

VOICE OVER 5G – EVOLUTION, DEPLOYMENT, TECHNOLOGY AND TESTING ASPECTS

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ROHDE & SCHWARZ

Make ideas real

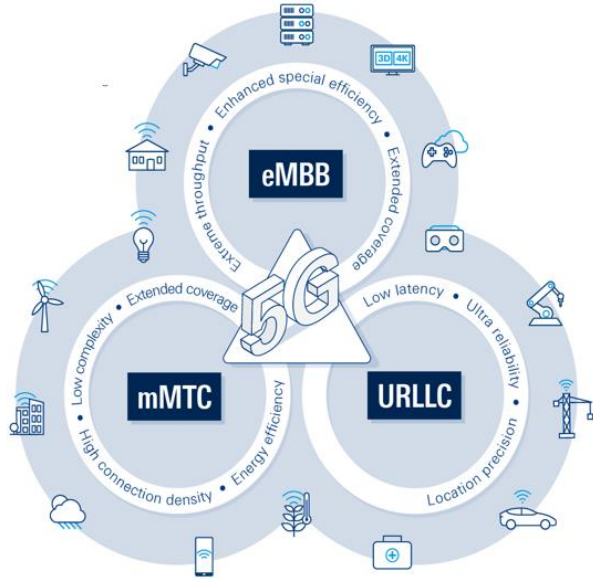


AGENDA

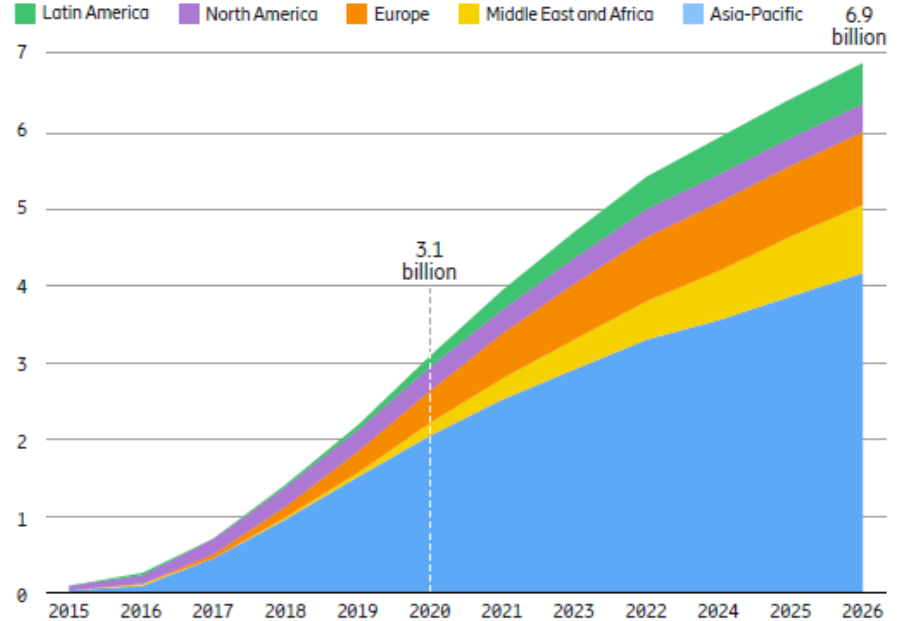
- ▶ Voice aspects in 5G networks
- ▶ Various deployment scenarios for voice
- ▶ Supplementary voice services
- ▶ Test setup and challenges for 5G voice aspects
- ▶ Voice in 5G – live demo using the R&S®CMX500 mobile radio tester



VOICE ASPECTS IN 5G NR - MOTIVATION



Voice and communications services are still growing!



(source: Ericsson mobility report November 2020)

The well-known 5G NR use case triangle
ITU vision of IMT 2020

VOICE ASPECTS IN 5G NR

In 3GPP, the used term is voice over IP. This implicits the usage of the IP multimedia subsystem (IMS).



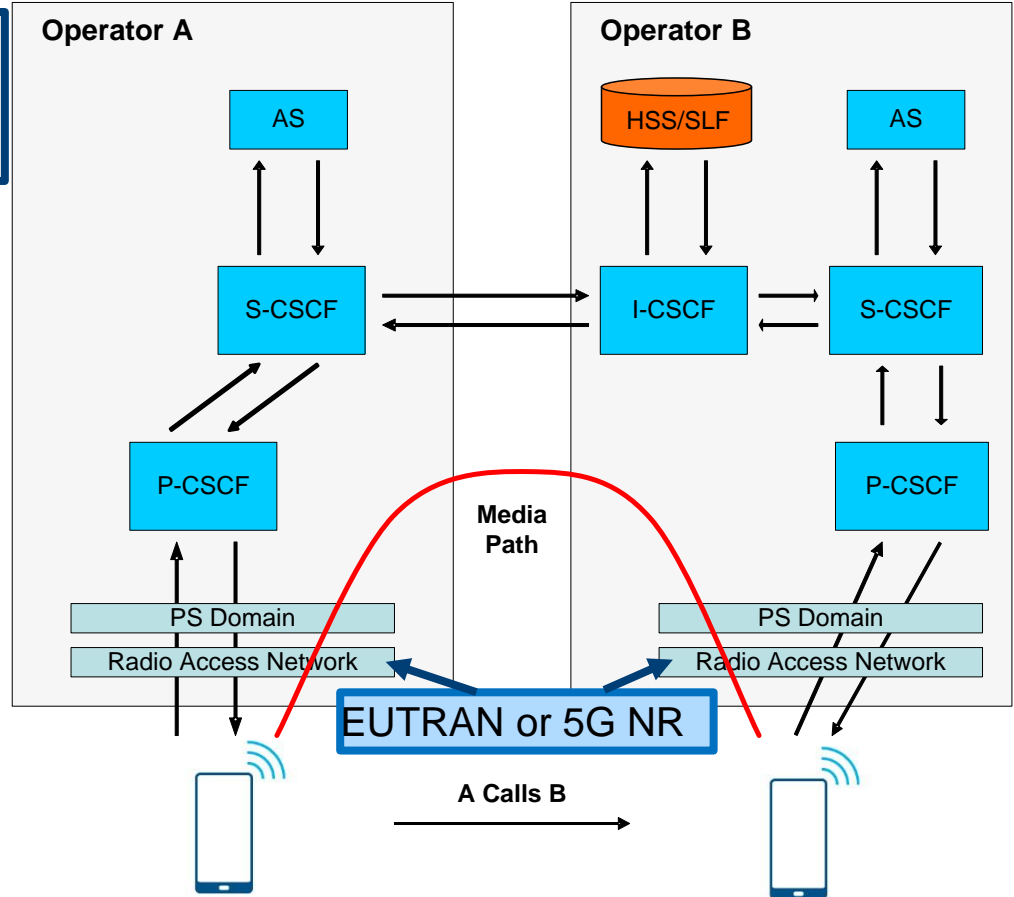
Voice over NR



Video over NR



Emergency calls + eCall



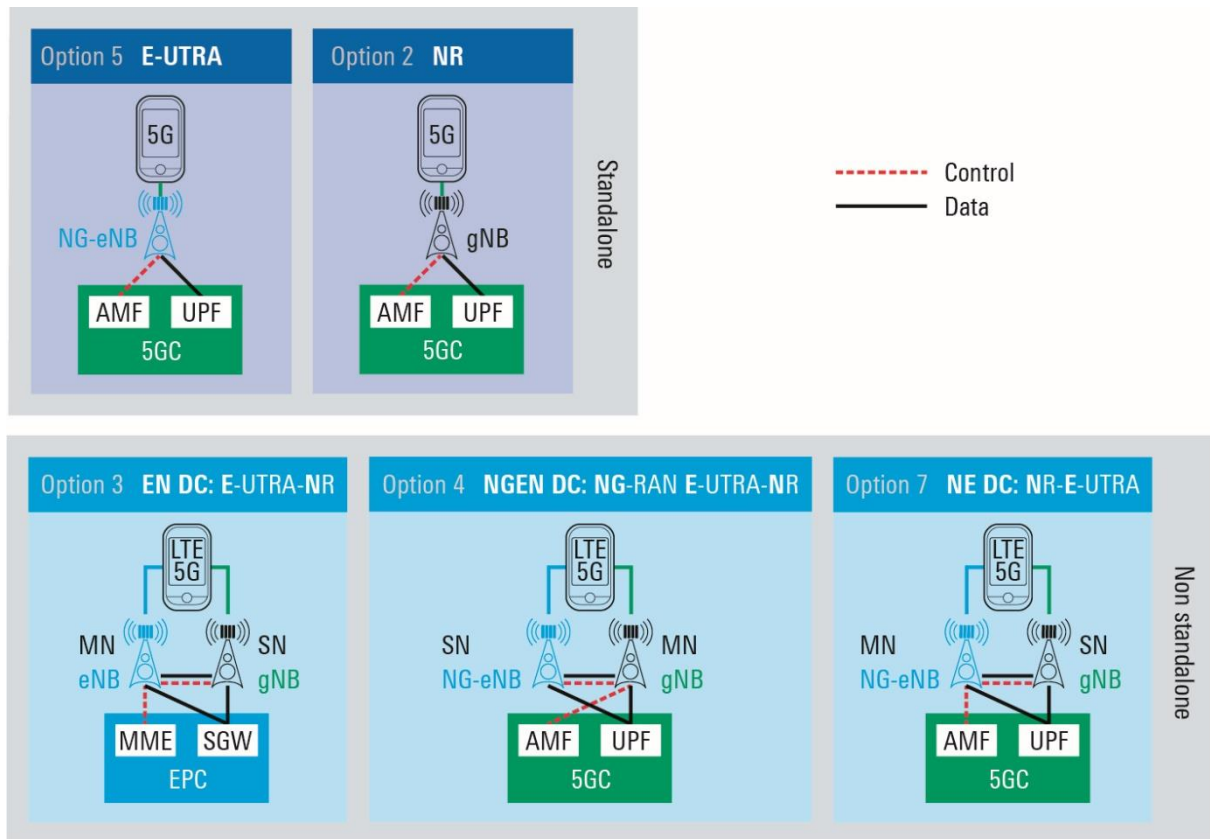
5G NR VOICE ASPECTS – DEPLOYMENT OPTIONS

There is no single technical solution for voice in 5G!

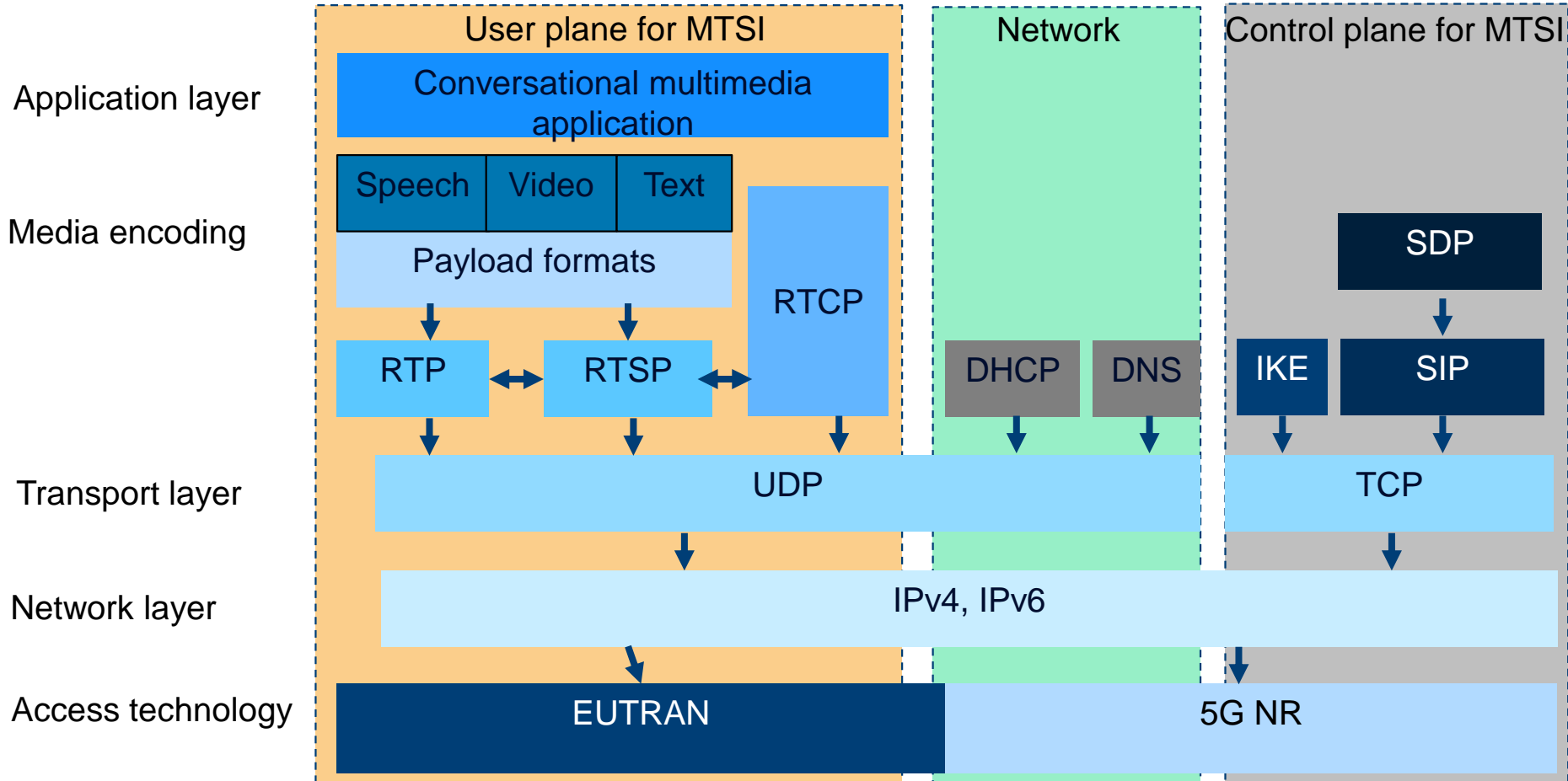
Various scenarios are possible: 2 questions to understand the background:

- What RAT is available and does it support voice? EUTRA or NR?
- What core network is available and does it support voice? 5GC or EPC?

Emergency calls are treated differently!



MTSI: MULTIMEDIA TELEPHONE SERVICES FOR IMS

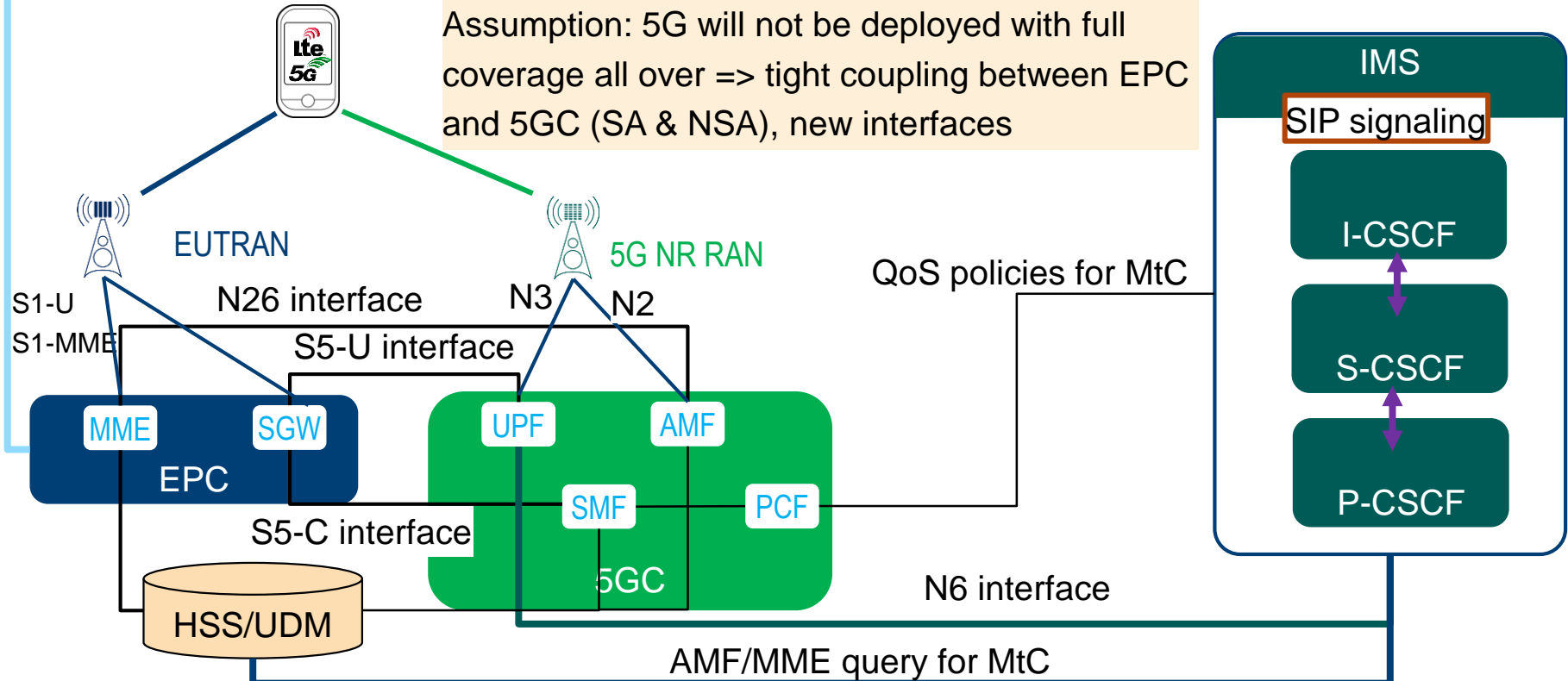


5G NR VOICE – INFRASTRUCTURE ASPECTS

2G/3G circuit switched voice

Handover to 3G/2G only via EUTRAN

Assumption: 5G will not be deployed with full coverage all over => tight coupling between EPC and 5GC (SA & NSA), new interfaces



USEFUL DOCUMENT FOR VOICE SERVICES OVER 5GS + IMS

GSM Association

Non-confidential

Official Document NG.114 - IMS Profile for Voice, Video and Messaging over 5GS

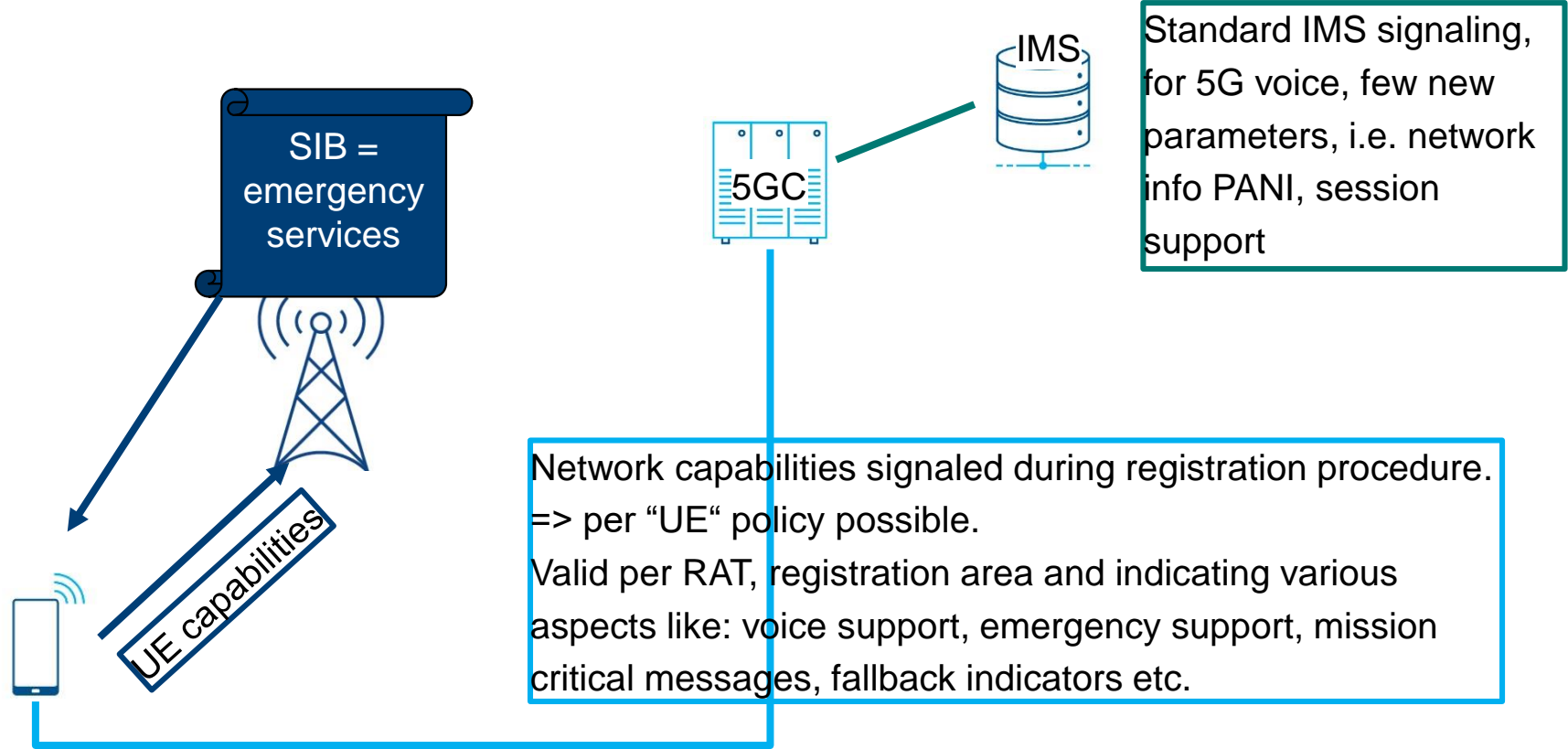


IMS Profile for Voice, Video and Messaging over 5GS

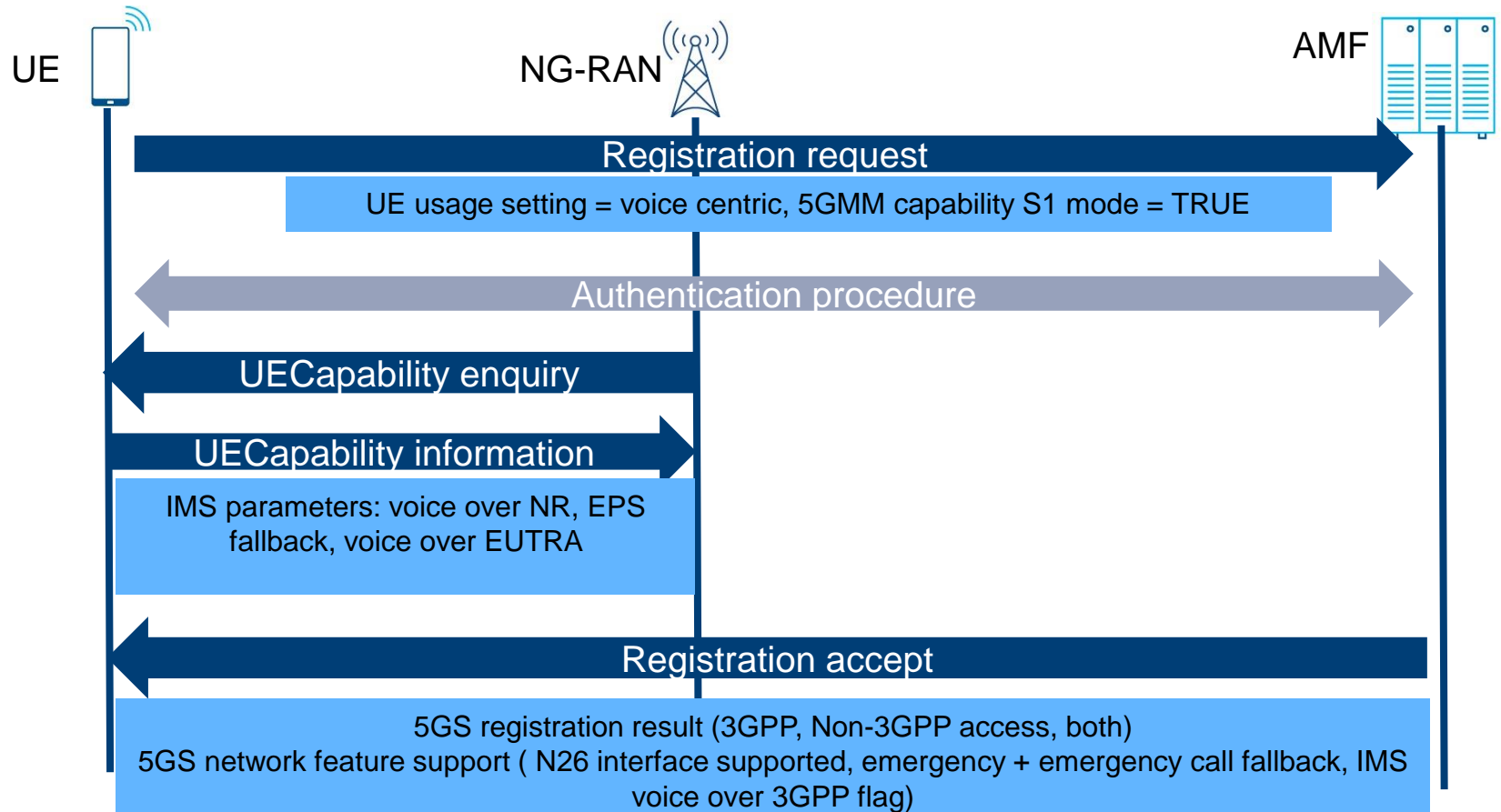
Version 1.0

07 August 2020

VOICE SUPPORT – SIGNALING ASPECTS



5GC REGISTRATION PROCEDURE ASPECTS (FOCUS ON VOICE)

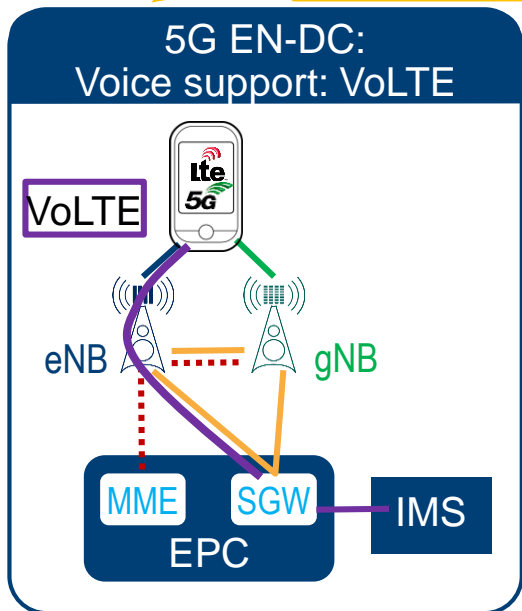


5G NR VOICE ASPECTS AND POSSIBLE DEPLOYMENTS

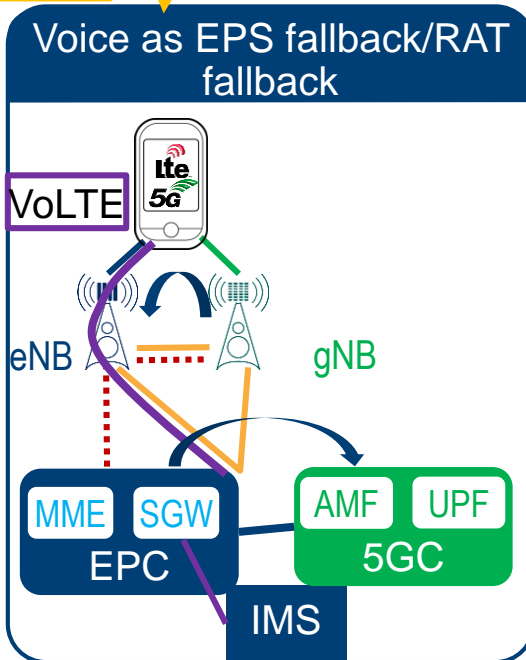
2G/3G circuit switched voice

Handover 4G ↔ 2G/3G

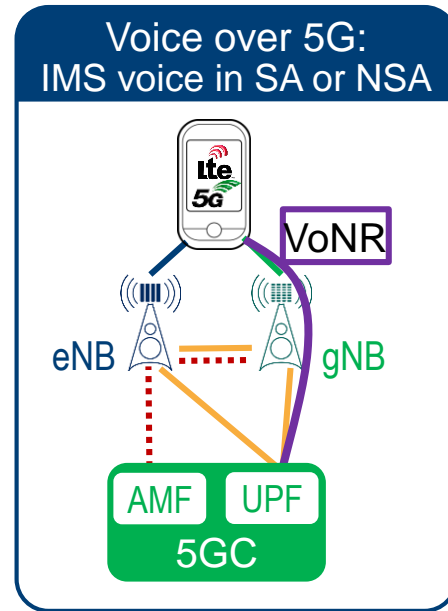
SRVCC*Rel. 16



- Dual connectivity: VoLTE + 5G data
- ⇒ UL coverage due to higher freq. 5G band
 - ⇒ Battery consumption

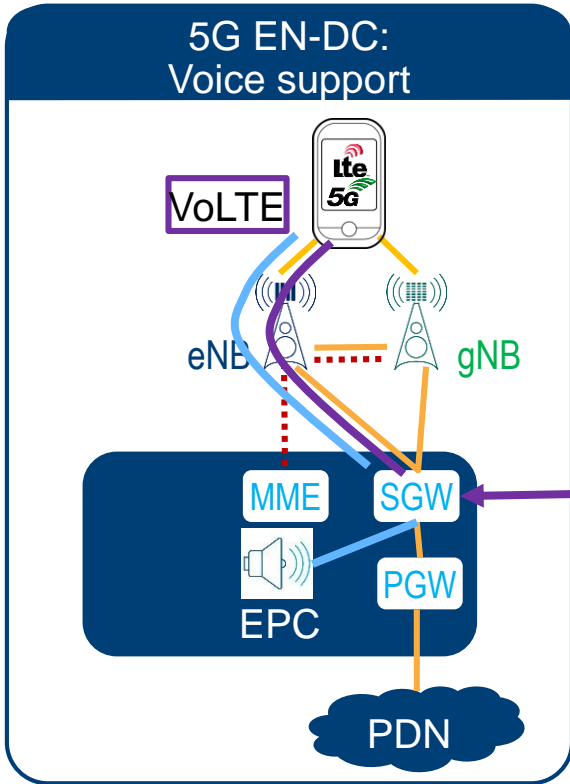


- EPS fallback: VoLTE only
- ⇒ Handover to EPC or EUTRA during call setup



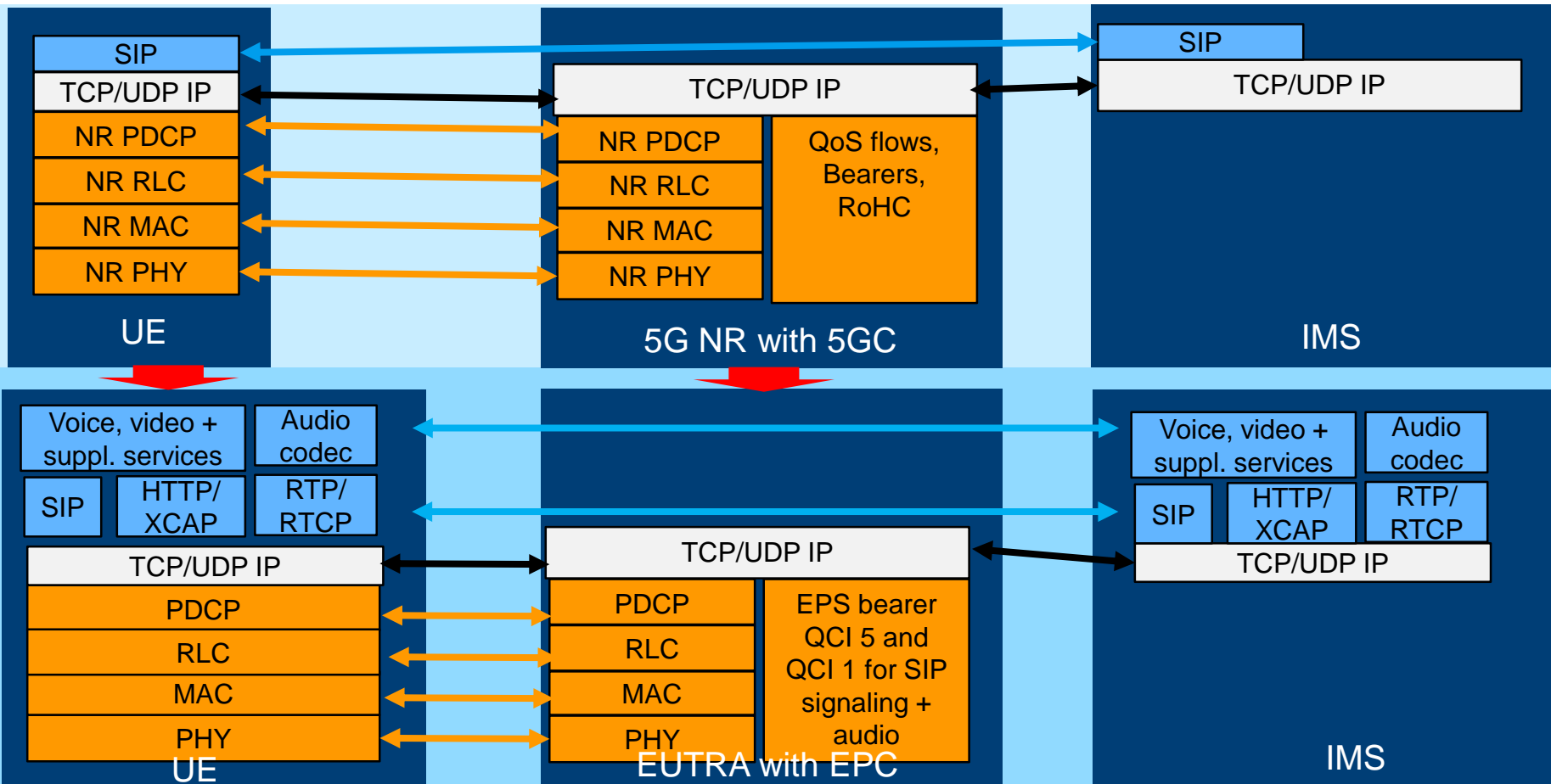
- Voice over 5G NR
- ⇒ Voice over NR and 5GC
 - ⇒ 5G coverage needed, risk of large #handovers/call drop

VoLTE IN 5G – OPTION 3 NSA MODE WITH IMS

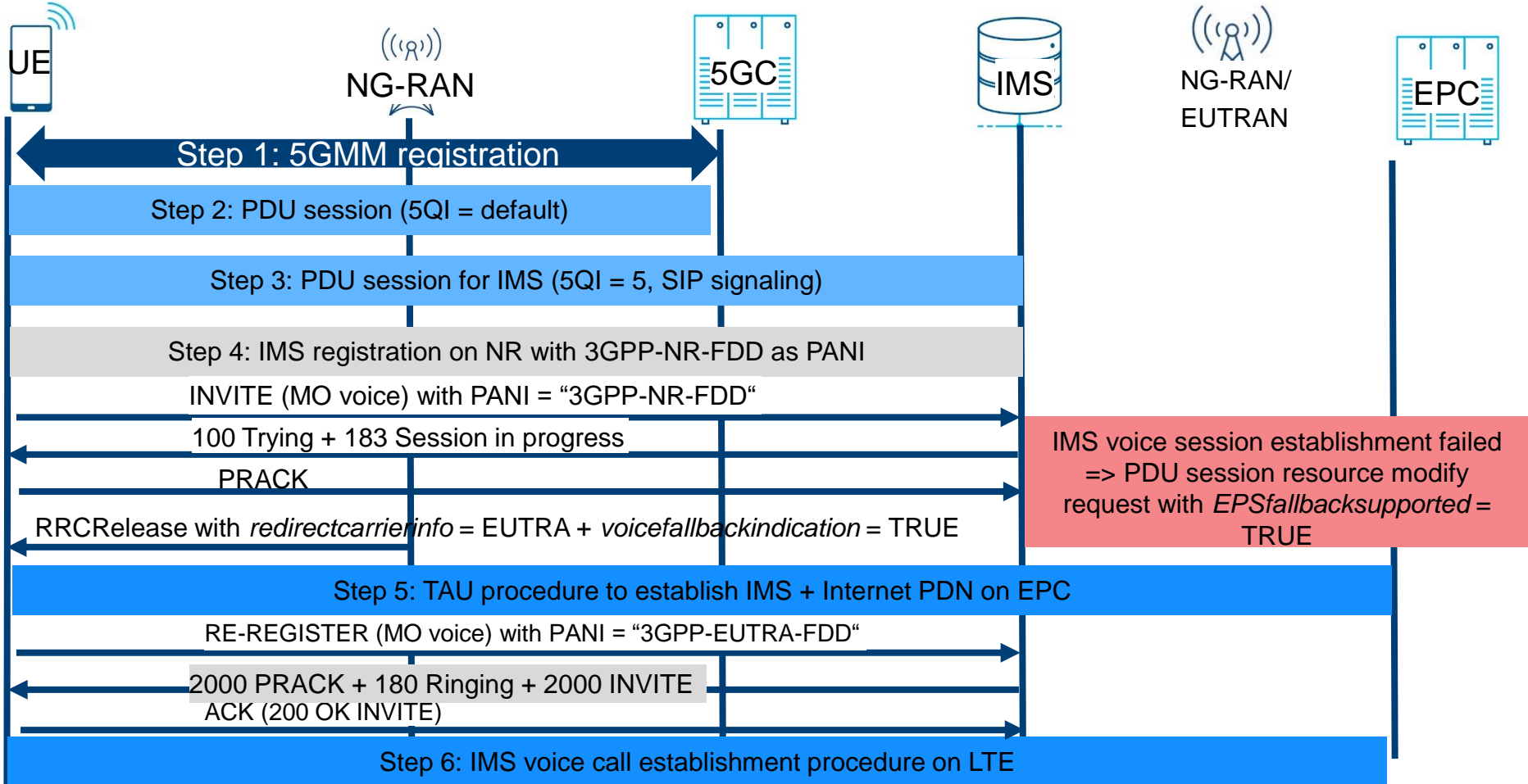


- Voice is using VoLTE principle.
- IMS connected to EPC
- IMS does not know about 5G NR
- VoLTE uses IMS SIP QoS profiles as known from VoLTE
- Depending on UE capability, 5G link is suspended during voice call or kept for simultaneous data
- Challenge: battery consumption + UE needs to support split bearer when simultaneous data

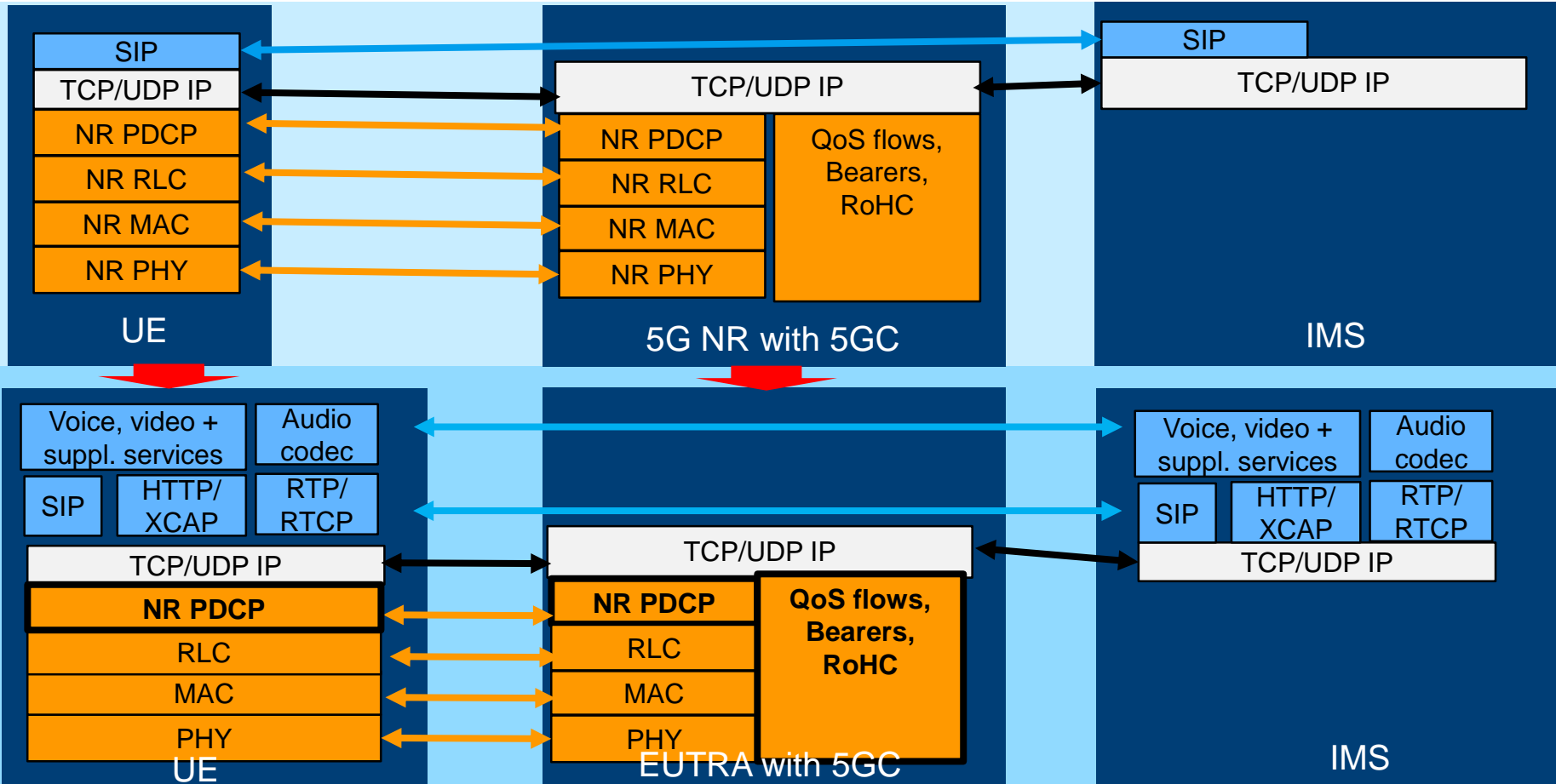
EPS FALLBACK SCENARIO



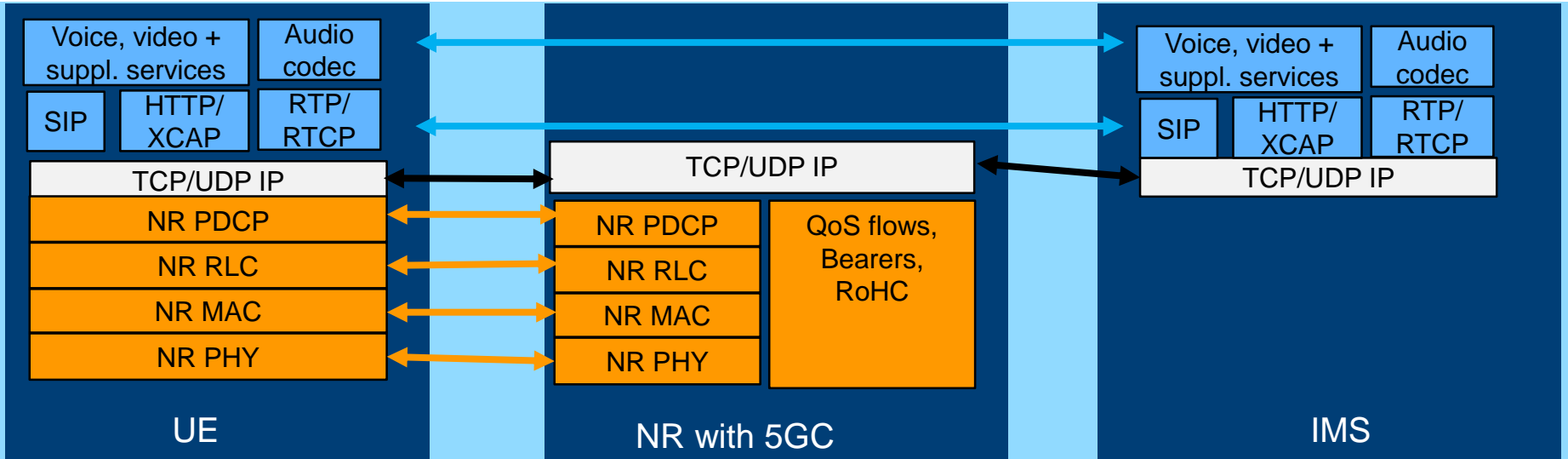
EPS FALLBACK SIGNALING PROCEDURE



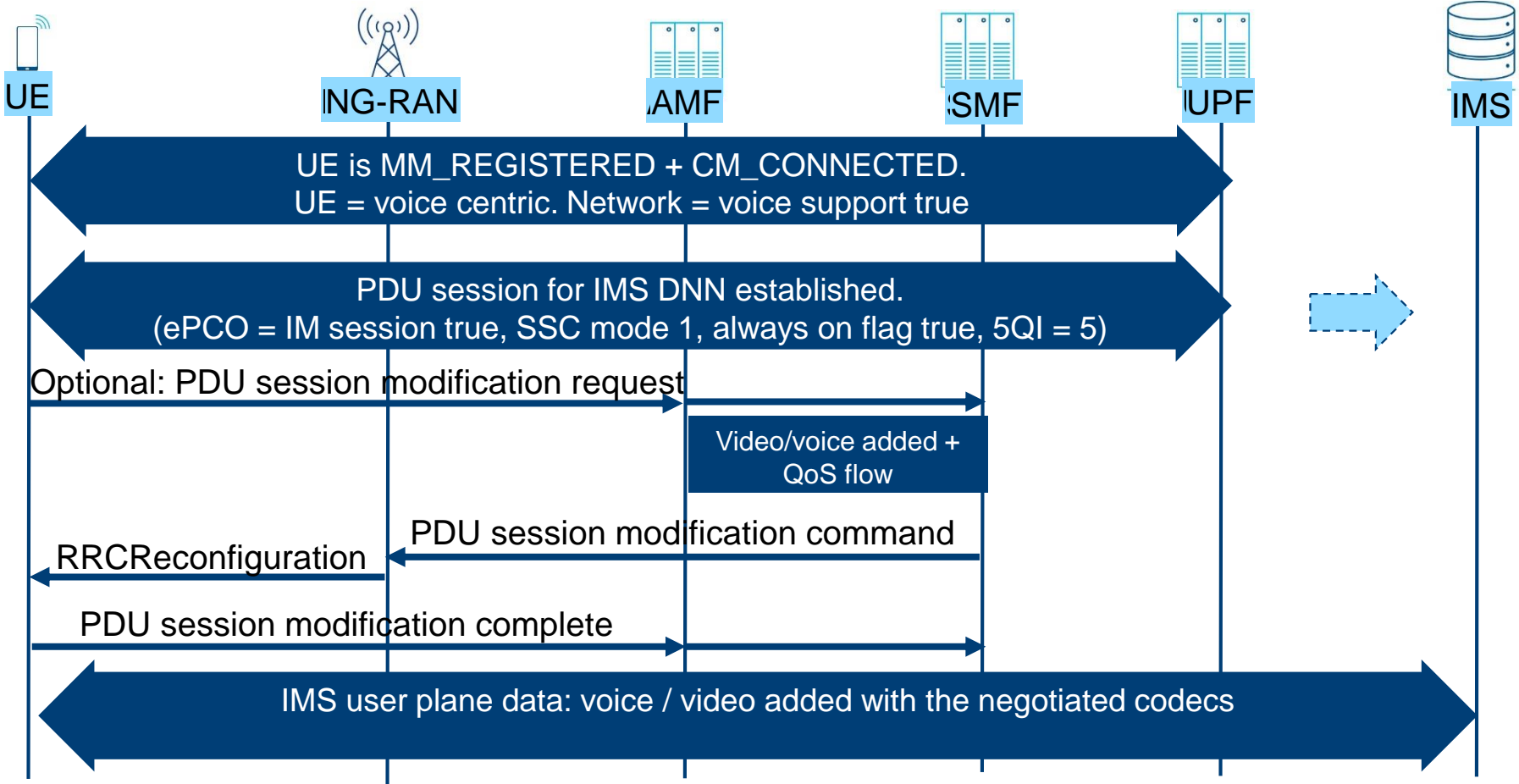
RAT FALLBACK FOR VOICE SUPPORT



VOICE OVER NR

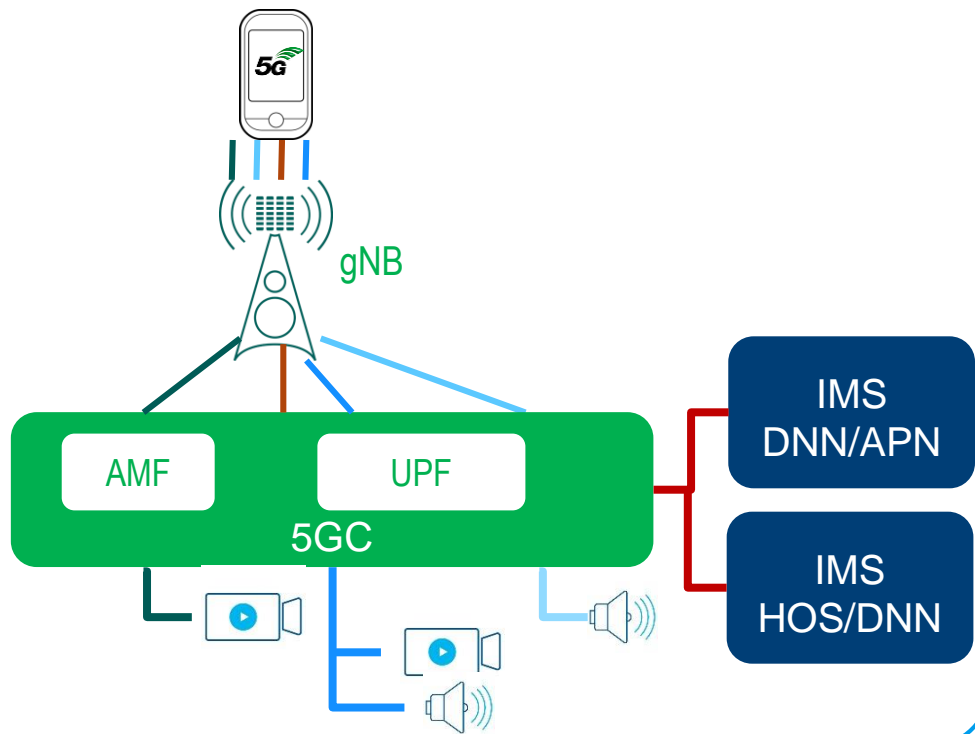


VOICE OVER NR - CALL FLOW



VOICE OVER NR – BEARER + IMS ASPECTS

VoNR targets for standalone (option 2), dual connectivity is possible



Radio bearer configuration and support request

- UM DRB with 5QI = 1 (conversational voice)
- UM DRB with 5QI = 2 (conversational video)
- AM DRB with 5QI = 5 (IMS SIP signaling)
- AM DRB with 5QI = 6-9 (non-GBR video)

1 or 2 IMS registrations:

- IMS DNN for all IMS services
- HOS IMS DNN for home operator RCS services

UE PDCP should support RTP and RTCP
RoHC compression and UE MAC layer should support DRX

MTSI: MULTIMEDIA TELEPHONE SERVICES FOR IMS

MTSI user plane stack is assumed on top of IP. Lower 5G layers, no specific settings for voice

Assumption: SDAP header = zero

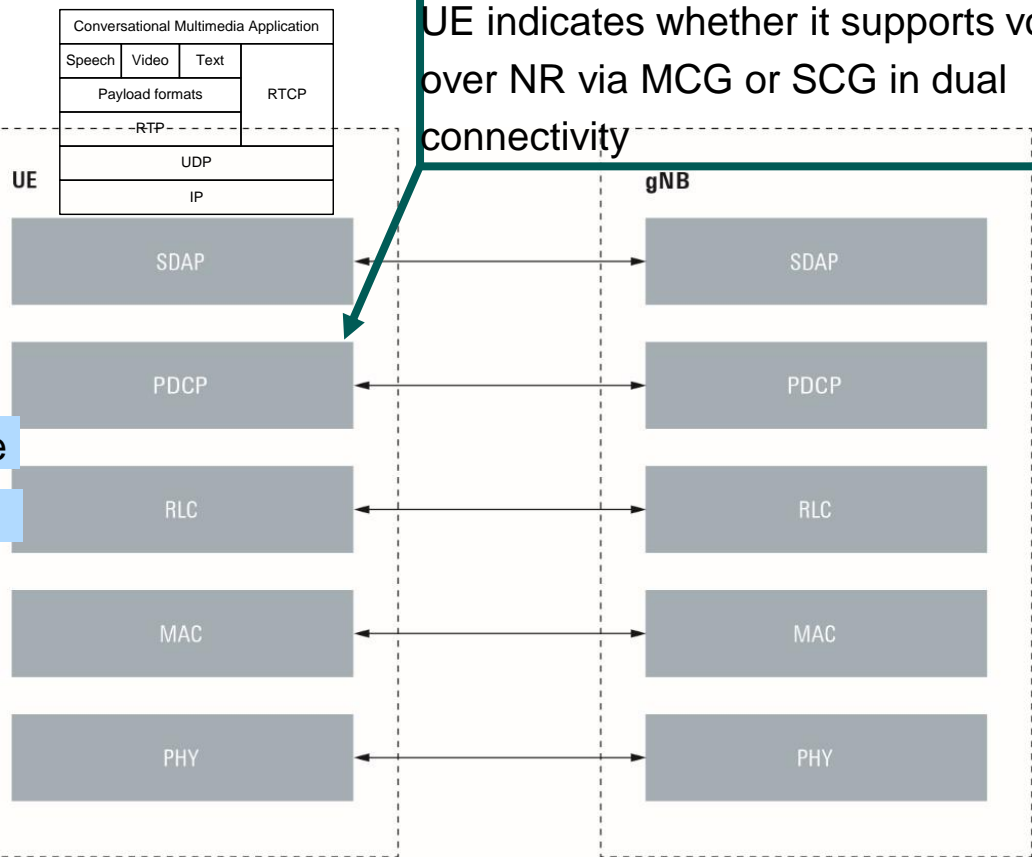
Assumption: PDCP header = focus on latency, no integrity check, only encryption

Assumption: RLC = unacknowledged mode

Assumption: MAC = low #HARQ process

Assumption: QoS settings: 5QI = 1 or 7 (5QI=7: priority 70, delay = 100ms, PER ~ 10^{-3})

Assumption: PHY supports semi-persistent scheduling, DRX + slot aggregation (e.g. TTI bundling in EUTRA)



5G NR VOICE: RRC MESSAGES WITH VOICE ASPECTS



```
IMS-Parameters ::= SEQUENCE {
    ims-ParametersCommon      IMS-ParametersCommon      OPTIONAL,
    ims-ParametersFRX-Diff    IMS-ParametersFRX-Diff    OPTIONAL, ...}

IMS-ParametersCommon ::= SEQUENCE {
    voiceOverEUTRA-5GC        ENUMERATED {supported}      OPTIONAL,
    ...,
    voiceOverSCG-BearerEUTRA-5GC  ENUMERATED {supported}      OPTIONAL
    voiceFallbackIndicationEPS-r16  ENUMERATED {supported}      OPTIONAL}

IMS-ParametersFRX-Diff ::= SEQUENCE {
    voiceOverNR                ENUMERATED {supported}      OPTIONAL,
    ...
}
```

If UE supports voice over standalone 5G NR, than above flag “voiceOverNR” must be true.

5G NR VOICE: NAS MESSAGE WITH VOICE ASPECTS



5GS network feature support IEI

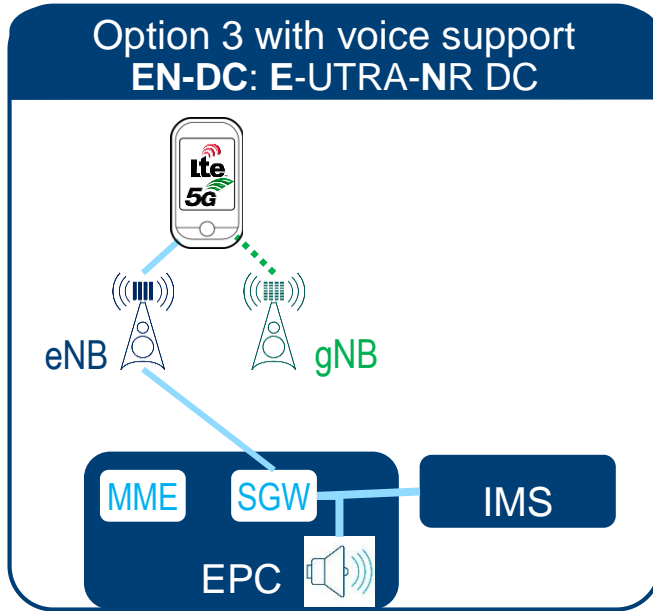
Length of 5GS network feature support contents

MPSI	IWK N26	EMF	EMC			IMS- VoPS-N3GPP	IMS- VoPS-3GPP
		Emergency service fallback		Emergency service capability		Voice service support	
5G-UP Clot	5G- HC-CP		IPHC-Clot	RestrictEC		MCSI	EMCN3
0 Spare	0 Spare	0 Spare	0 Spare	0 Spare	5G-EHC-CP Clot	ATS-IND	5G-LCS

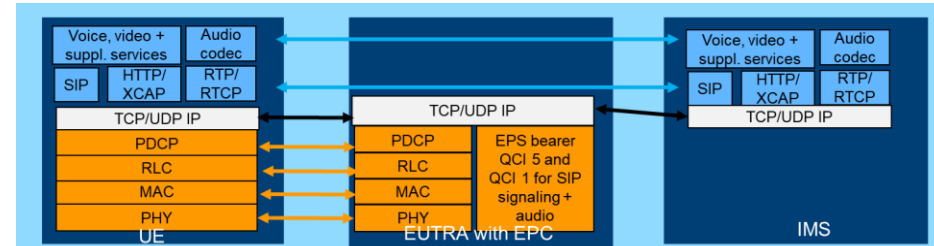
ARCHITECTURE OPTIONS AND VOICE SERVICES IN 5G

Option 3 supports two possible voice implementations:

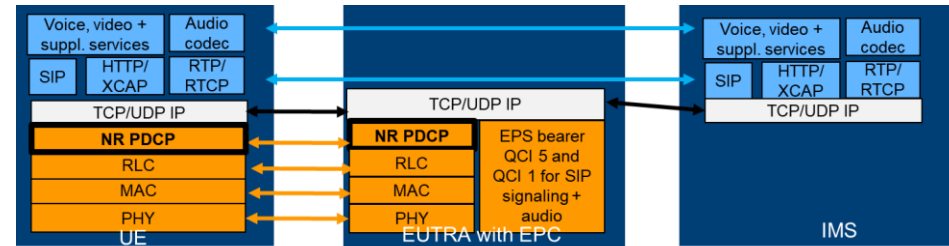
eNB is the Master Node



VoLTE as legacy in LTE

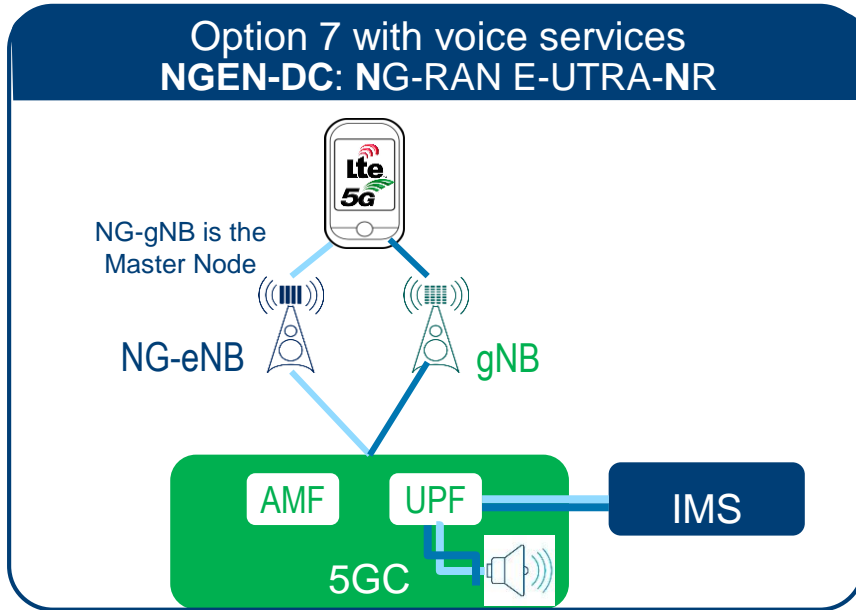


VoLTE using NR PDCP

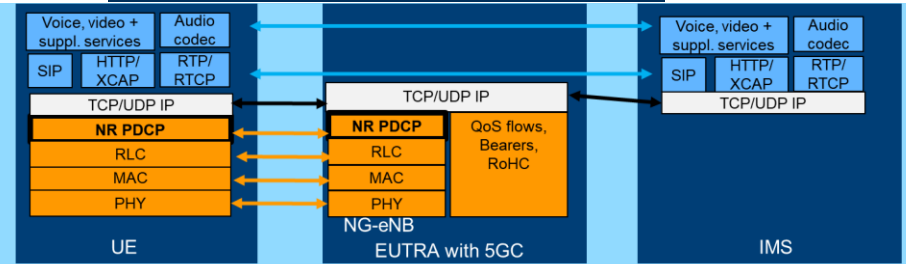


ARCHITECTURE OPTIONS AND VOICE SERVICES IN 5G

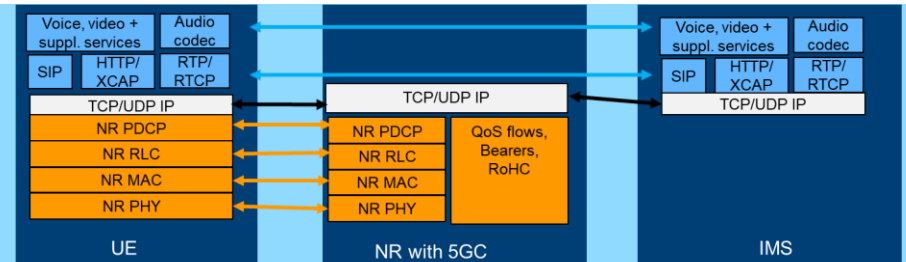
Option 7 supports two possible voice implementations:



VoLTE with NG-eNB and 5GC

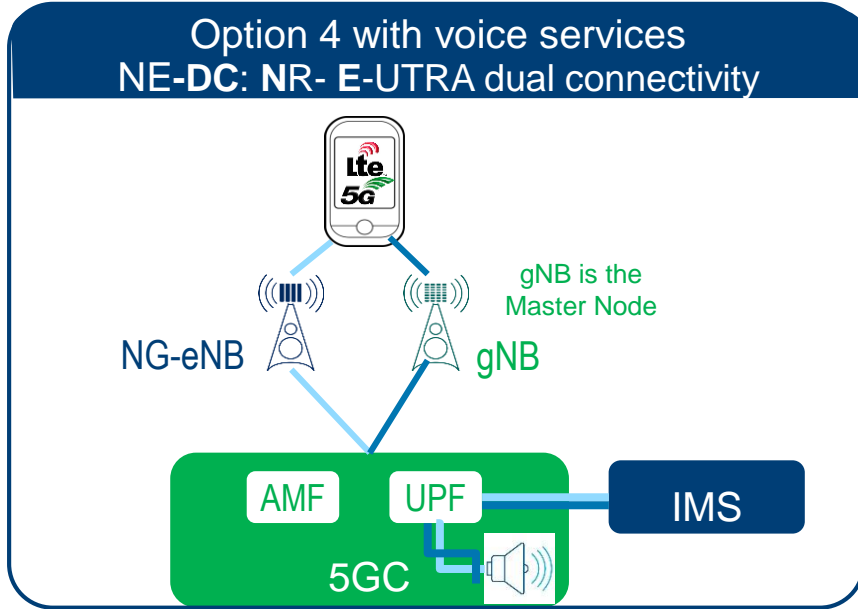


VoNR over SCG bearer

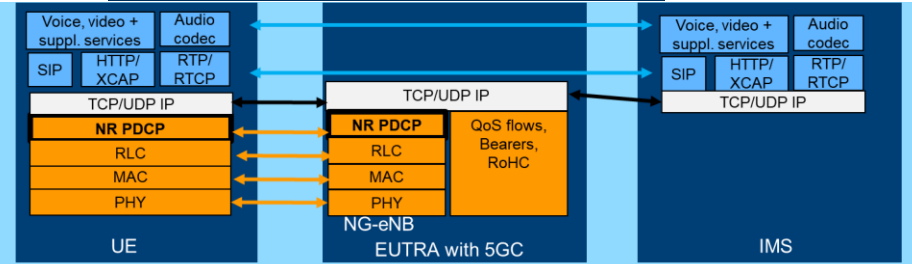


ARCHITECTURE OPTIONS AND VOICE SERVICES IN 5G

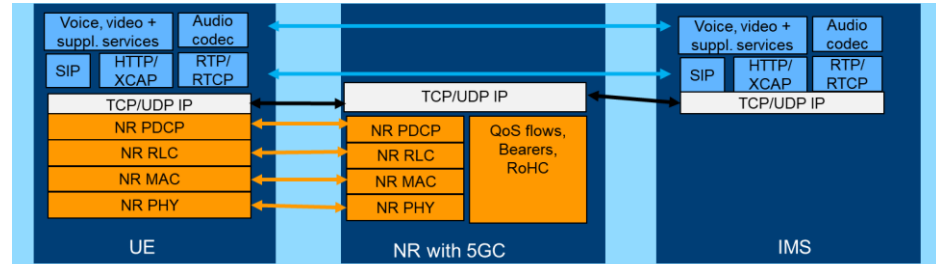
Option 4 supports two possible voice implementations:



VoLTE with NG-eNB and 5GC

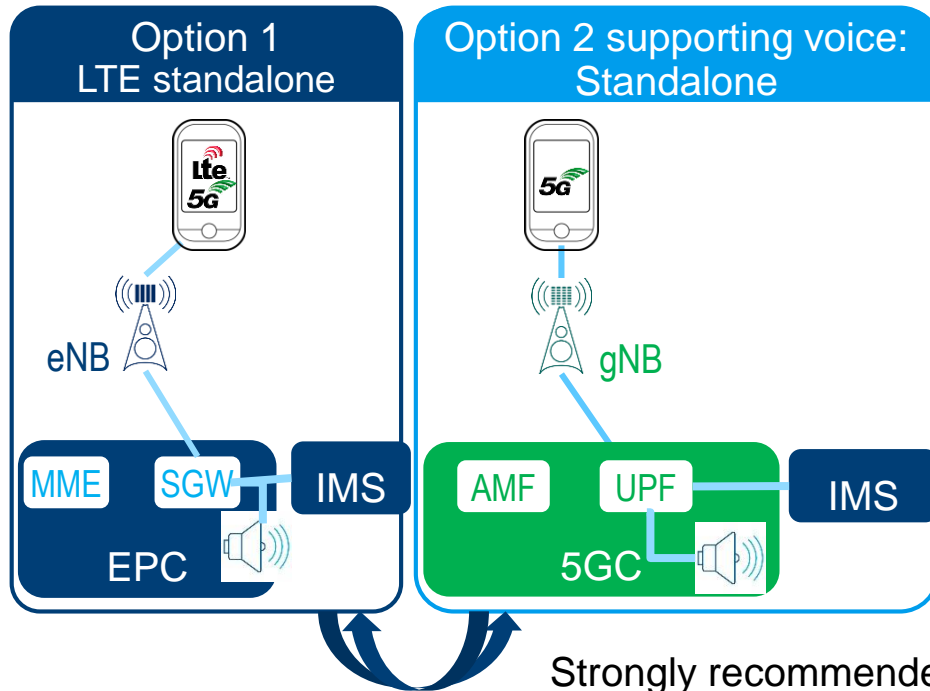


VoNR

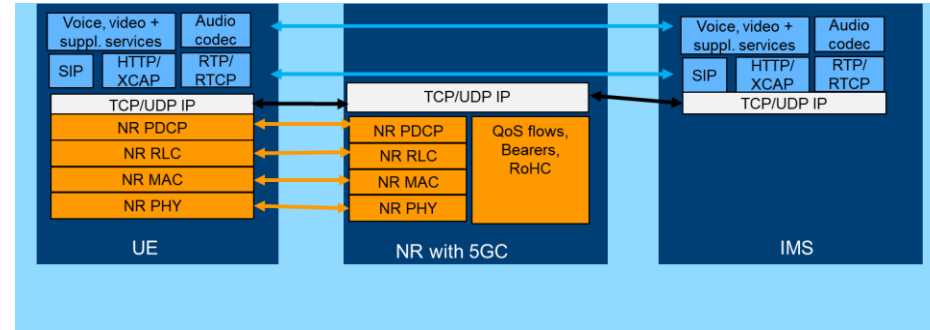


ARCHITECTURE OPTIONS AND VOICE SERVICES IN 5G

Option 2 supports VoNR with optional EPS fallback or RAT fallback depending on coverage

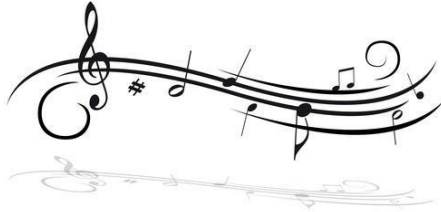
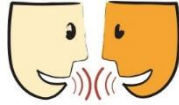


VoNR



Strongly recommended: LTE + 5G coexisting in parallel to support inter-system mobility for best voice QoS

ENHANCED VOICE SERVICES EVS



High data rate + good audio quality

Motivation for EVS is a mix of speech and audio data (music)

EVS

EVS primary mode

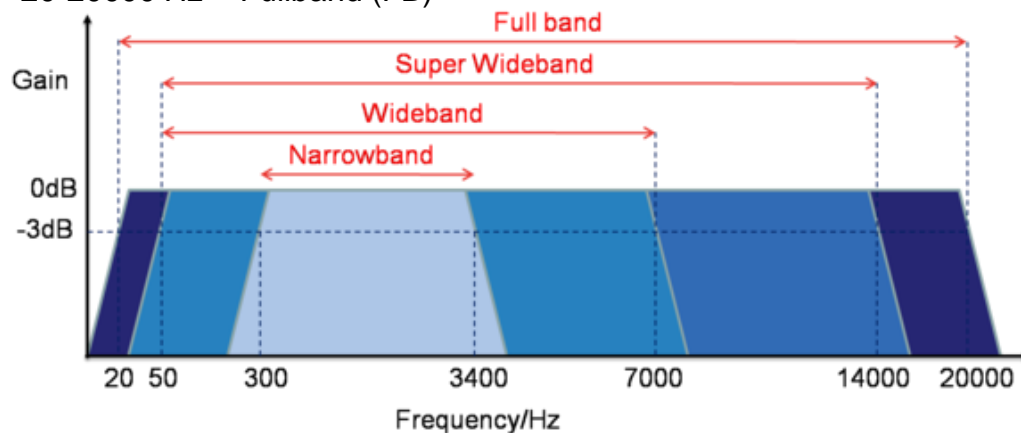
- 11 codec modes
- Requires transcoding when used with AMR-WB

EVS AMR-WB IO mode

- 9 codec modes
- No transcoding needed
- Fully compatible with AMR-WB

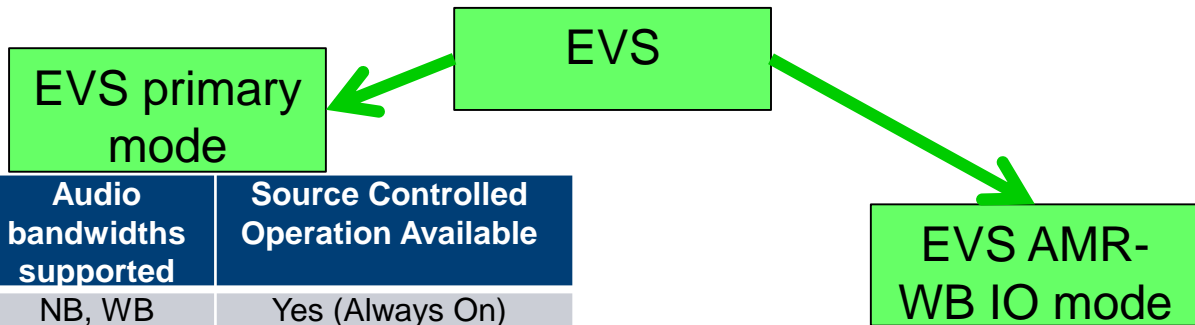
AUDIO BANDWIDTH DEFINITION

- ▶ 300-3400 Hz = Narrowband (NB)
- ▶ 50-7000 Hz = Wideband (WB)
- ▶ 50-14000 Hz = Super Wideband (SWB)
- ▶ 20-20000 Hz = Fullband (FB)



Working principle of speech codes are sampling rates of either 8, 16, 32 or 48 kHz converted into a 16 bit PCM

EVS CODE RATES

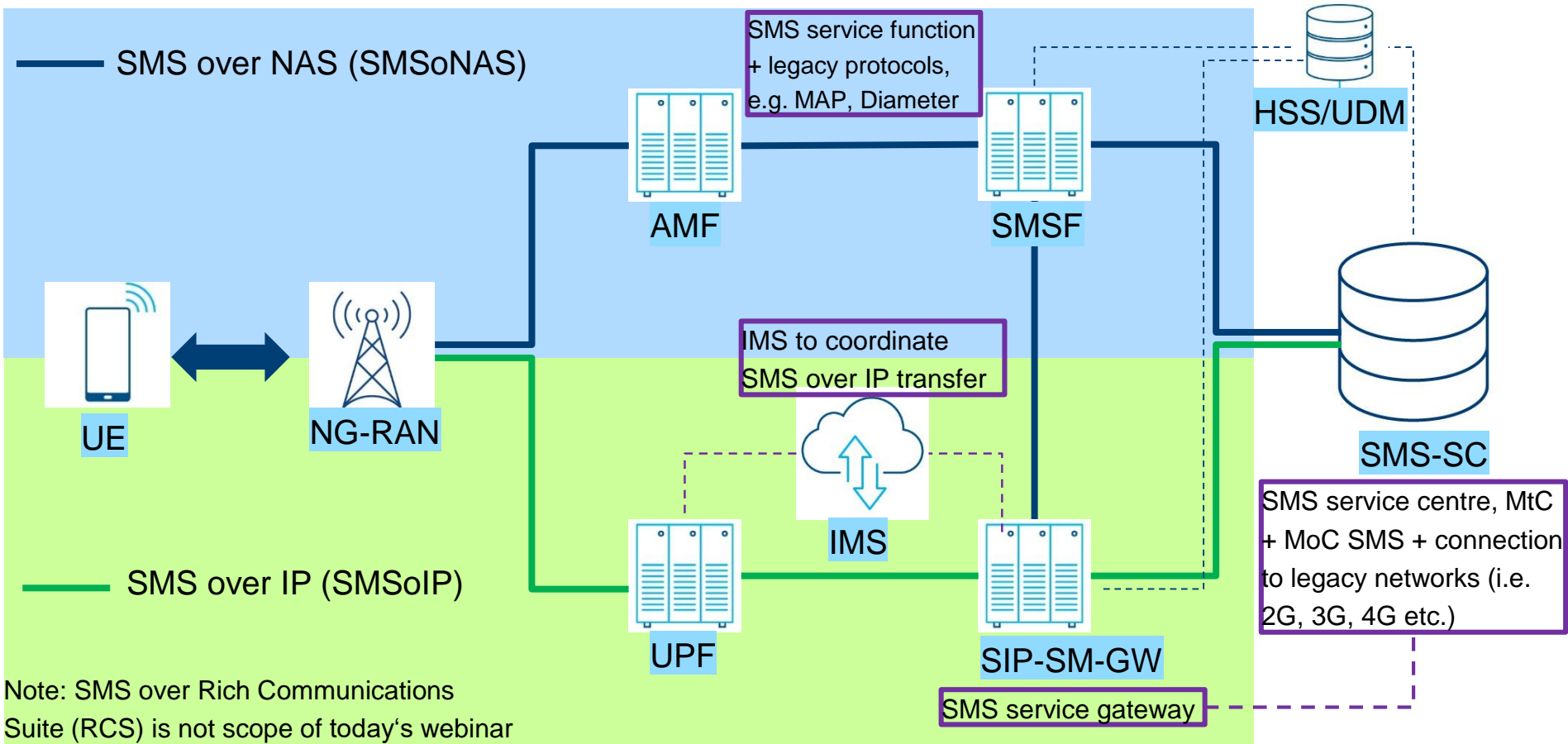


Source codec bit-rate (kbit/s)	Audio bandwidths supported	Source Controlled Operation Available
5,9 (SC-VBR)	NB, WB	Yes (Always On)
7,2	NB, WB	Yes
8,0	NB, WB	Yes
9,6	NB, WB, SWB	Yes
13,2	NB, WB, SWB	Yes
13,2 (channel aware)	WB, SWB	Yes
16,4	NB, WB, SWB, FB	Yes
24,4	NB, WB, SWB, FB	Yes
32	WB, SWB, FB	Yes
48	WB, SWB, FB	Yes
64	WB, SWB, FB	Yes
96	WB, SWB, FB	Yes
128	WB, SWB, FB	Yes

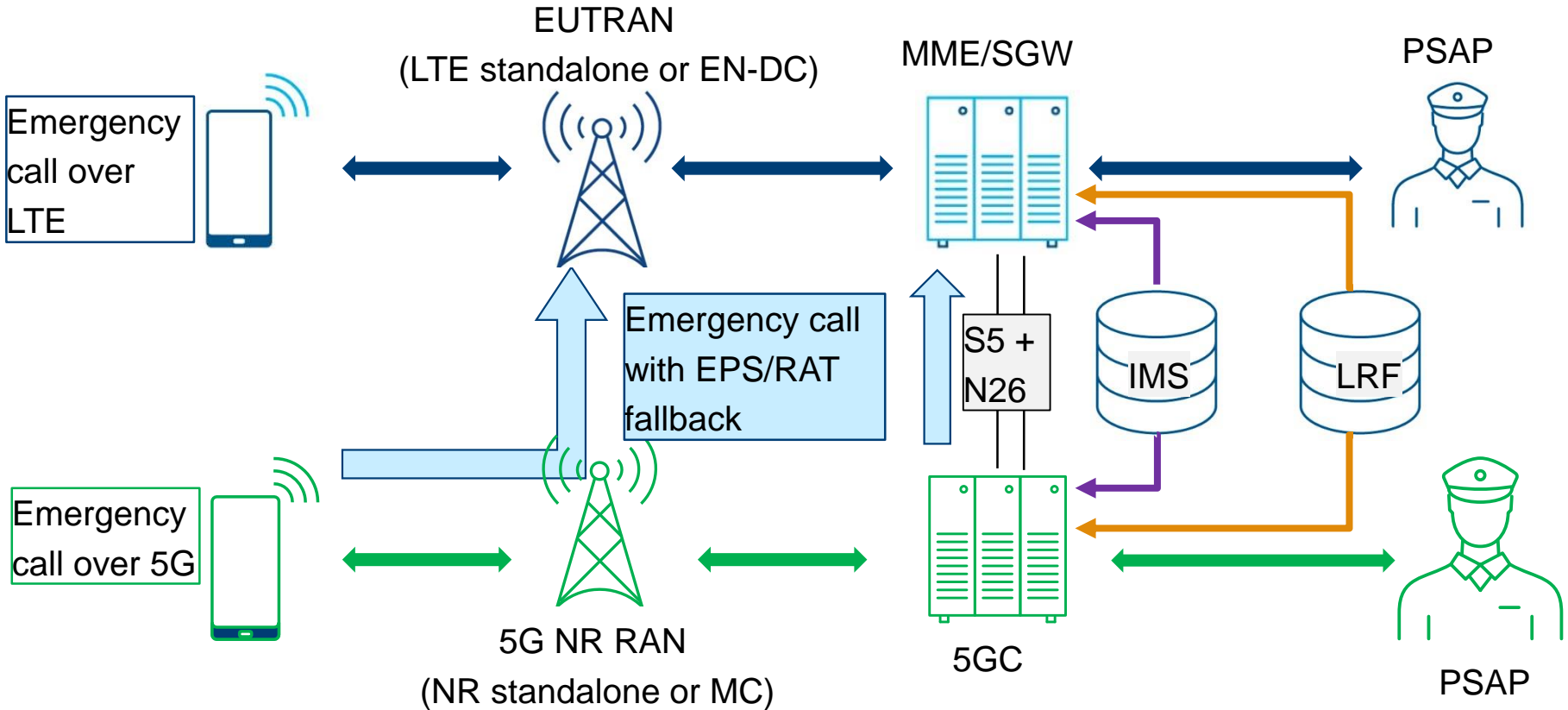
Source codec bit-rate (kbit/s)
6,6
8,85
12,65
14,25
15,85
18,25
19,85
23,05
23,85

AMR-WB interoperable mode for legacy codec compliance

SHORT MESSAGE SERVICE IN 5G NR



IMS EMERGENCY SERVICE OPTIONS IN LTE + 5G NR



R&S®CMX500 - 5G NR RADIO COMMUNICATION TESTER



R&S®CMX500 - 5G NR RADIO COMMUNICATION TESTER



CMX500 5G NR Signaling Tester

Future proof 5G NR signaling test platform

Independent Operating System (Linux)

Modular and scalable HW-Architecture

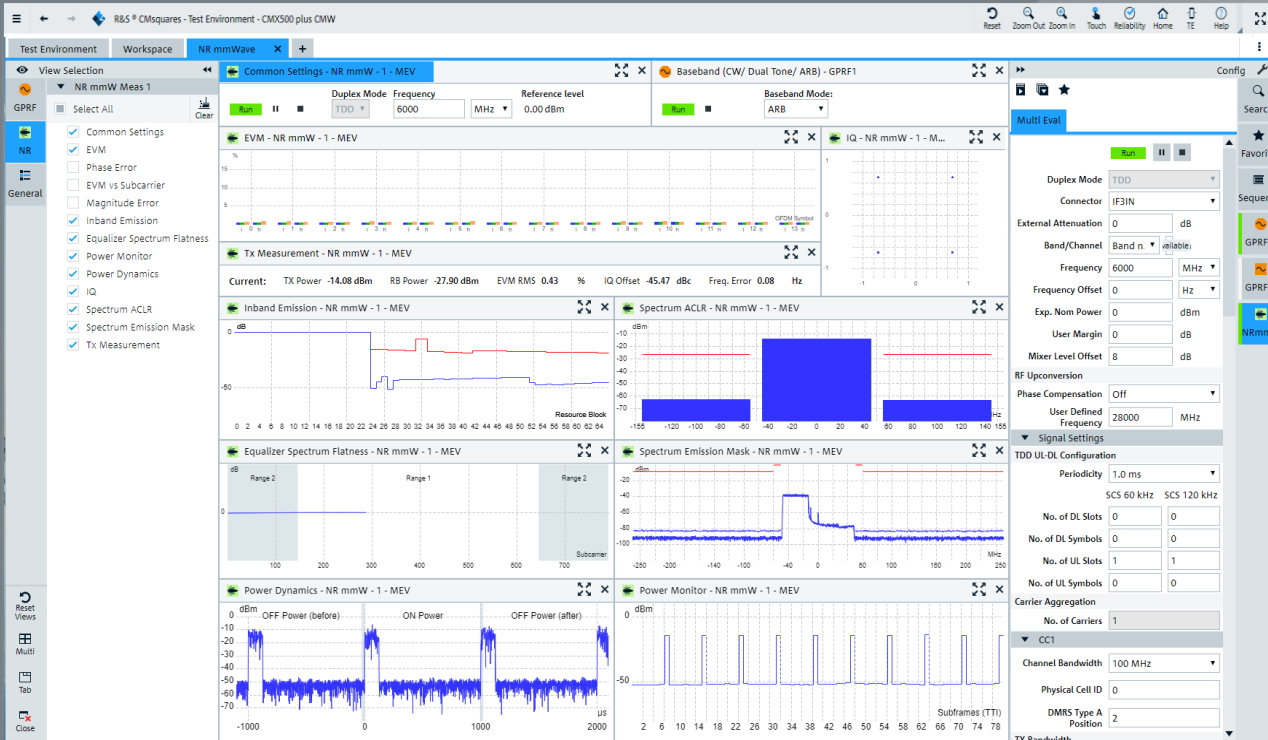
20 Gbps+ End-to-End IP Data Performance capability

FR2 Multiband Remote Radio Support (24 – 43.5GHz)

Single Web-based GUI for RF, Protocol and App Tests

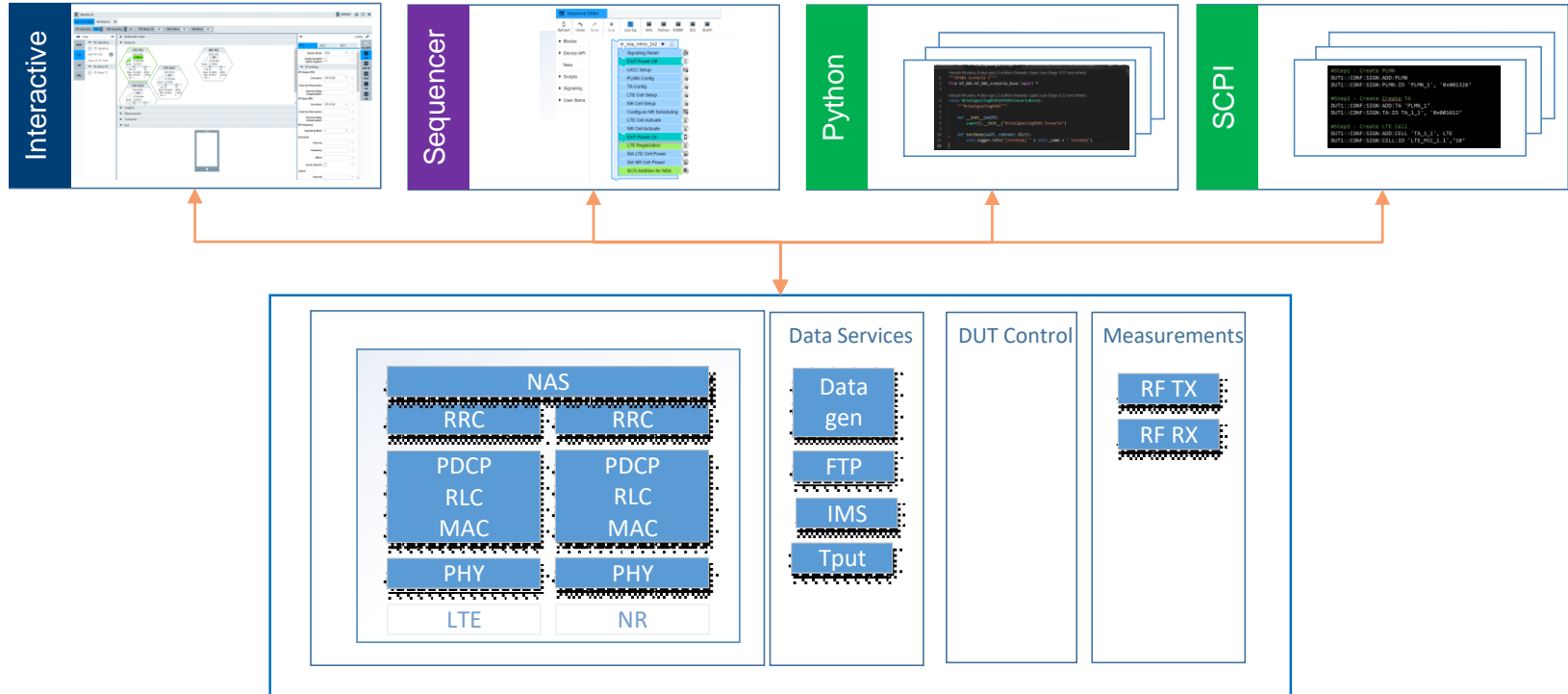
LTE Anchor support for up to 8CC LTE, 8x4 DL MIMO and 1024QAM (with CMW500)

UNIFIED USER INTERFACE FOR PROTOCOL, RF AND APPLICATION TESTING



CUSTOMER INTERFACES

REMOTE CONTROL

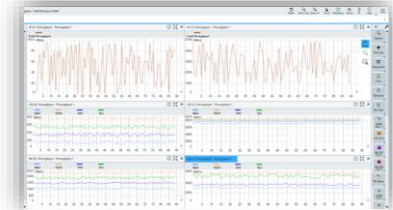
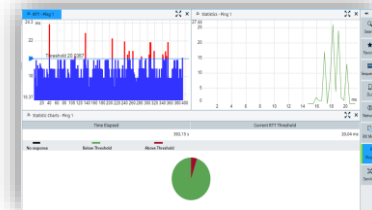
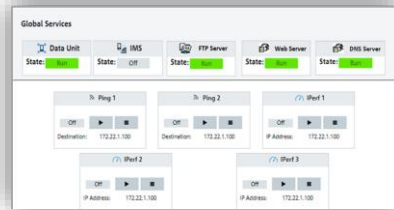


R&S®CMX500 APPLICATION TEST



Description:

- ▶ Fully integrated „In a Box“ IP data testing environment for 5G NR FR1/FR2 NSA and SA testing
- ▶ Optimized IPv4/IPv6 and Server environment for high throughput and low latency verification
- ▶ IP measurements and integrated tooling to support 5G E2E IP throughput test and latency measurement use-cases
- ▶ “Ready to use” and fully integrated application servers for testing common internet services e.g. File-Transfer, Web-Browsing, IMS-Services, Media-Streaming...
- ▶ “Simple to use and easy to configure” by **R&S®CMsquares** interactive mode or via remote (SCPI & XLAPI)



R&S®CMX500 APPLICATION TEST

Add measurements to Workspace

- Ping
- Iperf
- Throughput

The screenshot displays the R&S CMX500 software interface. The top section shows a 'Test Environment' workspace with a 'Network square' containing 'Cabling and DUT square'. Below this, a 'Services square' window is open, showing 'Global Services' with buttons for Data Unit, DNS, IMS (highlighted with a red box), FTP, and HTTP. Below these are four test application cards: 'Ping 1', 'Ping 2', 'IPerf 1', and 'IPerf 2', each with 'Off', 'Run', and 'Stop' buttons and a destination or IP address. The right side of the interface shows 'Services Configuration' for 'DUT State', including 'Common Settings' (MTU, IPv4 Mode, IPv6 Mode) and 'IPv4 Static' configuration (Application Tester, IPv4 Gateway, IPv4 addresses, Subnet Mask). A 'DUT' section lists various network interfaces like LTE TX 1, LTE TX 2, NB FR1 TX 1, NB FR2 TX 1, and RX Mess. The bottom status bar shows 'CopyMoveExport (1).zip' and 'CopyMoveExport.zip'.

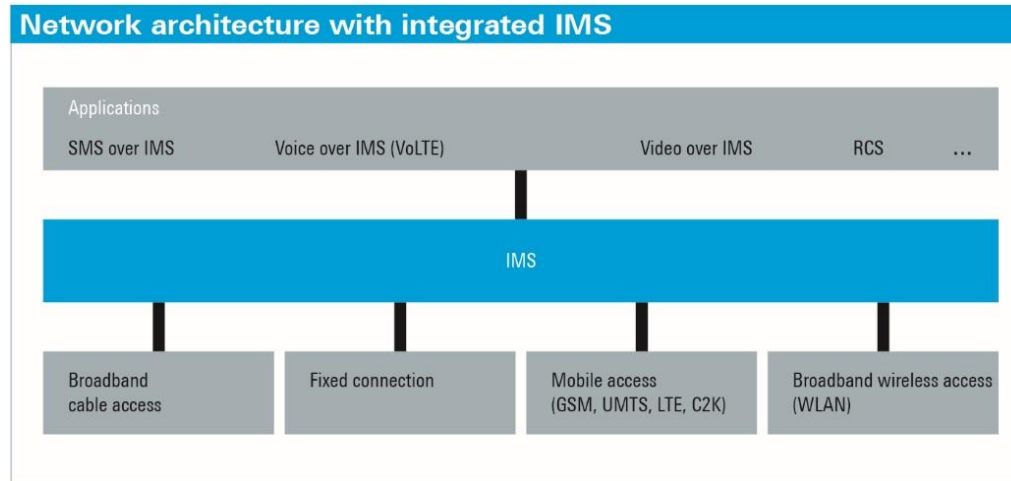
Configure IP settings and servers

Services Configuration

INTRODUCTION IMS – IP MULTIMEDIA SUBSYSTEM

DEFINITION

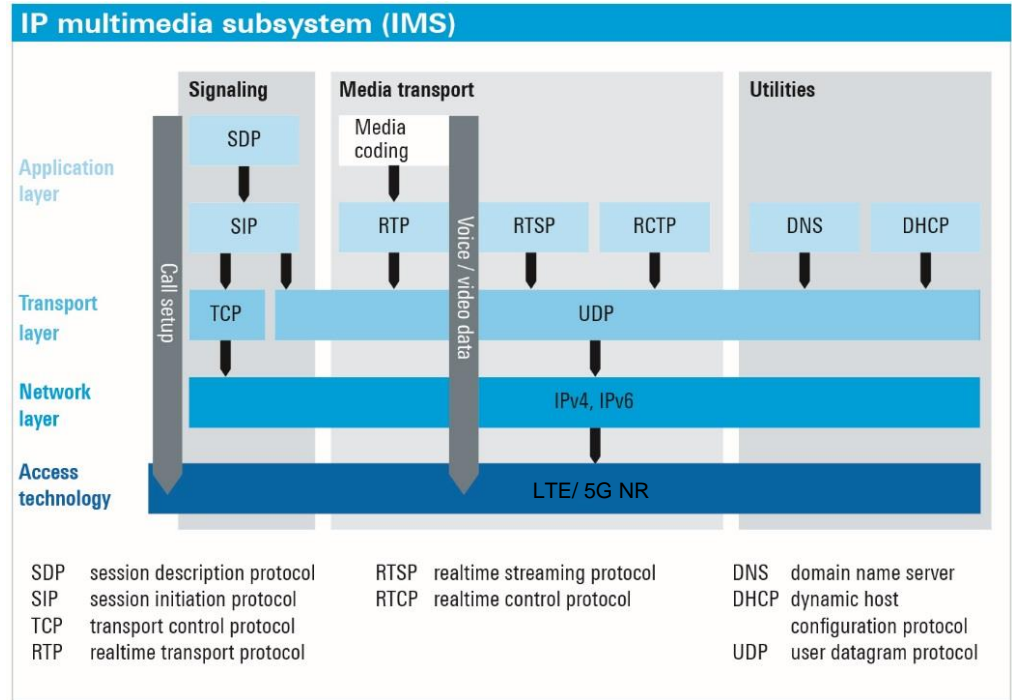
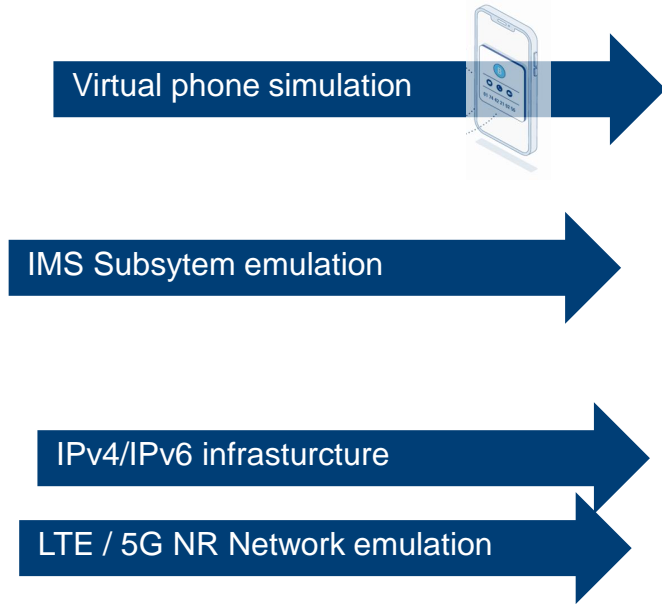
- ▶ IMS is the enabler for VoLTE & VoNR, SMS over IMS and value adding services.



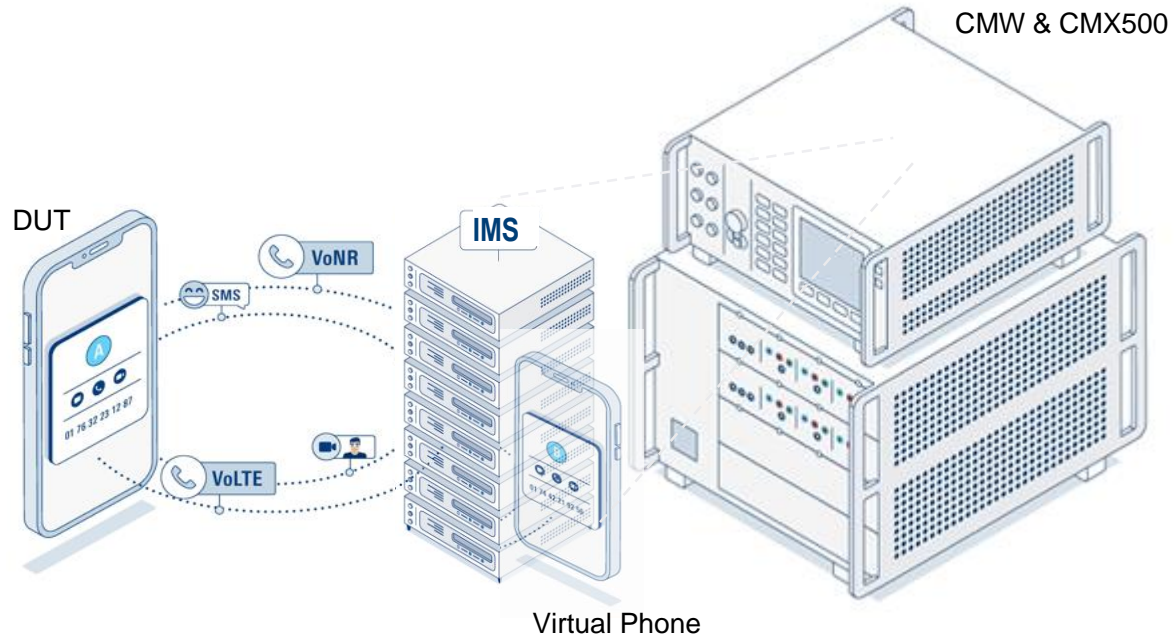
- ▶ IMS is a global access-independent and standards-based IP connectivity and service control architecture that enables various types of multimedia services to end-users using common Internet-based protocols.

IMS PROTOCOL STRUCTURE

TEST SOLUTION REQUIREMENTS



TEST SETUP



IMS SERVER

Use Case:

- ▶ Verification of IMS related functions e.g. registration procedures or voice/video calls
- ▶ Configuration of the internal IMS server
 - Switch ON/OFF
 - Configure parameters:
 - e.g. IP Sec Encryption Algorithm
 - Integrity Algorithm a.o.
 - Perform Voice and Video calls
 - ...

Services Configuration

DAU Config DNS **IMS**

Call Settings

Network Settings

- Authentication Scheme: AKA V1
- IPsec Enabled:
- IPsec Encryption Algorithm: Null Encryption
- IPsec Integrity Algorithm: Auto
- TCP Keep Alive: ON
- UDP TCP Threshold: Default 1300
- Timer T1: Default 2000
- Media Endpoint: Internal Loopback

Virtual UE

- Signaling Type: Without Preconditions
- Dedicated Bearers:
- Video Codec: H.264
- Video Attributes: [Red bar]
- Audio Codec: AMR-WB
- AMR-WB Alignment: Bandwidth Efficient

Modes [kb/s]	06.60	08.85	12.65
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

IMS

State: Run

Internal Loopback

External DAU USB sound card

Internal Loopback

IP Forward

Audio Codec: AMR

Alignment: Bandwidth Efficient

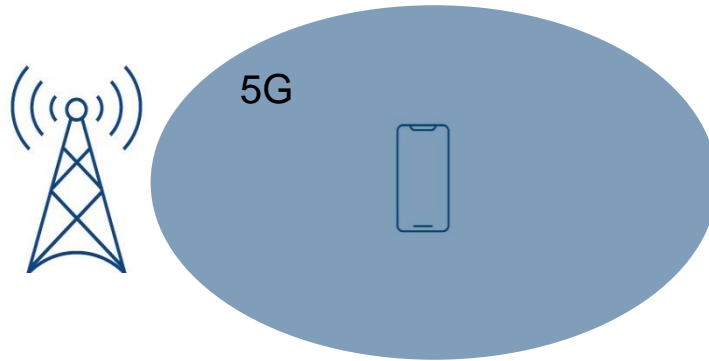
Modes [kb/s]	4.75	5.15	5.90	6.70
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

VoNR

- ▶ 5G SA Mode
- ▶ Successor of VoLTE
- ▶ Uses IMS as service enabler
- ▶ Ultra fast call setup time
- ▶ High quality Voice service

Procedure:

- ▶ UE registers to the 5G cell and internal CMX500 IMS Server
- ▶ User establishes a voice call with the UE
- ▶ The internal IMS Server set up the bearer with the 5G core
- ▶ Call is established in 5G
- ▶ The user can listen to the echo/loopback voice at the loudspeaker of the DUT

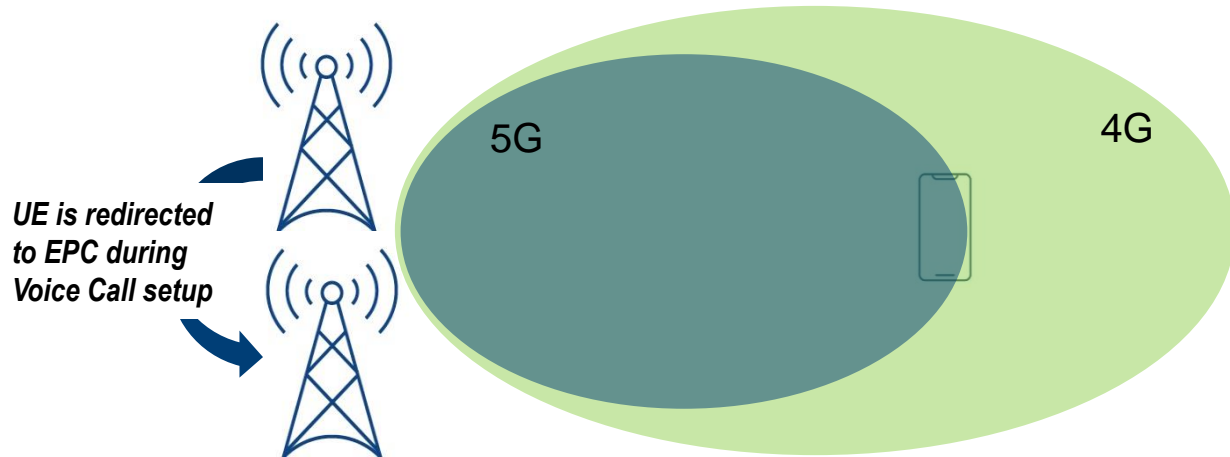


EPS FALLBACK

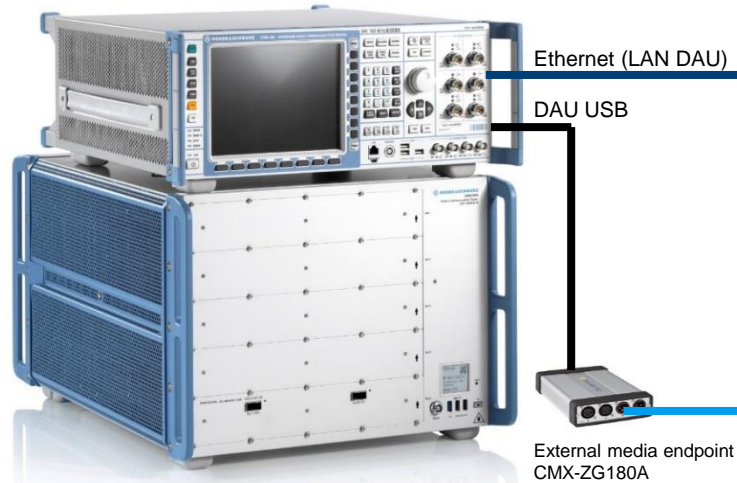
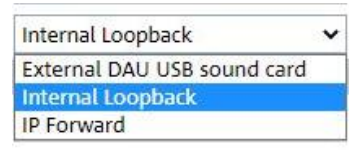
- ▶ Weak 5G coverage
- ▶ 5G cell not configured for VoNR calls
- ▶ Mobile device doesn't support VoNR calls
- ▶ Avoid handover during a call @ the cell edge

Procedure:

- ▶ UE registers to the 5G cell and internal CMX500 IMS Server
- ▶ User establishes a voice call with the UE
- ▶ The internal IMS Server tries to set up the bearer and the 5G core triggers the redirection to 4G
- ▶ After the redirection to 4G voice bearer setup continues / tracking area update happens and the VoLTE call is established
- ▶ The user can listen to the echo/loopback voice at the loudspeaker of the DUT



USE CASE: 5G AUDIO QUALITY TEST



Audio Analyzer

Ethernet interface

Audio Analyzer

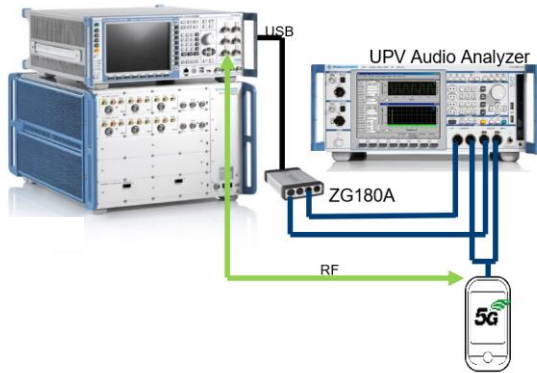
analog interface with e.g.
XLR connectors

Minimum Footprint Setup

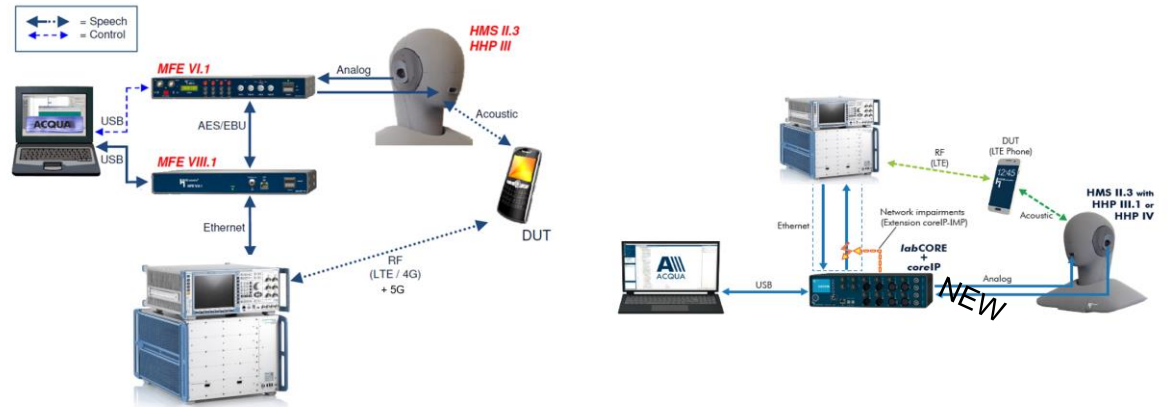
USE CASE: 5G AUDIO QUALITY TEST

Internal Loopback	▼
External DAU USB sound card	
Internal Loopback	
IP Forward	

Example Solution 1:



Example Solution 2:



POLQA test with R&S UPV- or other Audio Analyzers

VOICE OVER 5G – EVOLUTION, DEPLOYMENT, TECHNOLOGY AND TESTING ASPECTS

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