HEAD acoustics

APPLICATION NOTE

ACQUA

Establish NR (5G) / LTE (4G) connection to *lab*CORE via R&S®CMX500 OBT

Application Note

Establish NR (5G) / LTE (4G) connection to *lab*CORE via R&S®CMX500 OBT

Revision 3

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1 Introduction

1.1 Brief description

The application note describes the procedure to generate a NR (5G) / LTE (4G) network with Rohde & Schwarz Radio Communication Tester R&S®CMX500 and establish a voice call (VoNR / VoLTE) from the radio tester to a device under test in the NR (5G) / LTE (4G) network. HEAD acoustics' hardware platform *lab*CORE taps into the exchanged audio signals and forwards them to the ACQUA analysis software.

The procedure requires advanced knowledge of operating HEAD acoustics equipment, R&S®CMX500, and R&S®CMsquares. HEAD acoustics will not respond to support requests concerning general handling and technical configuration of Rohde & Schwarz equipment. In such cases, please refer to the documentation or customer support of Rohde & Schwarz at customersupport@rohde-schwarz.com.

All screenshots are exemplary and may differ from customer experience.

1.2 Reference documentation

Document name
*lab*CORE Manual
HMS II Series Manual
ACQUA Online Help
R&S®CMX500 Radio Communication Tester User Manual

1.3 Acronyms and abbreviations

Acronym / abbreviation	**Description**
ACQUA	Advanced Communication Quality Analysis
AMR	Adaptive multi-rate
AMR-WB	Adaptive multi-rate wideband
dB	Decibel
dBm	Decibel-milliwatts
DUT	Device under test
EVS	Enhanced voice services
GBit	Gigabit
IMS	IP Multimedia Subsystem
IP	Internet Protocol
LTE	Long Term Evolution
ms	Millisecond
NR	New Radio
NSA	Non-Standalone
OBT	One-box signaling tester
RF	Radio frequency
RTP	Real-time protocol
SA	Standalone
SIM	Subscriber identity module
VoIP	Voice over Internet Protocol
VoNR	Voice over New Radio

1.4 Applied interfaces at *lab*CORE | R&S®CMX500

1.4.1 *lab*CORE interfaces

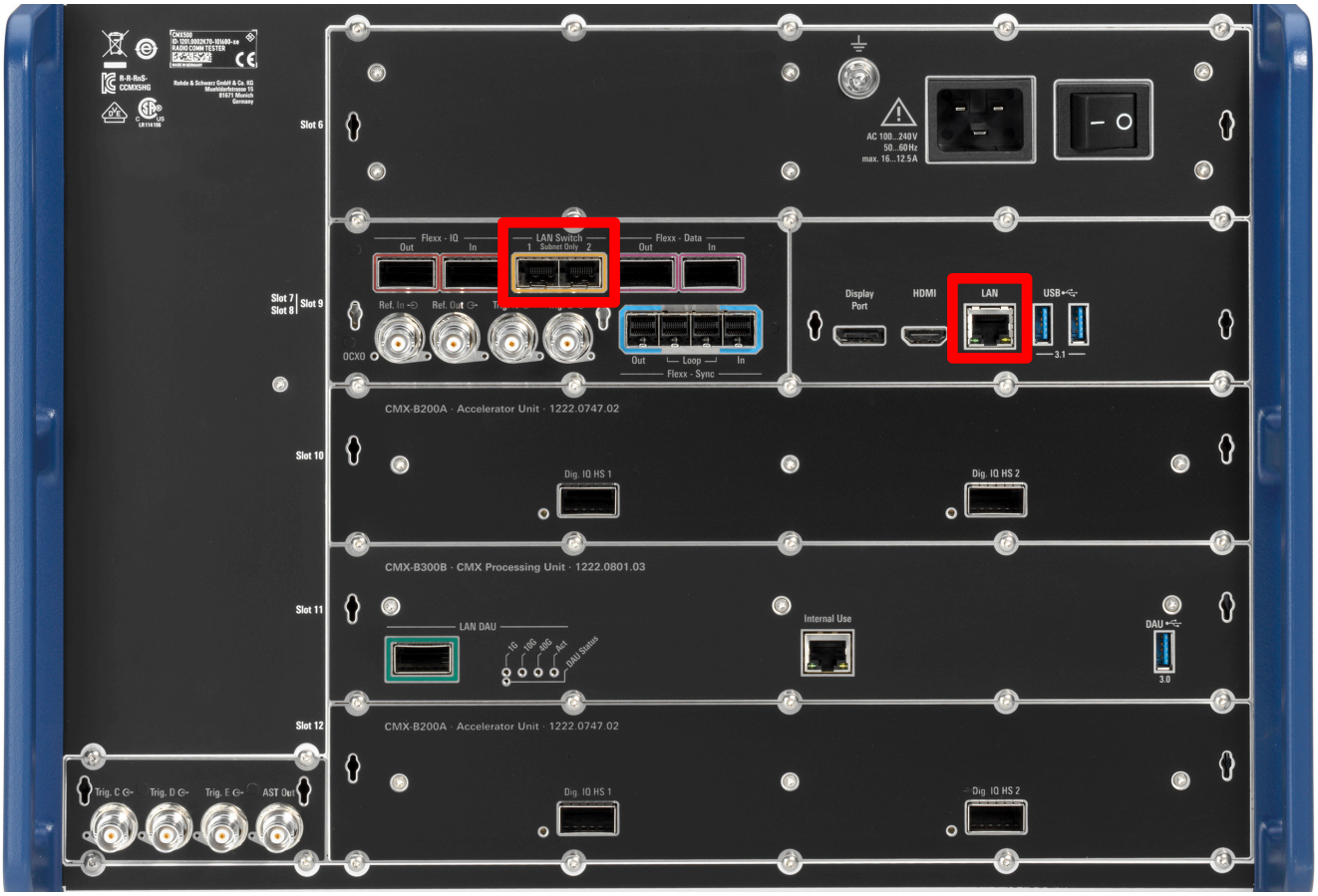
Ethernet interface (RJ45) for measuring IP-based communication.

1.4.2 R&S®CMX500 interfaces

Front panel

RF Com 1 socket for connection to antenna.

Back panel



- LAN Switch 1, QSFP socket for connection to *lab*CORE.
- LAN, Ethernet (RJ45) socket for connection to PC / Network

1.5 Equipment list

1.5.1 HEAD acoustics equipment

Required

- *lab*CORE (Code 7700), Modular multi-channel hardware platform
  - *core*BUS (Code 7710), I/O bus mainboard
  - *core*OUT-Amp2 (Code 7720), Power amplifier board
  - *core*IN-Mic4 (Code 7730), Microphone input board
  - *core*IP (Code 7770), VoIP software extension with at least one of the following voice codecs according to the technical specifications of the device under test
    - ► *core*IP-AMR (Code 7772), AMR extension
    - ► *core*IP-EVS (Code 7773), EVS extension
- ACQUA (Code 6810), Advanced Communication Quality Analysis software
- HMS II, nne of the listed versions
  - HMS II.3 (Code 1703), HEAD measurement system, basic version
  - HMS II.3 LN (Code 1703.1), HEAD measurement system, low-noise version
  - HMS II.3 LN HEC (Code 1703.2), HEAD measurement system, low-noise version with human-like ear canal simulator
  - HMS II.6 (Code 1706), HEAD measurement system, version with free-field microphones
  - HMS II.7 (Code 1707), HEAD measurement system, version with free-field ICP® microphones

Optional

- *lab*CORE extensions depending on device under test and/or application case
  - *core*USB-DR (Code 7705), USB device reference
  - *core*BEQ (Code 7741), Binaural equalization
  - *core*IP-IMP (Code 7771), VoIP impairment extension
- Any HEAD acoustics handset positioner
  - HHP III.1 (Code 1403), Handset positioner
  - HHP IV (Code 1406), Motorized handset positioner

1.5.2 Rohde & Schwarz equipment

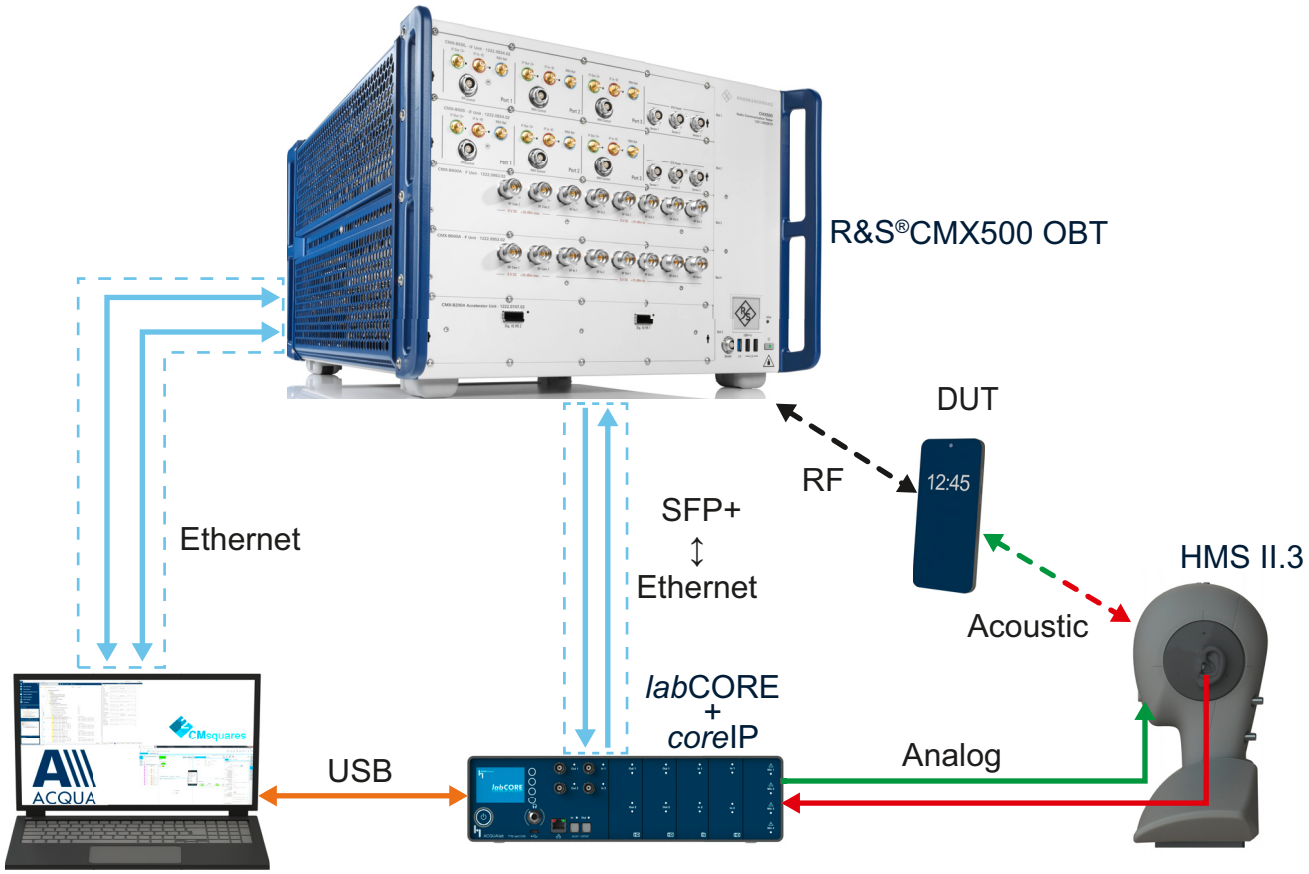
R&S®CMX500 Radio Communication Tester

- CMX500 Basic Assembly (R&S CMX-PB70H) incl. SFP+ 1Gbps adapter
- Accelerator Unit (CMX-B200A)
- Processing Unit (CMX-B300B)
- CMX RF Unit (CMX-B600A)
- CMX Application test feature set 1 (SL) (R&S CMXKA100)
- CMX 5G NR R15 SA FDD&TDD Basic Signaling Feature Set 1 (CMX-KS601B)
- CMX 5G NR R15 NSA+LTE FDD&TDD Basic Signaling Feature Set 1 (CMX-KS600B)

1.5.3 Third party equipment

- RF cable + RF antenna
- PC for running ACQUA software & browser to open web interface R&S®CMsquares
- DUT
- Test SIM card (e.g., R&S®CMX-Z01)
- Ethernet cable (RJ45)
- Mouse and keyboard (optional) for direct control of R&S®CMX500 OBT

1.6 Configuration overview

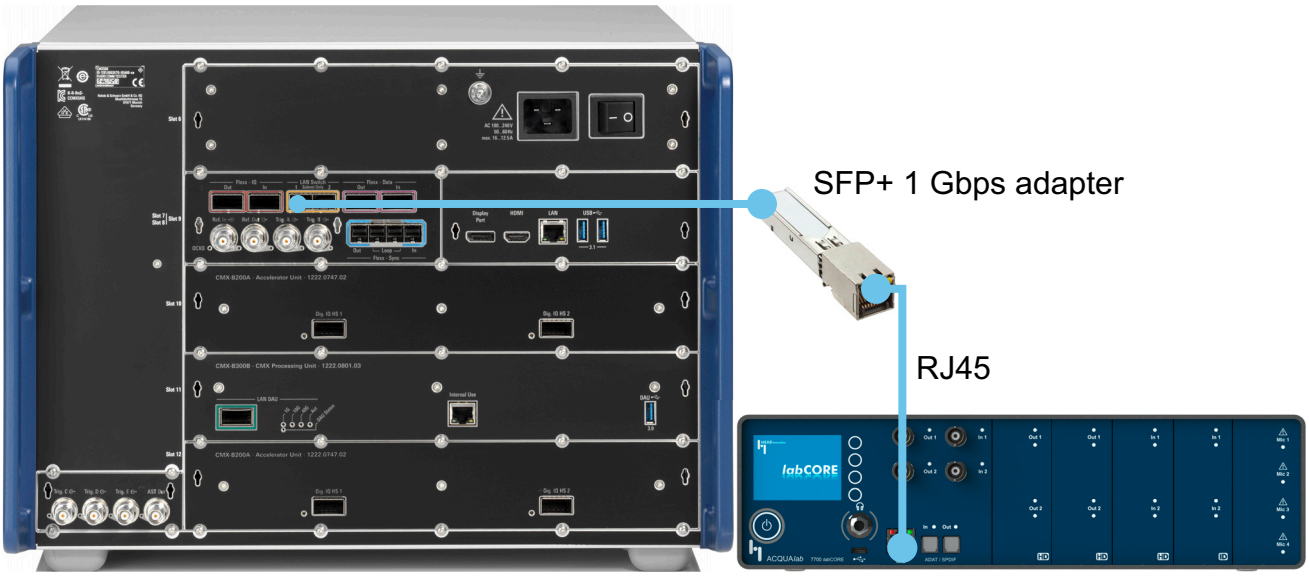


1.7 Cabling

1.7.1 Antenna

Attach the antenna to one of the provided RF COM connectors at R&S®CMX500.

1.7.2 R&S®CMX500 to *lab*CORE



- Connect SFP+ 1 Gbps adapter to LAN switch 1 at R&S®CMX500.
- Connect SFP+ 1 Gbps adapter to the Ethernet socket at the front of *lab*CORE via RJ45 cable.

1.8 R&S®CMX500 forwarding delays

1.8.1 4G delays

The 4G forwarding delays of R&S®CMX500 are determined and provided by Rohde & Schwarz.

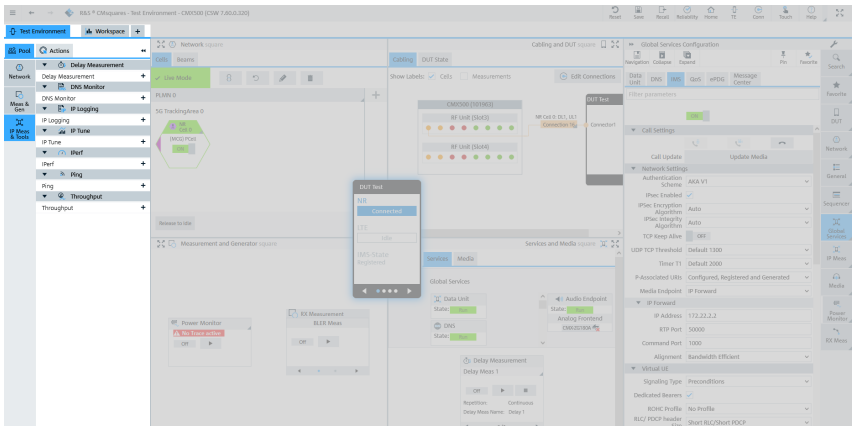
Rohde & Schwarz accounts for the accuracy of these values.

Network type	Uplink	Downlink
LTE (4G)	5 ms	7 ms

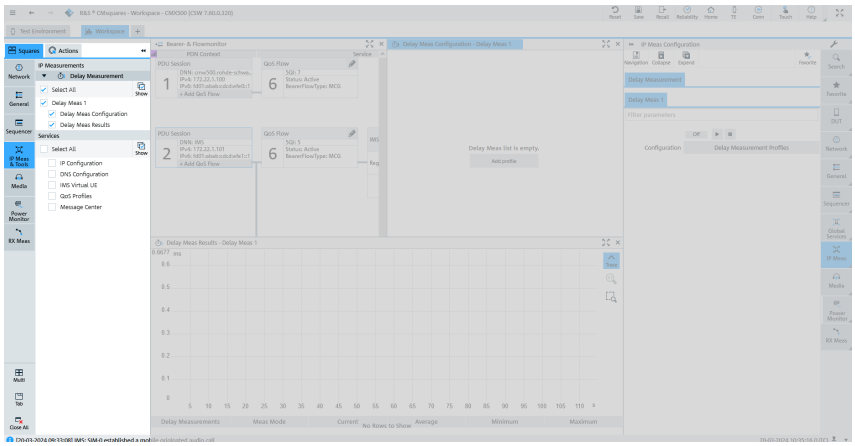
1.8.2 5G delays

R&S®CMX500 provides the functionality to determine the forwarding delays of a live call.

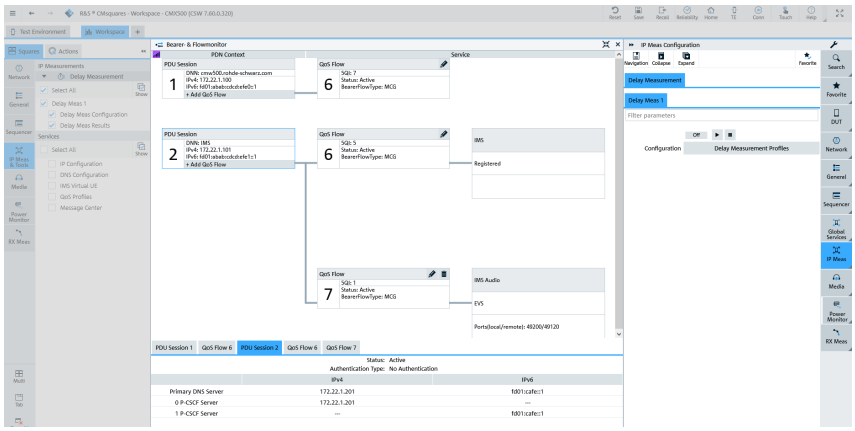
1. Establish a connection and a call according to the procedure in chapter 2.
2. Select the tab **Test Environment**.
3. Select the tab **Pool**.
4. Select **IP Meas & Tools** at the left toolbar.
5. Select **+** to expand **Delay Measurement**.



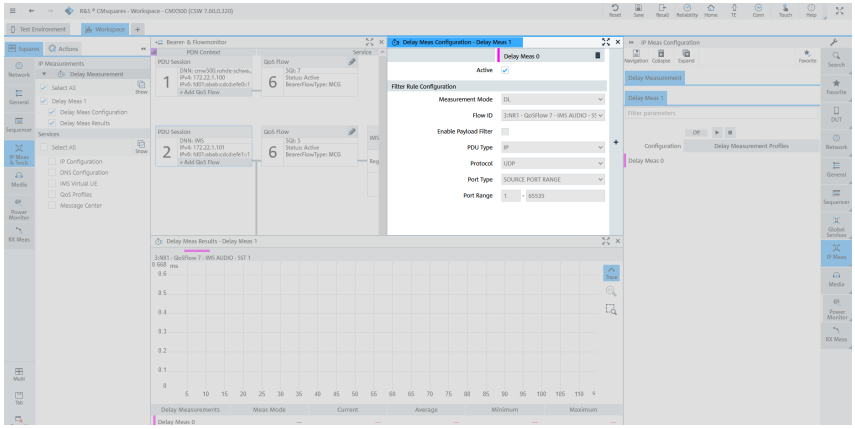
6. Enable **Select All** in **Delay Measurement** to show the necessary windows on screen.



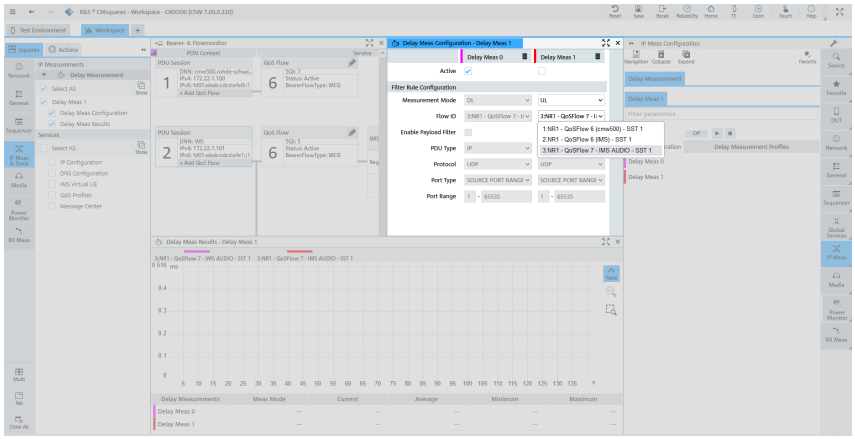
7. Maximize the **Bearer- & Flowmonitor.**
8. Identify the **Flow ID** of **IMS Audio** in the **Bearer- & Flowmonitor**.
9. Minimize the **Bearer- & Flowmonitor.**
10. Select **IP Meas** at the right toolbar.



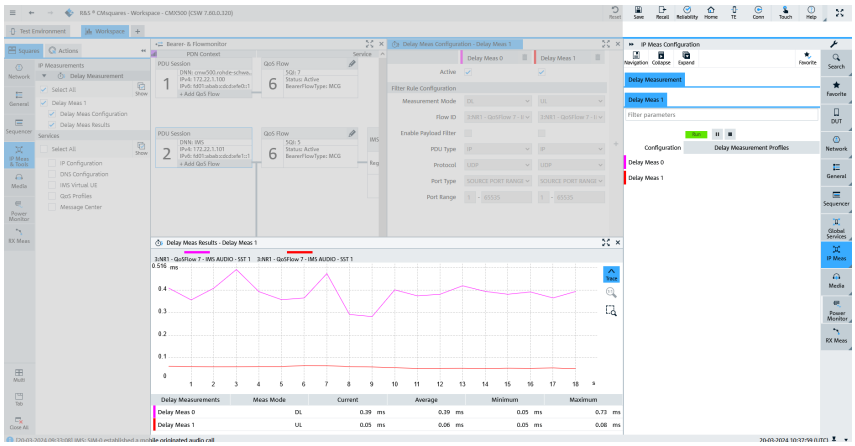
11. Go to **Delay Meas Configuration**.
12. Set **DL** (downlink) as **Measurement Mode**.
13. Set **IMS Audio** as **Flow ID**.
14. Enable **Delay Meas 0**.
15. Select **+** to add another delay measurement.



16. Set **UL** (uplink) as **Measurement Mode**.
17. Set **IMS Audio** as **Flow ID**.
18. Enable **Delay Meas 1**.



19. Got to **Delay Measurement**.
20. Select ▶ to start the delay measurement.
21. CMsquares displays the live delay values (uplink and downlink) in **Delay Meas Results**.



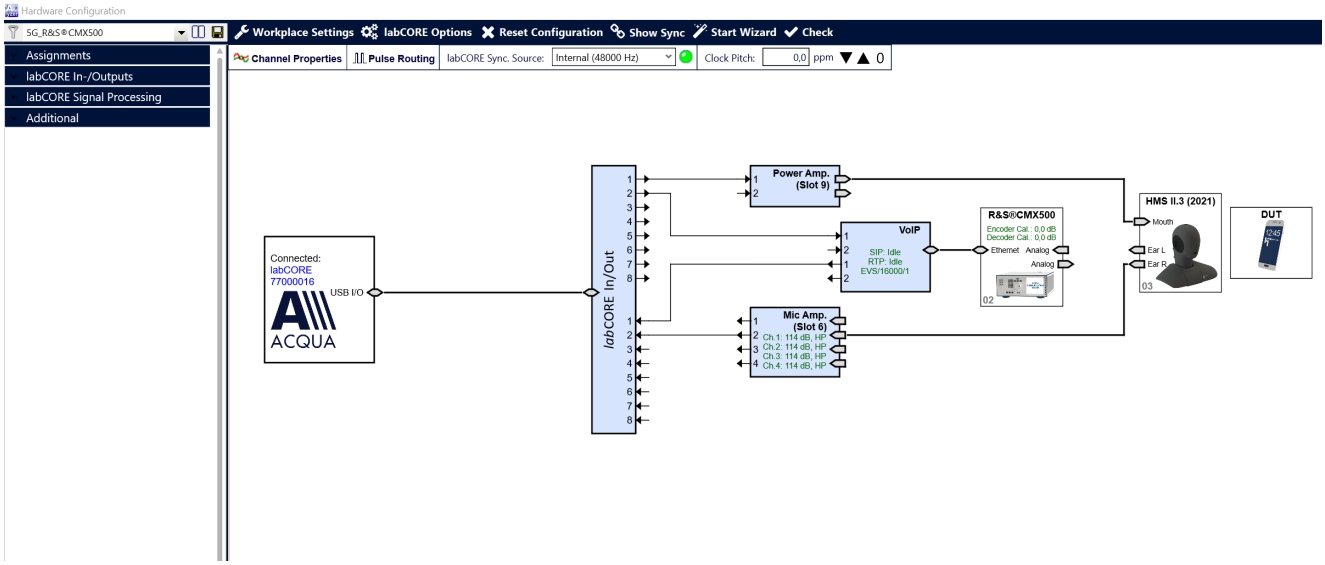
2 Connection establishment

2.1 Preparations

- Interconnect the hardware according to chapter 1.6 and chapter 1.7
- Boot up R&S®CMX500.
- Boot up ACQUA PC.
- Start ACQUA.
- Boot up *lab*CORE.
- Insert test SIM card into the device under test and boot it.
- Set the device under test offline / to Airplane mode.

2.2 Hardware configuration

ACQUA



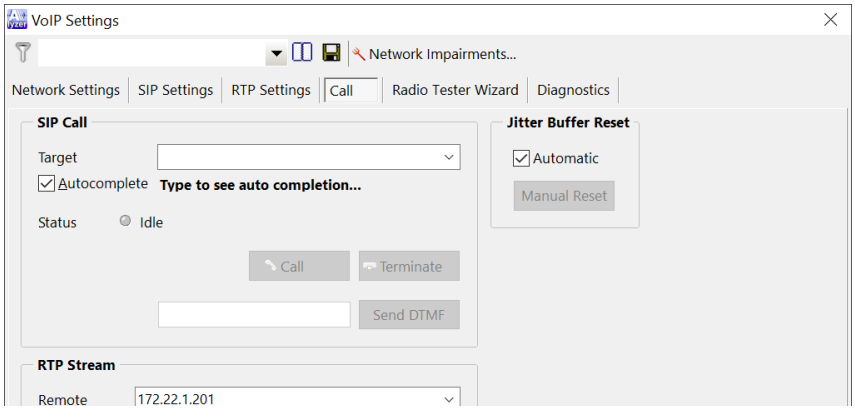
1. Go to **Hardware Configuration**.
2. Drag and drop the blocks from the left selection area into the right configuration area. Interconnect the blocks according to the applied connections.

   Alternatively, use the **Hardware Configuration Wizard**.

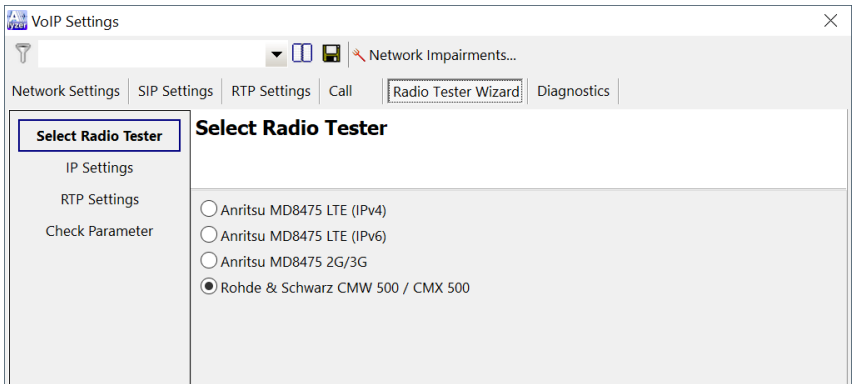
2.3 VoIP configuration

ACQUA

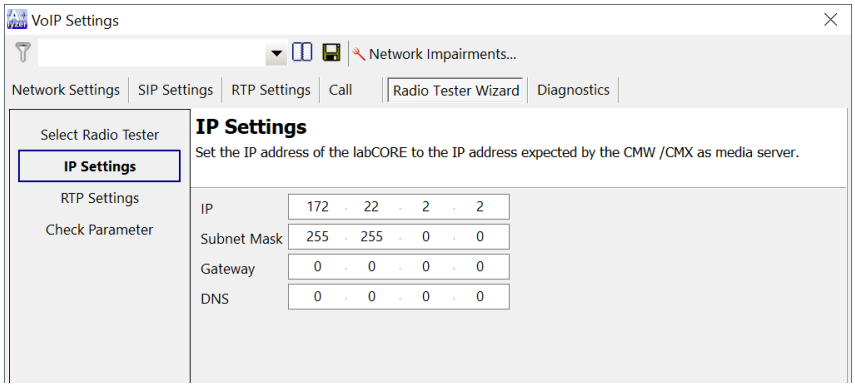
1. Open **VoIP Settings**.
2. Go to the tab **Call**.
3. Enable **Automatic** in the section **Jitter Buffer Reset**.



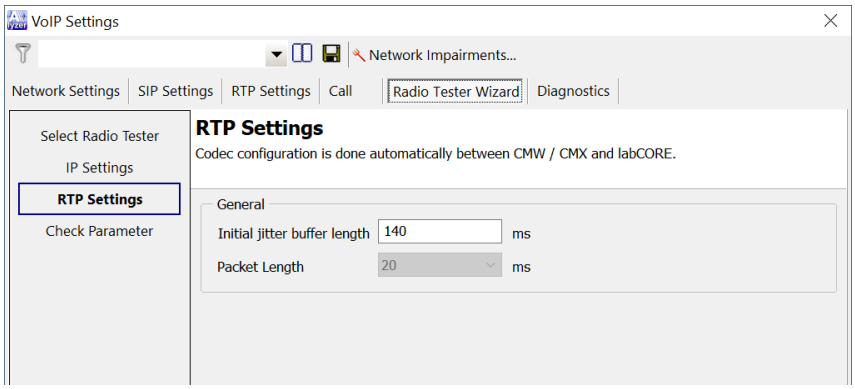
4. Go to the tab **Radio Tester Wizard**.
5. Select **Rohde & Schwarz CMX 500**.
6. Select **Next**.



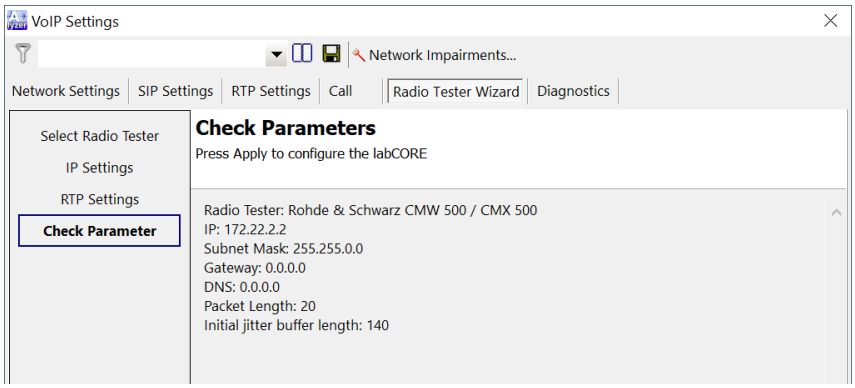
7. Specify the IP address of *lab*CORE. It is recommended to leave the default IP address.
8. Select **Next**.



9. Set the desired value for **Initial jitter buffer length**.
10. Select **Next**.



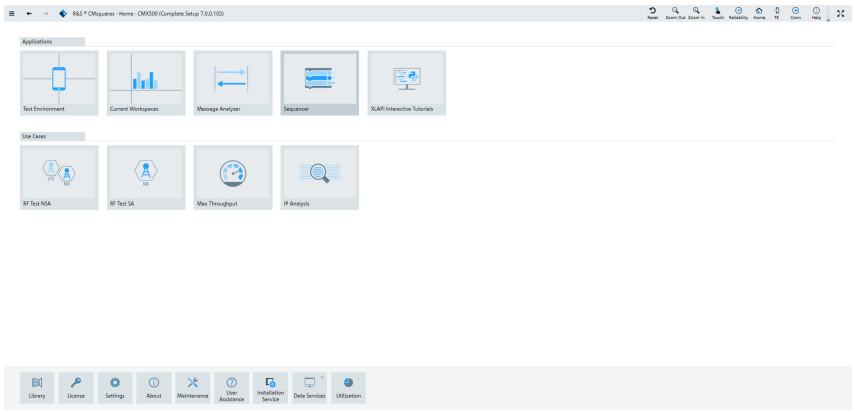
11. Check and confirm the parameters.
12. Select **Apply** to activate the parameters.



2.4 Network configuration

R&S®CMsquares

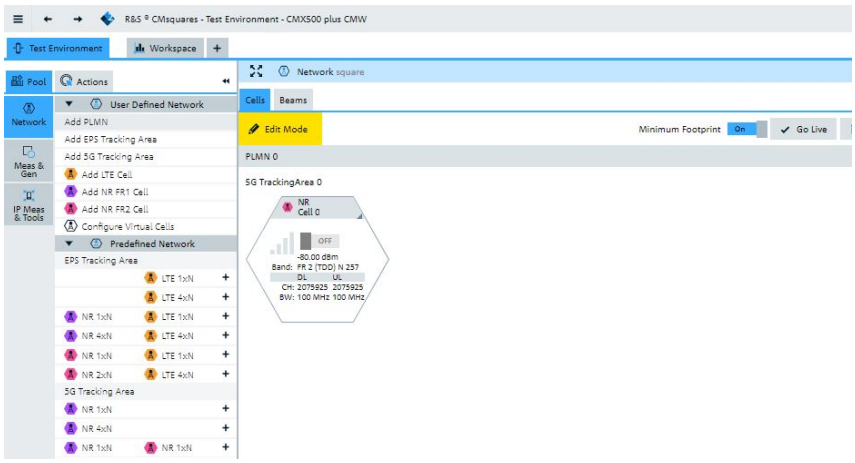
1. Open the web browser on a PC that is in the same network as R&S®CMX500.
2. Find the IP address of R&S®CMX500 at its front display. Enter the IP address of R&S®CMX500 in the URL field of the web browser.
3. The general user interface of CMsquares opens.
4. Select the square **Test Environment**.



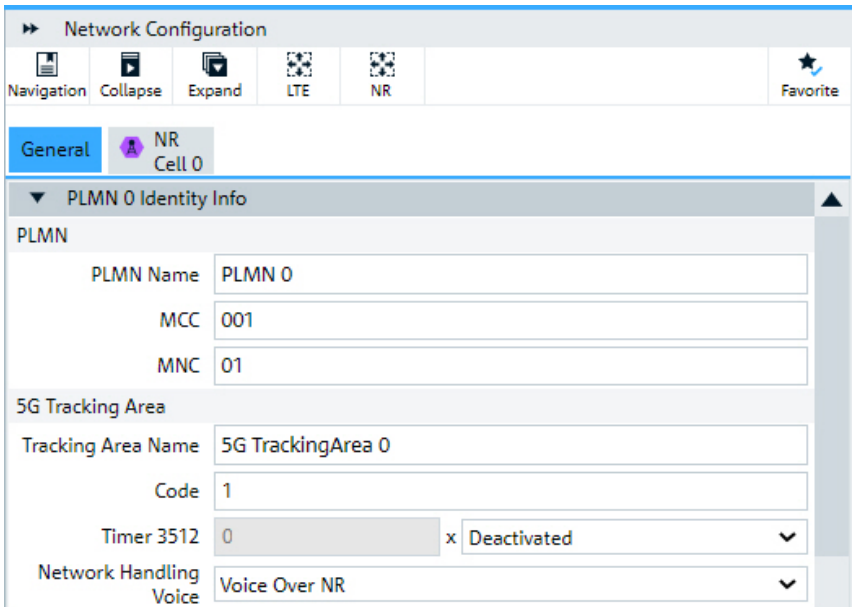
5. Select **Pool** → **Network** at the left toolbar.
6. Create and add customized NR (5G) / LTE (4G) network with a NR (5G) / LTE (4G) tracking area.

   or

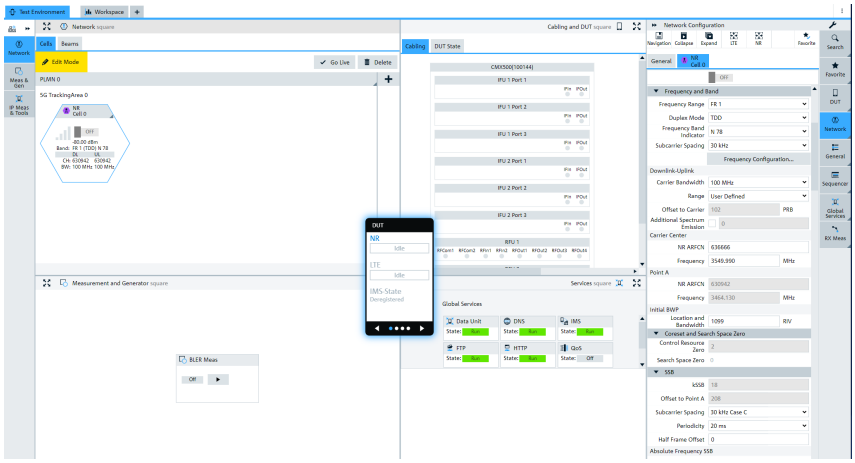
   Add predefined network (e.g, NR 4x4 Standalone) to the **Network** square by selecting + or drag & drop.



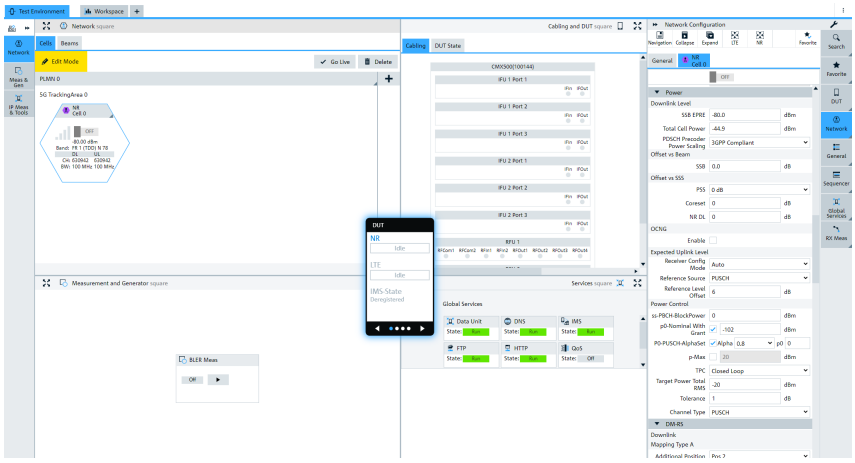
7. Select **Network** at the right toolbar.
8. Select the tab **General**.
9. Set **PLMN 0 Identity Info** according to the applied SIM card.



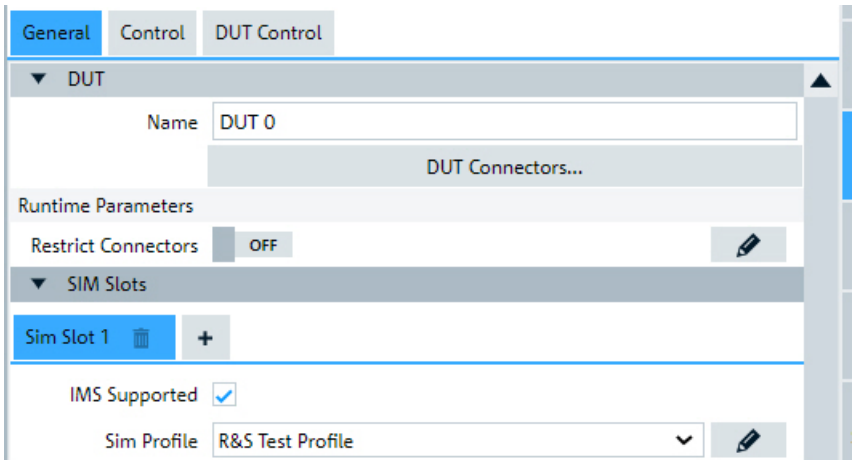
10. Select the tab **Cell**.
11. Set **Frequency Range** according to the test scenario (**FR 1** for ≤ 8 GHz; **FR2** up to 50 GHz).
12. Set **Duplex Mode** according to the test scenario (e.g., **TDD**).
13. Set **Frequency Band Indicator** according to DUT.



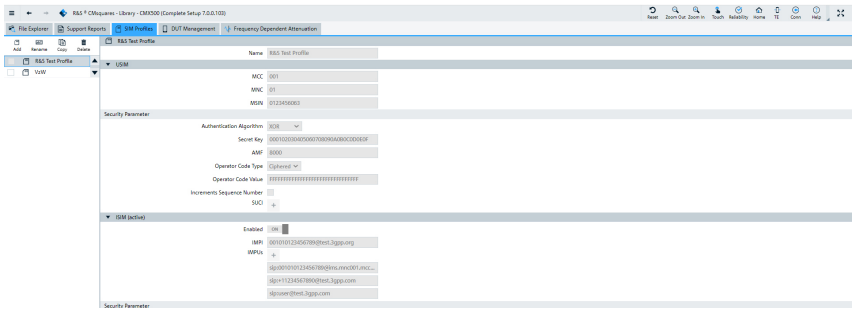
14. Set the **Power** parameters according to the applied equipment.



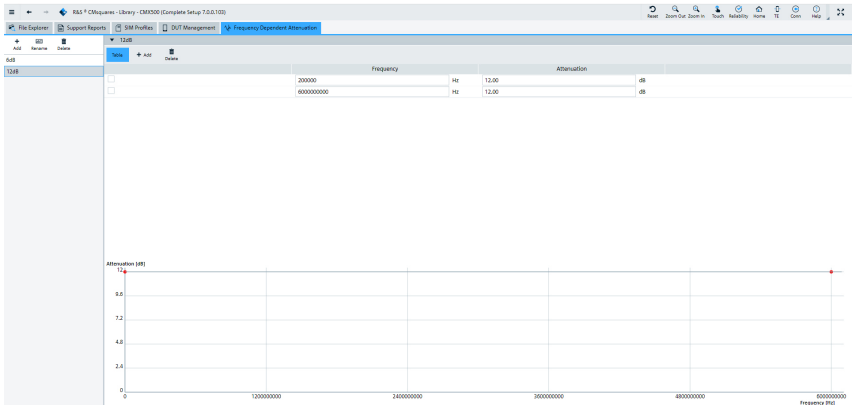
15. Select **DUT** at the right toolbar.
16. Select the tab **General**.
17. Select predefined SIM profile e.g.
    - R&S Test Profile
      or
    - R&S Test Profile Millenage (CMX-Z01)
      or



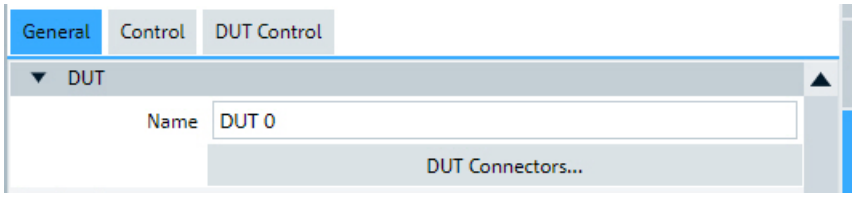
- Select to create a profile according to customized SIM settings.



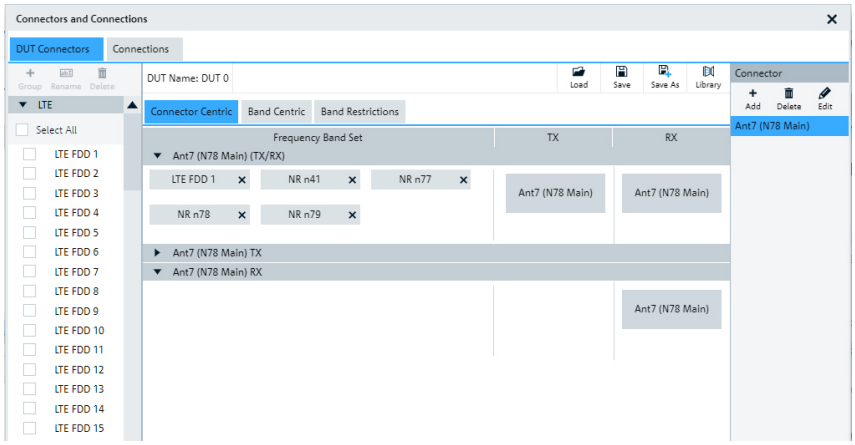
18. Go to the tab **Frequency Dependent Attenuation**.
19. Specify the attenuation for the desired frequency range.



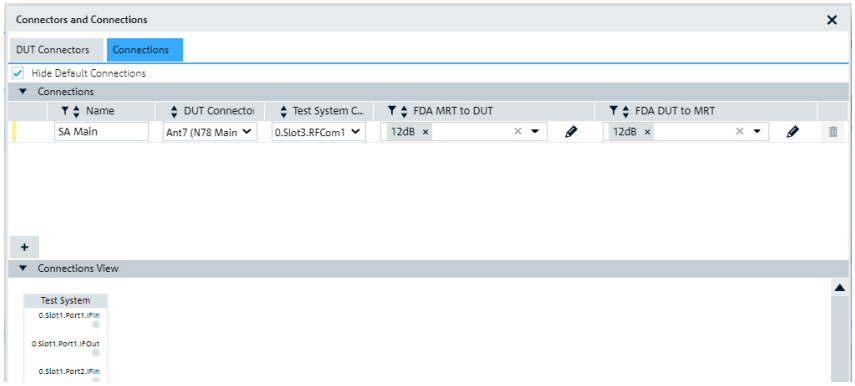
20. Go back to **Dut** → **General**.
21. Select the tab **DUT Connectors**.



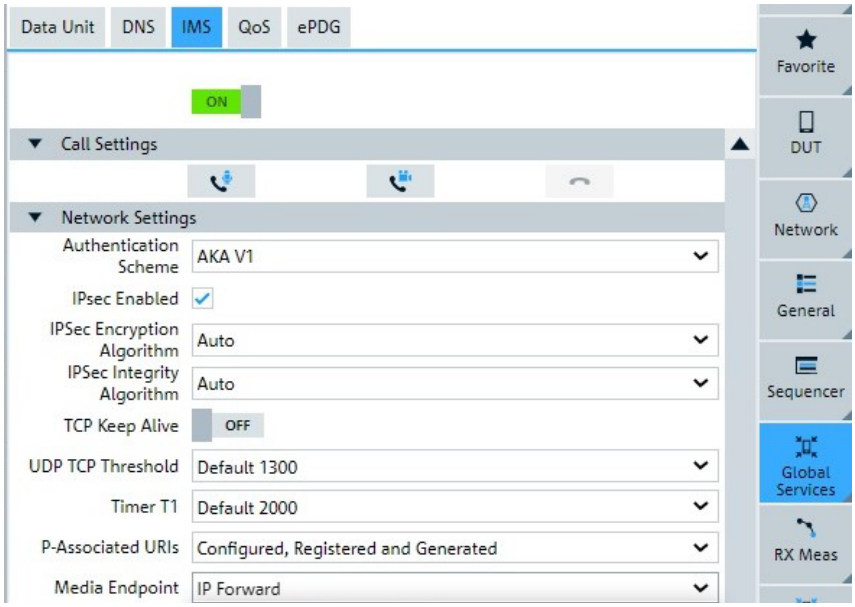
22. Select **Add** to specify the applied antenna.
23. Apply the frequency bands for the antenna according to the capabilities of the applied DUT.



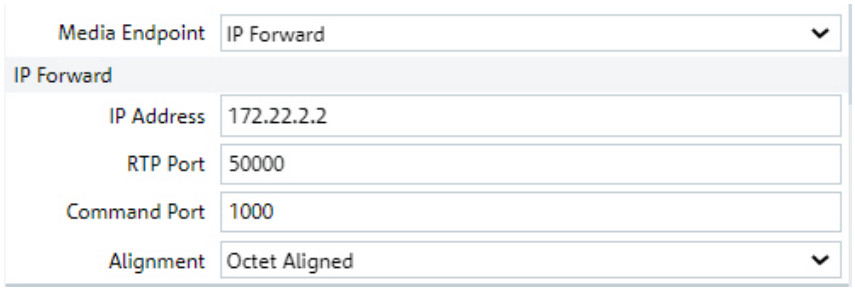
24. Go to the tab **Connections**.
25. Select to edit the attenuation of the antenna.
26. Close **Connectors and Connections**.



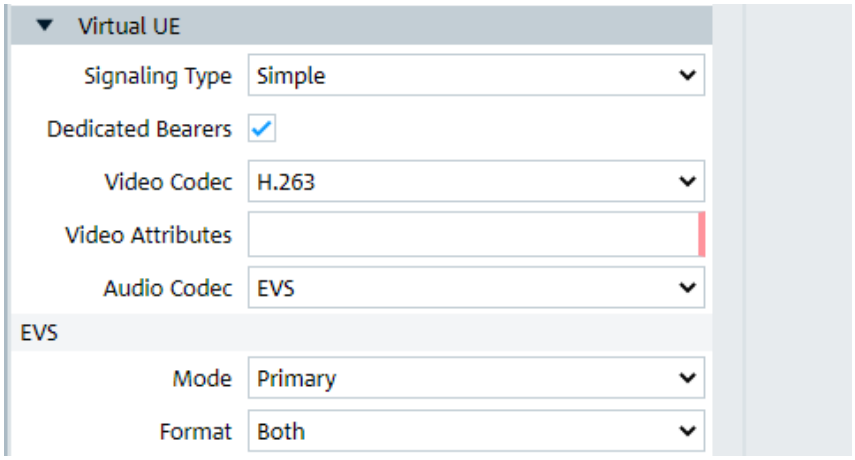
27. Select **Global Services** at the right toolbar.
28. Go to the tab **IMS**.
29. Switch **ON** (if necessary).
30. Go to **Network Settings**.
31. Set **Authentication Scheme** according to DUT.



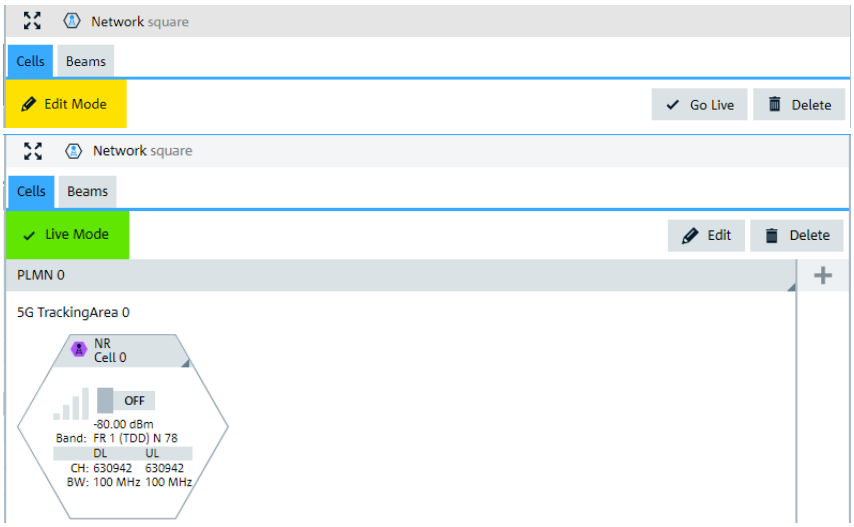
32. Set **Media Endpoint** to **IP Forward**.
33. Go to **IP Forward**.
34. Set **IP Address** to **172.22.2.2**.
35. Set **RTP Port** to **50000**.
36. Set **Command Port** to **1000**.



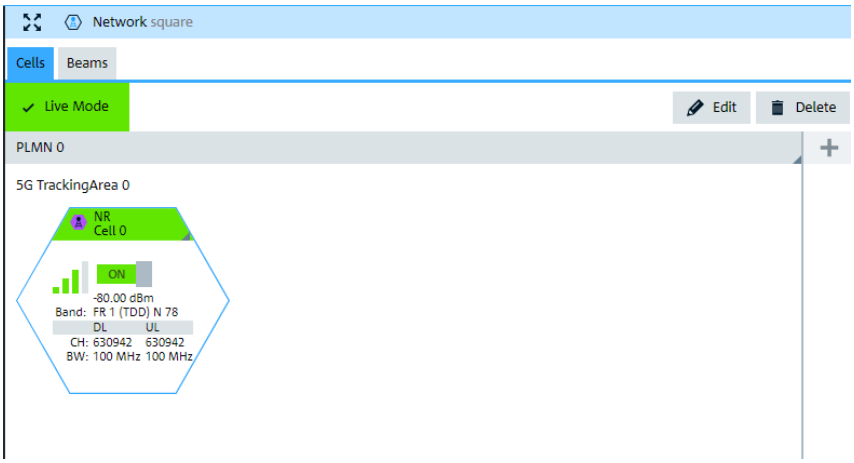
37. Go to **Virtual UE**.
38. Set the desired **Audio Codec** and its parameters.



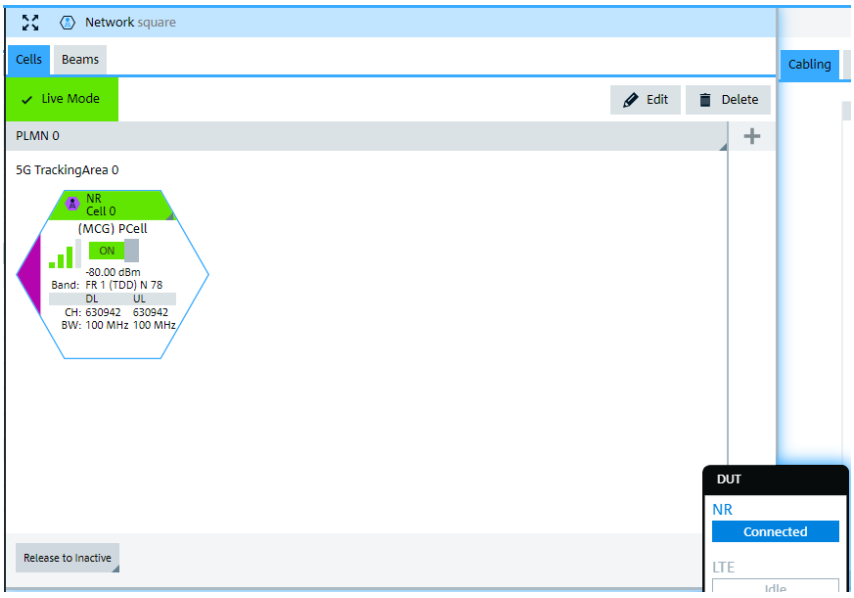
39. Go to **Network** square.
40. Select **Go Live**.



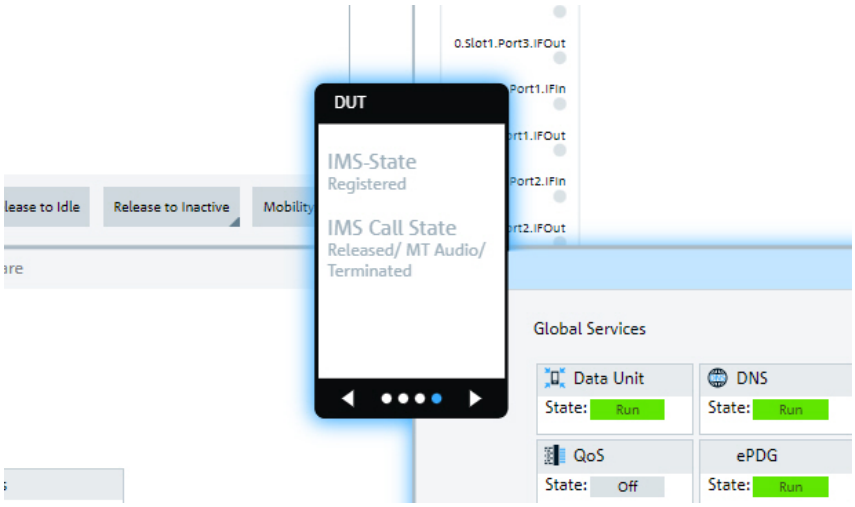
41. Go to **Network square**.
42. Switch cell **ON**.



43. Set DUT online.
44. The DUT connects to the network. A purple triangle in the corner of the NR cell hexagon indicates the successful connection.



45. The DUT registers at the IMS. Confirm the successful registration in the **DUT** or via **Cabling and DUT square → DUT state**.



2.5 Call establishment

R&S®CMsquares

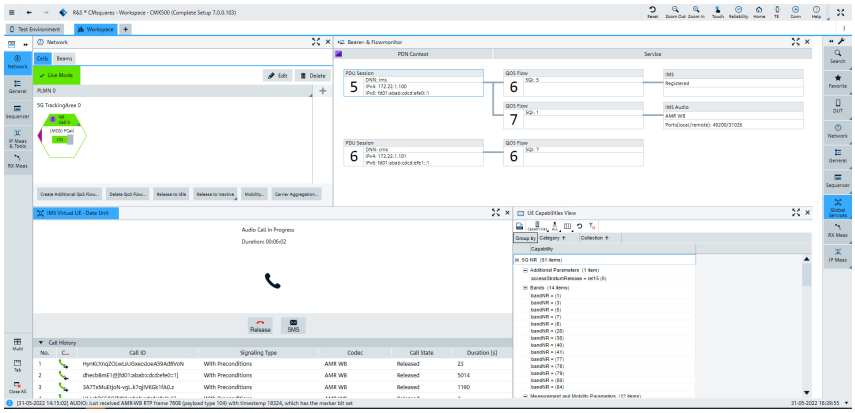
- Initiate a call
  - Call R&S®CMX500 from the DUT by dialing any number.

    or

  - Call the DUT from R&S®CMX500 by starting an **Audio Call** in **IMS Services → Call settings**.

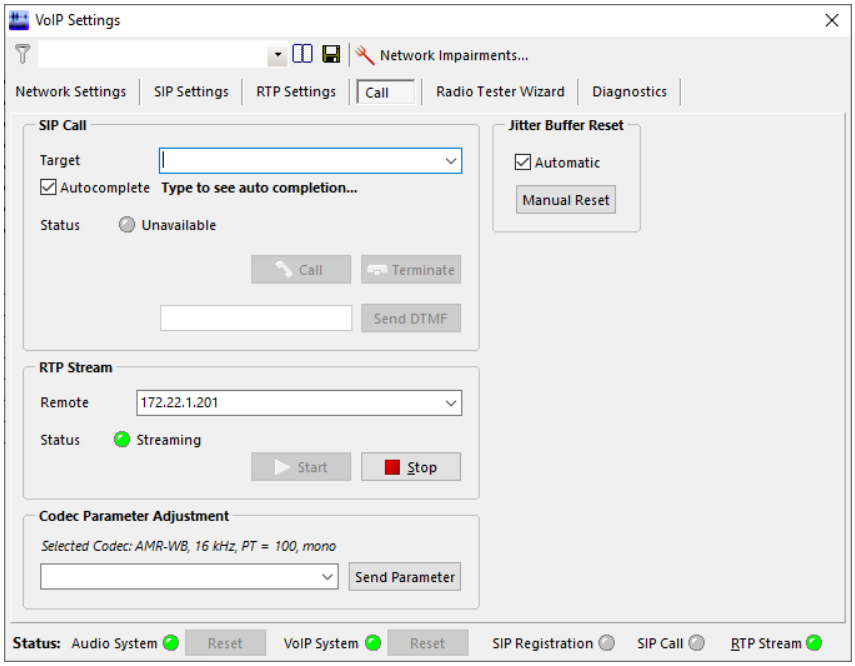
    or

  - Call the DUT from R&S®CMX500 by opening **IMS Virtual UE - Data Unit** and selecting the button **Audio**.



ACQUA

1. Open **Hardware Configuration** in ACQUA.
2. Open **VoIP Settings**.
3. Select the tab **Call**.
4. Confirm automatically established RTP stream.



2.6 Workspace customization

R&S®CMsquares

Customize the workspace as desired with various squares.

Recommended square arrangement:

Network

Monitor the network status

Bearer- & Flowmonitor

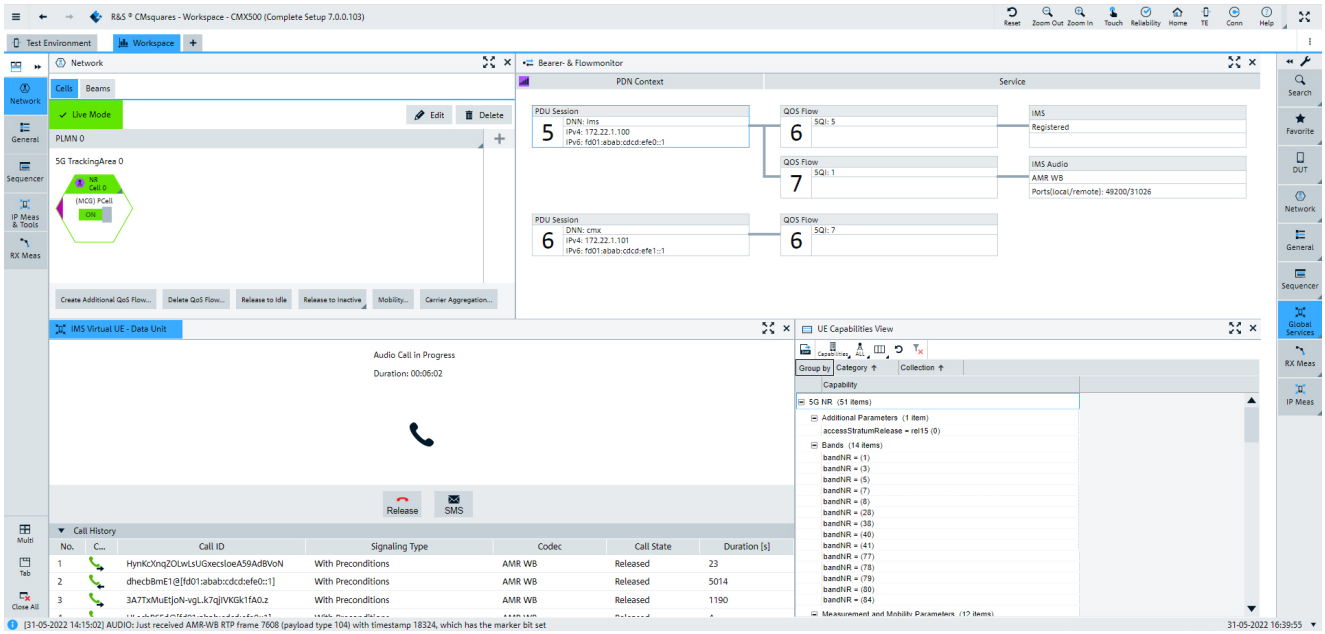
Monitor the bearer and the signal flow.

IMS Virtual UE - Data Unit

Initiate / terminate calls and view the call history.

UE Capabilities view

View the capabilities (e.g., available frequency bands) of the registered DUT.

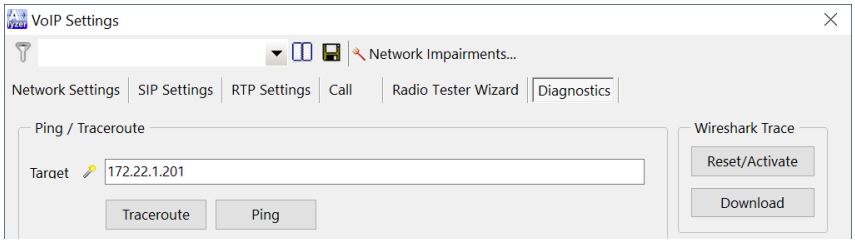


3 Troubleshooting

3.1 Troubleshooting via ACQUA

3.1.1 Diagnostics tab

1. Open **VoIP Settings**.
2. Go to the tab **Diagnostics**.



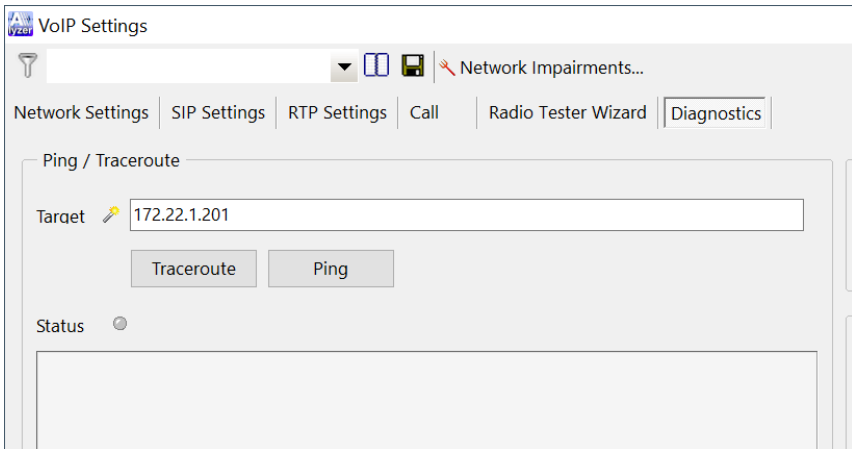
3.1.2 Ping / Traceroute

Ping

1. Enter the target IP address.
   or
   Select for provided IP addresses.
2. Select **Ping**.

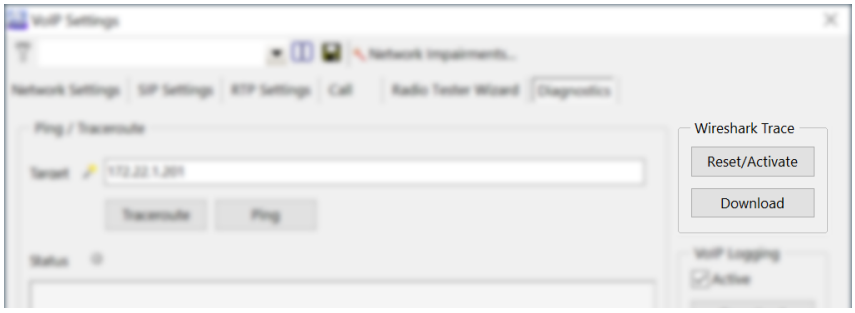
Traceroute

1. Enter the target IP address.
   or
   Select for provided IP addresses.
2. Select **Traceroute**.



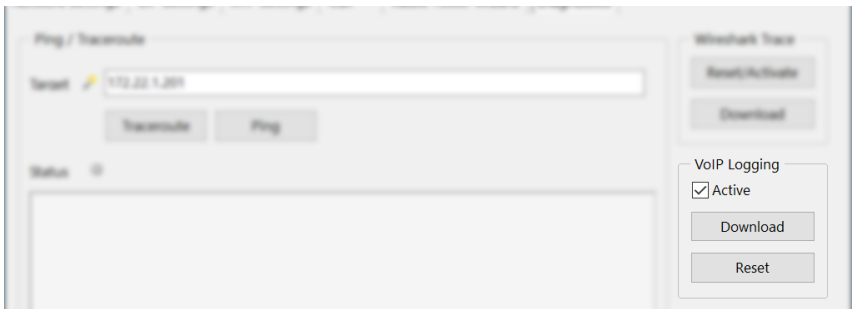
3.2 Wireshark Trace

- Select **Reset/Activate** to reset and start the Wireshark trace.
- Select **Download** to save the data of the Wireshark trace as packet capture file (*.pcap).
- Opening packet capture files requires the installation of Wireshark.



3.3 VoIP Logging

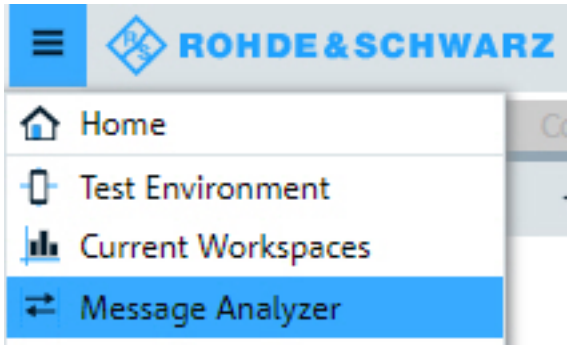
- Enable **Active** to activate VoIP logging.
- Select **Download** to save the log as text file.
- Select **Reset** to reset VoIP logging.



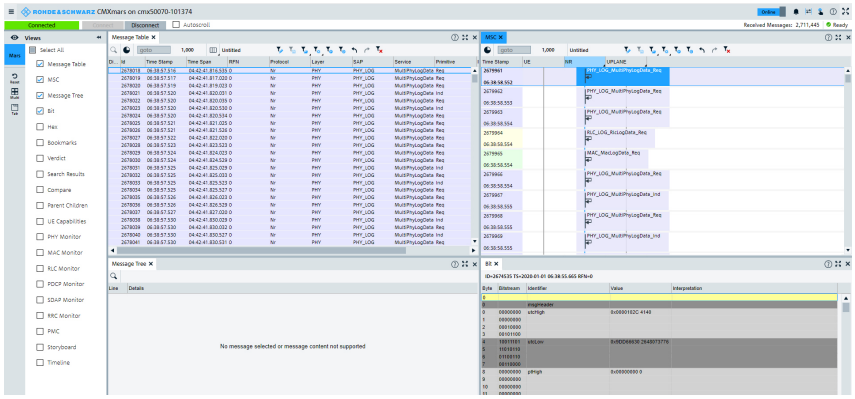
3.4 Troubleshooting via R&S®CMsquares

3.4.1 Message Analyzer

1. Select the menu button in the top left corner.
2. Select **Message Analyzer**.

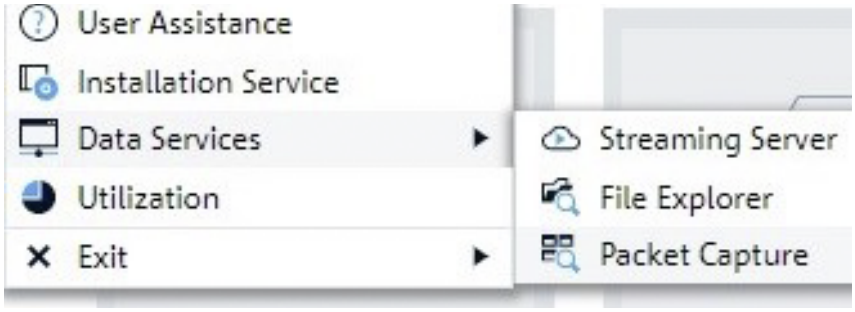


3. View system messages.
   - Enable the desired kinds of messages under **View**.
   - Arrange the message squares according to the desired preference.
   - Filter messages as desired.

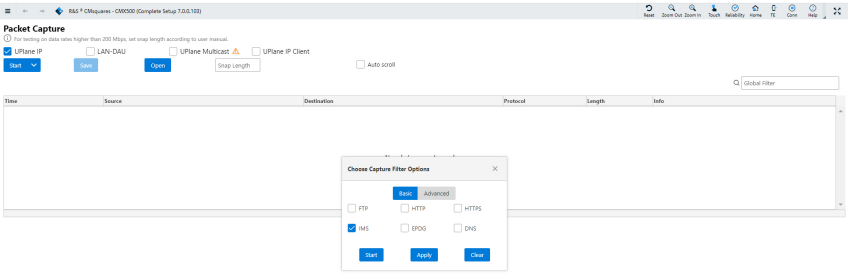
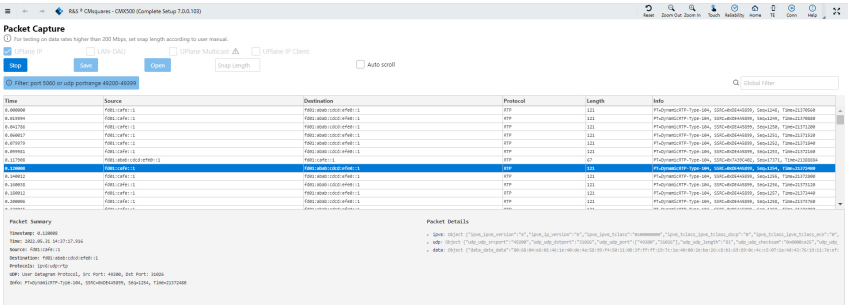


3.4.2 Packet capture

1. Select the menu button in the top left corner.
2. Select **Data Services** → **Packet Capture**.



3. Enable **UPlane IP**.
4. Select next to **Start**.
5. Enable **IMS**.
6. Select **Start**.



7. View details about every single package of the captured connection.