

Deep Dive into 5G Voice EPS Fallback “Everything You Need to Know”

Optimization



Technology



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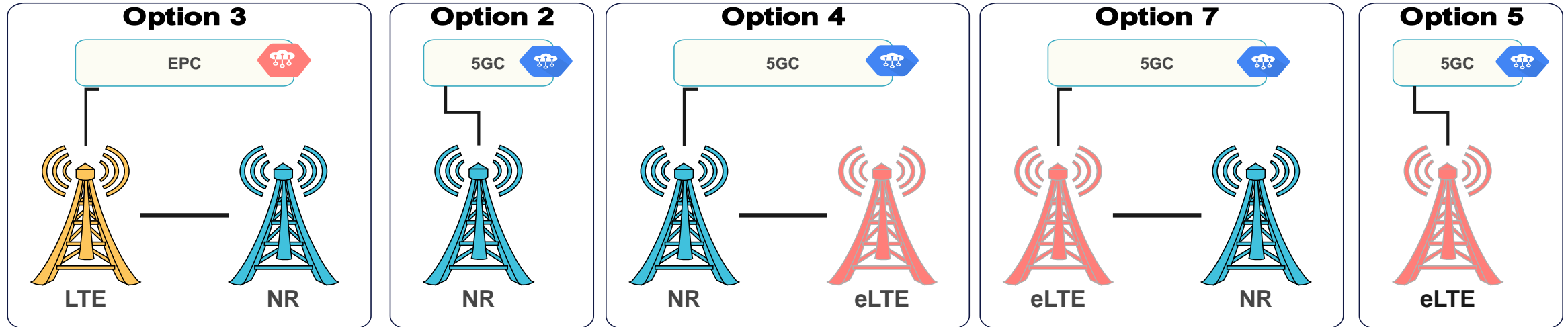
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5G Voice Services

- In 5G, the availability of specific solutions for the voice service depends **upon the Base Station architecture**.
- The solutions associated with each architecture are summarized in the below figure.
- All architectures support **OTT applications because these only require a data connection**, which can be either **an EPS Bearer towards the 4G core network** or **a PDU Session towards the 5G core network**.



OTT- Over the Top VoIP, e.g. Skype, Whatsapp, etc.

CS Fallback

EPS Fallback

RAT Fallback

VoLTE

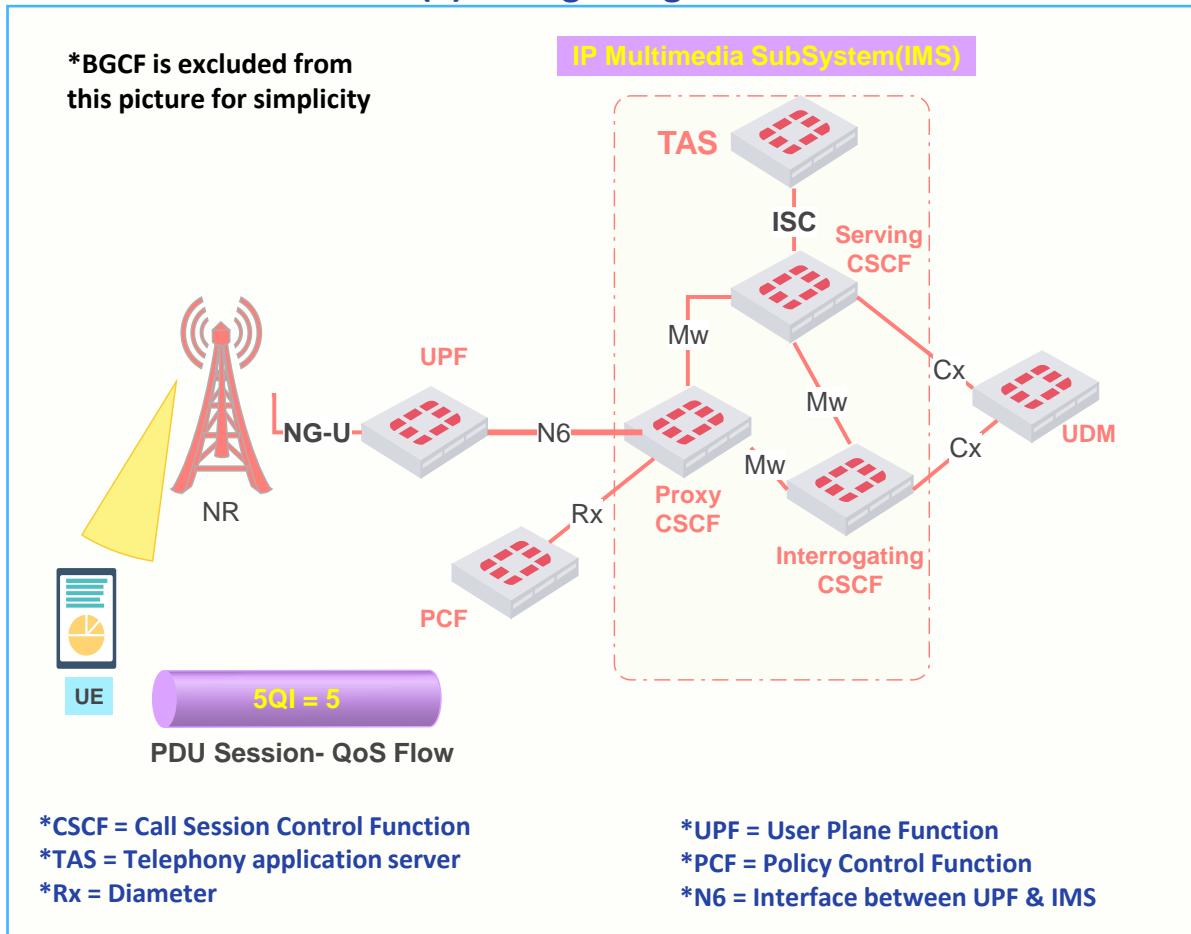
VoNR

VoeLTE 

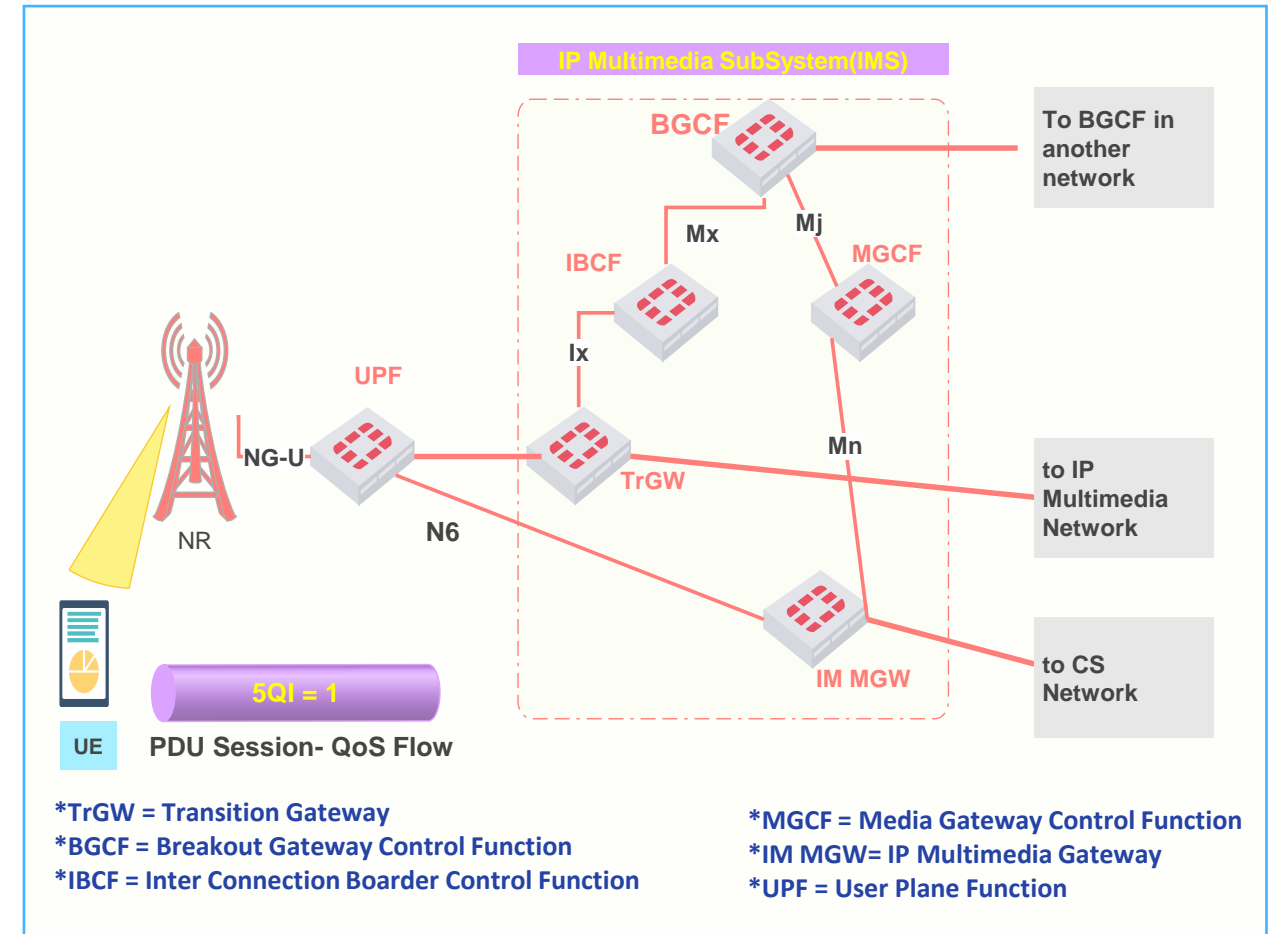
Voice Over New Radio

- Both VoNR and VoLTE rely upon connectivity **to an IP Multimedia Subsystem (IMS) to manage the setup**, maintenance, and release of voice call connections. Session Initiation Protocol (SIP) is used **for signaling procedures between the UE and IMS**.
- The general network architecture for transferring the **user plane speech packets** is illustrated in the figure below. **The PDU Session provides connectivity** between the UE and the UPF, **whereas the N6 interface provides connectivity** between the UPF and the IMS:

(1) SIP Signaling with IMS

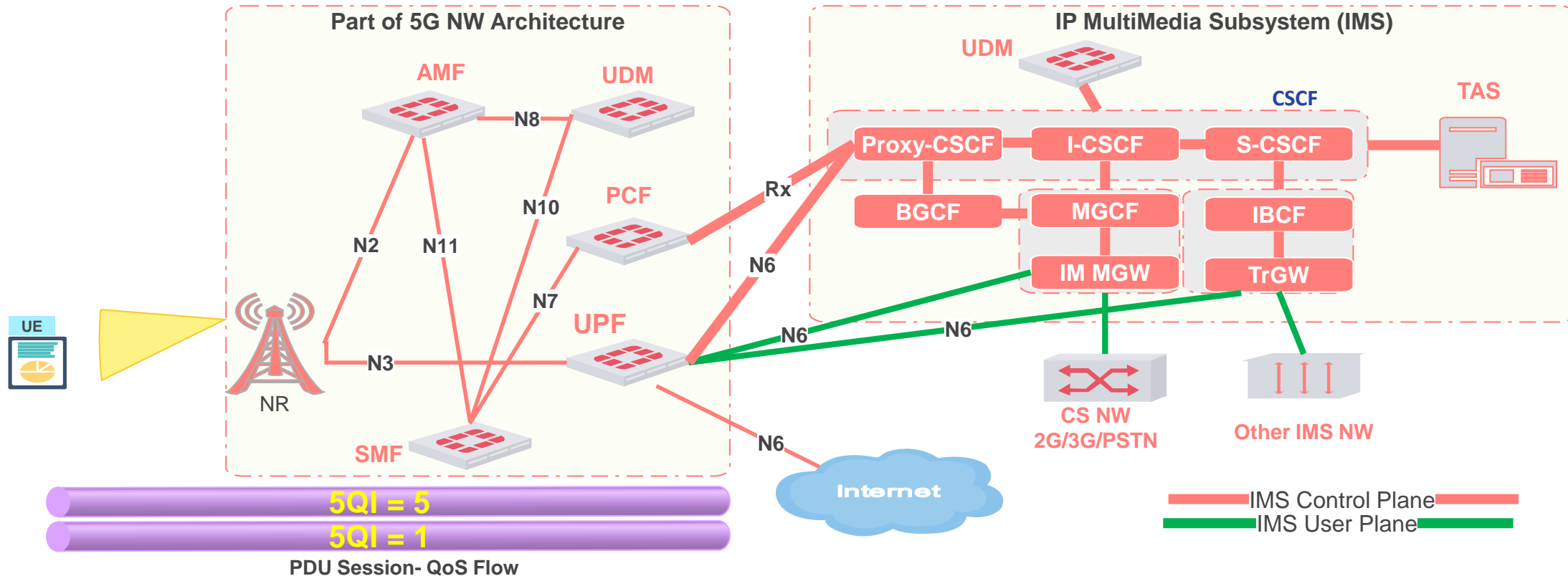


(2) Speech Packets Transfer



Voice Over New Radio

- Both VoNR and VoLTE rely upon connectivity to an IP Multimedia Subsystem (IMS) to manage the setup, maintenance, and release of voice call connections. Session Initiation Protocol (SIP) is used for signaling procedures between the UE and IMS.
- The general network architecture for transferring the user plane speech packets is illustrated in the figure below. The PDU Session provides connectivity between the UE and the UPF, whereas the N6 interface provides connectivity between the UPF and the IMS:



*CSCF = Call Session Control Function
 *I-CSCF = Interrogating CSCF
 *TAS = Telephony application server
 *Rx = Diameter

*UPF = User Plane Function
 *PCF = Policy Control Function
 *N6 = Interface between UPF & IMS

*TrGW = Transition Gateway
 *BGCF = Breakout Gateway Control Function
 *IBCF = Inter Connection Boarder Control Function

*MGCF = Media Gateway Control Function
 *IM MGW= IP Multimedia Gateway
 *UPF = User Plane Function

Fallback Mechanisms: EPS Fallback Vs. RAT Fallback

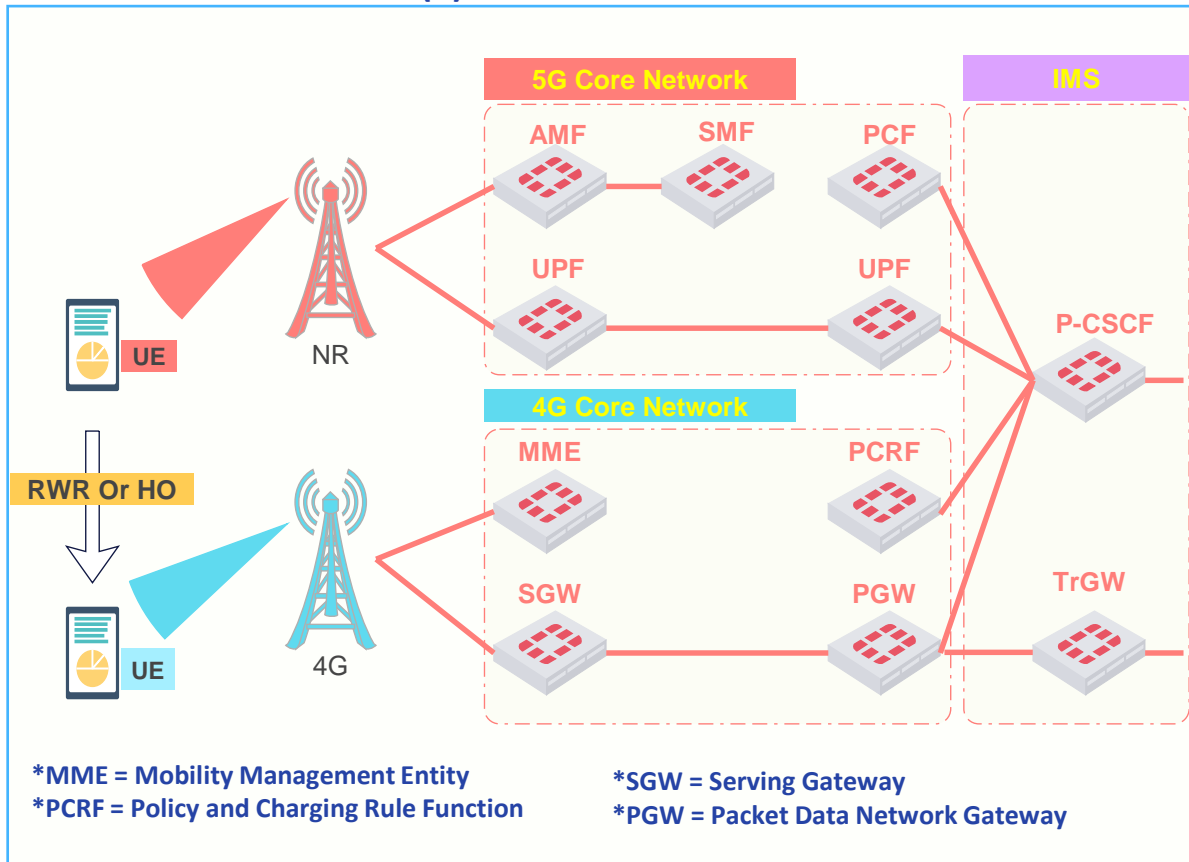
Why is Fallback necessary? When VoNR is not feasible due to any of the following reasons, Fallback to LTE will be initiated to establish voice services in VoLTE:

1. UE lacks VoNR capability.
2. The network lacks VoNR capability.
3. Both UE and the network lack VoNR capability.
4. Poor Coverage in VoNR, In such cases, EPS Fallback ensures a more reliable voice service by transitioning to LTE.

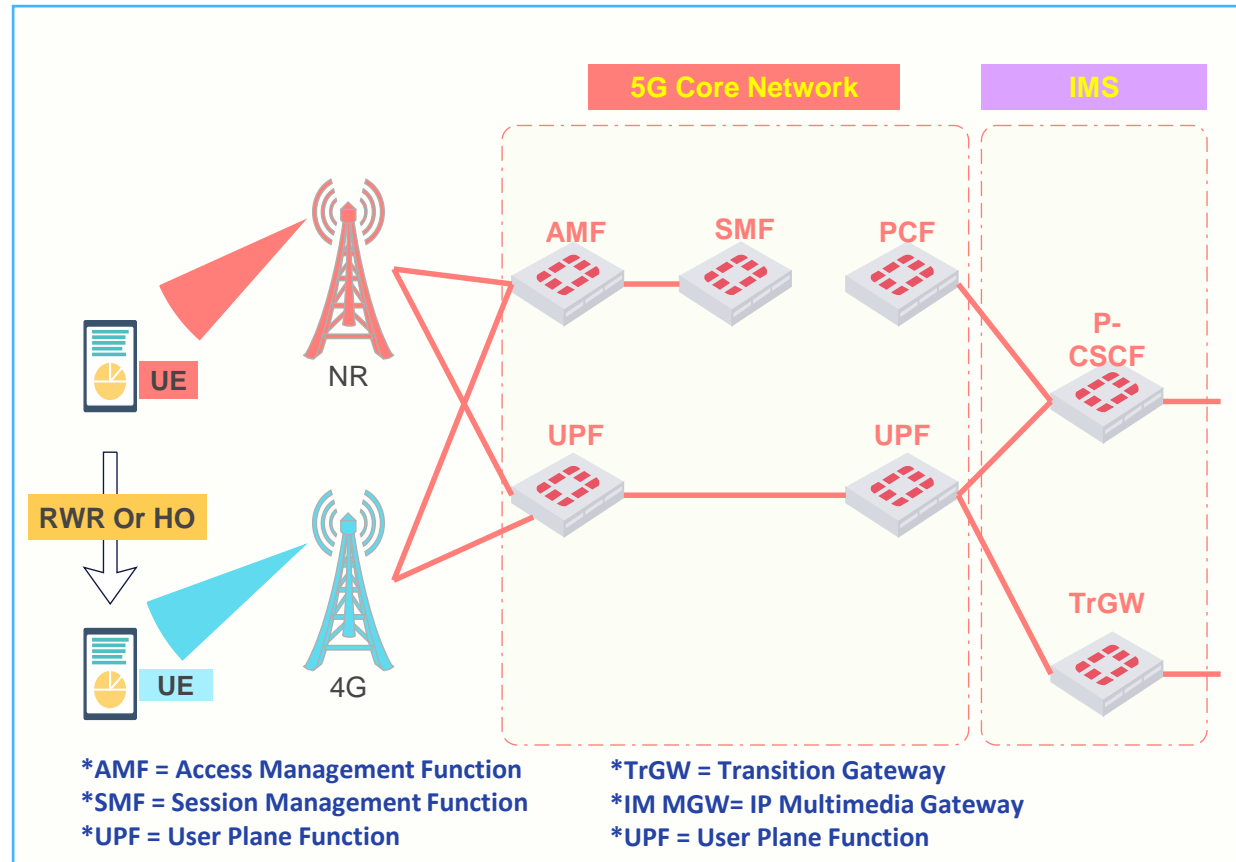
3GPP Specifies two fallback mechanisms to support IMS Voice services as follows:

Source: 5G NR in Bullets

(1) EPS Fallback

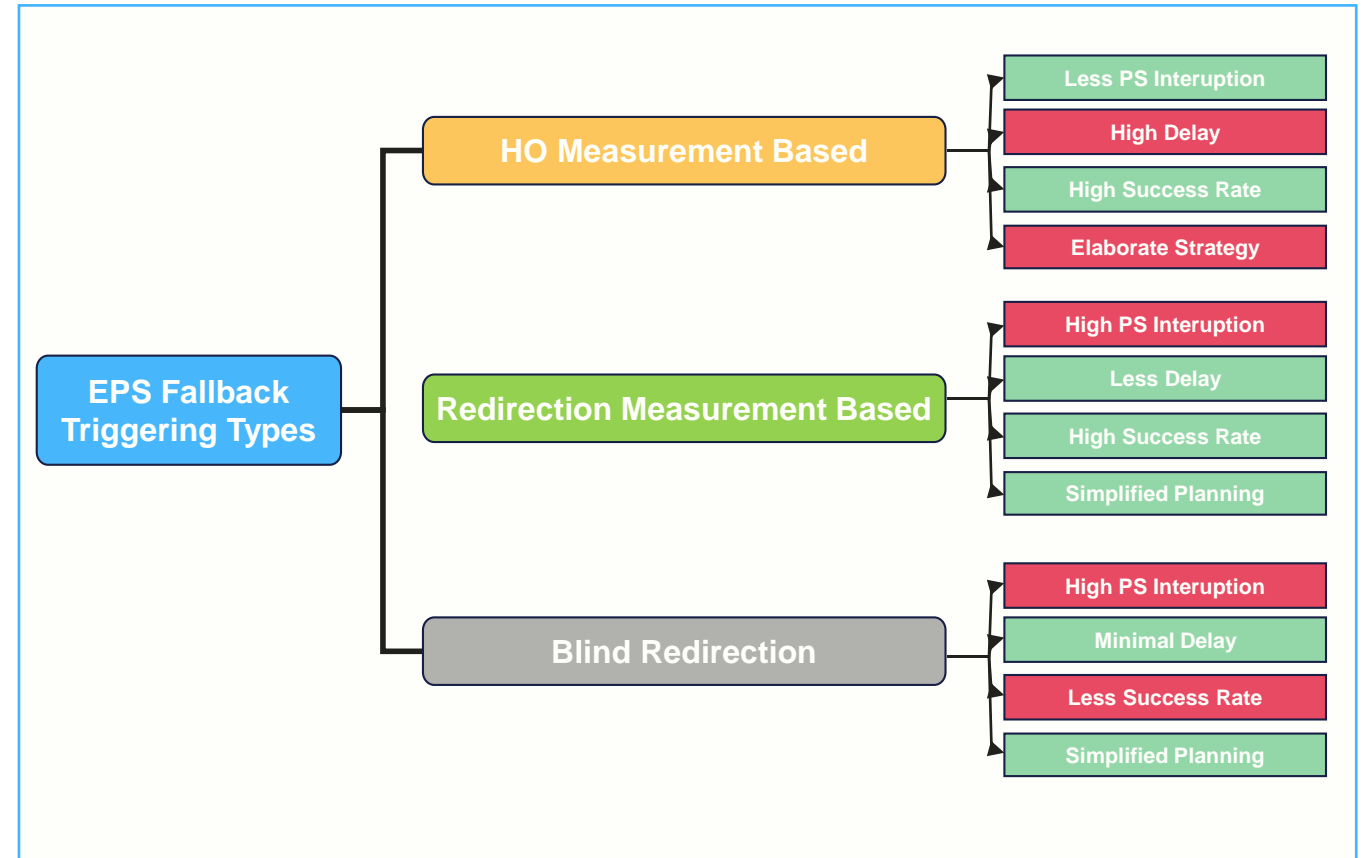
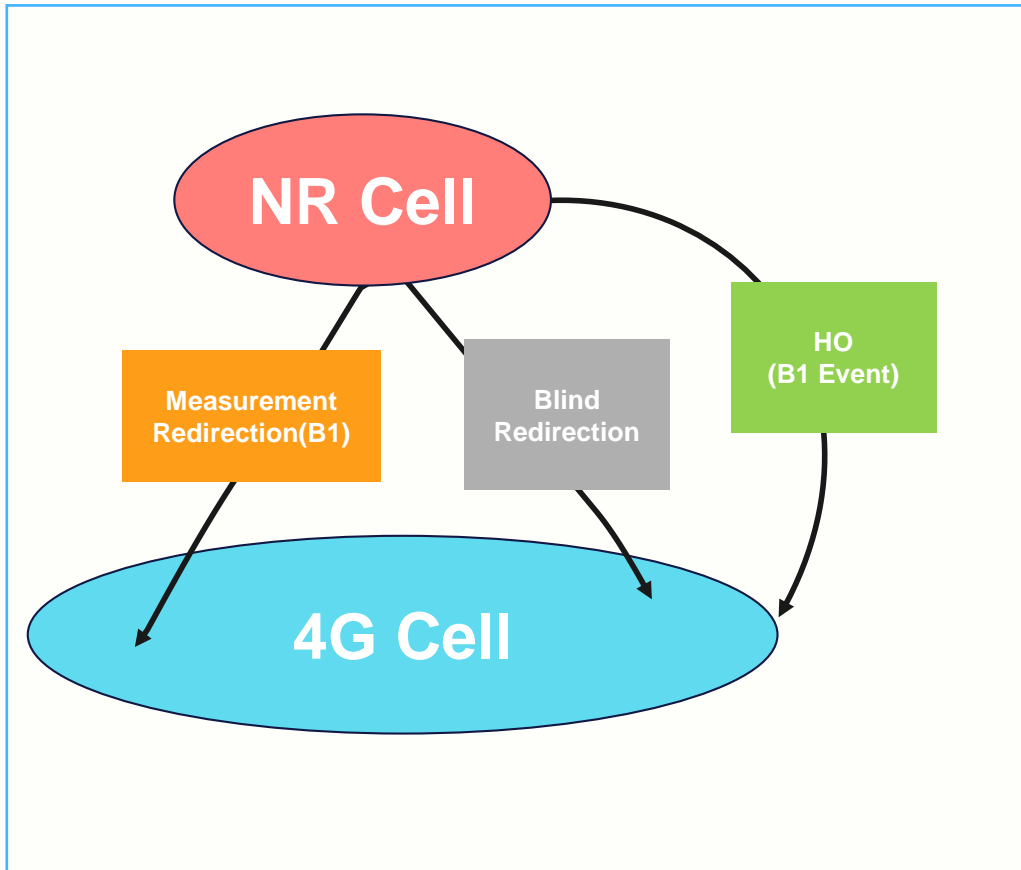


(2) RAT Fallback



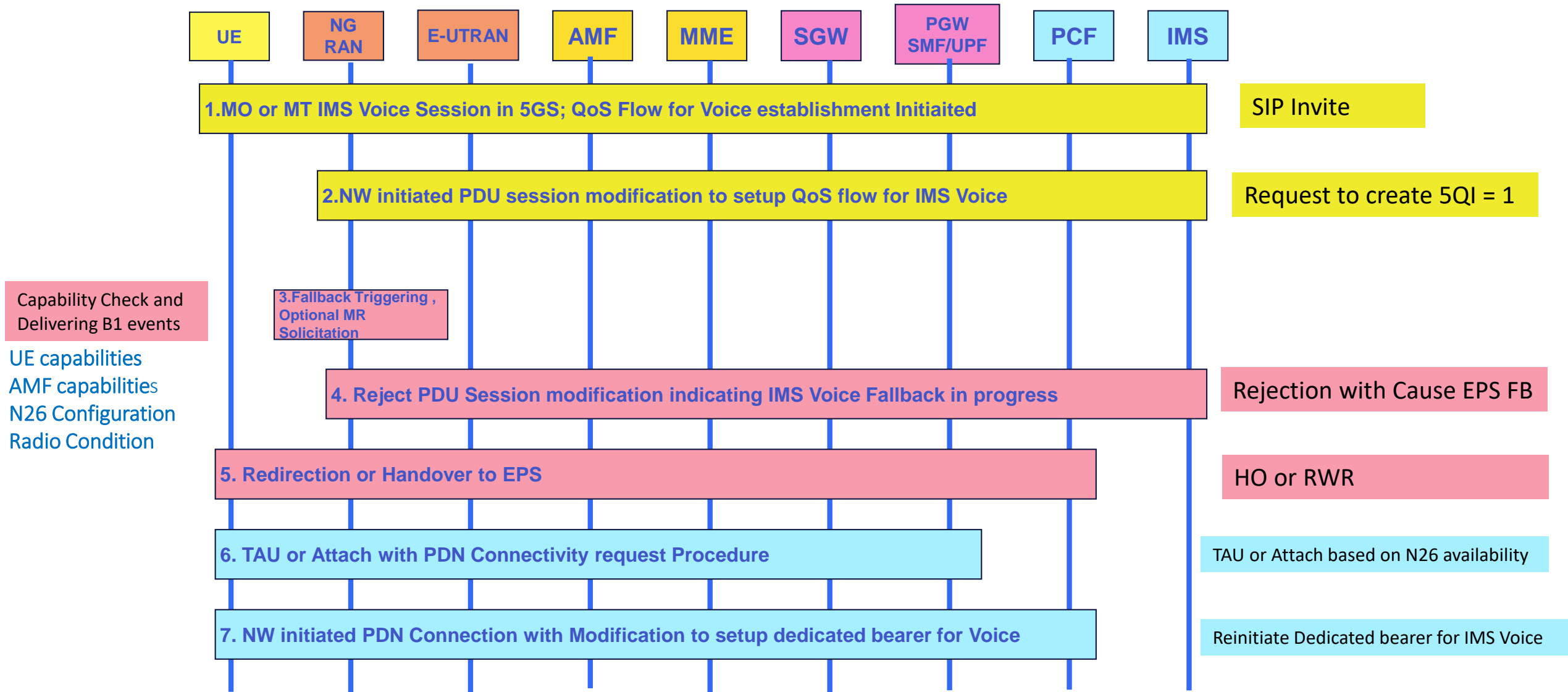
EPS Fallback Triggering Methods

- EPS FB Transfer an NR-Capable UE to an LTE connection when a voice call is made



EPS Fallback for IMS Voice – High-level Signaling View

- 3GPP TS 23.502: General Signaling Flow for EPS Fallback



Network & UE Capability

According to 3GPP TS 23.502,

If NG-RAN is configured to support EPS fallback for IMS voice and decides to trigger fallback to EPS, **the following is taken into account**

1. Message: NR UE capabilities:

- Supporting PS Handovers from NR to 4G
- Supporting the EUTRA Frequencies configured in gNB

```
interRAT-Parameters
├── eutra
│   └── supportedBandListEUTRA
│       ├── FreqBandIndicatorEUTRA: 0x1 (1)
│       ├── FreqBandIndicatorEUTRA: 0x2 (2)
│       └── FreqBandIndicatorEUTRA: 0x3 (3)
```

3. Message: Registration Accept

Network configuration (N26 availability)

If not supported and UE Moves to the 4G Network using an RWR, then UE completes an attach procedure to fetch the UE Context. Otherwise, UE will perform TAU.

iwk-n26-supported

2. Message: INITIAL CONTEXT SETUP REQUEST

Redirection Indication from AMF

Indication from AMF that "Redirection for EPS fallback for voice is possible. If not possible, then AN Release via inter-system redirection to EPS is not performed"

```
NGAP
Pdu: Value NGAP-PDU ..initiatingMessage
***00000
2 >09 00001001 ....procedureCode --- 0x9(9)
3 >00 00***** ....criticality --- reject(0)
...value
.....initialContextSetupRequest
.....protocolEs
.....SEQUENCE
10 >00 00000000 .....id --- 0x0(0)
11 >00 00***** .....criticality --- reject(0)
...value
RedirectionVoiceFallback Possible
```

3GPP TS 38.413

4. Message: RRC Reconfiguration message

Network configuration (Measurement Based)

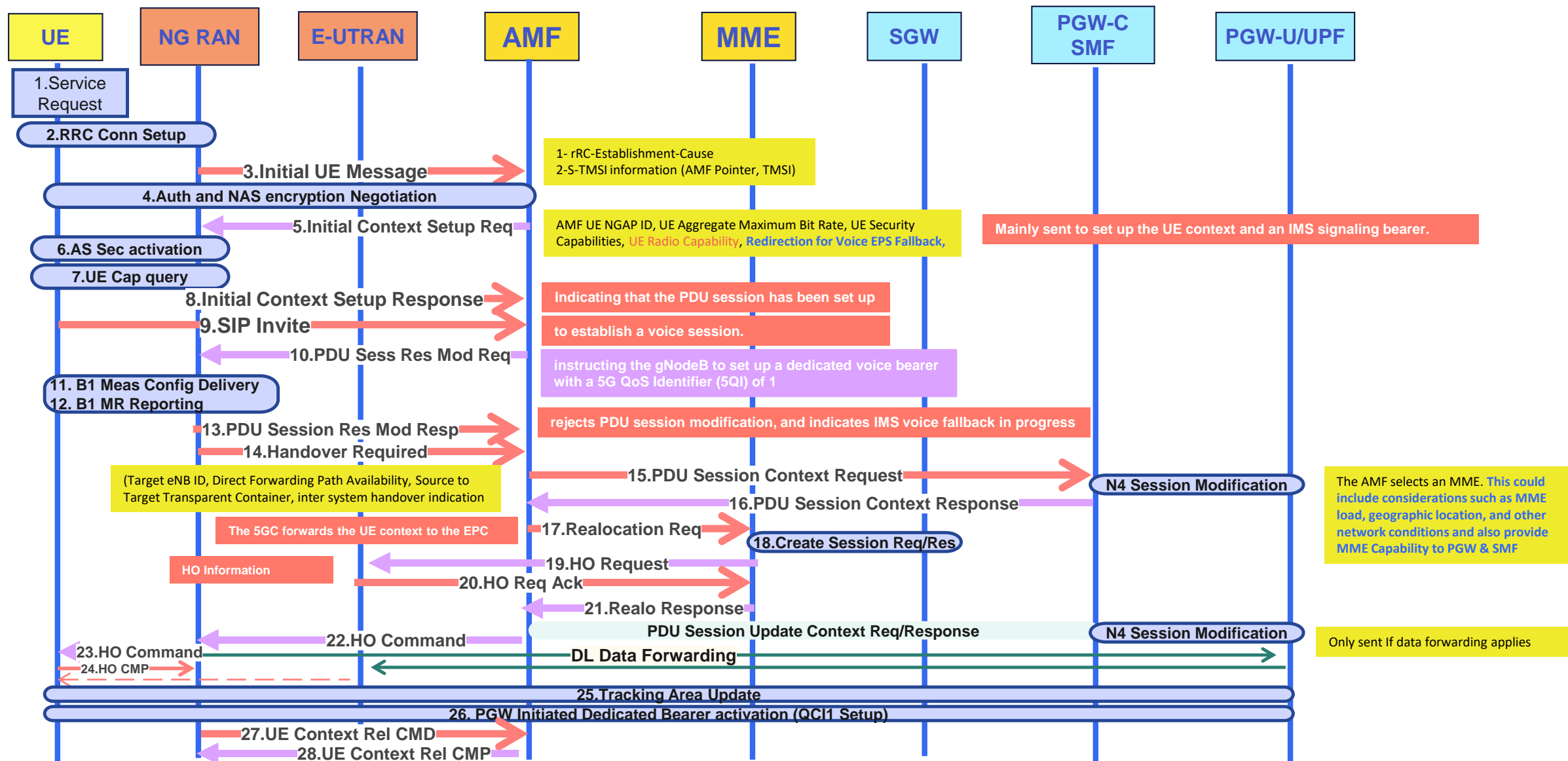
Radio Condition: if the configuration is based on measurement, then NG-RAN will initiate measurement report solicitation from the UE, including E-UTRAN as a target.

```
rrcReconfiguration
measconfig
measobjectToAddModList
MeasobjectToAddMod
measobjectid = 2
measobject
carrierFreq = 1850
allowedMeasBandwidth = mbw75
eutra-PresenceAntennaPort1 = false
eutra-Q-OffsetRange = dB0
widebandRSRQ-Meas = true
measobjectToAddModList
MeasobjectToAddMod
measobjectid = 3
measobject
carrierFreq = 700
allowedMeasBandwidth = mbw75
eutra-PresenceAntennaPort1 = false
eutra-Q-OffsetRange = dB0
widebandRSRQ-Meas = true
```

```
reportconfigId = 2
reportconfig
reportconfiginterRat
trigger type
event
eventid
eventB1-
b1-Threshold
RSRP (45)
Hysteresis: 0x2(2)
```

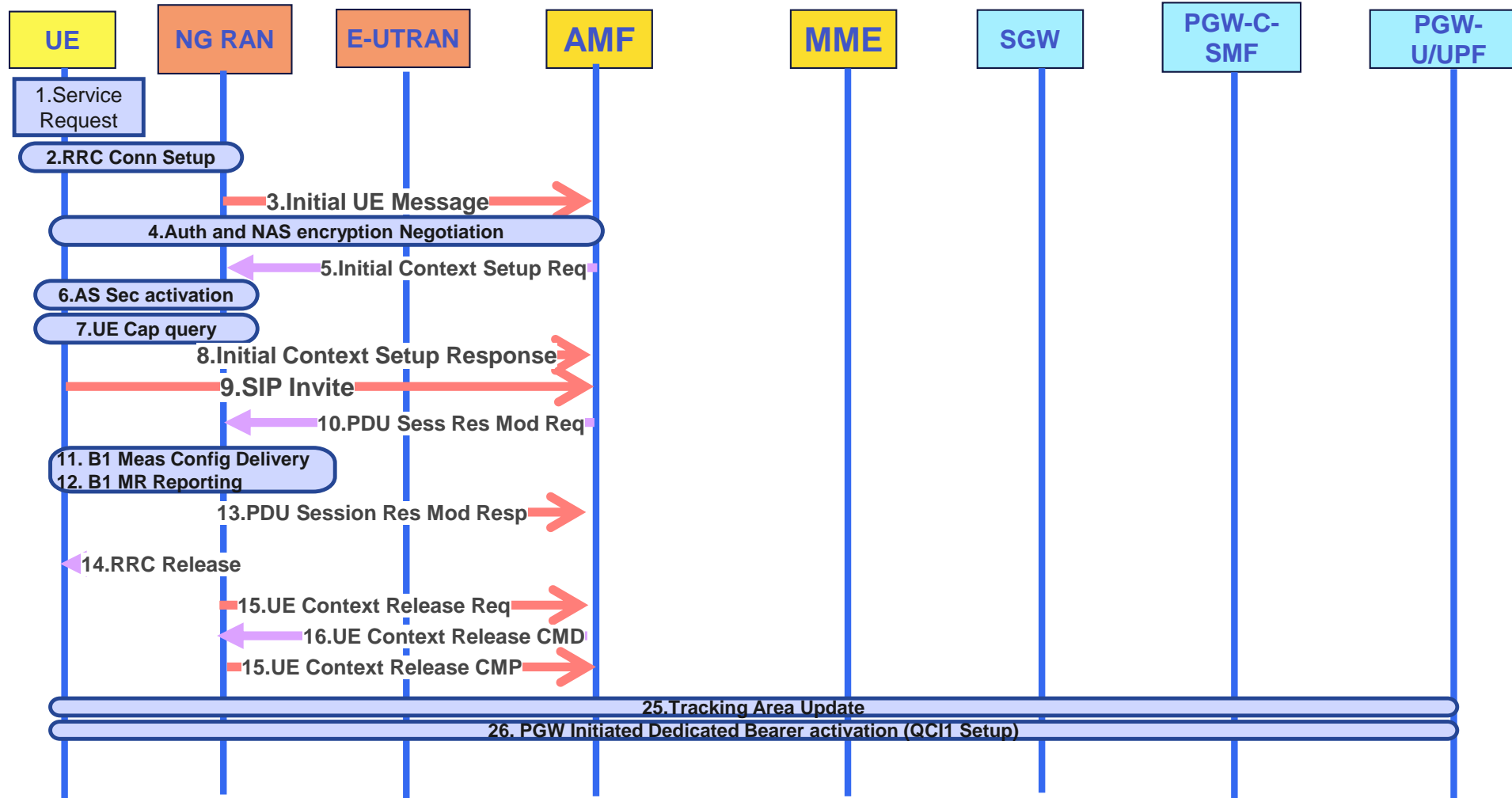
EPS Fallback for IMS Voice – 5GS to EPS handover

- 3GPP TS 23.502: NR to 4G IRAT Handover with N26 Interface Procedures:



EPS Fallback for IMS Voice – 5GS to EPS Redirection

- 3GPP TS 23.502: NR to 4G IRAT Redirection with N26 Interface Procedures:



How to Calculate the EPS Fallback Setup Time?

EPS FB Time = Ringing 180 – SIPP Invite

RWR & HO Measurement
3~4 Second

RWR Blind
1~1.5 Second

