Radio)

- ▶ **MLSR**  
Multi-Link Single Radio
  - allows the device to transmit/receive over one link at a time
  - Similar as SLO but association on both links
  
- ▶ **eMLSR**  
enhanced Multi-Link Single Radio
  - additional capability to listen on two links simultaneously
  - Dynamic switching of multi-link radio to a link for transmission/reception

## Multi-Radio Modes (MLMR = Multi Link Multi Radio)

- ▶ **STR MLMR**  
Simultaneous Transmit and Receive Multi-Link Multi Radio
  - Links are statically assigned and operate independently (Tx/Tx, Rx/Rx, or Tx/Rx)
  - Sufficient isolation required to avoid in device coex. interference
  
- ▶ **NSTR MLMR**  
Non-Simultaneous Transmit and Receive Multi-Link Multi Radio
  - Links are statically assigned but coordination required
  - Synchronous transmission or reception (Tx/Tx and Rx/Rx)
  
- ▶ **eMLMR – enhanced Multi-Link Multi Radio**
  - Most advanced configuration offering to dynamically reconfigure links

# MLO ASSOCIATION ON MLD (AP)

The screenshot displays the 'Network square' software interface. The 'Topology' tab is active, showing a 'WLAN Area' with two access points, 'WLAN AP 0' and 'WLAN AP 1'. Both are configured with 802.11be, 80 MHz bandwidth, and 5210 MHz / 5530 MHz frequencies. The 'MLD-AP 0' label is highlighted in red for both. The interface includes a 'Live Mode' button and options for 'Baseband Combining...', 'Reset DUT State', 'Edit', and 'Delete'. A mobile phone overlay on the right shows the status for 'Pixel8 MIMO Slot 5', with 'NR' and 'LTE' set to 'Idle', 'WLAN' set to 'Associated' (highlighted in red), and 'IMS-State' as 'Deregistered'.

Network square

Topology

✓ Live Mode Baseband Combining... Reset DUT State Edit Delete

WLAN Area

WLAN AP 0  
00:01:02:03:04:05  
802.11be ON  
BW: 80 MHz  
Ant1: 2.72 dBm  
Ant2: ~ dBm  
Freq: 5210 MHz  
CH: 42  
MLD-AP 0

WLAN AP 1  
00:01:02:03:04:06  
802.11be ON  
BW: 80 MHz  
Ant1: -44.48 dBm  
Ant2: ~ dBm  
Freq: 5530 MHz  
CH: 106  
MLD-AP 0

Measurement and Generator square

Pixel8 MIMO Slot 5

NR  
Idle

LTE  
Idle

WLAN  
Associated

IMS-State  
Deregistered

A nighttime photograph of a cable-stayed bridge with a large, illuminated stadium in the background. The scene is dark, with streetlights and stadium lights providing illumination. The text "Thank you very much" is overlaid in white.

Thank you  
very much



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