

# **APPLICATION NOTE**





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

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Establish NR (5G) / LTE (4G) connection to *lab*CORE via R&S<sup>®</sup>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<sup>®</sup>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<sup>®</sup>CMX500, and R&S<sup>®</sup>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 <u>customersupport@rohde-schwarz.com</u>.

All screenshots are exemplary and may differ from customer experience.

## 1.2 Reference documentation

Document name
labCORE Manual
HMS II Series Manual
ACQUA Online Help
R&S <sup>®</sup> 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<sup>®</sup>CMX500

### 1.4.1 *lab*CORE interfaces



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

# 1.4.2 R&S<sup>®</sup>CMX500 interfaces

### Front panel



RF Com 1 socket for connection to antenna.

#### Back panel



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

### 1.5 Equipment list

#### 1.5.1 HEAD acoustics equipment

#### Required

- labCORE (Code 7700), Modular multi-channel hardware platform
  - coreBUS (Code 7710), I/O bus mainboard
  - coreOUT-Amp2 (Code 7720), Power amplifier board
  - coreIN-Mic4 (Code 7730), Microphone input board
  - coreIP (Code 7770), VoIP software extension with at least one of the following voice codecs according to the technical specifications of the device under test
    - ► coreIP-AMR (Code 7772), AMR extension
    - ► coreIP-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
  - coreUSB-DR (Code 7705), USB device reference
  - coreBEQ (Code 7741), Binaural equalization
  - coreIP-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<sup>®</sup>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<sup>®</sup>CMsquares
- DUT
- Test SIM card (e.g., R&S<sup>®</sup>CMX-Z01)
- Ethernet cable (RJ45)
- Mouse and keyboard (optional) for direct control of R&S<sup>®</sup>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  $R\&S^{\textcircled{B}CMX500}$ .

# 1.7.2 R&S<sup>®</sup>CMX500 to *lab*CORE



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

# 1.8 R&S<sup>®</sup>CMX500 forwarding delays

### 1.8.1 4G delays

The 4G forwarding delays of R&S<sup>®</sup>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<sup>®</sup>CMX500 provides the functionality to determine the forwarding delays of a live call.

- 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.



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

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6

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1 IPv4 IPv6

2

0 P-CSCF Server

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- 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<sup>®</sup>CMX500.
- Boot up ACQUA PC.
- Start ACQUA.
- Boot up labCORE.
- 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.

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# 2.3 VoIP configuration

#### ACQUA

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

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🝸 💽 🖬 🔍 Network Impair	ments
Network Settings   SIP Settings   RTP Settings   Call   Radio Tester	r Wizard Diagnostics
SIP Call	Jitter Buffer Reset
Target ~	Automatic
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status i ule	
Call Terminate	
Send DTMF	
RTP Stream	
Remote 172.22.1.201 ~	

💌 🔲 🔚 🌂 Network Impairments...

Network Settings SIP Settings RTP Settings Call Radio Tester Wizard Diagnostics

Select Radio Tester

O Anritsu MD8475 LTE (IPv4)

Anritsu MD8475 LTE (IPv6)
 Anritsu MD8475 2G/3G

Rohde & Schwarz CMW 500 / CMX 500

4. Go to the tab Radio Tester Wizard.

🔛 VoIP Settings

Select Radio Tester
IP Settings
RTP Settings

Check Parameter

7

- 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.

🔛 VoIP Settings								$\times$
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Select Radio Tester IP Settings	IP Setting Set the IP addr	<b>JS</b> ess of the	labCO	RE to	o the I	P addre	ss expected by the CMW /CMX as media server.	
RTP Settings	IP	172 -	22		2	2		
Check Parameter	Subnet Mask	255 -	255		0	0	]	
	Gateway	0 ·	0		0	0	]	
	DNS	0 ·	0		0	0	]	
1	1							

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

🔛 VoIP Settings		$\times$
7	💌 🛄 🔚 🜂 Network Impairments	
Network Settings SIP Set	ings RTP Settings Call Radio Tester Wizard Diagnostics	
Select Radio Tester IP Settings	RTP Settings Codec configuration is done automatically between CMW / CMX and labCORE.	
RTP Settings	General	
Check Parameter	Initial jitter buffer length 140 ms	
	Packet Length 20 ms	

Const Jamen in Jack Salakin Marry Ti Conn Hala X

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

🔛 VoIP Settings		$\times$
7	💌 🛄 🔚 🔍 Network Impairments	
Network Settings SIP Sett	ngs RTP Settings Call Radio Tester Wizard Diagnostics	
Select Radio Tester IP Settings	Check Parameters Press Apply to configure the labCORE	
RTP Settings	Radio Tester: Rohde & Schwarz CMW 500 / CMX 500 IP: 172.22.2.2 Subnet Mask: 255.255.0.0 Gateway: 0.0.0 DNS: 0.0.0 Packet Length: 20 Initial jitter buffer length: 140	^

## 2.4 Network configuration

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#### R&S<sup>®</sup>CMsquares

- Open the web browser on a PC that is in the same network as R&S<sup>®</sup>CMX500.
- Find the IP address of R&S<sup>®</sup>CMX500 at its front display. Enter the IP address of R&S<sup>®</sup>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  $Pool \rightarrow Network$  at the left toolbar.
- 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.

➡ Network Configu	iration	
Navigation Collapse Exp	and LTE NR	* Favorite
General 🕼 NR Cell 0		
<ul> <li>PLMN 0 Identity</li> </ul>	Info	
PLMN		
PLMN Name	PLMN 0	
MCC	001	
MNC	01	
5G Tracking Area		
Tracking Area Name	5G TrackingArea 0	
Code	1	
Timer 3512	0 x Deactivated	~
Network Handling Voice	Voice Over NR	~

- 10. Select the tab Cell.
- 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	<b>DUT</b> at the right toolbar.	General Cor	ntrol D	OUT Control				
16. Select	the tab General.	▼ DUT						
17. Select	predefined SIM profile e.g.		Nama	DUT 0				
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<ul> <li>18. Go to t Attenua</li> <li>19. Specify desired</li> <li>20. Go bac</li> <li>21. Select</li> <li>22. Select antenn</li> <li>23. Apply t antenn</li> </ul>	he tab Frequency Dependent tion. / the attenuation for the d frequency range. k to Dut → General. the tab DUT Connectors. Add to specify the applied a. he frequency bands for the a according to the	Connectors and Connections     DUT Connectors	ntrol Dimensional 7.3.2.1. ntrol Dimensional 7.3.2. Na 1. Name I Name I S s connector Centr	Image: set of the set of th		Image: control of the second	Lbray Lbray Ant7 (N78 /	



24.	Go to the tab Connections.	Connectors and Connections									×
25.	Select 💉 to edit the attenuation	DUT Connectors Connection	IS								
	of the antenna.	<ul> <li>Hide Default Connections</li> <li>Connections</li> </ul>									
26.	Close Connectors and Connections.	▼ \$ Name SA Main	DUT 0 Ant7 (N78)	Connector	♣ Test System C 0.Slot3.RFCom1 ➤	▼ 🛊 FDA I 12dB ×	MRT to DUT	- /	▼ 🛊 FDA DUT t	o MRT	- / 1
		Connections View     Test System     Ostert Aentum     Ostert Aentum     Ostert Jentum     Ostert Jentum									ĺ
27.	Select <b>Global Services</b> at the right toolbar.	Data Unit DNS	IMS	QoS	ePDG						*
28.	Go to the tab IMS.		(	ON							Favorite
29.	Switch <b>ON</b> (if necessary).	▼ Call Settings	-								DUT
30.	Go to Network Settings.			e				~			001
31.	Set Authentication Scheme	▼ Network Settings									
	according to DUT.	Authenticatio	A A	KA V1						~	Network
		IPsec Enable	ed 🗸								
		IPSec Encryptic	A A	uto						~	General
		IPSec Integri	ty A	uto						~	
		Algorithm OFF TCP Keep Alive OFF UDD TCP Threshold Defends 1200								~	Sequence
											,"□,"
		Timer			00						Global Services
		D Associated US				1				-	2
		Madia Endeciate 10.5							<u> </u>	RX Meas	
		Media Endpor	nt IP	Forward	1					•	-
32.	Set Media Endpoint to IP Forward.	Media Endr	oint	IP For	ward						~
33.	Go to IP Forward.	IP Forward									
34.	Set IP Address to 172.22.2.2.	IP Add	lress	172.2	2.2.2						
35.	Set RTP Port to 50000.	DTD	IP Address								
36.	Set Command Port to 1000.	RIP	Port	50000	J						
		Command	Port	1000							
		Alignment Octet Aligned							~		
37	Go to Virtual IIE										

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

<ul> <li>Virtual UE</li> </ul>	
Signaling Type	Simple 🗸
Dedicated Bearers	✓
Video Codec	H.263 🗸
Video Attributes	
Audio Codec	EVS 🗸
EVS	
Mode	Primary 🗸
Format	Both 🗸

39.	Go to <b>Network</b> square.	Network square		
40.	Select <b>Go Live</b> .	Cells Beams		
		🖉 Edit Mode	🗸 Go Live	菌 Delete
		Network square		
		Cells Beams		
		✓ Live Mode	🖉 Edit	📋 Delete
		PLMN 0		+
		5G TrackingArea 0		
		NR Cell 0 -80.00 dBm Band: FR 1(TDD) 78 DL CH: 630942 630942 BW: 100 MHz 100 MHz		
41.	Go to Network square.	Network square		
42.	Switch cell <b>ON</b> .	Cells Beams		
		✓ Live Mode	🖉 Edit	Delete
		PLMN 0	U	- +
		5G TrackingArea 0		1.
		NR Cell 0           -0.00 dBm           Band: FR 1 (TDD) N 78           DL         UL           CH: 63042         63042           BW: 100 MHz 100 MHz		
43	Set DUT online			
43. ΔΔ	The DLIT connects to the network	Network square		_
	A purple triangle in the corner of the	Live Mode	alla 🚔 Dalaas	Cabling
	NR cell hexagon indicates the		dit Delete	
	successful connection.	5G TrackingArea 0	Т Т	
		NR Cell 0           CMCG) PCell           -90.00 dm           Banc: F1 (TDD) N 78           DL         UL           CH: 30.942           BW: 100 MHz	DUT NR Cor	Inected
		Release to inactive	LTE	Idle

45. The DUT registers at the IMS. Confirm the successful registration 0.Slot1.Port3.IFOut in the DUT or via Cabling and DUT ort1.IFIn DUT square  $\rightarrow$  DUT state. t1.IFOut IMS-State Registered ort2.IFIn Release to Inactive lease to Idle Mobilit IMS Call State rt2.IFOut Released/ MT Audio/ Terminated are **Global Services** 📜 Data Unit DNS •••• ◀ State: State: 🛛 🖉 🖉 ePDG ; State: Off State:

### 2.5 Call establishment

### R&S<sup>®</sup>CMsquares

- Initiate a call
  - Call R&S<sup>®</sup>CMX500 from • the DUT by dialing any number.

or

Call the DUT from R&S<sup>®</sup>CMX500 by starting an Audio Call in IMS Services  $\rightarrow$  Call settings.



- or
- Call the DUT from R&S<sup>®</sup>CMX500 by opening IMS Virtual UE Data Unit and selecting the button Audio. ٠

La VolP Settings

### ACQUA

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

KolP Settings	×
🝸 💽 🖬 🙀 Network Impairments	
Network Settings SIP Settings RTP Settings Call Radio Tester V	Nizard Diagnostics
SIP Call Target Autocomplete Type to see auto completion Status Unavailable Call Call Call Call Call Call Call Ca	ter Buffer Reset
Send Parameter	
Status: Audio System 🥥 Reset VoIP System 🥥 Reset SIP R	egistration 🥥 SIP Call 🔘 <u>R</u> TP Stream 🥝

### 2.6 Workspace customization

#### R&S<sup>®</sup>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

🔛 VoIP Settings

Ping / Traceroute

0

Status

Target 🎤 172.22.1.201

Network Settings SIP Settings RTP Settings Call

Ping

Traceroute

7

#### 3.1.1 Diagnostics tab

- 1. Open VolP Settings.
- 2. Go to the tab **Diagnostics**.

WolP Settings		×
🝸 📃 🖬 🔍 Network Impairments		
Network Settings SIP Settings RTP Settings Call Radio Tester Wizard Diagnostics		
Ping / Traceroute Target	Wireshark Trace Reset/Activate Download	
Traceroute Ping		

💌 🕕 🔚 🔌 Network Impairments...

Radio Tester Wizard Diagnostics

### 3.1.2 Ping / Traceroute

#### Ping

- Enter the target IP address. or Select provided IP addresses.
- 2. Select Ping.

#### Traceroute

- Enter the target IP address. or Select 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.

VoP Settings	
🝸 📃 🔝 🔛 💊 Network Impairments	
Network Settings SP Settings R1P Settings Cal Radio Tester Woard Diagnostics	
Fing / Taxamula	Wireshark Trace
	Reset/Activate
Brant / (19222-020)	
Traceroute Ping	Download
Ber I	Wolf Logging

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raet: 🥕 (+72.22.4.201	Reset; Inclinate
Tracertale Fing	Descritoad
AA 9	VoIP Logging
	Download
	Pecet

# 3.4 Troubleshooting via R&S<sup>®</sup>CMsquares

Home

Test Environment

Current Workspaces

### 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.

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🛞 ROHDEASCHWARZ (1	WXmars on cmx50070-10	1374											
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Virus ++	Message Table X						0 H ×	MSC X					() :: ×
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Noc.	2678020 06-38-57.519	04:42:41.819.023 0	NY	PHY	PHY_LOG	MultiPhyLogOata Reg		06-38-58.552	_				
Message Tree	2678021 06:38:57.520	04.42.41.820.031 0	Nr Nr	PHY	PHY_LOG	MultiPhyLogOata Ind		2679962		P	Workshiptogram (ked		
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	2678029 06.38.57.530	04.42.41.820.022.0	Nr	PRV	PHYLOG	MulSPhyLogData Req		06.20.50.555		P*			
PHY Monitor	2678040 06:58:57:530	04.42.41.850.527.0	NY NY	PHY	PHY_LOG	MultiPhyLogOate Ind MultiPhyLogOate Red		2579959		PHY_LOG	MultiPhyLogDeta_Ind		
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								III rescress					

ROHDE&SCHWARZ

### 3.4.2 Packet capture

- 1. Select the menu button in the top left corner.
- 2. Select Data Services  $\rightarrow$  Packet Capture.



- 3. Enable UPlane IP.
- Select v next to Start.
- 5. Enable IMS.
- 6. Select Start.
- 7. View details about every single package of the captured connection.

	R&S <sup>#</sup> CMsquares - CMICSOD (Complete Setup 7.0.0.103)				S Q Q Q S O D C C O
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6917	fd81:cafe::1	foN1:ebeb:cdcd:efe8::1	RTP	121	PT-dynamic#TP-Type-104, SSRC+8xd5446899, Seq=1251, Time=11371528
29979	fd81:cafe::1	foli:ebab:cdcd:efe8::1	RTP	121	PT-dynamic#TP-Type-104, SSRC+8xd6446099, Seq=1262, Time=11371848
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