ERICSSON

VoLTE Guidelines

User Guide

39/1553-LZA 701 6014/1-V1 Uen AD

Contents

1 Introduction

This document describes the support of the VoLTE service in the LTE RAN. The focus is on the used LTE RAN features, their configuration including recommended combinations and the performance monitoring.

1.1 Service Overview

The term Voice-over-LTE (VoLTE) is used to describe the Voice and Short Message Service (SMS) using LTE as access point, which has its origins in the 3GPP IMS-based multimedia telephony (MMTel) solution. With support of the MMTel system, which is mainly IMS based, the users can e.g. establish voice sessions, add video media (to the voice session) for conversational video calls and send short messages (SMS over IP). This document will focus on the voice session as specified in the GSMA IR.92.

Although MMTel forms the basis of the VoLTE solution, the EPC (with IP flow and bearer management) and LTE RAN (with conversational radio bearers) are integral parts of the service delivery.

The GSMA IR.92, IMS Profile for Voice and SMS, is a Permanent Reference Document (PRD) outlining a minimum set of features in the UE and network to provide a high-quality IMS-based telephony service over LTE. It also secure inter operability on all interfaces between devices and networks.

This document assumes a VoLTE service as defined in GSMA IR.92 and handles the LTE RAN part of the service. The SMS part is using the SIP signaling bearer and will not be included in this document since no separate handling of SMS is performed in the LTE RAN but handled in the same way as a SIP message transfer.

The Global Text Telephony (GTT) is not included since it's a service using a best effort "internet bearer", e.g. QCI 9, with no further impact in the LTE RAN.

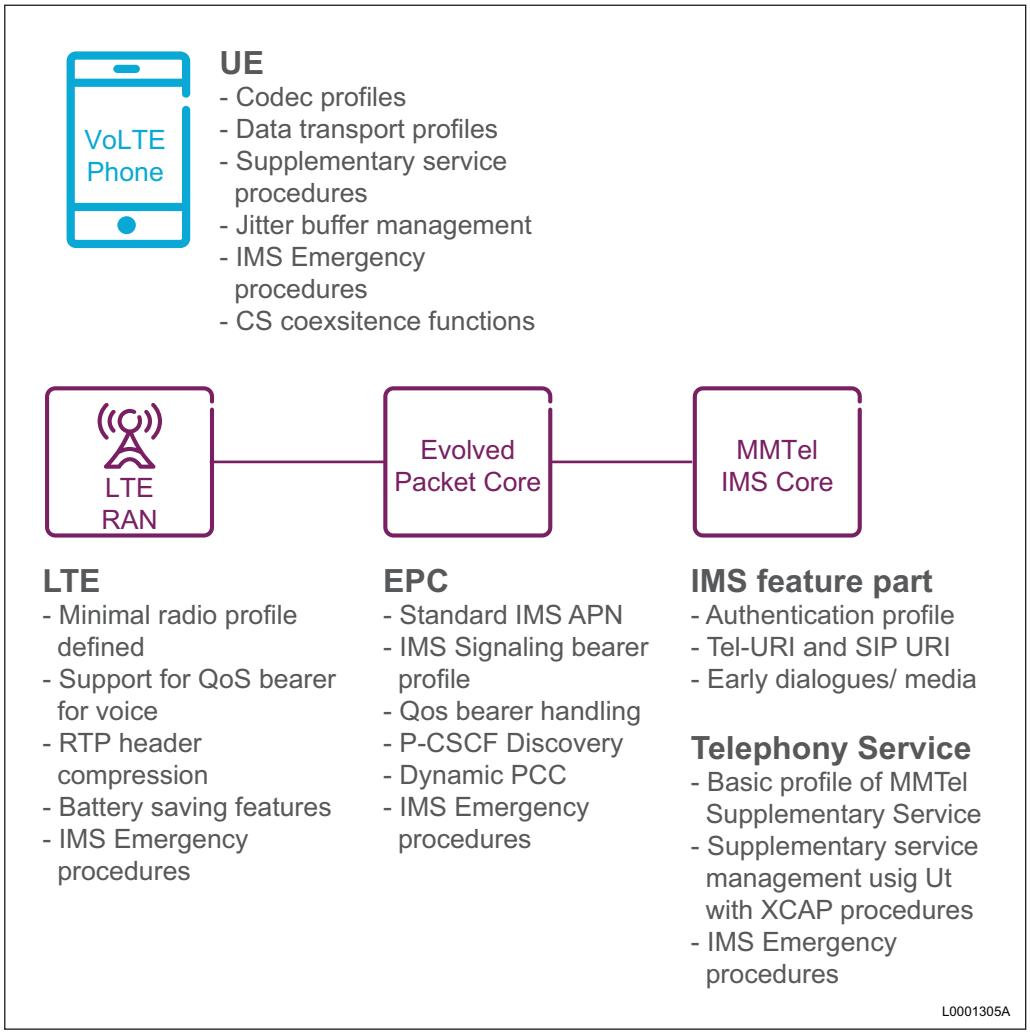

Figure 1 GSMA IR.92 overview of functionality covered

The following is the base for some of the VoLTE features:

— The UE will setup a connection towards the IMS APN using an E-RAB with QCI 5 configured as default bearer for the IMS APN, which is referred to as the SIP signaling bearer, since SIP signaling transport is the main intended use.

— A bearer of GBR type, an E-RAB using QCI 1 as specified in GSMA IR.92, is set up dynamically based on the SIP signaling and SDP data for the voice flow, referred to as the voice bearer.

— The voice media behavior is as specified in the GSMA IR.92 specification, see note below, where the most important characteristics are that each speech packet represents 20 ms of speech, specified by the *ptime* parameter in the SDP, and the use of talk and silence states with silence suppression implemented. The speech packets are transmitted every 20 ms, to be correct

they have a transmit interval time of *ptime*, in talk state while in silence state a SID (Silence Insertion Descriptor) representing the comfort noise during silence is sent at least every 160 ms which comes out of eight times *ptime*. In practice, jitter will make the packet inter arrival time variable for both the talk packets and the silence period SID packets.

If the voice service works in a different way or has other characteristics the performance/gain of the VoLTE features cannot be guaranteed.

Note: The VoLTE service uses a speech codec negotiated between the two clients, the originating and the terminating IMS client from which at least one must be located in an LTE UE. The LTE RAN is hence not involved in the codec selection, neither in the choice of the codec bit rate.

1.2 Benefits

When deploying a voice service in the LTE RAN according to GSMA IR.92 the use of the VoLTE features described in this document will:

— enhance the QoS control of voice

— enhance the coverage for voice

— enhance the capacity for voice

— minimize the impact on the MBB performance

The benefits require correct use and configuration of the VoLTE features.

1.3 Additional Information

1.3.1 Service availability

The VoLTE service availability is not known by the LTE RAN, since it is signaled in the NAS protocol between the MME and UE, see *3GPP TS 24.301*. The limitation is standard dependent and not a design choice.

The LTE RAN does of course have knowledge of established bearers that are connected with the VoLTE service, such as the SIP signaling bearer QCI 5 and the voice bearer QCI 1, which will be handled in accordance with their QoS specification to fulfill voice requirements.

Note: Fraudulent/inappropriate use of QCI 1 and QCI 5 will not be detected by the LTE RAN due to the above and must be detected in the EPC and/or IMS.

Note: To enable/disable the VoLTE service core network settings needs to be changed since the service availability is signaled in the NAS protocol from the MME to the UE.

1.3.2 UE Performance

Generally, GSMA IR.92 is based on 3GPP Release 8. It should be noted, however that not all the features mandatory in 3GPP Release 8 are required for compliance with this profile. Conversely, some features required for compliance with this profile are based on functionality defined in 3GPP Release 9 or higher releases. All such exceptions are explicitly mentioned in GSMA IR.92 along with the relevant Release 8 or higher 3GPP release specifications, respectively.

In accordance with GSMA IR.92 section 3.2.7, it is expected that the UE conforms to the minimum performance requirements on the acoustic characteristics specified in the latest version of *3GPP TS 26.131*, including the UE delay and jitter buffer requirements for MTSI based speech with LTE access defined in *3GPP TS 26.131* from 3GPP Release 12.

Note: Since *3GPP TS 26.131* does not specify functional requirements, a UE that is not fully compliant to these requirements may still perform the VoLTE services but may degrade the speech quality in some scenarios.

2 Service Operation

2.1 Network Requirements

The network requirements of the VoLTE service follows from the requirements of the used LTE RAN features. Additional information is available in Deployment Guideline for VoIP and Conversational Videoand VOIP Dimensioning.

The VoLTE service requires the LTE RAN to be connected to a VoLTE compliant core network. The network requirements, of the total VoLTE network, are specified by the minimum feature set specified to fulfill the requirements in the GSMA IR.92.

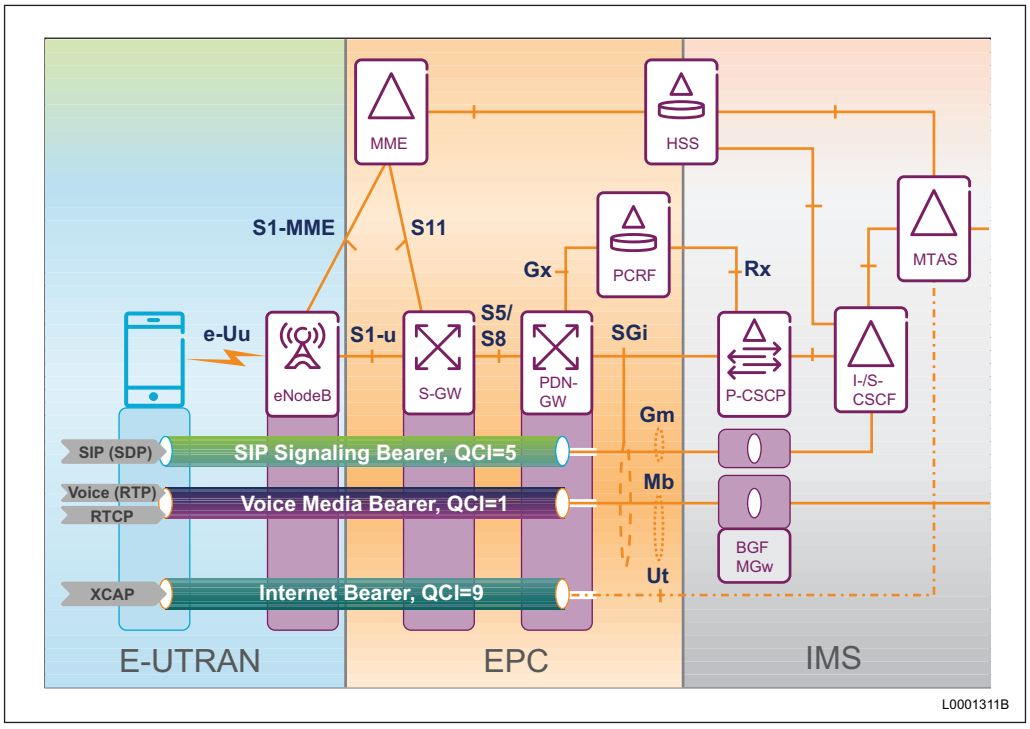

Figure 2 VoLTE network overview including the bearers of the VoLTE user

The high level network picture, see Figure 2, includes the most important nodes of the VoLTE network seen from an LTE RAN perspective. The bearers of a VoLTE user are included for information.

2.2 Service Operation Description

The VoLTE service offers MMTel based voice sessions using the LTE RAN as the access technology. As these voice sessions are a type of Voice over IP (VoIP) sessions, the service uses the same base functionality as the Mobile Broadband

(MBB), e.g. scheduling, link adaptation and mobility, but with functionality and QoS settings adopted for voice.

2.2.1 Attach and IMS Registration

The UE attaches to the E-UTRAN and EPC network and authenticates towards the EPC network. The UE has been assigned a default APN, specifying the default type of network connection to create, from which an IP address is assigned to the UE and a default bearer, which is the default connection within the specified APN handling all data flows not mapped to any dedicated bearer, is established. During the attach procedures, a VoLTE UE will not indicate any specific APN.

After completing the Attach procedure the UE establishes a new EPS bearer for the IMS APN, in case it is not the default APN, to be used for the SIP signaling.

The UE registers in the IMS network using the P-CSCF address provided from EPC when setting up the IMS APN.

Note: It is generally not recommended to have the IMS APN as default APN, see GSMA IR.88 section Default APN and GSMA IR.92 section Bearer Management for further information. Ericsson strongly recommends to use the "internet" APN as default APN.

2.2.2 Call Setup

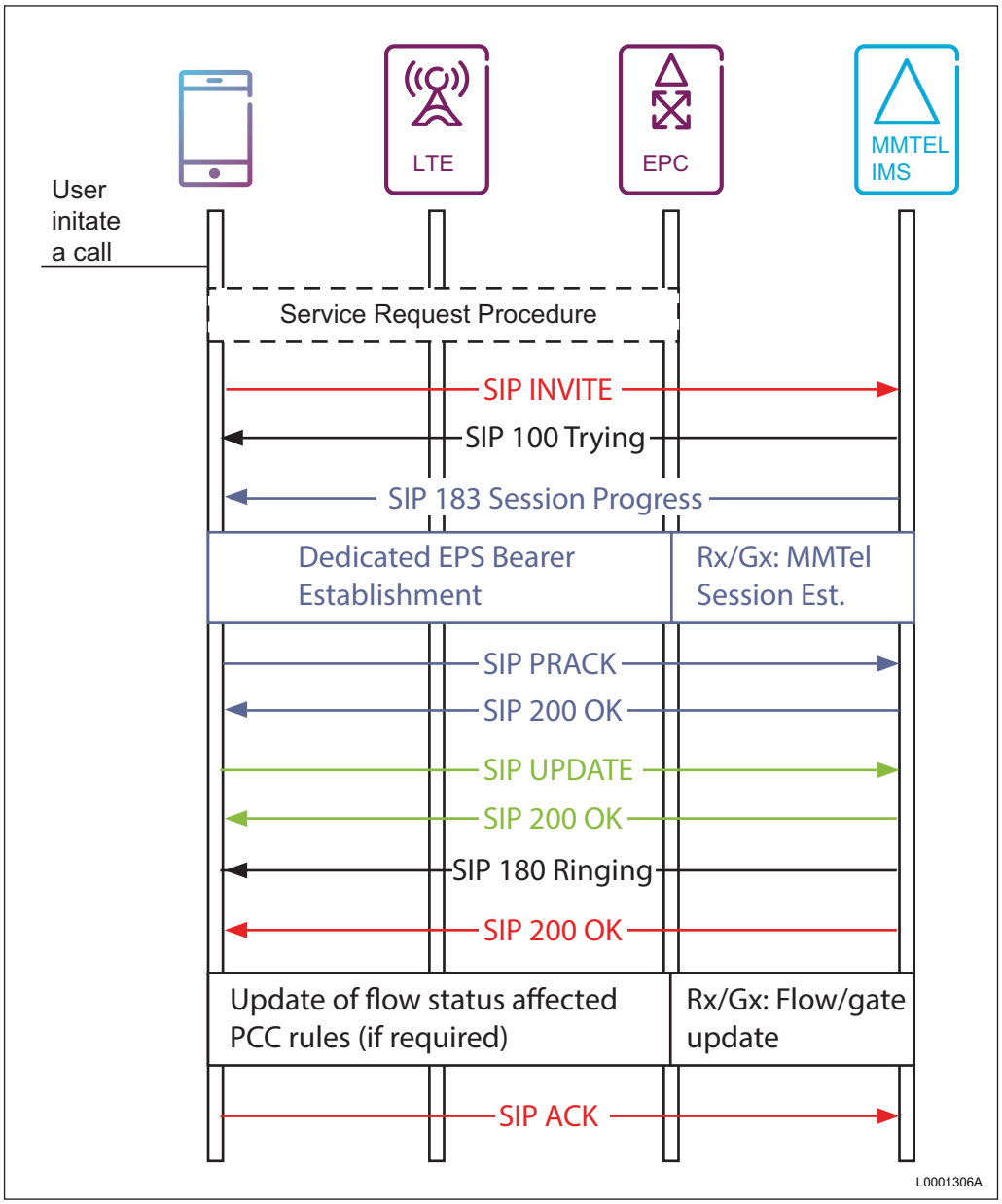

Figure 3 SIP signaling for call origination (on SIP signaling bearer)

If the UE is not already in active mode (RRC_CONNECTED), the UE re-activates the bearers by performing a service request triggered either by the initialization of the call in the originating UE or as a result of the paging procedure to the terminating UE. Once the SIP signaling bearer, QCI 5, is established the call is set up by means of the SIP signaling.

During the call setup the voice flow information is signaled in the Session Description Protocol (SDP), carried by some of the SIP messages, which is used

to setup the voice bearer. The SDP is interpreted by the Application Function (AF) in the P-CSCF which initializes the voice session, see Figure 4 the AAR message, over the Rx interface towards the Policy and Charging Rules Function (PCRF).

The establishment of the voice bearer could be performed early or late in the setup sequence. The early setup is initiated at SIP 18x answer on the INVITE, see Figure 3 signals and procedures in blue color, while the late setup is performed at SIP 200 OK, see Figure 3 the 200 OK in red, i.e. when the terminating subscriber answers the call.

If the establishment occurs late it's possible that voice media will flow over the SIP signaling bearer until the voice bearer is established*. This is due to the fact that the SIP signaling bearer is the default bearer towards the IMS APN.

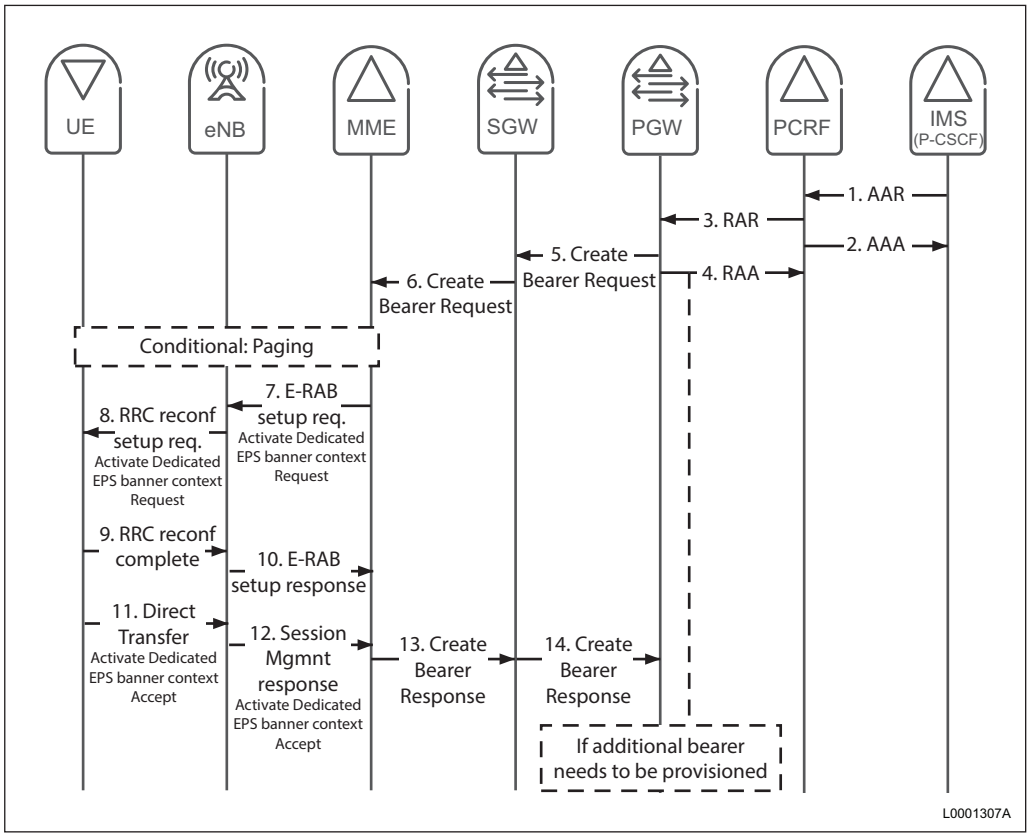

Figure 4 Dedicated EPS Bearer Creation

The PCRF controls if the user is allowed to use the voice service and if that's the case it adds a set of policy rules, e.g. QCI mapping, and forwards the session to the Policy and Charging Enforcement Function (PCEF) located in the PDN-GW.

The PDN-GW initializes a Create Bearer Request for an EPS bearer over S5 towards the S-GW which forwards the request to the MME, which sends a Create E-RAB request towards the eNB which carries out the setup using the RRC Connection Reconfiguration procedure. Now the media transfer over the voice bearer is possible.

Note: This could be avoided in DL using a filter in the PDN-GW which only allows SIP signaling over the SIP signaling bearer.

2.2.3 Mid Call Activity

When the voice session is established or even during the setup of it the voice flow might be modified by the clients or the core network. This will result in a Modify Bearer Request from the PDN-GW which results in a Modify E-RAB Request from the MME towards the eNB. The most common reason is a change in required bandwidth for the voice flow, e.g. when the call is answered the required bandwidth is modified to allow the voice flow in both directions.

This requires the Dynamic QoS Modification feature in the eNB.

Mobility, intra-LTE or inter-RAT, may of course occur during the call, see Mobility configuration on page 25 for further details.

2.2.4 Call Termination

To terminate* the voice session either of the clients initiate the procedure over the SIP signaling bearer. The termination will use the same control path as the setup with the difference of Delete Bearer Request being sent from the PDN-GW resulting in E-RAB Release Request towards eNB from MME.

Note: Session termination could be initiated by the core network, for example from the P-CSCF, but it will not make any significant difference in the LTE RAN.

2.2.5 Short Message Service

The short message service is assumed to use the established SIP signaling bearer, i.e. the service uses SIP Message as transport container, which is why no special consideration will be taken in this document.

3 Service Features

The VoLTE features in eNB are grouped into:

— Required features: Mandatory by GSMA IR.92, by EPC initiated procedures or by Ericsson.

— Recommended features: The features will enhance service quality, capacity or coverage.

— Related features: The features are indirectly affecting VoLTE, positively or negatively, depending on configuration.

Note: For a complete description of the following features see their respective Feature Description documents.

3.1 Required Features

3.1.1 Mandatory in IR.92

The features in this section are LTE features, provided by Ericsson LTE RAN, which are mandatory according to IR.92.

Note: The features are valid for both FDD and TDD unless stated otherwise.

3.1.1.1 Bearers and Services

3.1.1.1.1 Admission Control

Admission Control provides basic Emergency Call prioritization based on RRC Establishment cause and the ARP (Allocation and Retention Priority) value of the bearer, see Emergency Call Prioritization section in the feature CPI.

Note: The ARP values for the bearers are assigned by the core network (EPC/IMS) nodes HSS or PCRF, hence the RAN can only act according to received ARP values.

3.1.1.1.2 Efficient DRX/DTX for Connected UE

Efficient DRX/DTX for Connected UE provides support for DRX, i.e. providing opportunities for the UE to stop monitoring the PDCCH to reduce the battery consumption.

Note: DRX is expected to have a marginal negative impact on the voice quality, due to an introduction of delays and jitter, and needs to be configured according to the delay boundaries (pdb).

3.1.1.1.3 Limited Service Mode Emergency Call Support

Limited Service Mode Emergency Call Support enables emergency call functionality in limited service mode such as calling without a SIM or without service coverage from the home network, which in some countries is needed to fulfill regulatory requirements. Emergency calls, placed as a normal call, are supported without this feature.

3.1.1.1.4 Multiple Radio Bearers per User

Multiple Radio Bearers per User provides support for the required multiple bearers, see GSMA IR.92 section LTE Radio Capabilities, of a VoLTE user.

3.1.1.1.5 RLC in Unacknowledged Mode

RLC in Unacknowledged Mode provides the possibility to configure the bearer to use RLC in unacknowledged mode, i.e. RLC UM.

3.1.1.1.6 Robust Header Compression

Robust Header Compression provides the functionality to compress the IP-, UDP- and RTP-headers of the voice packets into a single and compact ROHC Header.

Note: Enabling ROHC is only supported for a QCI, that is intended to carry RTP, RTCP, or UDP based VoIP traffic (for example, standardized QCI 1 as specified in 3GPP TS 23.203), and not supported for any other type of traffic.

3.1.1.2 Radio Access

3.1.1.2.1 QoS-Aware Scheduler

QoS-Aware Scheduler provides the basic support for QoS in the scheduler, i.e. it will make it possible to assign different QoS settings per QCI.

3.1.1.3 Mobility

3.1.1.3.1 Coverage-triggered GERAN Session Continuity

Coverage-triggered GERAN Session Continuity is required by SRVCC Handover to GERAN.

3.1.1.3.2 Coverage-triggered UTRAN Session Continuity

Coverage-triggered UTRAN Session Continuity is one of three alternative features that could fulfill the pre-requisites for SRVCC Handover to UTRAN.

3.1.1.3.3 Coverage-Triggered WCDMA IRAT Handover

Coverage-Triggered WCDMA IRAT Handover is required to handover the PS bearers, when existing at the same time as the voice bearer, to the WCDMA system in an SRVCC handover to UTRAN.

Note: The feature is only mandatory for simultaneous HO of voice and data to WCDMA, i.e. HO of voice connection will work without this feature.

3.1.1.3.4 SRVCC Handover to CDMA 1X

SRVCC Handover to CDMA 1X provides support for Single Radio Voice Call Continuity (SRVCC) handover to the CDMA 1X.

Note: Core network and UE support is needed for the feature to work.

3.1.1.3.5 SRVCC Handover to GERAN

SRVCC Handover to GERAN provides support for Single Radio Voice Call Continuity (SRVCC) handover to the GSM/EDGE Radio Access Network (GERAN).

Note: Requires Coverage-triggered GERAN Session Continuity feature.

3.1.1.3.6 SRVCC Handover to UTRAN

SRVCC Handover to UTRAN provides support for Single Radio Voice Call Continuity (SRVCC) handover to the UMTS Radio Access Network (UTRAN).

Note: Requires at least one of Coverage-triggered UTRAN Session Continuity, Mobility Control at Poor Coverage or Inter-RAT Offload to WCDMA as pre-requisite.

3.1.2 Mandatory to support EPC initiated procedures

The following features are mandatory in case the related procedures, which is the normal case, are initiated in or received from the EPC.

3.1.2.1 Bearers and Services

3.1.2.1.1 Dynamic QoS Modification

Dynamic QoS Modification supports modification of QoS parameters and is mainly used to change bandwidth, GBR and MBR values in UL/DL for the voice bearer, at voice call setup.

Note: Note the relation to the Dynamic GBR Admission Control, see section Affected Features, feature regarding rejection of modification due to over allocation of system resources.

3.1.2.2 Radio Access

No applicable features exists in this area.

3.1.2.3 Mobility

No applicable features exists in this area.

3.1.3 Mandatory Ericsson VoLTE Features

3.1.3.1 Bearers and Services

3.1.3.1.1 Service Specific DRX

Service Specific DRX provides the functionality to change DRX Profile, that is, the DRX configuration, when a VoLTE call is established, that is, at setup of the voice bearer, to match the behavior/characteristics of the voice flow giving the UE an opportunity for battery savings. The feature requiresEfficient DRX/DTX for Connected UE to be active.

It is important to set the DRX priority parameter correctly and use recommended values. Normally, only the conversational video bearers associated QCI will have a higher DRX priority.

Note: Even when the DRX profile is optimized for voice, it is expected to have a marginally negative impact on the voice quality due to introduction of delays and jitter, and needs to be configured according to delay boundaries. The voice specific DRX profile is designed to make use of the delay boundaries to give battery savings in the UE with acceptable quality degradation.

When eMBMS is activated and a VoLTE bearer is setup, the system selects the eMBMS VoLTE DRX profile (drxProfile=18). The eMBMS VoLTE DRX profile is described in Service Specific DRX.

When ELC is activated and a VoLTE bearer is setup, the system selects the ELC specific DRX profile automatically. The DRX profile for voice as set in Table 1 will be overridden by the ELC specific DRX profile.

Table 1 DRX Profile 1 DRX profile for voice (MO: DrxProfile)

DRX parameter(1)	Value - FDD	Value - TDD
onDurationTimer	PSF4	PSF10
drxInactivityTimer	PSF4	PSF8

DRX parameter(1)	Value - FDD	Value - TDD
drxRetransmissionTimer	PSF2	PSF2
shortDrxCycle	SF40	SF40
shortDrxCycleTimer (2)	0	0
longDrxCycle	SF40	SF40
longDrxCycleOnly	SF40	SF40

(1) If both FDD and TDD are used for VoLTE on the same eNB the TDD DRX profile needs to be used.

(2) The shortDrxCycleTimer value of 0 means that the shortDrxCycle is not used.

The Service Specific DRX feature provides the possibility to disable DRX when the UE experiences poor RF. This can improve the performance of a UE with DRX configured.

3.1.3.1.2 Service Specific Inactivity Timer

The main purpose of the Service Specific Inactivity Timer feature is to prolong the UE inactivity timer, `Rcs.tInactivityTimer` , for a VoLTE call using QCI-1 according to GSMA IR.92 to keep the UE that originates the VoLTE call in RRC_CONNECTED when the terminating VoLTE user does not answer for a long time, i.e. a time exceeding the common inactivity time.

Note: The prolonged Inactivity Timer will only have effect in the call setup phase when pre-conditions are used or at least the voice bearer (QCI 1) is established in the beginning of the alerting phase.

3.1.3.1.3 TCP Optimization

TCP Optimization is recommended to use for the voice bearer where it will reduce the effect of delay peaks, i.e. the time to catch up will be reduced and packets too old to contribute to the voice quality are discarded.

The *pdbOffset* parameter is used to enhance the voice quality by allowing the Jitter Buffer Manager (JBM) in the UE to use "slightly" old packets to enhance the end user experience. The recommended value is 50, which is a trade-off between delay and JBM performance.

3.1.3.2 Radio Access

3.1.3.2.1 Delay-Based Scheduling and Grant Estimation

Delay-Based Scheduling and Grant Estimation provides improved Mobile Broadband (MBB) services performance when mixed with the VoLTE service without reducing the capacity of the VoLTE service.

The overall VoLTE quality is improved by the packet age based prioritization and by securing transmission of all the segments of a VoIP packet in consecutive TTIs, in case of segmentation.

End user service experience is enhanced by providing the possibility, in co-operation with the DRX and Service Specific DRX features, for the UE to save on the battery, while still providing superior VoLTE quality.

3.1.3.3 Mobility

No applicable features exists in this area.

3.1.4 Conditional Regulatory Requirement Features

Regulatory requirements may require location support features, for example A-GPS Control Plane Location Support or A-GPS User Plane Location Support, hence making them mandatory.

3.2 Recommended Features

3.2.1 Bearers and Services

3.2.1.1 Differentiated Admission Control

Differentiated Admission Control provides means to control admission at initial setup of UE's and/or E-RAB's. It is possible get higher relative accessibility for UEs and E-RABs with high ARP priority. For example the feature makes it possible to admit the voice bearer while rejecting the video bearer, provided that the ARP priority is higher for the voice bearer. To achieve this, Dynamic GBR Admission Control also has to be activated.

Without Dynamic GBR Admission Control, ARP differentiation (beyond the Privileged Access aspects) only matters if pre-emption is enabled (with regard to congestion of transport network resource and the license resource).

The priority and pre-emption behavior of VoLTE can be affected by the SPID-based pre-emption function of the Differentiated Admission Control feature.

Note: The ARP values are set in the core network, hence the LTE RAN has no knowledge of the interpretation of an absolute value but can only act on the relative difference in combination with the setting of `AdmissionControl.paArpOverride`, see Admission Control

3.2.1.2 Dynamic GBR Admission Control

Dynamic GBR Admission Control assists in ensuring that the Quality of Service (QoS) is maintained for the already established GBR bearers after a successful

initial setup, for example the voice bearers (QCI 1), in the system by limiting the number of GBR bearers based on resource usage.

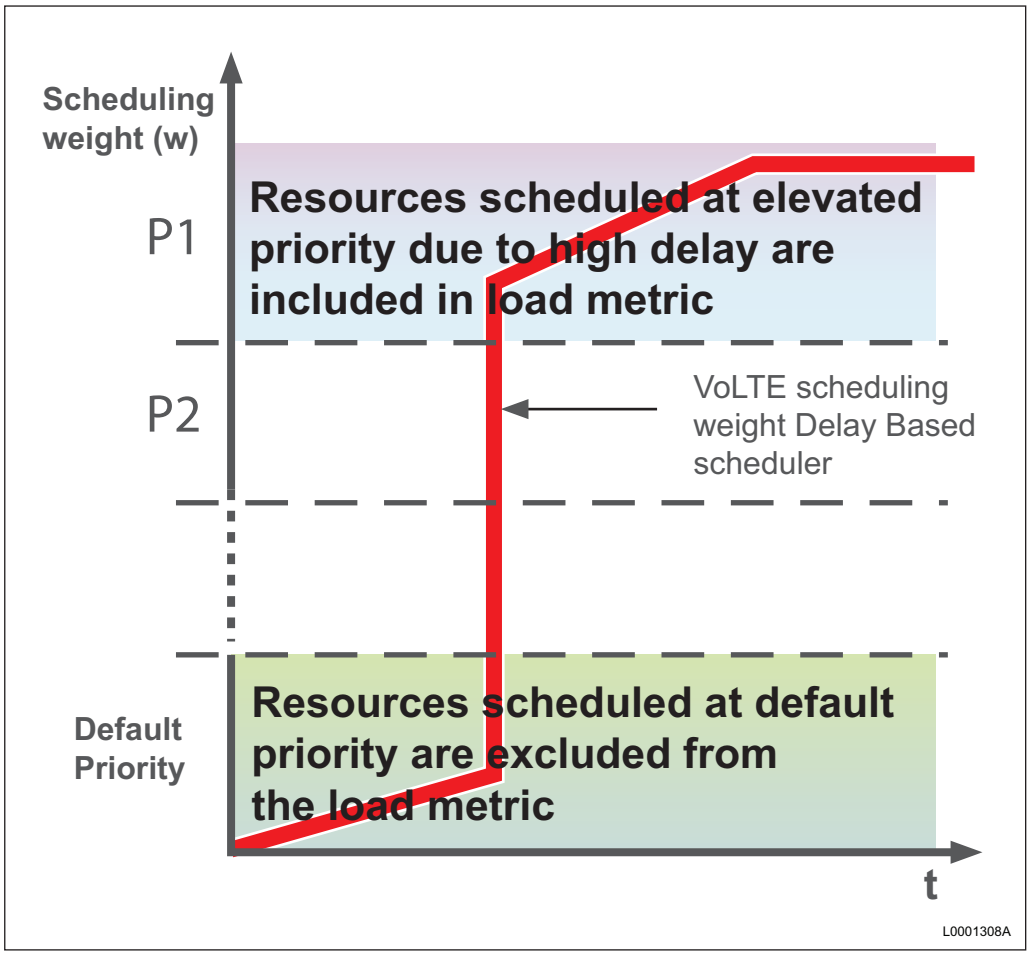

Figure 5 Overview how Dynamic GBR Admission Control monitors load for VoLTE

Only resources associated with high priority scheduling, i.e. not scheduled with default priority see Figure 5, are considered. Since MBB traffic will increase delays for GBR traffic the load metric used by Dynamic GBR Admission control would be affected also by MBB traffic.

Note: The parameter settings are related to the operator strategy/preference, hence the values will depend on the level of integrity wanted for already established GBR bearers.

3.2.1.3 Multi-Target RRC Connection Re-establishment

Multi-Target RRC Connection Re-establishmentwill make it possible for the voice session to survive when the connection with the UE is lost on the radio interface.

It will also reduce the signaling between the RAN, CN and UE compared to a other re-connection options.

Note: Make sure the requirements regarding for example X2 availability are fulfilled, see section Feature Operation Sequence Diagram in Multi Target RRC Connection Re-establishment

3.2.2 Radio Access

3.2.2.1 Enhanced PDCCH Link Adaptation

Enhanced PDCCH Link Adaptation increases the PDCCH capacity by replacing a conservative fixed SINR margin with a PDCCH link adaptation outer loop.

3.2.2.2 PDCCH Power Boost

PDCCH Power Boost will increase the capacity by boosting the PDCCH power instead of increasing the number of allocated CCEs. Note that it is recommended to keep the MOM parameter `EUtranCellFDD.pdcchPowerBoostMax` / `EUtranCellTDD.pdcchPowerBoostMax` at the default value 0 dB as this parameter only applies to coverage improvement in specific scenarios. The capacity boosting of PDCCH through this feature is enabled whenever the feature is enabled, regardless of the value of *pdcchPowerBoostMax*, but the capacity gain is reduced with increasing *pdcchPowerBoostMax* value.

3.2.2.3 TTI Bundling

TTI Bundling increases the coverage and the quality in poor radio conditions, in the UL direction, for the VoLTE service.

`EUtranCellFDD.ttiBundlingSwitchThres` and
`EUtranCellFDD.ttiBundlingSwitchThresHyst`

`QciProfilePredefined.tReorderingUl`

Note: If the TTI Bundling threshold isn't correctly set it might not increase coverage (too low, drop service before it's activated) or waste resources (too high, the four immediate transmissions are unnecessary).

Note: TTI Bundling is not recommended to be used with conversational video service. It shouldn't be a problem if the network is dimensioned for conversational video, since the SINR wouldn't get low enough normally to activate TTI Bundling, but in reality low SINR values will occur. The video quality will be limited in this state.

Note: TTI Bundling is available for FDD only.

3.2.2.4 VoLTE Frequency Hopping

VoLTE Frequency Hopping will enhance the VoLTE coverage by using frequency hopping for UEs in TTI Bundling.

Note: VoLTE Frequency Hopping is available for FDD only.

3.2.3 Mobility

3.2.3.1 Data Forwarding at Intra-LTE Handover

Data Forwarding at Intra-LTE Handover will reduce the packet loss **(in VoLTE late packets are regarded the same as lost)** in DL direction at an intra-LTE handover during a voice session.

3.2.3.2 Packet Forwarding at S1 Handover

Packet Forwarding at S1 Handover gives the same type of benefits as Data Forwarding at Intra-LTE Handover when no X2 HO is possible.

3.2.3.3 Service Triggered Mobility

Service Triggered Mobility allows for mobility thresholds per QCI, i.e. it is possible to adjust the thresholds for VoLTE, i.e. the voice bearer, to values optimal for the service.

Note: If a higher threshold value is used for the voice bearer (QCI 1) or the SIP signaling bearer (QCI 5) than for the internet bearer (e.g. QCI 9) it will increase the risk of SRVCC in pre-alerting and alerting phase. This will lead to call drop before this is supported by the core network.

3.2.3.4 Robust SRVCC Handover at Call Setup

Robust SRVCC Handover at Call Setup delays SRVCC handover to reduce the drop risk in a network where SRVCC handover in pre-alerting phase is not supported.

3.3 Related Features

3.3.1 Bearers and Services

3.3.1.1 PHICH Group Spreading

PHICH Group Spreading will enhance the UE capability of correct decoding of HARQ ACK/NACK feedback on the PHICH. This will prevent unnecessary retransmissions which reduces the delay leading to better voice quality.

3.3.2 Radio Access

3.3.2.1 Differentiated UE Handling

Differentiated UE Handling adds the possibility of enabling/disabling features and/or chose DRX Profiles based on UE type, differentiated by information in the IMEISV.

When specific DRX profiles are configured for IMEISV identified UE, it will override ELC DRX profiles (i.e. `nonVoiceDrxProfileRef` will override ELC 40ms/320ms DRX profiles and `voiceDrxProfileRef` will override ELC VoLTE DRX profile).

3.3.2.2 Prioritization of VoLTE in Access Barring

Prioritization of VoLTE in Access Barring enables the possibility to prioritize VoLTE traffic by allowing UEs to skip access class barring check when moving to connected mode due to establishing a VoLTE service.

3.3.2.3 Prioritized SR Scheduling

Prioritized SR Scheduling improves the fairness between UEs with different sets of Data Radio Bearers, which might improve the performance during high load as the total amount of SRs is reduced.

3.3.3 Mobility

3.3.3.1 Inter-RAT Offload to WCDMA

Inter-RAT Offload to WCDMA provides offload to UTRAN network.

Note: No direct VoLTE impact unless offload is allowed for QCI 1. It is one of three alternative features that could fulfill the pre-requisites for SRVCC Handover to UTRAN.

3.3.3.2 Mobility Control at Poor Coverage

Mobility Control at Poor Coverage is used to enhance the control of the UE mobility behavior in poor coverage.

A small search zone should be configured to allow for reduced usage of measurements gaps. The size of the search zone is controlled via the difference between start of search (A2search) and critical (A2critical) trigger.

The `MeasControl.a5b2MobilityTimer` would be restarted at expiry if a voice bearer is established.

Note: It is one of three alternative features that could fulfill the pre-requisites for SRVCC Handover to UTRAN.

3.3.3.3 Service or Priority-Triggered Inter-Frequency Handover

Service or Priority-Triggered Inter-Frequency Handover will move the voice session to a frequency band allowed for voice services to fulfill legal aspects and also improve the positioning service by moving the user with a specific ARP value to the most suitable frequency.

Note: It is important to use a mobility strategy for voice.

3.3.3.4 Service Specific Load Management

Service Specific Load Management should be used to exclude VoLTE UEs from load-triggered handovers as handovers effect the voice quality negatively.

3.4 Service Affecting Features and Functions

3.4.1 Carrier Aggregation and VoLTE

3.4.1.1 Enhanced PDCCH Link Adaptation

If Enhanced PDCCH Link Adaptation is used SCell PDSCH transmission is not allowed when there is DL VoLTE data on that TTI, only PCell PDSCH transmission is allowed. In all other TTIs where there is no DL VoLTE data, PCell and SCell PDSCH transmissions are allowed.

3.4.1.2 Dynamic SCell Selection for Carrier Aggregation

VoLTE drop rate can increase due to additional RLC AM transmissions from features such as Dynamic SCell Selection for Carrier Aggregation sent during poor RF conditions and thus discovering RLF.

3.4.1.3 VoLTE Optimized Carrier Aggregation

The VoLTE Optimized Carrier Aggregation feature improves VoLTE retainability during VoLTE calls.

When the VoLTE Optimized Carrier Aggregation feature is activated, VoLTE retainability is improved because no addition or removal of UL and DL SCells takes place, and the number of RRC signaling is reduced due to deconfiguration of SCells and measurement related to CA and SCell.

4 Configuration

4.1 Feature Combinations

4.1.1 VoLTE Configuration

The base VoLTE configuration, consisting of mandatory VoLTE features see Table 2, and optimal settings, as summarized in Table 3, to provide good VoLTE call quality and performance and avoid unnecessary negative impact on other services such as MBB, due to introduction of the higher priority VoLTE traffic. Higher QCI1 priority, relative to QCI 5, will ensure that extensive traffic on QCI5, due to IMS services such as RCS, messaging and presence, will not affect the VoLTE speech quality.

Additional features can be used to enhance VoLTE coverage, to increase VoLTE capacity, to increase robustness and to provide improved handling capabilities in high traffic sites as indicated in Table 2 .

4.1.2 VoLTE Features Overview

Table 2 Overview of VoLTE Features in the VoLTE Configurations

Feature	Feature Type
Admission Control	Mandatory according to IR.92
Efficient DRX/DTX for Connected UE	Mandatory according to IR.92
Limited Service Mode Emergency Call Support	Mandatory according to IR.92
Multiple Radio Bearers per User	Mandatory according to IR.92
RLC in Unacknowledged Mode	Mandatory according to IR.92
Robust Header Compression	Mandatory according to IR.92
QoS-Aware Scheduler	Mandatory according to IR.92
Coverage-triggered GERAN Session Continuity	Conditional according to IR.92, dependent on GERAN availability.
Coverage-triggered UTRAN Session Continuity	Conditional according to IR.92, dependent on UTRAN availability.
SRVCC Handover to GERAN	Conditional according to IR.92, dependent on GERAN availability.
SRVCC Handover to UTRAN	Conditional according to IR.92, dependent on UTRAN availability(1).

Feature	Feature Type
Dynamic QoS Modification	Mandatory due to core network procedures (Modify Bearer Request originating in PDN-GW).
A-GPS Control Plane Location Support	Conditional to fulfill regulatory requirements.
A-GPS User Plane Location Support	Conditional to fulfill regulatory requirements.
Delay Based Scheduling and Grant Estimation	Mandatory Ericsson VoLTE feature
Service Specific DRX	Mandatory Ericsson VoLTE feature
Service Specific Inactivity Timer	Mandatory Ericsson VoLTE feature (when using SRVCC in alerting phase)
TCP Optimization	Mandatory Ericsson VoLTE feature
Enhanced PDCCH Link Adaptation	Capacity Enhancing Feature
PDCCH Power Boost	Capacity Enhancing Feature
TTI Bundling	Coverage Enhancing Feature
VoLTE Frequency Hopping	Coverage Enhancing Feature
Differentiated Admission Control	Robustness Enhancing Feature
Dynamic GBR Admission Control	Robustness Enhancing Feature
Multi Bearer Retainability	Robustness Enhancing Feature
Multi Target RRC Connection Re-establishment	Robustness Enhancing Feature
Differentiated UE Handling	Robustness Enhancing Feature
PHICH Group Spreading	Robustness Enhancing Feature
Prioritization of VoLTE in Access Barring	Accessibility Enhancing Feature
Data Forwarding at Intra-LTE Handover	Robustness Enhancing Feature
Data Forwarding at S1 Handover	Robustness Enhancing Feature
Robust SRVCC Handover at Call Setup	Mobility Enhancing Feature(2)

(1) Requires at least one of Coverage-triggered UTRAN Session Continuity, Mobility Control at Poor Coverage or Inter-RAT Offload to WCDMA.

(2) Requires at least one of SRVCC Handover to GERAN or SRVCC Handover to UTRAN.

4.2 QoS configuration

Table 3 QoS parameters for VoLTE (MOs: QciProfilePredefined and QciProfileOperatorDefined)

QoS parameter	Parameter Value	
	QCI 1	**QCI 5**
QciProfilePredefined.AbsPrioOverride and QciProfileOperatorDefined.AbsPrioOverride	*NO_OVERRIDE*	*HIGH_PRIO_OVERRIDE*
QciProfilePredefined.AQMMode and QciProfileOperatorDefined.AQMMode	*GBR (2)*	*OFF (0)*
QciProfilePredefined.counterActiveMode and QciProfileOperatorDefined.counterActiveMode	TRUE/FALSE(1)	FALSE
QciProfilePredefined.dataFwdPerQciEnabled and QciProfileOperatorDefined.dataFwdPerQciEnabled	TRUE	TRUE
QciProfilePredefined.drxPriority and QciProfileOperatorDefined.drxPriority	98(2)	1
QciProfilePredefined.drxProfile and QciProfileOperatorDefined.drxProfile	1(2)(3)	0(4)
QciProfilePredefined.inactivityTimerOffset and QciProfileOperatorDefined.inactivityTimerOffset	20(5)	0
QciProfilePredefined.logicalChannelGroupRef and QciProfileOperatorDefined.logicalChannelGroupRef	*LCG 1*	*LCG 1*
QciProfilePredefined.pdb and QciProfileOperatorDefined.pdb	80	100
QciProfilePredefined.pdbOffset	50	0
QciProfilePredefined.pdcpSNLength and QciProfileOperatorDefined.pdcpSNLength	*12*(6)	*12*
QciProfilePredefined.priority and QciProfileOperatorDefined.priority	1	2
QciProfilePredefined.qci and QciProfileOperatorDefined.qci	1	5
QciProfilePredefined.rlcMode and QciProfileOperatorDefined.rlcMode	*UM*	*AM*
QciProfilePredefined.rochEnabled and QciProfileOperatorDefined.rochEnabled	TRUE	FALSE

QoS parameter	Parameter Value	
QciProfilePredefined.schedulingAlgorithm and QciProfileOperatorDefined.schedulingAlgorithm	*DELAY_BASED*	*RESOURCE_FAIR*
QciProfilePredefined.serviceType and QciProfileOperatorDefined.serviceType	*VOIP*	*IMS_SIGNALING*

(1) VoLTE Observability, see page 31

(2) When ELC is active, the setting will be overridden by ELC specific DRX profile.

(3) DRX Profile 1, see SRVCC Handover to GERAN on page 12.

(4) DRX Profile 0, default DRX profile used by the operator.

(5) It is recommended to use at least 20 s, which allows an extra 20 s for the B-side to answer, on top of the *tInactivityTimer* time, without the A-side transition to RRC_IDLE state. The feature requires that the voice bearer is established at the beginning of the alerting phase.

(6) The current Ericsson recommended setting for PDCP sequence number length provides better robustness against long fading dips than the IR.92 recommendation of 7 bits.

4.3 Capacity Configuration

4.3.1 PDCCH CFI Mode

As VoLTE is a service with a high packet frequency a high number of scheduling occasions are needed. This will lead to a utilization of a high amount of PDCCH resources, hence it is recommended to configure the PDCCH to have a high capacity. It is recommended to set *EUtranCell.pdcchCfiMode* to 5 (CFI_AUTO_MAXIMUM_3).

4.4 Mobility configuration

Intra-LTE mobility when it comes to VoLTE is not different from mobility for MBB services. There are however some specific tuning options available when a UE has an active Voice bearer. One difference is also that non-optimized configuration and tuning will be more noticeable, i.e. the service is more vulnerable to reduced mobility performance. For example an RRC Connection Re-establishment will be noticed by the VoLTE user while the MBB users typically don't notice the interruption.

There are a few things that should be considered.

— Reduce the number of handovers (cell planning, voicePrio)

Note: A needed HO can't be omitted/ignored, the reduction should e.g. be to not perform HO to a "small" cell on another frequency when the macro cell has a good enough radio environment, while HO to a better cell on the same frequency should typically always be performed.

— Reduce the need of measurements (ANR, known neighbours)

4.4.1 Connected Mode Priorities

When a UE has an active voice bearer, the parameter voicePrio will determine the layer priority order and control how the UE is transferred to LTE inter-frequency (IF) or inter-radio access technology (IRAT) neighbors. The parameter `EUtranCellRelation.connectedModeMobilityPrio` is used for UEs which do not have an active voice bearer, although they may or may not be VoIP capable.

Note: The call setup phase should ideally use `EUtranCellRelation.voicePrio` and call release phase use `connectedModeMobilityPrio` for optimal performance but will use the opposite priorities due to lack of 3GPP support to fully identify these phases. The eNB will only change the used priority based on if the voice bearer is established or not.

4.4.2 SRVCC

The Single Radio Voice Call Continuity (SRVCC) HO will only be initiated when a voice bearer is established, provided that the UE, which is indicated in the Feature Group Indicator bits in UE Capability, and the MME supports SRVCC, which is derived from the Initial Context Setup procedure.

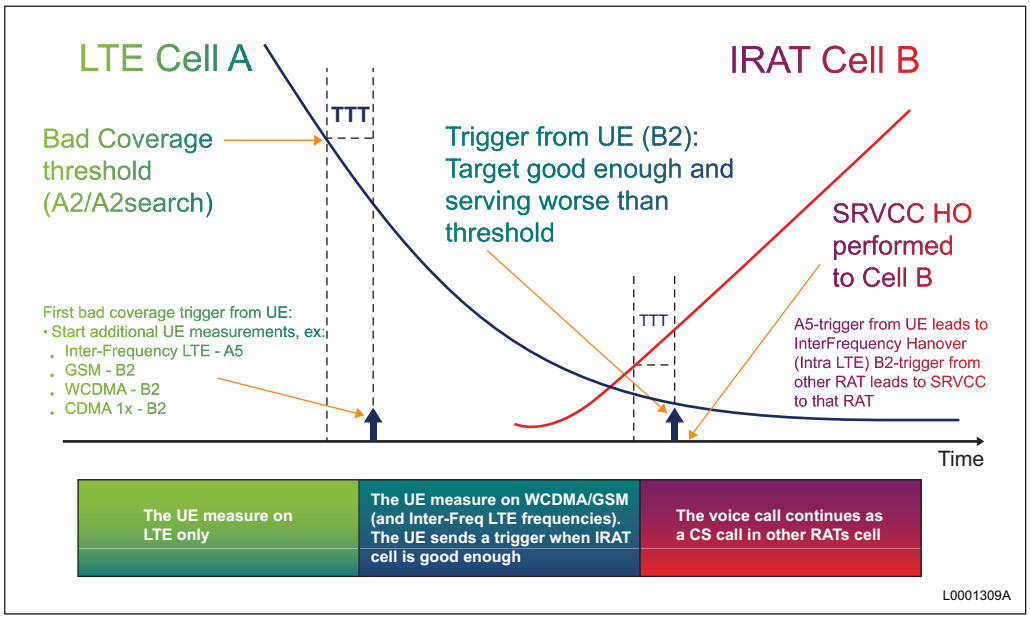

Figure 6 Schematic overview of SRVCC in eNB

The SRVCC HO is triggered using the B2 trigger as for any IRAT HO. The UE behavior could be further controlled using the Mobility Control at Poor Coverage feature specifying a search zone, see Mobility Control at Poor Coverage .

If an IRAT HO occurs in the pre-Alerting phase, i.e. between the initialization of a call setup, essentially sending/receiving SIP INVITE message, and the establishment of the voice bearer it will result in a call drop if not explicit support is provided by the core network.

Note: Release 15B of EPC/IMS/MSC is needed not to drop in alerting phase, which occurs between SIP 180 Ringing and SIP 200 OK for the INVITE message. Release 16A of the MSC also supports pre-alerting, which occurs between the voice bearer establishment and SIP 180 Ringing.

Note: If the UE goes to RRC_IDLE during the call setup no SRVCC will be performed, see Service Specific Inactivity Timer on page 14.

4.4.3 Mobility triggers

The optimization tuning of handover when having an established voice bearer is typically the same as for MBB in relation to the radio environment and for Intra frequency best cell triggered Handovers. Measurement gap start and Inter frequency and IRAT event that trigger HO may be adjusted with an offset when a Voice bearer is established. The default for this offset is 0 i.e the same thresholds are used for MBB and when Voice bearer is established.

4.4.3.1 Service Specific Triggers

The service specific triggers can be used to e.g. get earlier triggers for IFHO or SRVCC since it might be considered more beneficial for the voice call to use the other frequency band or radio access technology.

The service specific triggers can be used to fulfill a mobility strategy.

In the below figure and recommendations the following is assumed:

QCI 1 voice bearer (priority 1)

QCI 5 SIP signaling bearer (priority 2)

QCI 9 Internet bearer (priority> 5)

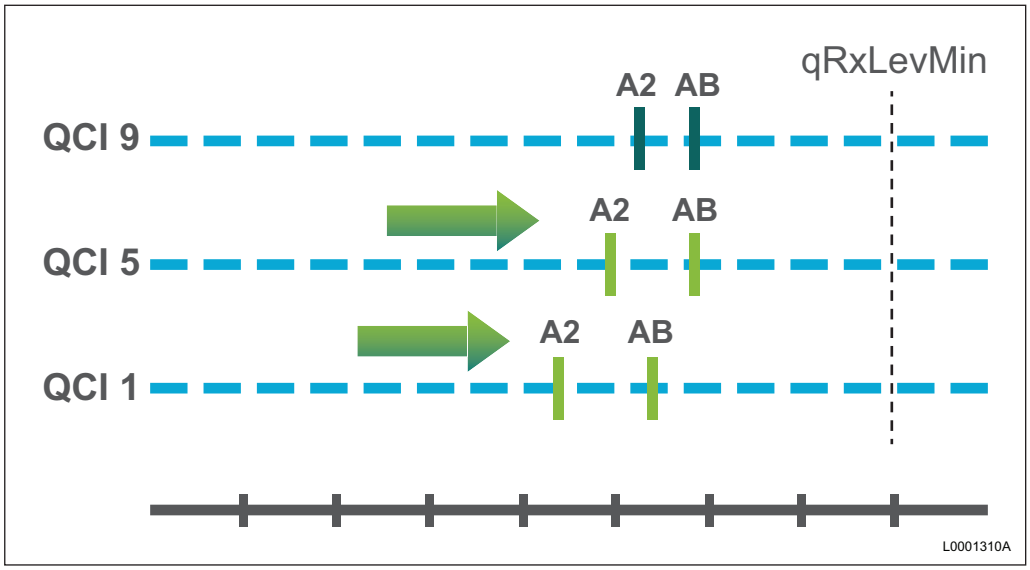

Figure 7 Example of Service Specific Triggers for VoLTE

Recommendations, which are illustrated in Figure 7:

— minimize the offset difference between QCI 5 and QCI 9

Note: A VoLTE UE will always have QCI 5 established which in fact means the UE will use the service triggers for QCI 5

— minimize the offset difference for the thresholds for QCI 1 and 5

- minimize the risk of an SRVCC HO in pre-alerting or alerting state, which might not be supported by the CN (EPC, IMS and MSS), when QCI 1 is established during call setup

— differentiate A2 and B2 thresholds

- the differentiation of the thresholds allows for intra-LTE HO, intra- or inter-frequency, to occur before IRAT provided that A3 and A5 thresholds including offsets are set correctly, which for a VOLTE UE means a chance to stay on LTE rather than perform SRVCC

Further the service specific triggers can be used for:

— move the active VoLTE UE to a preferred frequency, i.e. intra-frequency HO (A3) versus inter-frequency HO (A5)

— move the UE to a preferred RAT, i.e. intra-LTE HO (A3/A5) versus IRAT/ SRVCC (B2)

Note: The use of `EUtranCellRelation.voicePrio` will enhance the possibilities of steering the mobility towards the preferred frequency band.

5 Network Impact

The Network Impact from VoLTE will be the sum of the impact of the used VoLTE features.

5.1 Capacity and Throughput

This section provides information on the impact of the service on network capacity and throughput.

The VoLTE service will have an impact on the UL and DL MBB throughput since it:

— Has high priority due to its real time requiements

— Is packet intensive, i.e. many packets are sent per time unit

— Uses small packet sizes which in most cases leads to lower spectrum efficiency

The degree of capacity degradation in MBB is dependent on the used features and configuration.

5.2 Retainability

The overall retainability values will differ due to the usually longer times spent in RRC connected mode for an active VoLTE user as compared to data traffic user, using short RRC IAT timer settings at for example 10 seconds. If Number of UE drops is expressed as number of drops per UE and per connected hour the values should be comparable.

6 Performance

As VoLTE is an IMS based/owned service the end-to-end performance monitoring needs to be based there. The end user perceived quality is only possible to measure, with accuracy and confidence, in the clients due to the nature of the service.

The LTE RAN performance measurements, as presented here, are indicators of the service quality on the LTE RAN contributions to the service delivery. The measurements are traditional radio access performance indicators with a voice flavor.

6.1 KPIs

The Key Performance Indicators are applicable for the VoLTE service if used according to the following.

6.1.1 Accessibility

In most RRC-Idle to RRC-Connected state transitions the SIP signaling bearer establishment will be covered by the ***Initial*** E-RAB Establishment Success Rate KPI per QCI[5]. This formula is thus the most relevant indicator showing the SIP signaling establishment accessibility. During the attach procedure, the SIP signaling bearer will be added after the default MBB bearer and will in this case show up in the ***Added*** E-RAB Establishment Success Rate KPI per QCI[5].

When setting up a VoLTE call, the voice bearer establishment will only show up in the ***Added*** E-RAB Establishment Success Rate KPI per QCI[1] since it is added dynamically for each voice session. Thus this formula reflects the voice accessibility for UEs in RRC-Connected state.

It is possible for the operator to combine the above formulas in order to capture the voice accessibility for UEs in RRC-Idle state. Such a formula would look like this:

```
Acc(voice) = Init_Erab_Succ(QCI5) * Added_Erab_Succ(QCI1)
```

Voice accessibility from Idle = ***Initial*** E-RAB Establishment Success Rate KPI per QCI (for the signaling bearer) * ***Added*** E-RAB Establishment Success Rate KPI per QCI (for the voice bearer)

It should be noted that the above formula includes all signaling bearer establishments regardless whether or not a voice call is subsequently established.

Note: The voice bearer might show up in the Initial E-RAB Establishment Success Rate KPI per QCI (QCI=1) if the UE is temporarily lost and then saved by the MME.

6.1.2 Retainability

For retainability of the SIP signaling bearer the E-RAB Retainability Percentage Lost per QCI formula provides the most relevant measure.

For retainability of the voice bearer any of the following two formulas can be used: E-RAB Retainability Session Time Normalized per QCI Loss Rate or E-RAB Retainability Percentage Lost per QCI.

To properly identify voice Retainability, it is important that the relevant "Act" counters are pegged for abnormal Releases of the voice bearer. The attribute setting `QciProfilePredefined.counterActiveMode` = TRUE will force the correct QCI=1 counter pegging.

6.1.3 Integrity

Voice quality is measured by the VoIP Integrity KPI covering the UL direction, which in most cases is the weaker link. The Downlink Latency Per QCI is another Performance Indicator that can be used for the voice bearer.

7 O&M Information

This section provides Operation and Maintenance (O&M) information for the VoLTE Service.

Activation of VoLTE is performed in the EPC, IMS and the terminal. The VoLTE service as such does not require a license in the LTE RAN, but the used features may require individual licenses. For more information see the separate CPI for each feature.