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# 5G voice – network evolution aspects

Voice services in a 5G System with 3GPP option 2 deployment

# Abstract

This document is part of a series of papers explaining the network evolution aspects for 5G voice services. The intended audience for this paper is familiar with 4G VoLTE and wants to know how to take the voice service into 5G.

The journey to 5G has several possible migration paths and steps. Voice service must be supported in all 5G evolution steps. This paper outlines the voice service aspects, migration aspects and recommendations for deployments using option 3 and option 2.

In initial 5G deployments using option 3, 5G EPS includes NR non-standalone in the RAN. 4G voice (VoLTE) and other IMS services continue to be used without the need for any core network upgrades. IMS is not aware of the updated RAN. All 4G VoLTE principles remain.

5G system (5GS) using option 2 means NR standalone in the RAN. Initially but in some cases also longer-term, a 5G system (5GS) will not be deployed with full served network coverage. Therefore, the 5GS needs to be tightly coupled to

an existing 4G VoLTE deployment, to provide a seamless voice service across the whole 4G+5G network with good characteristics.

Voice over NR implies that voice calls can be made on NR. This requires NR in NG-RAN to support all voice related capabilities and being dimensioned for voice coverage.

Voice over NR with EPS Fallback includes an additional mobility trigger by which the UE falls back from NG-RAN to LTE during call establishment. This may be needed, e.g., in case not all feature for voice over NR are implemented in the UE or in case of temporary lack of radio resources in NR.

The intended audience for this paper is familiar with 4G VoLTE and wants to know how to take the voice service into 5G.

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# Architecture for voice over NR incl. EPS fallback

At least initially, but in some deployments also longer-term, a 5G system (5GS) will not be deployed with full network coverage. Therefore, the 5GS needs to be tightly coupled to an existing 4G VoLTE deployment to provide a seamless voice service across the whole network with good characteristics.

The architecture serving voice users with 5GS enabled in subscription is a tightly-coupled system based on:

- SMF and UPF supporting S5 which replaces the 4G PGW for voice services in the combined EPS and 5GS.
- Interworking with N26 between MME and AMF in 5GC. This enables context transfer and network-controlled handover between EPC and 5GC.
- Combined HSS/UDM network functions and PCF with Rx.
- PCF with Rx.

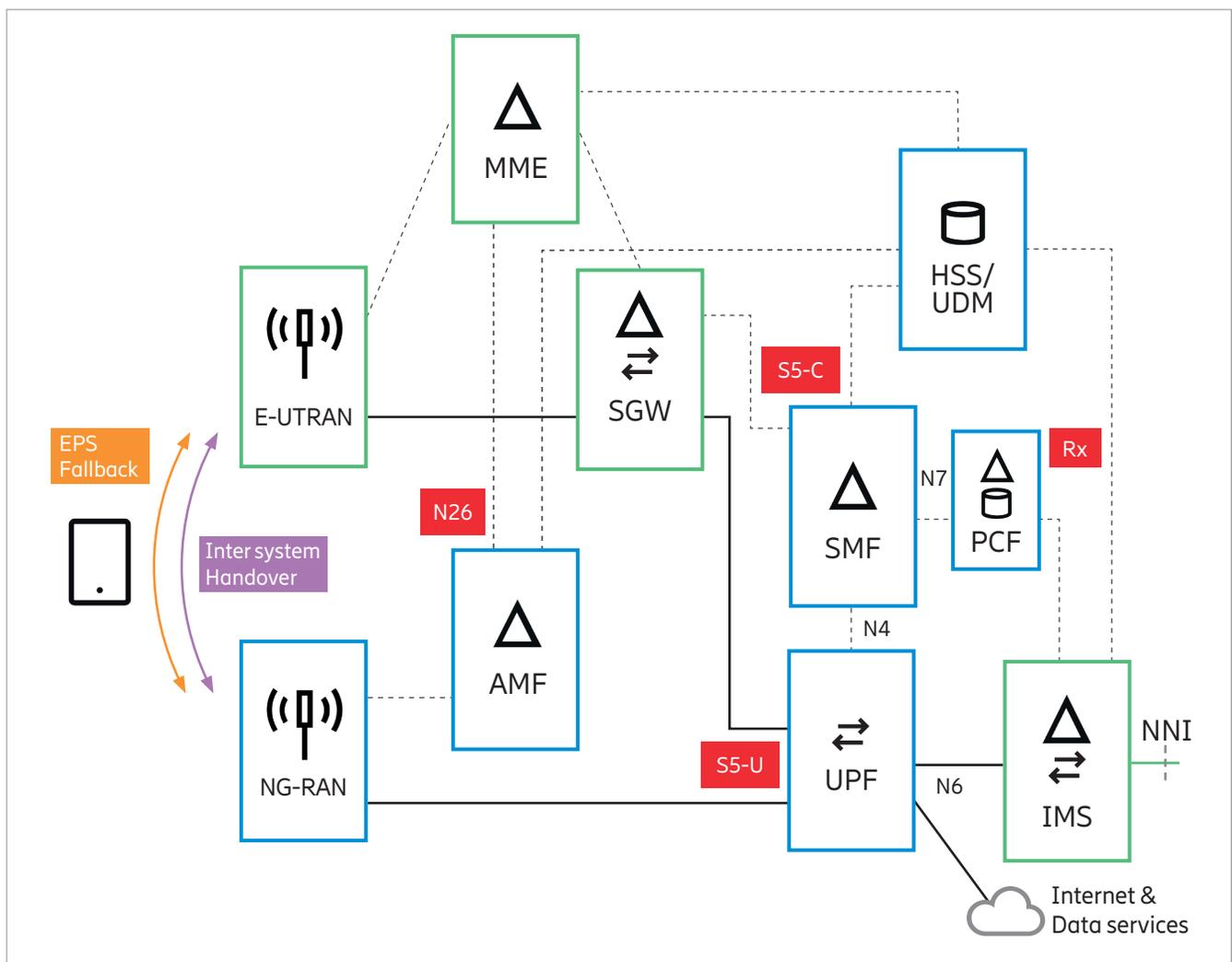


Figure 7 Conceptual architecture for voice in 5GS with tight coupling to 4G VoLTE.

The SMF and UPF provides control and user plane functions. IP flows use the same UPF controlled by the same SMF, regardless of the UE is camping on NR or LTE. The IP address of the UE can then be maintained. The SMF and UPF support the interfaces to SGW (S5-C

and EPS QoS parameters (5QI and QCI) and provides a single control point for a combined 4G/5G policy control function PCF. The SMF and UPF are also used by outbound 5G roamers to networks supporting 5GC and/or EPC.

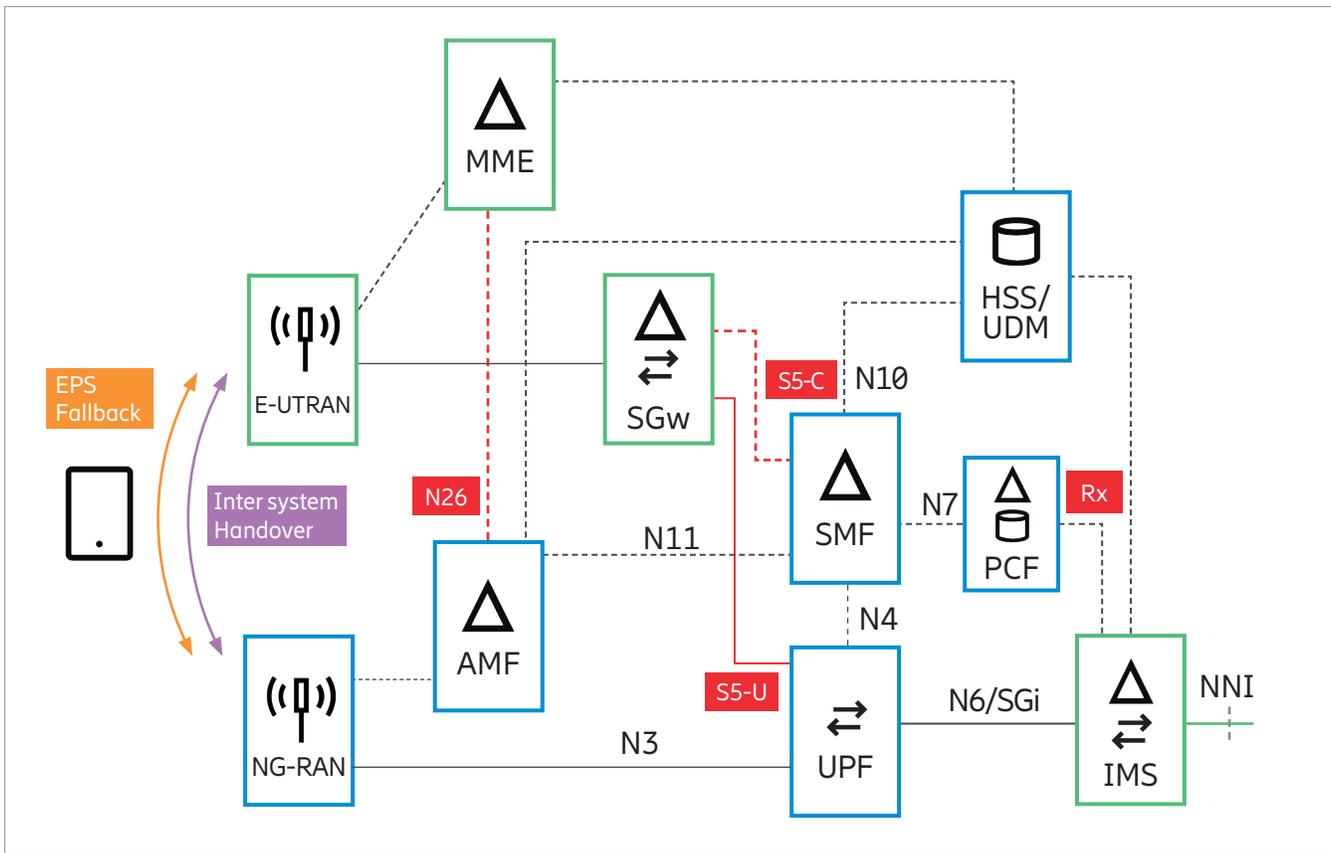


Figure 8 SMF and UPF supporting S5 and AMF interworking with N26

As shown above, a pre-requisite for the 5GS architecture is that smartphones can register to 5G Core (5GC) and IMS over NR in NG-RAN. The selection of NR is enabled by a "IMS Voice over PS indicator" in the NAS signaling from the 5GC. The smartphone's Radio Access Technology (RAT) preference setting must also be set to "NR preferred" so the smartphone stays in NR also when in overlapping LTE/NR coverage.

The combination of interworking with S5 between SMF, UPF and SGW and of interworking with N26 between

AMF and MME limits the time, added by EPS fallback, during call setup. The architecture is required to ensure that inter-system handover can be performed, without exceeding the voice gap KPI.

Ericsson does not recommend deploying 5G voice that rely on 4G coverage without tight interworking between MME and AMF (also called interworking without N26). In such deployment, network-controlled inter-system handover would not work at all and the call setup time at EPS Fallback would be much longer.

# Voice over NR

Voice over NR implies that voice calls can be made on NR SA in case of option 2. This requires UE, NR in NG-RAN, 5GC and IMS to support all voice related capabilities. It also requires that NG-RAN is dimensioned and tuned for voice.

Handover of voice calls between 5GS and 5G EPS can be performed, e.g. based on measurement reports provided by the UE.

The initial coverage and deployment scenario for voice over NR is as follows:

- NR coverage controlled by a 5G Core that supports voice. The NR coverage can be embedded in or outside LTE coverage served by EPC.
- LTE coverage controlled by EPC supporting VoLTE
- IMS emergency calls supported on NR (and LTE), if required by national regulation.

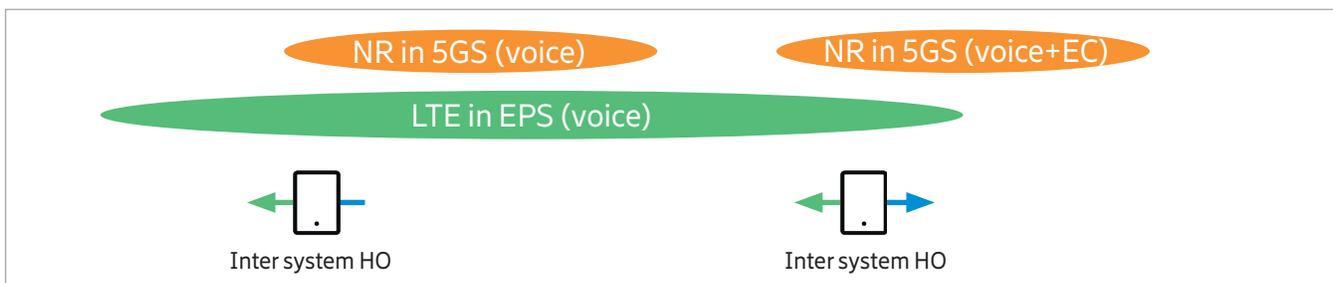


Figure 9 Typical coverage scenario for EPS and 5GS with support of voice

Handling of voice requires that both NR and UE support the QoS flow for voice over the radio access, i.e., the QoS flow establishment is supported by NR gNodeB. The NR gNodeB may initiate an inter-system handover

to EPS any time later, based on measurement reports provided by the UE.

The inter-system handover of voice calls between 5GS and EPS is described in the following figure.

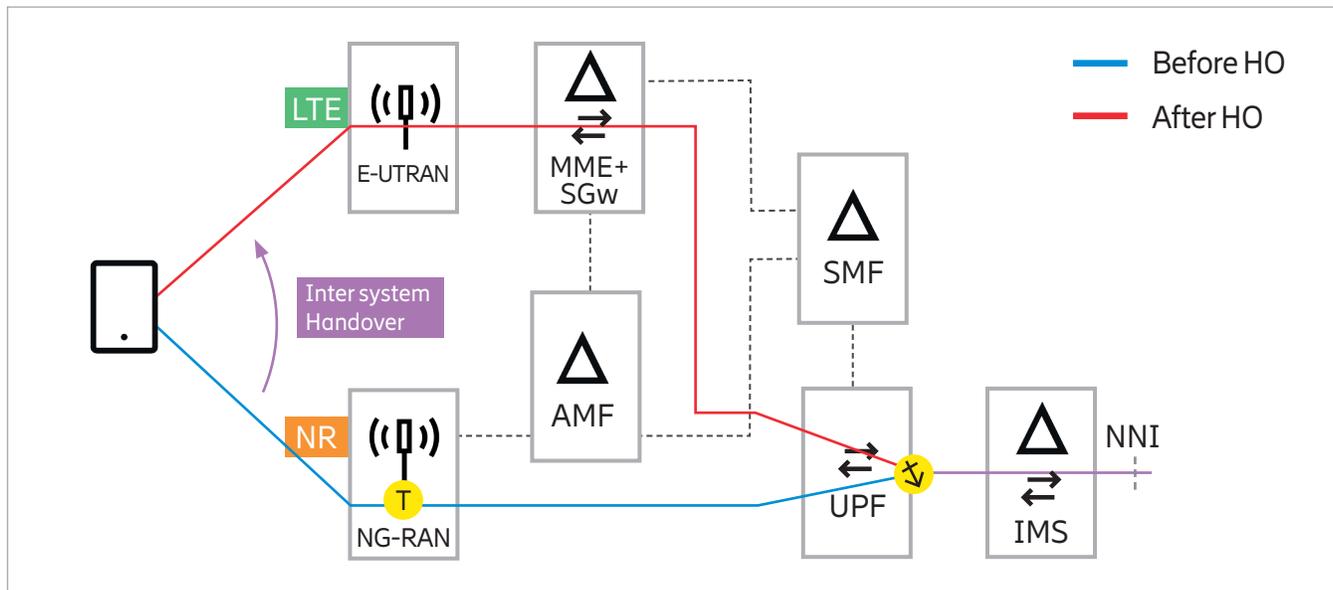


Figure 10 Conceptual illustration of a voice call intersystem handover from 5GS to EPS.

In a deployment with support of voice in 5GS, both a SMF/UPF supporting S5 and tight interworking between AMF and MME (using the N26 reference point) are key to provide seamless mobility with good voice characteristics.

The intersystem handover is triggered in NG-RAN, e.g. when loosing NR coverage during a call. NG-RAN initiates transfer of all PDU sessions from 5GS to EPS. All flows in the IMS PDU session / IMS PDN are transferred between AMF and MME, using intersystem handover signaling over N26. The SMF and UPF ensures IP address preservation and QoS mapping between 5QI and QCI for the flows in the IMS PDU

session. Handover of EPS to 5GS follows the same procedures. The intersystem handover procedure is required to fulfill the voice gap KPI.

Phased introduction of handover capabilities is possible, starting with one-way handover (NR in 5GS to LTE in EPS), followed by two-way handover. In the case of one-way handover, the phone stays on the underlying LTE network during rest of the call, even if it moves back into NR coverage.

During a voice call, after an inter system handover to LTE/EPC, 4G SRVCC can be performed if the 4G VoLTE deployment is supported by CS coverage.

# Terminology

5GC	5G Core
5GS	5G System, consists of 5GC, NG-RAN and UE
5G Voice	IMS voice in the 5G system
AMF	Access and Mobility Management Function
EN-DC	E-UTRA NR Dual Connectivity (in RAN connected to EPC)
eLTE	LTE in NG-RAN connected to 5GC
EPC	Evolved Packet Core, 4G packet core
EPS	Evolved Packet System consist of EPC and LTE RAN
gNodeB	Node providing NR user plane and control plane protocol terminations towards the UE
HSS	Home Subscriber Server in 4G
IMS	IP Multimedia Subsystem
I-MME	Intermediate MME
KPI	Key Performance Indicator
MME	Mobility Management Entity in EPC
NG-RAN	Next Generation RAN, RAN connected to 5G Core
NR	New Radio
PCF	Policy Control Function in 5GC
PGW	PDN Gateway in EPC
RAN	Radio Access Network
RAT	Radio Access Technology eg. LTE, NR
SEPP	Security Edge Protection Proxy
SGW	Serving Gateway in the evolved packet core
SMF	Session Management Function in 5GC
UDM	User Data Management in 5GC
UE	User Equipment
UNI	User Network Interface
UPF	User Plane Function in 5GC

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