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Foreword

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Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

The present document provides a summary of the Release 14 Features and other significant Work Items for which a summary has been agreed to be provided.

There is one clause per Feature. Each clauses begins with a table providing references that can be used to get further information, as described in clause 4. This table is then followed by a summary of what the feature does and how it does it.

The summaries are based inputs from the Rapporteur, provided as tdoc number to the plenary. The tdoc number where the original version of the summary can be found is provided in the first sentence of each clause.

1 Scope

The present document provides a summary of each Feature or, whenever needed, of each significant Work Item, introduced in Release 14.

The information provided in the present document is limited to an overview of each feature, explaining, in about a page, its purpose and the main lines of its behaviour.

The next step to retrieve more information on a given feature is to consult the 3GPP Ultimate web site, as explained in Clause 4.

This document presents the "initial state" of the Features introduced in Release 14, i.e. as they are by the time of publication of this document. It is however important to note that each Feature is subject to be later modified or enhanced, over several years, by the means of Change Requests (CRs) associated to the Feature or to "TEI" (Technical Enhancements and Improvements). It is therefore recommended to retrieve all the CRs which relate to the given Feature, as explained in Clause 4, to further outline a feature at a given time.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

Note: Due to the specificity of the present document, consisting in a collection of independent summaries, the references are given at the end of each clause rather than in this clause.

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1]. Abbreviations specific to a given clause are provided in the clause they appear.

Rel 3GPP Release

4 Process to get further information

4.1 Introduction

Since the present document is limited to provide an overview of each Feature, this chapter explains how to get additional information, in particular how to retrieve all the Specifications (TSs) and Reports (TRs) as well as all the CRs which relate to a given Work Item.

The Unique Identifier (UID) is the key to get additional information on a given Work Item. It can be found in the table located just below the clause's header. The table has the following format:

Table 4.1-1: table format

Unique Identifier (UID)	Name	Acronym	Outline Level (1=Feature, 2=Building Block, 3=Work Task)	Responsible Working Group	Work Item Description

For readability reasons, the table headers are omitted in the continuation of the present document.

For instance, for the "Mission Critical Push to Talk over LTE Realignment", the table has to be understood as:

Table 4.1-2: Example of table at the introduction of each Feature

Unique Identifier (UID)	Name	Acronym	Outline Level	Responsible Working Group	Work Item Description
700029	**Mission Critical Push to Talk over LTE Realignment**	MCImp-MCPTTR	2	S1	SP-150821

Thus, the UID for this Work Item is 700029.

Two methods are now possible to retrieve more information on a given feature: the "Step by step method" and the "Direct method". The "direct method" is faster but implies to know the hierarchical structure of the Work Items. The "step by step method" is slower but is easier to use, in particular when the hierarchical structure is unknown.

For instance, for retrieving all the CRs that relate to "Enhancements for Mission Critical Push To Talk", the search has to be done on UID 740022 but also potentially on its children Work Items (UID 720056, 740023 and 740024).

Table 4.1-3: Example of a hierarchical structure and its consequences on the search procedure

740022	**Enhancements for Mission Critical Push To Talk**	MCImp-eMCPTT		SP-160490
720056	Stage 2 of Enhancements for Mission Critical Push To Talk	MCImp-eMCPTT	S6	SP-160490
740023	Stage 3 of Enhancements for Mission Critical Push To Talk	MCImp-eMCPTT-CT	CT	CP-160824
740024	CT1 aspects of Enhancements for Mission Critical Push To Talk	MCImp-eMCPTT-CT	C1	CP-160824

These two methods are described in the following clauses.

4.2 Direct method

The links below lead to the pages containing respectively all the Specifications and all the Change Requests (CRs) linked to a given Feature:

https://portal.3gpp.org/Specifications.aspx?q=1&WiUid=[UID]

https://portal.3gpp.org/ChangeRequests.aspx?q=1&workitem=[UID]

where "[UID]" has to be preplaced by the UID value.

Using the example provided in the table 4.1-3, the specification linked to "Stage 2 of Enhancements for Mission Critical Push To Talk" can be found in:

https://portal.3gpp.org/Specifications.aspx?q=1&WiUid=720056

And all the related Change Requests are listed in:

https://portal.3gpp.org/ChangeRequests.aspx?q=1&workitem=720056

4.3 Step by step method

This method is to be used when the hierarchical structure is not known or when the "direct method" above does not show the expected results.

In this case, the 3GPP Ultimate web site has to be used:

https://portal.3gpp.org

As a preliminary step, it is essential that the "Customized Selection" is set to "All TSGs" (otherwise, a filter would be applied).

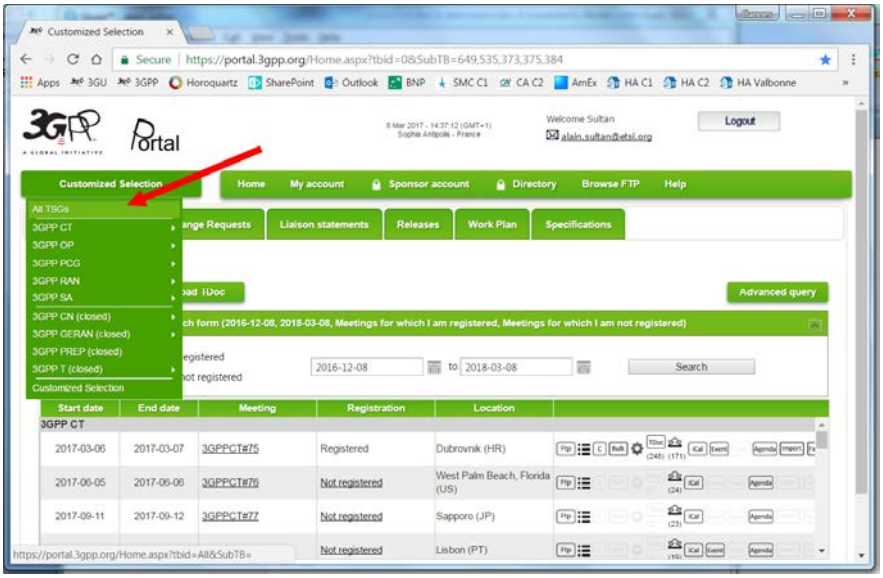


Figure 4.3-1: Selecting "All TSGs" in "Customized Selection" as to remove any potential filter on the Search

Then select the "Work Plan" tab (upper red arrow in the figure below).

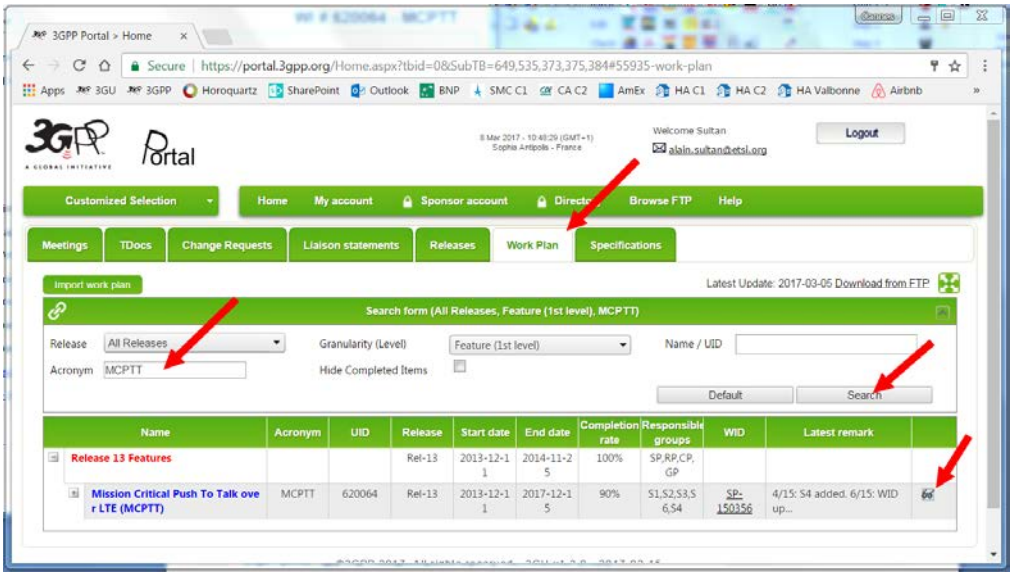


Figure 4.3-2: Using the 3GU Portal to retrieve more information on a given Feature

Then the search might be performed by either typing the Acronym (as shown by the left red arrow on the figure above, using the example "MCPTT"), or by the name or UID (right box) then by clicking on the "Search" button. Watch the "Granularity (Level)" field, which is a filter to return only the Items which level is specified here.

In the results, the icon depicting some binoculars has to be hit (lower right red arrow on the figure above).

This will lead to the page shown in the figure below:

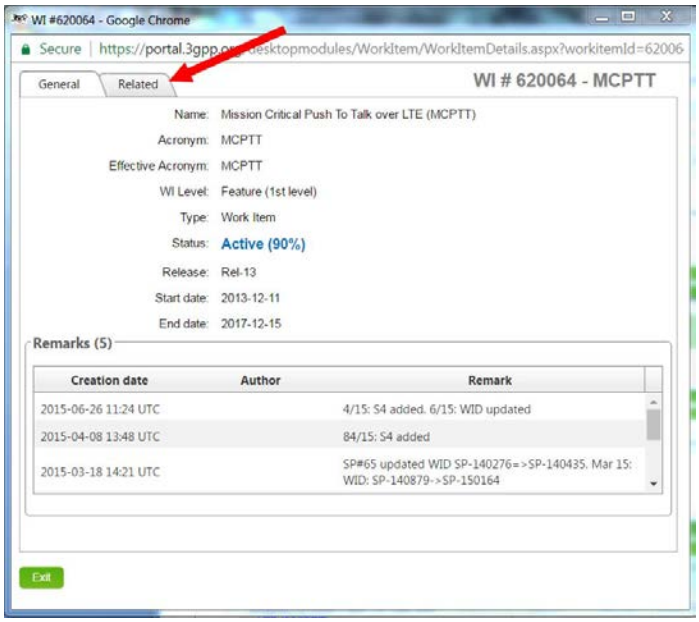


Figure 4.3-3: Window resulting from a "Search"

On this window, the "Related" tab has to be clicked, as pointed by the red arrow in the figure above. This will lead to the window depicted in the figure below.

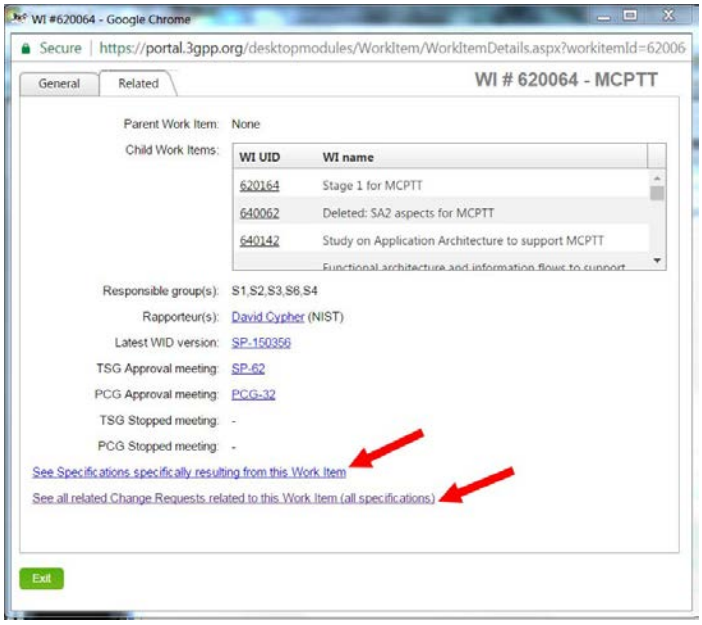


Figure 4.3-4: "Related" tab in a Work Item search, with links to all related Specifications and Change Requests

The two links pointed by the red arrows in the figure above lead to the pages containing respectively all the Specifications and all the Change Requests (CRs) linked to this Feature.

5 Rel-14 Executive Summary

Release 14 focuses on the following Features:

- Improvements of the Mission Critical (MC) aspects, in particular by introducing Video and Data MC services.
- Introducing Vehicle-to-Everything (V2X) communications, in particular Vehicle-to-Vehicle (V2V).
- Improvements of the Cellular Internet of Things (CIoT) aspects, with 2G, 3G and 4G support of Machine-Type of Communications (MTC).
- Improvements of the radio interface, in particular by enhancing the aspects related to coordination with WLAN and unlicensed spectrum.
- A set of uncorrelated improvements, e.g. on Voice over LTE (VoLTE), IMS, Location reporting.

The continuation of the present document provides an exhaustive view of all the items specified in Release 14 by 3GPP.

6 Mission Critical related items

6.1 Mission Critical Improvements general aspects

700027	Mission Critical Improvements	MCImp

This is an "umbrella" Feature, which is a mere grouping of all its constituent Building Blocks, described in the following clauses.

For readability purposes, the two following clauses on Re-organizing the MCPTT Stage 1 and Stage 2 documents are presented here although they were actually developed under the respective Work Items "Mission Critical Push to Talk over LTE Realignment" (described in 6.2) and Common functional architecture to support mission critical services (described in 6.6).

6.1.1 Re-organizing the MCPTT Stage 1 documents

In Release 13, there was a single Stage 1 Technical Specification related to MCPTT, i.e. TS 22.179 ("Mission Critical Push to Talk (MCPTT) over LTE; Stage 1").

In Release 14, three new TSs were introduced to cover dedicated MCPTT topics: TS 22.281 for MCPTT Video (MCVideo); TS 22.282 for MCPTT Data (MCData), and TS 22.280 ("Mission Critical Services Common Requirements").

The text in TS 22.179 Rel-13 was "redistributed", and some new text was added, to 22.179 Rel-14 and to the newly created 22.280, 22.281 and 22.282 as follows:

- requirements specific to MCPTT Video were moved to TS 22.281.
- requirements specific to MCPTT Data were moved to TS 22.282.
- requirements specific to MCPTT "basic service" (i.e. Voice) remained to the Rel-14 version of TS 22.179.
- requirements common to different mission critical services were moved to TS 22.280.

Each requirement that was moved out of 22.179 Rel-13 was voided in the Rel-14 version of TS 22.179 (also known as "the realignment version"), with an informative annex created at the end TS 22.179 Rel-14 documenting the location of the originating TS 22.179 requirement in the other TSs.

6.1.2 Re-organizing the MCPTT Stage 2 documents

As seen in clause above, in Release 14, the stage 1 MCPTT documentation is arranged to be: stage 1 requirements are specified for MCVideo in TS 22.281, for MCData in TS 22.282, for MC common requirements in TS 22.280 and for some enhancements to MCPTT in TS 22.179.

Similarly, for Stage 2, and as part of the work for the MCImp-MC_ARCH work item, the following structure of Stage 2 documentation was adopted:

1) The common functional architecture to support mission critical services including the common services for identity management, configuration management, key management and group management are specified in TS 23.280;
2) The MCPTT service architecture is based on the common functional architecture and is specified in TS 23.379;
3) The MCVideo service architecture is based on the common functional architecture and is specified in TS 23.281; and
4) The MCData service architecture is based on the common functional architecture and is specified in TS 23.282.

It can be noted that, contrarily to Stage 1, where a same TS number (i.e. TS 22.179) was reused between Rel-13 and Rel-14 to handle the basic -voice only- MCPTT service, the Stage 2 documentation took a different approach: the MCPTT functional architecture and information flows are covered in TS 23.179 for Rel-13 and, from Release 14 onwards, a new Specification was created, namely TS 23.379.

For MCPTT security aspects, a similar approach as for Stage 2 was decided: Release 13 is covered in TS 33.179 while, in Release 14, a new specification is created in TS 33.180.

6.1.3 MCPTT documents structure

With this restructuring of documentation, the Release 14 TS and TR specific to Mission Critical Improvements are:

Studies:

TR 22.879 Feasibility Study on Mission Critical Video Services over LTE

TR 22.880 Feasibility Study on Mission Critical Data Communications

Stage 1:

TS 22.179 Mission Critical Push To Talk (MCPTT) over LTE; Stage 1

TS 22.280 Mission Critical Services Common Requirements (MCCoRe); Stage 1

TS 22.281 Mission Critical video services over LTE (MCVideo)

TS 22.282 Mission Critical data services over LTE (MCData)

Stage 2 (including information flows, procedures, and configuration):

TS 23.179 Functional architecture and information flows to support mission critical communication services; Stage 2 (Rel-13 only)

TS 23.379 Functional architecture and information flows to support Mission Critical Push To Talk (MCPTT); Stage 2 (from Rel-14 onward)

TS 23.280 Common functional architecture to support mission critical services; Stage 2

TS 23.281 Functional architecture and information flows to support Mission Critical Video (MCVideo); Stage 2

TS 23.282 Functional architecture and information flows to support Mission Critical Data (MCData); Stage 2

Stage 3:

TS 24.282 Mission Critical Data (MCData) signalling control; Protocol specification

TS 24.379 Mission Critical Push To Talk (MCPTT) call control; Protocol specification

TS 24.380 Mission Critical Push To Talk (MCPTT) media plane control; Protocol specification

TS 24.481 Mission Critical Services (MCS) group management; Protocol specification

TS 24.482 Mission Critical Services (MCS) identity management; Protocol specification

TS 24.483 Mission Critical Services (MCS) Management Object (MO)

TS 24.484 Mission Critical Services (MCS) configuration management; Protocol specification

TS 24.582 Mission Critical Data (MCData) media plane control; Protocol specification

Codec:

TS 26.179 Mission Critical Push To Talk (MCPTT); Codecs and media handling

TS 26.281 Mission Critical Video (MCVideo); Codecs and media handling

Security:

TS 33.179: Security of Mission Critical Push-To-Talk (Rel-13 only)

TS 33.180 Security of the mission critical service (from Rel-14 onward)

Others:

TS 23.303 Proximity-based services (ProSe); Stage 2 (ProSe is an enabler for the MCPTT service)

TS 23.468 Group Communication System Enablers for LTE (GCSE_LTE) (GCSE_LTE is also an enabler for the MCPTT service, in particular GCSE for multicast communication)

TS 29.213 Policy and Charging Control signalling flows and Quality of Service (QoS) parameter mapping

TS 29.214: Policy and Charging Control over Rx reference point

TS 29.283: Diameter data management applications (includes the MCPTT service for data management related to MC service user profile)

6.2 Mission Critical Push to Talk over LTE Realignment

Summary based on the input provided by the U.S. Department of Commerce/ FirstNet in SP-170406.

700029	**Mission Critical Push to Talk over LTE Realignment**	MCImp-MCPTTR	2	S1	SP-150821

This Work Item consists mostly in re-shuffling and re-organizing several sections related to Mission Critical Push to Talk into different TRs and TSs.

Re-organizing the MCPTT Stage 1 documents

See clause 6.1 above on re-organizing the MCPTT Stage 1 documents.

Overview of TS 22.179 on MCPTT Services

The main classification of MCPTT Services refers to their accessibility: they are classified as being accessible when "on-network" (i.e. they require the UE to be attached to the PLMN), when "off-network", or both.

Some MCPTT Service capabilities which are common to "on-network" and "off-network" are:

- Receiving from multiple MCPTT calls, MCPTT Private Call (with floor control) general, commencement, termination and administration capabilities, MCPTT Priority Service including MCPTT Emergency Private Call (with floor control), Location, Interaction between MCPTT Groups calls and MCPTT Private Calls (with Floor control).

Some MCPTT Service capabilities which are only "on-network" are:

- MCPTT Call commencement modes for MCPTT Group calls, Floor control including requesting permission to transmit, override, terminating permission to transmit, transmit time limit, audio cut-in for designated MCPTT Groups, Call Termination, General Group Call Administration,

- Dynamic Group management (i.e., dynamic regrouping) for group and user regrouping, Private Call with or without floor control general capabilities, Private Call with and without floor control commencement, Private Call without floor control termination, Private Call back request, MCPTT Service Priority including general, application layer priorities and call types based on priorities (MCPTT Emergency Private Call (with floor control)), Interactions for MCX Service Group and Private Communications, Audio MCPTT Call Performance (including MCPTT access time and mouth to ear latency, Late call entry performance, audio /voice quality), Ambient Listening.

- Interaction with telephony services, Interworking with non-LTE PTT systems (including P25, Tetra, and Legacy land mobile radio).

Some MCPTT Service capabilities which are only "off-network" are:

- Floor control (including general aspects, requesting permission to transmit, override, terminating permission to transmit, transmit time limit), Call Termination and MCPTT priority.

6.3 Mission Critical Services Common Requirements

Summary based on the input provided by the U.S. Department of Commerce/ FirstNet in SP-170407.

700028	**Mission Critical Services Common Requirements**	MCImp-MCCoRe	2	S1	SP-150822

Introduction

Clause 6.1 explains the relationship in Rel-14 between TS 22.179 (MCPTT), TS 22.280 (MCCoRe), TS 22.281 (MCVideo) and TS 22.282 (MCData).

This clause deals more specifically with TS 22.280, which provides the MCPTT requirements applicable by two or more mission critical services, referred to as "MCX" (Mission Critical X, with X = PTT or X = MCVideo or X = Data).

Overview of TS 22.280 on MCPTT Common Requirements

TS 22.280 follows the same overall structure as TS 22.179, the main clauses being: "on-network", "off-network" or common. TS 22.280 also specifies other types of MCX Service capabilities: Inter-MCX Service interworking, Air ground air communication and MCX Service in IOPS mode.

Some MCX service capabilities common to "on-network" and "off-network" are:

- General Group Communication, Broadcast Group Communication, Late Communication Entry, Receiving from multiple MCX Service communication, Private Communication, MCX Service Priority, MCX Service User ID, MCX UE Management and User Profile, Support for multiple devices, Location, Security and Media quality.

- Relay and Gateway capability, Control and management by Mission Critical Organizations, General administrative –groups and users, open interfaces for MCX Services, Media forwarding, Receipt notification and additional services for MCX Service communications.

Some MCX service capabilities specific to "on-network" are:

- General administrative groups and users, MCX Service communications with notification and acknowledgement for Group Communications and Queuing, General capabilities, General MCX Service Group Communications and Broadcast Group Communication.

- Dynamic Group management (i.e., dynamic regrouping), Private Communication, MCX Service Priority, IDs and aliases, MCX Service User Profile management, Support for multiple devices, Location, Security, Interactions for MCX Service Group and Private Communications, Additional Services (including Discreet and Ambient Listening, Remotely initiated Communication as well as recording and audit requirements).

- Interaction with telephony services, Interworking (including non-3GPP access and Interworking between MCX Service systems), MCX Service coverage extension using ProSe UE-to-Network Relays and Additional MCX Services related to Communication rejection and queuing.

Some MCX service capabilities specific to "off-network" are:

- General off-network MCX Services, Admission control, Communication termination, Broadcast Group, MCX Service priority requirements, Communication types based on priority, Location, Security, Off-Network operations and UE functionality, Streaming for ProSe UE-to-UE and UE-to-Network Relay, Switching to off-network MCX Service, Off-network recording and audit, and Off-Network UE-to-UE Relay for Private and Group communications

Finally, here are some examples of Inter-MCX Service interworking requirements:

- Concurrent operation of different MCX Services, Use of un-sharable resources within a UE, Single group with multiple MCX Services, Priority between services,

6.4 Mission Critical Video over LTE

Summary based on the input provided by Huawei in SP-170767.

720053	**Mission Critical Video over LTE**	MCImp-MCVideo	2		SP-150849

670006	Study on Mission Critical Video over LTE	FS_MCVideo	3	S1	SP-150048
700030	Stage 1 of MCVideo	MCImp-MCVideo	3	S1	SP-150849
720051	Stage 2 for MCVideo	MCImp-MCVideo	3	S6	SP-160491
750018	MCVideo codecs and media handling	MCImp-MCVideo	3	S4	SP-170020
740033	Stage 3 of MCVideo	MCImp-MCVIDEO-CT	3	CT	CP-160827
740034	CT1 aspects 3 of MCVideo	MCImp-MCVIDEO-CT	4	C1	CP-160827
740035	CT3 aspects 3 of MCVideo	MCImp-MCVIDEO-CT	4	C3	CP-160827
740036	CT4 aspects 3 of MCVideo	MCImp-MCVIDEO-CT	4	C4	CP-160827
740037	CT6 aspects 3 of MCVideo	MCImp-MCVIDEO-CT	4	C6	CP-160827

Introduction

Clause 6.1 above explains the relationship in Rel-14 between TS 22.179 (MCPTT), TS 22.280 (MCCoRe), TS 22.281 (MCVideo) and TS 22.282 (MCData).

This clause deals more specifically with TS 22.281, which provides the MCPTT requirements applicable to MC Video, and the corresponding Stage 2 in 23.281.

The MCImp-MCVideo work item specifies the MCVideo service communications to support on-network and off-network operations. It defines the identities, procedures, information flows and related configurations corresponding to UE, user profile, group and service.

It specifies video media communication between several users (i.e. group call or private call), where each user has the ability to gain access to the permission to stream video in an arbitrated manner for on-network and off-network operations.

The Stage 2 (Architecture) for MCVideo is organized as the Stage 1, i.e.:

- TS 23.280 specifies the common functional architecture aspects service including the common services core and the generic mechanisms like UE-to-network relay, affiliation and emergency alerts. These common aspects applies to MCVideo; and

- TS 23.281, specifically dedicated to MCVideo. It specifies the MCVideo service functional architecture, procedures, information flows and related configuration information .

Overview of TS 22.281 on MCPTT Video

The MCVideo service capabilities specified for on-network operations are:

- MCVideo group affiliation, MCVideo group de-affiliation and remote change of affiliation to MCVideo groups.

- Group call setup, group call release, late entry to group call and re-joining a group call enabled for pre-arranged groups. Group call setup up, group call release, joining a group call and re-joining a group call enabled for chat groups. Exiting a group call due to de-affiliation is applicable for pre-arranged and chat group calls.

- Emergency group call commencement, emergency group call cancel and upgrade of a group call to emergency group call.

- Imminent peril group call commencement, imminent peril group call cancel and upgrade of a group call to imminent peril group call.

- Emergency alert initiation and emergency state cancel (applicable for group calls)

- Private call setup in automatic and manual commencement mode.

- Transmission initiation and control, remotely initiated transmission, transmission revoke, transmission cancel, transmission queued, user or server initiated transmission cancel from queue and user or remote authorized user or server initiated transmission end.

- Reception initiation and control, user or server initiated reception and mandatory or negotiated reception override.

- Configurations for MCVideo service pertaining to UE, user profile, service and group.
- User authentication (see TS 24.482) and MCVideo service authorization.

The MCVideo service capabilities specified for off-network operations are:

- Group communication setup, active join to group communication, passive join to group communication and group communication release due to inactivity.
- Emergency group communication commencement, emergency group communication cancel and upgrade of a group communication to emergency group communication.
- Imminent peril group communication commencement, imminent peril group communication cancel and upgrade of a group communication to imminent peril group communication.
- Emergency alert initiation and emergency state cancel (applicable for group calls).
- Private call setup in automatic and manual commencement mode.
- Granting a transmission, rejecting a transmission, releasing a transmission, overriding a transmission due to limit of maximum simultaneous transmissions reached and handling simultaneous transmissions.
- Transmission control in single arbitration or self-arbitration modes, overriding a transmission of a single arbitrator and assignment of a new transmission arbitrator, releasing a transmission arbitrator and delegating a new transmission arbitrator when releasing.
- Configurations for MCVideo service pertaining to UE, user profile, service and group. (see TS 24.481, TS 24.483 and TS 24.484)

The MCVideo service communications uses H.264 (AVC) codec as specified in TS 26.281. Based on operator or MCVideo service provider policy, the MCVideo service may optionally and additionally support the H.265 (HEVC) codec as specified in TS 26.281. If MCVideo service supports combined or separate handling of video and audio streams, then MCPTT audio codecs may be supported as specified in TS 26.179. The media transport protocols supported for MCVideo service are RTP and SRTP as specified in TS 26.281.

6.5 Mission Critical Data over LTE

Summary based on the input provided by the UK Home Office in SP-170749.

720054	**Mission Critical Data over LTE**	MCImp-MCData	2		SP-150850
670007	Study on Mission Critical Data Communications	FS_MCDATA	3	S1	SP-150049
700031	Stage 1 of MCData	MCImp-MCData	3	S1	SP-150850
720052	Stage 2 for MCData	MCImp-MCData	3	S6	SP-160492
740028	Stage 3 of MCData	MCImp-MCDATA-CT	3	CT	CP-160826
740029	CT1 aspects of MCData	MCImp-MCDATA-CT	4	C1	CP-160826
740030	CT3 aspects of MCData	MCImp-MCDATA-CT	4	C3	CP-160826
740031	CT4 aspects of MCData	MCImp-MCDATA-CT	4	C4	CP-160826
740032	CT6 aspects of MCData	MCImp-MCDATA-CT	4	C6	CP-160826

Introduction

Clause 6.1 above explains the relationship in Rel-14 between TS 22.179 (MCPTT), TS 22.280 (MCCoRe), TS 22.281 (MCVideo) and TS 22.282 (MCData).

This clause deals more specifically with TS 22.282, which provides the MCPTT requirements applicable to MC Data, and the corresponding Stage 2 in 23.282.

With the progress of Mission Critical Push To Talk (MCPTT) it was identified that there remained a need for other Mission Critical Services which could also make use of the security, identity obfuscation and quality of service handling which serve as the basis for MCPTT. Mission Critical Data (MCData) is the Work Item addressing handling of data services within that Mission Critical framework.

Overview of TS 22.282 on MCPTT Data

MCData in Release 14 is defined to include a short message service and a file transfer service with conversation management and disposition reporting. There is also an enhanced status reporting capability. Other data services initially envisaged at stage 1 have been postponed to Release 15.

The Short message Distribution Service (SDS) can deliver messages over the signalling channel or over a media bearer. SDS over media bearer can be standalone where the media bearer is set up for the purpose of delivering one message only and then disconnected afterwards or the media bearer can be established as a session for a group to carry multiple messages among group members. As a short message service, there is no pre-check for permission to transmit. The protocol used will handle any size of message so no segmentation or concatenation is required, but a configurable size limit is introduced to protect against unlimited and uncontrolled permission to transmit.

The File Distribution service (FD) can be:

- session based when all recipients are required to make mandatory download; or
- http upload and temporary store in the controlling MCData server followed by distribution of notification of the file availability for the target recipients. This way distribution control is managed and the recipient clients can manage their own reception. There is also provision for mandatory download with the http method.

Mandatory download is indicated from the sending user to the receiving user(s).

SDS and FD can utilize a combined conversation management capability for conversation tracking and grouping.

SDS and FD also both use a disposition mechanism to indicate the status of delivery of the content.

6.6 Common functional architecture to support mission critical services

Summary based on the input provided by Huawei in SP-170766.

720055	**Common functional architecture to support mission critical services**	MCImp-MC_ARCH	2	S6	SP-160489

See clause 6.1 above on re-organizing the MCPTT documents.

The main objective of the MCImp-MC_ARCH work item is to specify a common functional architecture for all mission critical services to support on-network and off-network operations. This common functional architecture includes the common services core functions and certain generic mechanisms (e.g. affiliation) for MCPTT, MCVideo and MCData services to be uniformly developed. This work item enables the re-use of the common services by other mission critical services not limited only to MCPTT.

The common functional architecture to support mission critical services can be used for public safety applications and also for general commercial applications e.g. utility companies and railways.

The MCImp-MC_ARCH work item is applicable for two or more mission critical services and consists of architectural requirements, common functional models for on network and off network, identities, deployment models, procedures and information flows and configurations corresponding to UE, user profile, group and service.

The common functional architecture to support MC services utilizes aspects of the IMS architecture defined in TS 23.228, the Proximity-based Services (ProSe) architecture defined in TS 23.303, the Group Communication System Enablers for LTE (GCSE_LTE) architecture defined in TS 23.468 and the PS-PS access transfer procedures defined in TS 23.237.

The MC service UE primarily obtains access to a MC service via E-UTRAN, using the EPS architecture defined in TS 23.401.

Certain MC service functions such as dispatch and administrative functions can be supported using either MC service UEs in E-UTRAN or using MC service UEs via non-3GPP access networks. These aspects are fully compliant with the MCPTT architecture specified for Release 13 in TS 23.179.

The common functional architecture provides for common functionalities (common services core) to support MC services (MCPTT service, MCVideo service and MCData service). The key functionalities supported by common services core are:

1. Enhancements to Group management for supporting multiple MC services including group creation, group re-grouping (temporary groups), group information query and group information management to support on-network operations. (see TS 24.481)

2. Enhancements to general user authentication to support authorization for multiple MC services (see TS 24.482).

3. Enhancements to MC service configurations for supporting multiple MC services to support the provisioning of UE, user profile, service and group information. (see TS 24.484 and for MO definitions, see TS 24.483)

The generic mechanisms specified are applicable to at least two or more MC services. The generic mechanisms are documented in TS 23.280 for purpose of reducing duplication of procedures for each MC service. The following generic mechanisms are specified:

- Use of UE-to-network relay service to allow ProSe UE to UE communications to support off-network operations for MCPTT service, MCVideo service and MCData service. Support for restricting the relayed group communication on a per group basis. (Implemented only for MCPTT service in Release 14)

- Affiliation to groups, affiliation to groups defined in partner MC system, de-affiliation from groups, de-affiliation from groups defined in partner MC system and remote change of a MC service user's affiliation to groups defined primary or partner MC systems by authorized users. The groups may be enabled for any combination of MCPTT service, MCVideo service and MCData service communications.

- On-network and off-network emergency alert initiation and emergency state cancel for MCVideo service and MCData service communications.

6.7 Enhancements for Mission Critical Push To Talk

Summary based on the input provided by Motorola Solutions in SP-171009.

740022	**Enhancements for Mission Critical Push To Talk**	MCImp-eMCPTT	2		SP-160490
720056	Stage 2 of Enhancements for Mission Critical Push To Talk	MCImp-eMCPTT	3	S6	SP-160490
740023	Stage 3 of Enhancements for Mission Critical Push To Talk	MCImp-eMCPTT-CT	3	CT	CP-160824
740024	CT1 aspects of Enhancements for Mission Critical Push To Talk	MCImp-eMCPTT-CT	4	C1	CP-160824
740025	CT3 aspects of Enhancements for Mission Critical Push To Talk	MCImp-eMCPTT-CT	4	C3	CP-160824
740026	CT4 aspects of Enhancements for Mission Critical Push To Talk	MCImp-eMCPTT-CT	4	C4	CP-160824
740027	CT6 aspects of Enhancements for Mission Critical Push To Talk	MCImp-eMCPTT-CT	4	C6	CP-160824

Enhancements to the MCPTT service were provided for call control and media handling, configuration and security, as detailed below.

The MCPTT enhancements for call control and media handling include:

- Ambient listening call, both remotely and locally initiated; First-to-answer call, Private call call-back request; and Floor control for an audio cut-in enabled group. These enhancements are applicable to "on-network" operation.

The MCPTT enhancements for configuration include:

- Updating the selected MC service user profile for the MCPTT service; and Authorized user remotely changes another MCPTT user's selected MCPTT group – mandatory mode.

The MCPTT enhancements for security include:

- addition of the KMS (Key Management Server) URI for security domain; and security aspects related to operation of the MCPTT service across more than one security domain.

7 Vehicle-to-Everything (V2X) related items

7.1 LTE support for V2X services

Summary based on the input provided by LG Electronics in SP-170412.

720030	**LTE support for V2X services**	V2XLTE	1		SP-150573
690035	**Stage 1 for LTE support for V2X services**	V2XLTE	2	S1	SP-150573
720011	**Architecture enhancements for LTE support of V2X services**	V2XARC	2	S2	SP-160317
740009	**Security aspect of LTE support of V2X services**	V2XLTE-Sec	2	S3	SP-160955
720090	**RAN aspects of LTE-based V2X Services**	LTE_V2X	2		RP-161298
720190	Core part: LTE-based V2X Services	LTE_V2X-Core	3	R1	RP-162519
720290	Perf. part: LTE-based V2X Services	LTE_V2X-Perf	3	R4	RP-162519
730026	**CT aspects of V2X Services**	V2X-CT	2	CT	CP-160584
730027	CT1 aspects of V2X Services	V2X-CT	3	C1	CP-160584
730028	CT3 aspects of V2X Services	V2X-CT	3	C3	CP-160584
730029	CT4 aspects of V2X Services	V2X-CT	3	C4	CP-160584
730030	CT6 aspects of V2X Services	V2X-CT	3	C6	CP-160584
700019	**Study on LTE support for V2X services**	FS_V2XLTE	2		SP-150051
670009	Study on Stage 1 of LTE support for V2X services	FS_V2XLTE	3	S1	SP-150051
700050	Study on Stage 2 of LTE support for V2X services	FS_V2XARC	3	S2	SP-150852
700045	Study on security aspects for LTE support of V2X services	FS_V2XLTE	3	S3	SP-150852
680058	RAN1 Study on LTE-based V2X Services	FS_LTE_V2X	3	R1	RP-161263

The V2X (Vehicle-to-Everything) Feature encompasses all aspects of the 3GPP work needed to support vehicle-based communications: enhancements of the air interface, protocols, and impacts on the LTE core network.

There are two modes of operation for V2X communication, as shown in Figure 7.1-1:

a) V2X communication over PC5 interface: PC5 interface directly connects UEs (User Equipments) so that over-the-air V2X message from a UE is directly received by UEs around the transmitter.

b) V2X communication over LTE-Uu interface: LTE-Uu interface connects UEs with eNB (E-UTRAN NodeB) which plays the role of base station in the LTE networks.

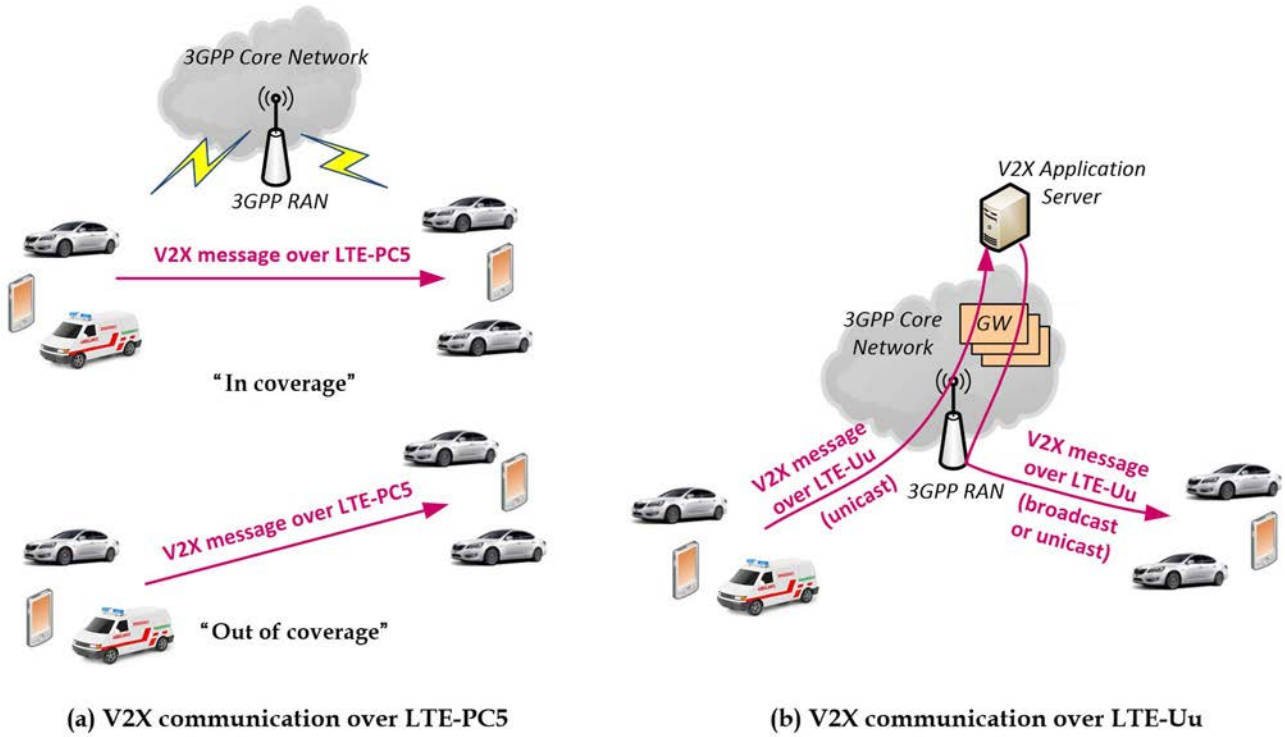


Figure 7.1-1: V2X communication over PC5 interface and LTE-Uu interface

These two communication interfaces may be used by a UE independently for transmission and reception.

V2X communication over PC5 is supported using sidelink when the UE is inside LTE network coverage, i.e. "served by E-UTRAN" and when the UE is out of network coverage, i.e. "not served by E-UTRAN".

For V2X communication over LTE-Uu, which is supported only when the UE is inside network coverage, a UE may receive V2X messages via downlink unicast or broadcast while transmitting V2X messages via uplink.

Service requirements, architecture enhancements and security aspects

- Service requirements

The Work Item on "Stage 1 for LTE support for V2X services (V2XLTE)", driven by SA WG1, defines the following major service requirements for typical V2X application in TS 22.185 [1]:

- Message transfer latency no longer than 100 ms with 20 ms maximum allowed latency in some specific use cases
- Transfer of message size up to 1200 bytes
- Support of up to 10 message transfer per second in typical cases while enabling maximum message transfer frequency of 50 Hz
- Communication range sufficient to give driver enough response time (e.g. 4 seconds)
- Support of relative vehicle speed up to 500 km/h
- Support of V2X communication both in and out of network coverage

These service requirements are based on use cases identified during the study phase in SA WG1 and the use cases consider the previous works done by many other SDOs in the fields of automotive.

- Architecture enhancements

The Work Item on "Architecture enhancements for LTE support of V2X services (V2XARC)", driven by SA WG2, specifies the V2X architectures, functional entities involved for V2X communication, interfaces, provisioned parameters and procedures in TS 23.285 [2].

Figure 7.1-2 depicts an overall architecture for V2X communication. The "V2X Control Function", which communicates with UEs via the V3 interface (not shown on the figure), is the logical function defined for network related actions required for V2X and performs authorization and provisioning of necessary parameters for V2X communication to the UE.

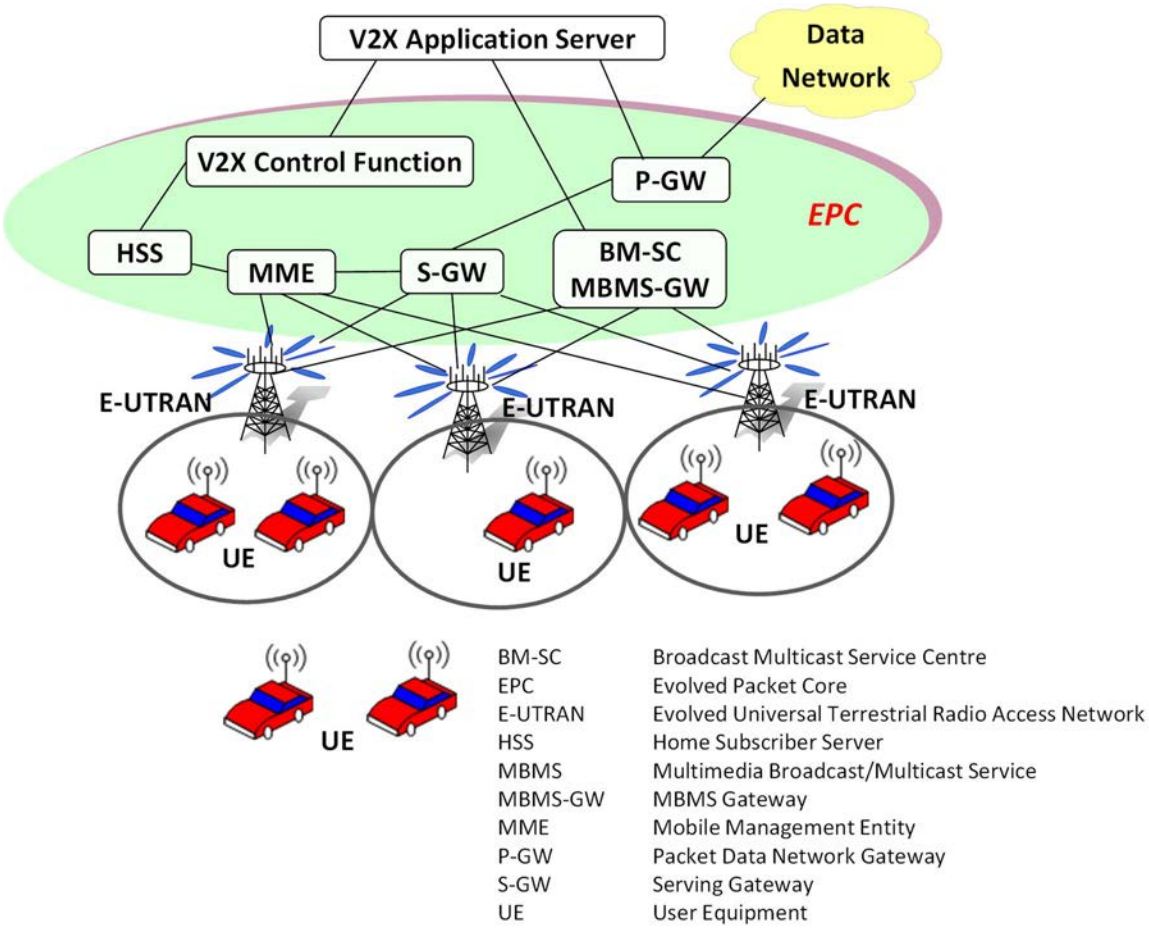


Figure 7.1-2: Overall architecture for V2X communication

When the UE is "served by E-UTRAN", it can send V2X messages over PC5 interface by using network scheduled operation mode (i.e. centralized scheduling) and UE autonomous resources selection mode (i.e. distributed scheduling). When the UE is "not served by E-UTRAN", it can send V2X messages over PC5 interface only by using UE autonomous resources selection mode.

For V2X messages over PC5, both IP based and non-IP based are supported. For IP based V2X messages over PC5, only IPv6 is used. PPPP (ProSe Per-Packet Priority) reflecting priority and latency for V2X message is applied to schedule the transmission of V2X message over PC5.

A UE can send V2X messages over LTE-Uu interface destined to a locally relevant V2X Application Server, and the V2X Application Server delivers the V2X messages to the UE(s) in a target area using unicast delivery and/or MBMS (Multimedia Broadcast/Multicast Service) delivery.

For V2X communication over LTE-Uu, both IP based and non-IP based V2X messages are supported. In order to transmit non-IP based V2X messages over LTE-Uu, the UE encapsulates the V2X messages in IP packets.

For latency improvements for MBMS, localized MBMS can be considered for localized routing of V2X messages destined to UEs.

For V2X communication over LTE-Uu interface, the V2X messages can be delivered via Non-GBR bearer (i.e. an IP transmission path with no reserved bitrate resources) as well as GBR bearer (i.e. an IP transmission path with reserved (guaranteed) bitrate resources). In order to meet the latency requirement for V2X message delivery, the following standardized QCI (QoS Class Identifier) values defined in TS 23.203 [3] can be used:

- QCI 3 (GBR bearer) and QCI 79 (Non-GBR bearer) can be used for the unicast delivery of V2X messages.

- QCI 75 (GBR bearer) is only used for the delivery of V2X messages over MBMS bearers.

- Security aspects

The Work Item on "Security aspect of LTE support of V2X services (V2XLTE-Sec)", driven by SA WG3, specifies the security aspects for LTE based V2X communication in TS 33.185 [4], including security architecture, security requirements, as well as procedures and solutions to meet those requirements.

Overall, security mechanisms from TS 33.303 [5] and TS 33.401 [6], initially designed for ProSe (Proximity-based Services) and LTE respectively are applicable to security support of V2X services, since V2X architecture is based on those architectures. The V3 interface between the UE and the V2X Control Function can be secured in the same way as the PC3 interface between the UE and the ProSe Function, as in TS 33.303 [5]; PSK TLS with GBA (Pre-shared Key Transport Layer Security with Generic Bootstrapping Architecture) is used for UE initiated messages, while PSK TLS including option of GBA push are used for network initiated messages.

For V2X application data, the security requirements are all satisfied by employing application-layer security as defined in other SDOs (e.g. IEEE or ETSI ITS), which is outside the scope of 3GPP. The field related to group keys are all set to zero for PC5 based V2X communications, and the LTE security mechanism for air interface confidentiality (see TS 33.401 [6]) is used for LTE-Uu based V2X communications.

No additional privacy features beyond the regular LTE privacy features are supported for LTE-Uu based V2X communications, while the privacy requirements will likely depend on regional regulatory requirements and/or operator policy. For the privacy of PC5 transmissions, the UE changes and randomizes the source Layer-2 ID, and the source IP address periodically or when indicated by the V2X application that the application layer identifier has changed.

Core network and UE protocol aspects

The Work Item "CT aspects of V2X Services (V2X-CT)", driven by the CT WGs, defines the core network and UE protocol aspects, as summarized below.

- CT WG1

CT1 specified the following protocols in TS 24.386 [7]:

- for V2X authorization between the UE and the V2X Control Function over the V3 interface;

- for V2X communication among the UEs over the PC5 interface; and

- for V2X communication between the UE and the V2X Application Server over the LTE-Uu interface.

The V2X communication is configured by the V2X configuration parameters. The V2X configuration parameters are categorized into "V2X provisioning", "V2X communication over PC5" and "V2X communication over LTE-Uu". The "V2X provisioning" is used for V2X Control Function discovery. The V2X configuration parameters can be 1) pre-stored in the ME (Mobile Equipment), 2) stored in the USIM (User Services Identity Module) or 3) provided by the V2X Control Function to the ME over the V3 interface. The UE uses the V2X configuration parameters in the order of increasing precedence. Further details for the configuration parameters can be found in TS 24.385 [8].
For V2X communication over PC5, the V2X message includes data PDU, a Layer-3 protocol data type (i.e. IP or non-IP), the source Layer-2 ID, the destination Layer-2 ID, and for non-IP V2X message the non-IP type field. The source Layer-2 ID is self-assigned by the UE. The destination Layer-ID is set to one of Layer-2 ID mapping with the V2X service identifier of the V2X service and the default destination Layer-2 ID based on configuration. The non-IP type field is set to corresponding V2X message family (i.e. IEEE 1609, ISO or ETSI-ITS).
For V2X communication over LTE-Uu, the V2X Application Server address can be determined by V2X Application Server discovery procedure using configured V2X Application Server information or using MBMS procedure. For transport of non-IP based V2X messages and IP based V2X message except for using TCP transport, the UE generates UDP/IP packets for V2X message and send it over UDP/IP to the determined V2X Application Server address.

- CT WG3

CT3 specified protocols for the localized MBMS data delivery. The V2X Application Server has pre-configured local MBMS information which consists of MBMS information (e.g., IP Multicast Address) and user-plane information for the localized routing (e.g., MBMS-GW IP Address, and BM-SC IP Address and port number). The local MBMS information is delivered from the V2X Application Server to BM-SC via MB2 interface or xMB interface and MBMS-GW via SGmb interface when activating MBMS bearers. The V2X Application Server can deliver V2X message to the UE via the MBMS bearer activated by the local MBMS information. Further details for the local MBMS information and protocols between the V2X Application Server and BM-SC can be found in TS 29.468 [9] for MB2 interface and

TS 29.116 [10] for xMB interface. Further details for protocols between BM-SC and MBMS-GW can be found in TS 29.061 [11]. Localized MBMS deployment options can be found in TS 23.285 [2].

- CT WG4

CT4 specified the protocols for V2X authorization between the V2X Control Function and the HSS (Home Subscriber Server) over the V4 interface and between the V2X Control Functions over the V6 interface. The V2X Control Function can request service authorization information for the UE in V2X subscription data to HSS. When receiving the request, HSS can provide the list of the PLMNs (Public Land Mobile Networks) where the UE is authorized to perform V2X communication over PC5 interface. Diameter-based V4 interface related procedures and information elements exchanged between the V2X Control Function and the HSS are specified in TS 29.388 [12]. The V2X Control Function in the HPLMN (Home PLMN) can request service authorization information for the UE to the V2X Control Function in the VPLMN (Visited PLMN). When receiving the request, the V2X Control Function in the VPLMN can provide indication for whether the user is allowed to use V2X communication over PC5 in the VPLMN, indication for whether the user is allowed to use V2X communication over MBMS in the VPLMN and V2X Application Server information (e.g., FQDN or IP address). Diameter-based V6 interface related procedures and information elements exchanged between V2X Control Function can be found in TS 29.389 [13].

- CT WG6

CT6 specified V2X configuration and operation related to USIM in TS 31.102 [14] where 'V2X' is added in USIM Service Table for service management and DF (Dedicated File) for V2X (DF_{V2X}) is defined to contain management objects for V2X specified in TS 24.385 [8].

RAN aspects

RAN groups specified the initial version of LTE sidelink enhancement, i.e., sidelink transmission modes 3 and 4, in the context of V2X under work item on "Support for V2V services based on LTE sidelink (LTE_SL_V2V)". However, the outcome as a result of the work item has the limitation that LTE-Uu interface using uplink/downlink was not utilized and only V2V (Vehicle-to-Vehicle) services were considered in a limited operation scenario (e.g., use of only a single carrier in Band 47, only GNSS (Global Navigation Satellite System) as synchronization source outside eNB coverage, etc.).

Work item on "RAN aspects of LTE-based V2X Services (LTE_V2X)" started to further enhance LTE for better V2X services. This work specifies enhancements required to enable V2X services with LTE uplink and downlink, to enable LTE PC5 interface using sidelink to support additional V2X services such as V2P (Vehicle-to-Pedestrian), and to support more operational scenarios for V2V services using LTE sidelink. To be specific, RAN groups considered the following as the main features:

- Uplink and sidelink enhancement to enable eNB to quickly change SPS (Semi-Persistent Scheduling) in adaptation to a change in the V2X message generation pattern
- Introduction of shorter scheduling periods in downlink and sidelink for broadcasting V2X messages within latency requirements
- Introduction of an additional resource allocation procedure in sidelink mode 4 for power saving in pedestrian UEs
- Introduction of sidelink congestion control for operation in high traffic load
- Enhancement to sidelink synchronization for operation outside GNSS or eNB coverage
- Support of simultaneous V2X operations over multiple carriers

As a result, the LTE radio standard supports the two LTE V2X communication methods illustrated in Figure 1. A summary of the key functionalities made by RAN WG1, RAN WG2, RAN WG3 and RAN WG4 is as below and last status report for the work item on "RAN aspects of LTE-based V2X Services (LTE_V2X)" can be found in RP-170236 [15].

- Uplink and sidelink SPS enhancements

An eNB can configure multiple SPS configurations each of which may have different parameters such as the resource period. The UE can report the assistance information to the eNB to indicate the expected message generation period, time offset, maximum message size, etc. The eNB can activate/release each SPS configuration based on the reported

information. The same principle applies to uplink SPS for LTE-Uu based V2X and sidelink SPS for PC5 based V2X. Figure 7.1-3 shows an example of using three SPS configurations with different resource periods.

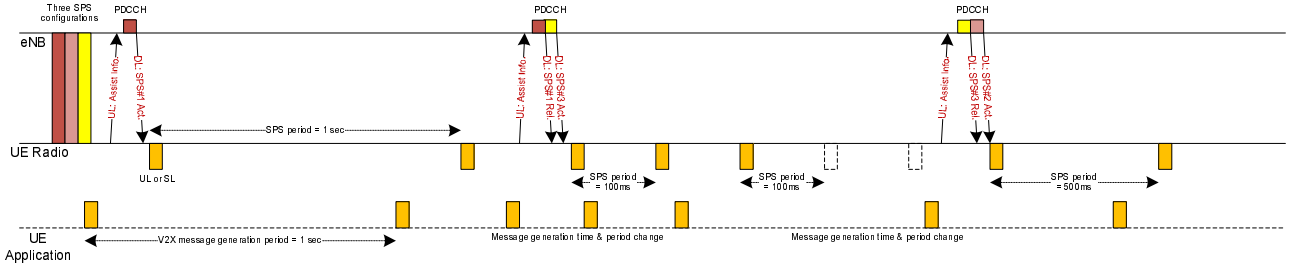


Figure 7.1-3: An example of using multiple SPS configurations in adaptation to V2X message generation changes

- Shorter message transmission periods in downlink and sidelink

As the downlink transmission method for V2X messages, the network can use either per-cell multicast/broadcast transmission mechanism by SC-PTM (Single Cell Point To Multi-point) or multicast/broadcast transmission over multiple cells by MBSFN (Multicast/Broadcast Single Frequency Network). In order to provide sufficiently low latency for V2X services, shorter control and data periods are introduced for SC-PTM and MBSFN. Shorter message transmission periods are also introduced for sidelink and the minimum period of 20 ms can be supported.

- Additional procedure in sidelink transmission mode 4 for pedestrian UEs

Sidelink transmission mode 4 in the existing specification is based on continuous channel monitoring at each transmitter UE in order to reduce the probability of packet collisions, i.e., two UEs transmit using the same time/frequency resources. The RAN Work Item (WI) introduces an additional procedure for the resource selection in sidelink transmission mode 4 in order to reduce the power consumption of pedestrian UEs. Random resource selection is supported such that a pedestrian UE not having the sidelink reception capability can transmit its own V2X messages. Partial sensing is also supported, and the pedestrian UE can monitor the channel only in a subset of subframes as illustrated in Figure 4. Partial sensing can reduce the resource collision probability compared to the random selection but requires more power consumption. The eNB can control which resource selection procedure is used by the pedestrian UEs.

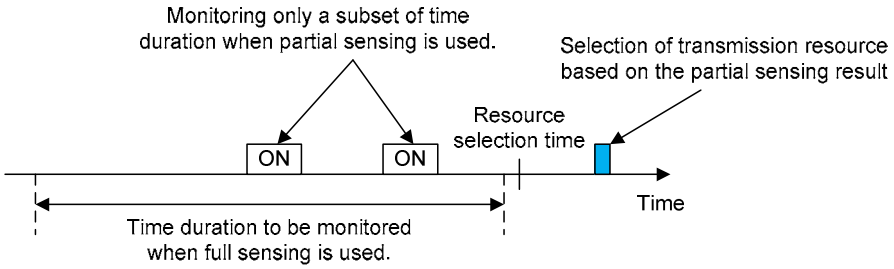


Figure 7.1-4: Illustration of partial sensing

- Sidelink congestion control

The UE measures the CBR (Channel Busy Ratio) which denotes the portion of time/frequency resources in which strong signal is observed. Higher CBR will be typically measured when more UEs transmit more V2X messages in a given channel. Congestion control can adjust each UE's transmission parameters such as transmit power and resource size based on the CBR measurement either in the centralized manner or distributed manner. In centralized congestion control, CBR measured at the UE is reported to the eNB, and the eNB can adjust the resource configuration appropriately, for example, by commanding each UE to lower the transmit power and resource size. In distributed congestion control, the UE adjusts its own transmission parameters within the allowed range which is a function of CBR measurement.

- Enhancement to sidelink synchronization using sidelink signals/channels

Sidelink transmission modes 3 and 4 in the existing specification can use either GNSS signal or the eNB signal as the synchronization reference, so no sidelink operation is possible when a UE cannot receive either signal. The RAN WI enhances this so that a UE operating PC5 based V2X can transmit and receive SLSS (SideLink Synchronization Signal)

which can be used as another type of synchronization reference in sidelink communications. Two UEs using the same SLSS as their synchronization reference can align their time and frequency references before transmitting and receiving V2X messages even when no GNSS signal or eNB signal is detected.

- Support of simultaneous V2X operations over multiple carriers

The RAN WI extends the V2X operation scenarios by supporting simultaneous V2X operations over multiple carriers. In one scenario, a UE can operate LTE-Uu based V2X in a carrier while operating PC5 based V2X in another carrier. In another scenario, a UE can operate PC5 based V2X simultaneously over two carriers. Tables 7.1-1 and 7.1-2 list the combinations of V2X carriers supported for V2X services. The RAN WI specifies a mechanism to determine the transmission power of each carrier based on the priority level. Such simultaneous V2X operations can be used to increase the maximum bandwidth of the V2X services or to support inter-PLMN operations where multiple operators provide V2X services over different carriers.

Table 7.1-1: V2X inter-band multi-carrier configurations

V2X multi-carrier Configuration	E-UTRA Bands	Interface	1.4 MHz	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz	Maximum bandwidth [MHz]
V2X_3A-47A	B3 (@1.8 GHz)	Uu	Yes	Yes	Yes	Yes	Yes	Yes	40
	B47 (@5.9 GHz)	PC5				Yes		Yes	
V2X_7A_47A	B7 (@2.6 GHz)	Uu			Yes	Yes	Yes	Yes	40
	B47 (@5.9 GHz)	PC5				Yes		Yes	
V2X_8A-47A	B8 (@900 MHz)	Uu	Yes	Yes	Yes	Yes			30
	B47 (@5.9 GHz)	PC5				Yes		Yes	
V2X_39A-47A	B39 (@1.9 GHz)	Uu			Yes	Yes	Yes	Yes	40
	47 (@5.9 GHz)	PC5				Yes		Yes	
V2X_41A-47A	B41 (@2.5 GHz)	Uu			Yes	Yes	Yes	Yes	40
	47 (@5.9 GHz)	PC5				Yes		Yes	

Table 7.1-2: V2X intra-band multi-carrier configurations

V2X multi-carrier Configuration	Channel BW of carrier 1	Channel BW of carrier 2	Maximum aggregated BW [MHz]
V2X_47A_47A (@5.9 GHz)	10	10	20

References

[1] TS 22.185: "Service requirements for V2X services".
[2] TS 23.285: "Architecture enhancements for V2X services".
[3] TS 23.203: "Policy and charging control architecture".
[4] TS 33.185: "Security aspect for LTE support of V2X services".
[5] TS 33.303: "Proximity-based Services (ProSe); Security aspects".
[6] TS 33.401: "3GPP System Architecture Evolution (SAE): Security Architecture".
[7] TS 24.386: "User Equipment (UE) to V2X control function; protocol aspects; Stage 3".
[8] TS 24.385: "V2X services Management Object (MO)".
[9] TS 29.468: "Group Communication System Enablers for LTE (GCSE_LTE); MB2 reference point; Stage 3".
[10] TS 29.116: "Representational state transfer over xMB reference point between Content Provider and BM-SC".
[11] TS 29.061: "Interworking between the Public Land Mobile Network (PLMN) supporting packet based services and Packet Data Networks (PDN)".
[12] TS 29.388: "V2X Control Function to Home Subscriber Server (HSS) aspects (V4); Stage 3".

[13] TS 29.389: "Inter-V2X Control Function Signalling aspects (V6); Stage 3".
[14] TS 31.102: "Characteristics of the Universal Subscriber Identity Module (USIM) application".
[15] RP-170236: "Status report of WI: RAN aspects of LTE-based V2X Services".

7.2 Support for V2V services based on LTE sidelink

Summary based on the input provided by Qualcomm Incorporated, LGE, CATT, III, Panasonic, Huawei, HiSilicon, Kyocera, Ericsson, Vodafone, Sony in RP-161788.

700061	**Support for V2V services based on LTE sidelink**	LTE_SL_V2V	1		RP-152293
700161	**Core part: Support for V2V services based on LTE sidelink**	LTE_SL_V2V-Core	2	R1	RP-161603
700261	**Perf. part: Support for V2V services based on LTE sidelink**	LTE_SL_V2V-Perf	2	R4	RP-161603
730073	**UE Conformance Test Aspects - Support for V2V services based on LTE sidelink**	LTE_SL_V2V-UEConTest	2	R5	RP-161716

The V2V Work Item outlines the scope of the work and defines a number of specific objectives on which RAN working groups have concentrated their efforts.

This clause provides a high level description of the main aspects comprising the V2V feature, as identified by the WI objectives.

V2V communications are based on D2D communications defined as part of ProSe services in Rel-12 (RP-142043) and Rel-13 (RP-150441). As part of ProSe services, a new D2D interface (designated as PC5, also known as sidelink at the physical layer) was introduced and now as part of the V2V WI it has been enhanced for vehicular use cases, specifically addressing high speed (up to 250Kph) and high density (thousands of nodes).

To that end, a few fundamental modifications to PC5 have been introduced.

Firstly additional DMRS symbols have been added to handle the high Doppler associated with relative speeds of up to 500kph and at high frequency (5.9GHz ITS band being the main target). This results in the sub-frame structure illustrated in Figure 7.2-1.

As illustrated the V2V sub-frame for PC5 interface has 4 DMRS symbols, in addition to the Tx-Rx turnaround symbol at the end, allowing for better tracking of the channel at high speed.

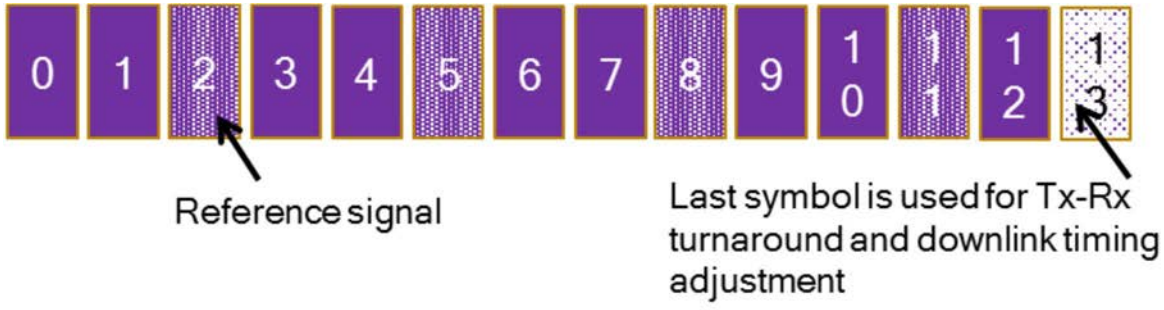


Figure 7.2-1: a V2V sub-frame for PC5 interface

Secondly a new arrangement of scheduling assignment and data resources has been agreed. The arrangement is illustrated in Figure 7.2-2 and is designed to enhance the system level performance under high density while meeting the latency requirements of V2V. Scheduling assignments (SA or PSCCH) are transmitted in sub-channels using specific RBs across time. Data transmissions associated with said scheduling assignments are occupying adjacent RBs in the same subframe. Note that another variant where SA and associated data transmissions are not necessarily transmitted on adjacent RBs has also been standardized.

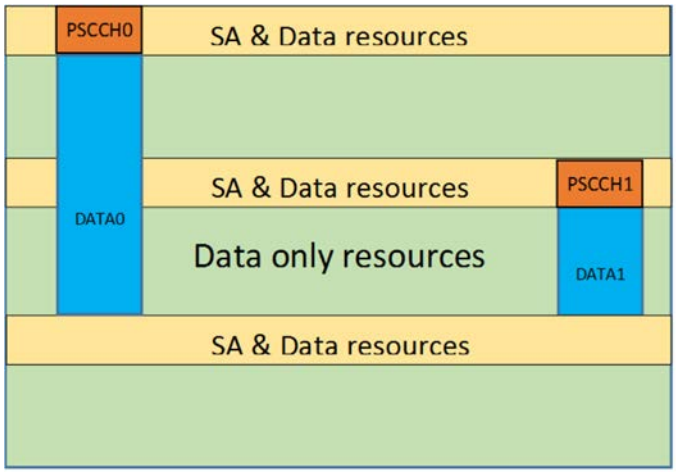


Figure 7.2-2: new arrangement of scheduling assignment and data resources

Finally for distributed scheduling (a.k.a. Mode 4) a sensing with semi-persistent transmission based mechanism was introduced. V2V traffic from a device is mostly periodic in nature. This was utilized to sense congestion on a resource and estimate future congestion on that resource. Based on estimation resources were booked. This technique optimizes the use of the channel by enhancing resource separation between transmitters that are using overlapping resources.

The design is scalable for different bandwidths including 10 MHz bandwidth.

Based on these fundamental link and system level changes there are two high level deployment configurations currently defined, and illustrated in Figure 7.2-3.

Both configurations use a dedicated carrier for V2V communications, meaning the target band is only used for PC5 based V2V communications. Also in both cases GNSS is used for time synchronization.

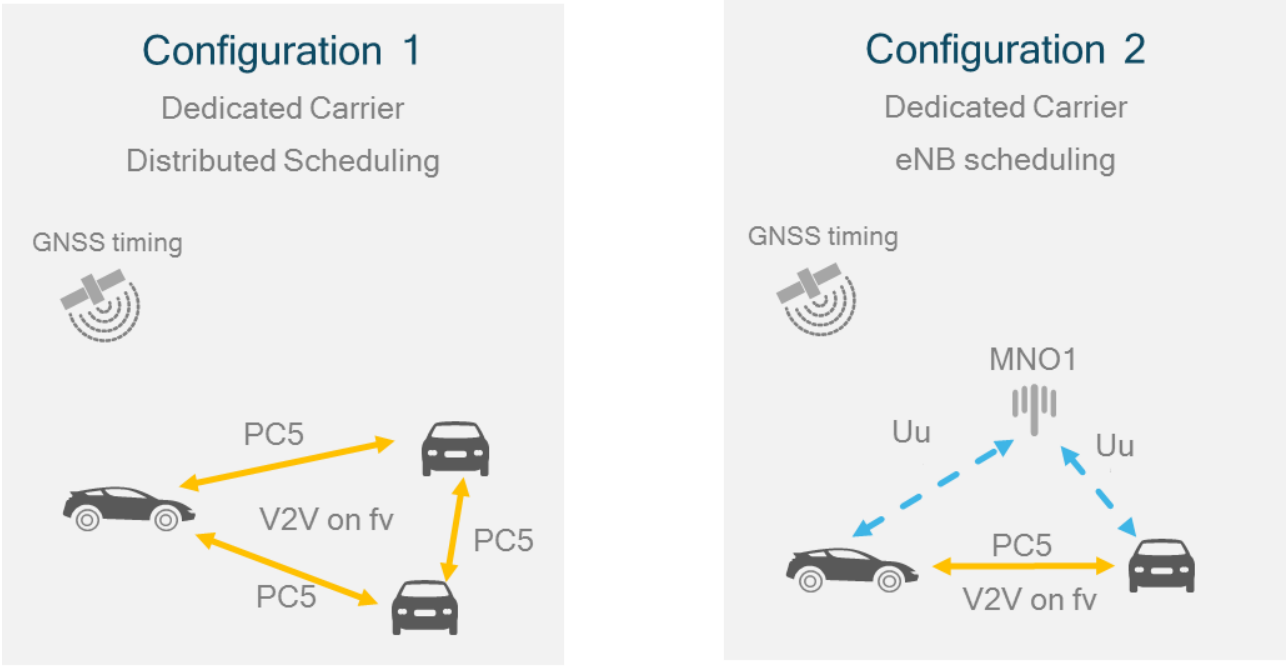


Figure 7.2-3: the two high level deployment configurations

In "Configuration 1" scheduling and interference management of V2V traffic is supported based on distributed algorithms (Mode 4) implemented between the vehicles. As mentioned earlier the distributed algorithm is based on sensing with semi-persistent transmission. Additionally, a new mechanism where resource allocation is dependent on geographical information is introduced. Such a mechanism counters near far effect arising due to in-band emissions.

In "Configuration 2" scheduling and interference management of V2V traffic is assisted by eNBs (a.k.a. Mode 3) via control signaling over the Uu interface. The eNodeB will assign the resources being used for V2V signaling in a dynamic manner.

8 Cellular Internet of Things (CIoT) related items

8.1 System improvements for MTC

8.1.1 Extended architecture support for Cellular Internet of Things

Summary based on the input provided by Intel in SP-170748.

730359	**Extended architecture support for Cellular Internet of Things**	CIoT_Ext	1		SP-160732
720081	**Study on extended architecture support for Cellular Internet of Things**	FS_CIoT_Ext	2	S2	SP-160505
730059	**Stage 2 of Extended architecture support for Cellular Internet of Things**	CIoT_Ext	2	S2	SP-160830
740038	**Stage 3 of extended architecture enhancements for Cellular Internet of Things**	CIoT_Ext-CT	2	CT	CP-160701
740039	CT1 aspects of extended architecture enhancements for Cellular Internet of Things	CIoT_Ext-CT	3	C1	CP-160701
740040	CT4 aspects of extended architecture enhancements for Cellular Internet of Things	CIoT_Ext-CT	3	C4	CP-160701

An extended architecture to support Cellular Internet of Things was studied in TR 23.730. In Rel-14, as part of normative work, the following enhancements were specified.

- Restriction of use of Enhanced Coverage

The support of UEs in Enhanced Coverage is specified in TS 36.300. The usage of Enhanced Coverage may require use of extensive resources (e.g. radio and signalling resources) from the network. This feature enables the operator to prevent specific subscribers from using Enhanced Coverage. The Enhanced Coverage Restricted parameter is introduced as part of the subscription data in the HSS that specifies per PLMN whether the enhanced coverage functionality is restricted or not for the UE. The MME receives Enhanced Coverage Restricted parameter from the HSS. If the UE includes the support for restriction of use of Enhanced Coverage, the MME sends the Enhanced Coverage Restricted parameter to the UE in the Attach/TAU Accept message. The UE uses the value of Enhanced Coverage Restricted parameter to determine if the enhanced coverage feature is restricted or not. The MME also provides an Enhanced Coverage Restricted parameter to the eNB via S1 signalling whenever the UE context is established in the RAN, e.g., during service request procedure, attach procedure, and TAU procedure. The Restriction of use of the Enhanced Coverage is specified in TS 23.060 and TS 23.401. The support for Enhanced Coverage (i.e. CE Mode B) for both "data centric" and "voice centric" UEs is specified in TS 23.401 and TS 23.228.

The support for Enhanced Coverage Restriction Control via SCEF was also specified which enables 3rd party service providers to query status of the enhanced coverage restriction or enable/disable enhanced coverage restriction per individual UEs. The Enhanced Coverage Restriction Control via SCEF is specified in TS 23.682.

Stage-3 aspects for restriction of use of Enhanced Coverage are specified in TS 24.301, TS 23.008, TS 29.272, and TS 29.002.

- Reliable Data Delivery

The Rel-13 solution for non-IP data delivery (NIDD) via the SCEF is unreliable, i.e., there is no mechanism for the SCEF to determine if the data was successfully delivered to the UE (e.g., in case of UE radio link failure, or if the UE is out of coverage) and for the UE to determine if the data was successfully delivered to the SCEF (e.g., in case of T6a/b connection failure, SCEF congestion etc.). Rel-14 introduced enhancements for reliable delivery of NIDD. Two complimentary mechanism were specified –

a) Reliable delivery by acknowledgements on a hop-by-hop basis, i.e. the link layer protocol on each interface used for NIDD uses acknowledgments and nodes apply retransmissions if needed to ensure reliable delivery;

b) Reliable Data Service (RDS) between UE and SCEF. The RDS provides a mechanism for the SCEF to determine if the data was successfully delivered to the UE and for the UE to determine if the data was successfully delivered to the SCEF. When a requested acknowledgement is not received, the RDS retransmits the packet. The RDS is enabled or

disabled based on APN Configuration per (Service Level Agreement) SLA. The RDS protocol is specified in TS 24.250.

- Inter RAT idle mode mobility to/from NB-IoT

Rel-13 does not support idle mode mobility to and from the NB-IoT RAT and if the MME identifies an attempt for RAT change to or from NB-IoT (e.g., at reception of a Context Request or Context Response message or at intra-MME TAU), the MME requires the UE to reattach. Rel-14 introduced the support for idle mode inter-RAT mobility to and from NB-IoT. To ensure a UE initiates tracking area updating procedure when performing inter-RAT mobility between NB-IoT and WB-E-UTRAN, the E-UTRAN has to be configured such that a Tracking Area does not contain both WB-E-UTRAN and NB-IoT cells, and the MME shall not allocate a Tracking Area Identity list that contains both NB-IoT and WB-E-UTRAN Tracking Areas.

A new subscription parameter PDN-Connection-Continuity was added to indicate, on per APN basis, how to handle the PDN connection when the UE moves between "broadband" (WB-E-UTRAN, UTRAN) and "narrowband" (NB-IoT, GPRS, EC-GSM-IoT). The serving node based on the PDN-Connection-Continuity subscription parameter and on the operator policy determines whether to maintain the PDN connection or disconnect the PDN connection with/without a reactivation request. Stage-2 details are specified in TS 23.401 and TS 23.060.

Stage-3 details are specified in TS 29.272 and TS 29.274.

- MBMS user service for UEs using power saving functions

MBMS Bearer Services (see TS 23.246) together with MBMS User Services (see TS 26.346) provide a means to deliver data or triggering payload over broadcast to multiple UEs at the same time. One of the key requirements is how to provide MBMS service to the UEs using power saving functions (e.g. Power Saving Mode or eDRX). Details of MBMS user service for UEs using power saving functions is specified in TS 23.401.

- Enhancements to Location Services for CIoT

Location Services (LCS) are defined in TS 23.271. In order to support Location Services for CIoT UEs, the following enhancements to Location Services are defined:

- Deferred Location for the UE availability event

- Indication of UE RAT type and/or coverage level to Evolved Serving Mobile Location Centre (E-SMLC)

- Support of UE positioning measurements in idle mode

- Addition of Periodic and Triggered Location for EPC

- Support of Last Known Location for a UE that are unreachable for long periods of times

Stage-2 details are specified in TS 23.682 and TS 23.271.

- Inter UE QoS for NB-IoT UEs using Control Plane CIoT EPS optimization

To allow the E-UTRAN to prioritize resource allocation between different NB-IoT UEs when some of the UEs are using the Control Plane CIoT EPS optimization, the eNB may request, based on configuration, the MME to supply the eNB with the negotiated QoS profile for any UE that is using the Control Plane CIoT EPS optimization. The QoS profile sent to the eNB by the MME consists of the E-RAB Level QoS Parameter in the E-RAB to be Setup List IE . The eNB can use the QoS profile to assist with resource prioritization decisions between different NB-IoT UEs (irrespective of whether the UE/eNB is using the Control Plane CIoT EPS optimization, or, the User Plane CIoT EPS optimization).

Stage-2 details are specified in TS 23.401. Stage-3 details are specified in TS 36.413.

- CN overload control for data transfer via Control Plane CIoT EPS Optimization

Further enhancements to handle the CN overload from data transmission via Control Plane CIoT EPS Optimization were specified. Under overload conditions the MME may restrict requests from UEs for data transmission via Control Plane CIoT EPS Optimization. A first option consists in a Control Plane data back-off timer returned by the MME to the UE via NAS signalling. While the Control Plane data back-off timer is running, the UE shall not initiate any data transfer via Control Plane CIoT EPS Optimization. The MME has to store the Control Plane data back-off timer per UE and has to reject any further request (other than exception reporting) for data transmission via Control Plane Service Request from that UE while the Control Plane data back-off timer is still running. A second option is based on the

MME requesting the eNB, using OVERLOAD START message, not to accept RRC connection requests with RRC establishment cause "mo-data" or "delayTolerantAccess" from UEs that only support Control Plane CIoT EPS Optimization.

Stage-2 details are specified in TS 23.401. Stage-3 details are specified in TS 24.301, TS 36.331 and TS 36.413.

8.1.2 Enhancements of Dedicated Core Networks selection mechanism

Summary based on the input provided by Ericsson in SP-170537.

720006	Enhancements of Dedicated Core Networks selection mechanism	eDecor	1		SP-160310
690051	**Study on Enhancements of Dedicated Core Networks selection mechanism**	FS_eDecor	2	S2	SP-150518
720007	**Enhancements of Dedicated Core Networks selection mechanism**	eDecor	2	S2	SP-160310
730013	**CT aspects of eDecor**	eDecor-CT	2	CT	CP-160475
730014	CT1 aspects of eDecor	eDecor-CT	3	C1	CP-160475
730015	CT4 aspects of eDecor	eDecor-CT	3	C4	CP-160475
730016	CT6 aspects of eDecor	eDecor-CT	3	C6	CP-160475
740067	**RAN aspects of eDECOR for UMTS and LTE**	eDECOR-UTRA_LTE	2	R3	RP-162543
740167	Core part: RAN aspects of eDECOR for UMTS and LTE	eDECOR-UTRA_LTE-Core	3	R3	RP-162543

See also "Dedicated Core Networks for GERAN" (DECOR_GERAN) under GERAN

This feature is an enhancement of Release 13's DECOR (Dedicated Core Networks selection mechanism) Feature. Two functionalities are introduced:

- "UE-assisted DCN selection", as to reduce the DECOR re-routing;
- and in E-UTRAN, a mechanism is introduced to improve the load balancing between MMEs when DCN is used.

This work item specifies the use of DCN-ID (Dedicated Core Network – Identity) to assist the RAN (GERAN, UTRAN and E-UTRAN) in selecting the correct DCN, as to reduce the use of DECOR re-routing. The DCN-ID is allocated by the core network and sent to the UE in the Non-Access Stratum (NAS) "accept" messages. The DCN-ID is stored in the UE per PLMN. The UE provides the DCN-ID in the RRC message in Attach Request, Tracking Area Update Request (TAU) or Routing Area Update Request (RAU) messages. If the RAN cannot find a serving MME/SGSN related to GUTI, NRI, etc. provided by the UE, RAN uses the DCN-ID to select correct MME/SGSN serving the requested DCN. The DCN-ID is also sent to the selected MME/SGSN over S1AP.

In E-UTRAN, the MME sends for each DCN-ID (that it supports) a weight factor in the S1 Setup and MME Configuration update procedure. The weight factor per DCN represents the relative processing capacity of an MME node for a specific DCN relative to other MME nodes' capacity for that DCN within the same MME pool area. The eNB can use this information to perform load balancing.

A number of specifications have been updated but no new spec has been created.

8.2 LTE enhancements for MTC

8.2.1 Further enhanced MTC for LTE

Summary based on the input provided by Ericsson LM in RP-171441 (replacing RP-171177).

720092	Further enhanced MTC for LTE	LTE_feMTC	1		RP-161321
720192	**Core part: Further enhanced MTC for LTE**	LTE_feMTC-Core	2	R1	RP-162520
720292	**Perf. part: Further enhanced MTC for LTE**	LTE_feMTC-Perf	2	R4	RP-162520

LTE Rel-13 introduced improved support for machine-type communications (MTC) in the form of a low-complexity UE category, coverage enhancement modes and extended discontinuous reception, and this work item broadens the range of use cases that can be addressed by LTE MTC by providing higher data rate support, multicast support, improved positioning, VoLTE enhancements and mobility enhancements.

Higher data rate support

The low-complexity UE category introduced in LTE Rel-13 (Cat-M1) has a UE bandwidth of 1.4 MHz and a peak rate of 1 Mbps in DL and UL. Coverage enhancement (CE) modes A and B, which are applicable to both Cat-M UEs and normal LTE UEs, are also restricted to 1.4 MHz in Rel-13. This work item introduces the following data rate improvements in order to be able to address a wider range of use cases.

- **New UE category M2:** A new UE category (Cat-M2) is introduced with a UE bandwidth of 5 MHz and peak rates of approximately 4 Mbps in DL and 7 Mbps in UL. These peak rates apply for UEs supporting full-duplex FDD operation – the peak rates for UEs supporting half-duplex FDD are approximately half of these numbers and the peak rates for UEs supporting TDD depend on the DL/UL subframe configuration.

- **Wider bandwidth in CE mode:** CE modes A and B are improved to support maximum data channel bandwidths of 5 or 20 MHz in DL, and CE mode A is improved to support a maximum data channel bandwidth of 5 MHz in UL. The control signaling (MPDCCH, system information, etc.) is still restricted to 1.4 MHz in order to re-use as much as possible of the Rel-13 design.

- **Higher UL peak rate for Cat-M1:** Support for a larger transport block size (TBS) of 2984 bits instead of 1000 bits is introduced in order to increase the UL peak rate for Cat-M1. Increasing the UL TBS is not expected to increase the UE complexity significantly but will provide an UL peak rate boost which may be particularly useful in DL-heavy TDD configurations.

- **10 DL HARQ processes in FDD:** In order to enable UEs that support full-duplex FDD operation to do continuous DL data transmission, the number of DL HARQ processes is increased from 8 to 10, increasing the DL peak rate with 25%. This will also benefit half-duplex FDD UEs configured with HARQ-ACK bundling.

- **HARQ-ACK bundling in HD-FDD:** In half-duplex FDD operation, the DL peak rate is limited by the fact that the UE needs to switch to UL in order to transmit HARQ-ACK feedback. This work item introduces HARQ-ACK bundling, where the UE transmits a single HARQ-ACK feedback for multiple DL transport blocks, thereby enabling the UE to incease the portion of subframes that can be used for DL data transmission from 30% to 53% (or to 59% using 10 DL HARQ processes).

- **Faster frequency retuning:** Since the UE bandwidth of Cat-M UEs can be smaller than the system bandwidth, a guard period of 2 OFDM symbols is applied in CE mode to allow these UEs to do frequency retuning within the system bandwidth. This work item introduces support for shorter guard periods of 1 symbol (for Cat-M) and 0 symbols (for normal LTE UEs in CE mode), allowing for somewhat improved link performance.

These features can be supported by Cat-M2 and normal LTE UEs supporting CE mode. All features except the wider bandwidth can also be supported by Cat-M1.

Multicast support

Multicast is introduced based on SC-PTM with modifications to suit the low complexity of Cat-M UEs and enhanced coverage of UEs operating in CE mode. Similar to LTE, SIB20 configures the transmission of the single SC-MCCH per cell which in turn configures up to 128 SC-MTCHs. Each SC-MTCH can be configured to support up to 1 Mbps over 1.4 MHz or 4 Mbps over 5 MHz, with or without frequency hopping. The modification and repetition periods of SC-MCCH are extended to account for the repetitions used for coverage extension on MPDCCH and PDSCH. To keep UE complexity low, the UE is only required to receive SC-PTM in RRC_IDLE mode, and it is not required to process SC-MCCH at the same time as SC-MTCH, nor is it required to process any SC-PTM transmission at the same time as paging or random access. Differently to LTE, there is no SC-N-RNTI. Instead, notification of SC-MCCH change is indicated directly in the downlink control information (DCI) which schedule SC-MCCH and SC-MTCH to avoid the need to send change notification separated in time from the scheduling DCIs.

Improved positioning

The necessary signaling for the LTE positioning methods E-CID and OTDOA is supported already in Rel-13 for Cat-M1 and other UEs in CE mode but this work item introduces full standard support by also including measurement performance requirements. Also, additional OTDOA enhancements are introduced in order to take into account the limited UE bandwidth of Cat-M UEs and the low signal-to-noise ratio (SNR) operating point of UEs in CE mode. Each

cell and UE can be configured with up to three Positioning Reference Signals (PRS) instead of just one, each PRS with its own configured transmission interval, duration and bandwidth, with or without frequency hopping. The intervals can now be as short as 10 ms (previously 160 ms) and the duration as long as 160 ms (previously 6 ms). Although these OTDOA enhancements have been designed with Cat-M and other UEs in CE mode in mind, they can be supported by LTE UEs that do not support CE mode.

VoLTE enhancements

Cat-M1 and other UEs in CE mode A support VoLTE already in Rel-13 but this work item introduces optimizations to improve the coverage for VoLTE and other delay sensitive services in particular in half-duplex FDD and TDD where the number of available DL/UL subframes is limited.

- **New PUSCH repetition factors:** Two new subframe repetition factors (12, 24) were included in the existing range (1, 2, 4, 8, 16, 32) for the uplink data channel (PUSCH) in order to allow more efficient use of available subframes.
- **Dynamic HARQ-ACK delays:** A field indicating a HARQ-ACK delay was introduced in the downlink control information (DCI) to allow more flexible scheduling of the HARQ-ACK feedback for DL data transmissions.
- **SRS coverage enhancement:** Support for sounding reference signal (SRS) repetition in the special subframe in TDD was introduced in order to enable improved link adaptation.

These features are not limited to VoLTE but can be used with any service for Cat-M or other UE in CE mode A. The SRS coverage enhancement can furthermore be supported also by LTE UEs that do not support CE mode.

Mobility enhancements

Rel-13 has full standard support for intra-frequency measurements for Cat-M1 and other UEs in CE mode including signaling and measurement performance requirements and has signaling support for inter-frequency measurements. This work item introduces full standard support for inter-frequency measurements by also including measurement performance requirements.

8.3 GPRS/GERAN enhancements for MTC

8.3.1 New band support for Rel-14 Narrowband Internet of Things (NB-IOT)

Summary based on the input provided by Ericsson in RP-170970.

730083	New band support for Rel-14 Narrowband Internet of Things (NB-IOT)	NB_IOT_R14_bands	1	R4	RP-161890
730183	**Core part: New band support for Rel-14 Narrowband Internet of Things (NB-IOT)**	NB_IOT_R14_bands-Core	2	R4	RP-161890
730283	**Perf. part: New band support for Rel-14 Narrowband Internet of Things (NB-IOT)**	NB_IOT_R14_bands-Perf	2	R4	RP-161890

This work item introduces support of NB-IoT for new bands 11, 21, 25, 31, and 70.

The corresponding changes are applied to UE RF specification, BS RF specification and RRM requirements.

This Work Item is generic to all bands, meaning that when a new band is specified or when an operator wishes to operate NB-IoT in an existing band, there is not need to specify a new WI for each band.

8.3.2 Enhancements of NB-IoT

Summary based on the input provided by Huawei and HiSilicon in RP 171061.

720093	Enhancements of NB-IoT	NB_IOTenh	1		RP-161324
720193	**Core part: Enhancements of NB-IoT**	NB_IOTenh-Core	2	R1	RP-161901
720293	**Perf. part: Enhancements of NB-IoT**	NB_IOTenh-Perf	2	R4	RP-161901

Whereas the Rel-13 NB-IoT specifications provide the fundamental air interface for ultra-low complexity UEs which can be connected to a network in massive numbers in extremely challenging coverage whilst having a long battery life, this work item gives NB-IoT support for positioning, multicast, connected mode mobility (without handover), higher data rates, load balancing for paging and random access onto non-anchor carriers, and support for a UE power class of 14 dBm to permit use of small form-factor batteries with very low peak-current delivery.

A. Positioning

LPP (Location and Positioning Protocol) signalling is introduced as the positioning protocol for NB-IoT. The UE indicates its capability to perform OTDOA-, A-GNSS-, E-CID, terrestrial beacon service-, sensor-, WLAN-, and Bluetooth-based positioning. Of these, OTDOA and E-CID are specified in 3GPP. The UE indicates in the capability signalling when it requires idle mode to perform the measurements.

OTDOA

A new Narrowband Positioning Reference Signal (NPRS) is introduced, based on LTE's PRS in one PRB. NPRS are configured to occur periodically in the time domain. There can be a bitmap, 'Part A', mapping to successive 10 or 40 subframes indicating which subframes may contain NPRS, and/or there can be a configuration of a number of consecutive subframes, a period, and an offset within the period of the starting subframe (collectively 'Part B'). The NPRS pattern in one subframe is shown in Figure 1, and depends on whether the NB-IoT carrier containing the NPRS is deployed in-band to LTE, in an LTE guard-band, or standalone. Hearability of the pattern is improved by offsetting the pattern according to a UE-specific ID in the frequency domain, and by each Part being independently mutable in a configurable pattern corresponding to its periodicity, illustrated in Figure 2. The UE only needs to make RSTD measurements in RRC_IDLE mode, and it is the eNB's responsibility to avoid collisions between NPRS and other transmissions the UE may need to receive in RRC_IDLE. Assistance information is provided for each non-serving NB-IoT carrier configured for NPRS to tell the UE the offset in time between the reference cell and the neighbour cell, and the subframes where SIB1-NB occurs if the neighbour cell is an anchor carrier.

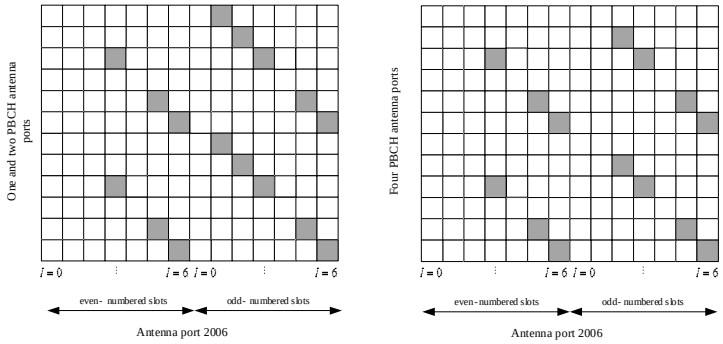


Figure 8.3.2-1a: NPRS for in-band NB-IoT carriers for $N_{\mathrm{ID}}^{\mathrm{NPRS}}$ mod 6 = 0.

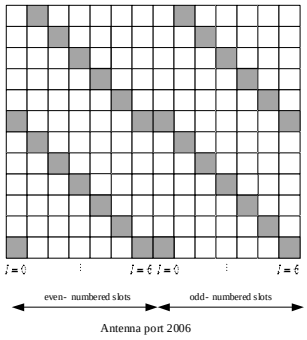


Figure 8.3.2-1b: NPRS for guard-band/standalone NB-IoT carriers for $N_{\mathrm{ID}}^{\mathrm{NPRS}}$ mod 6 = 0.

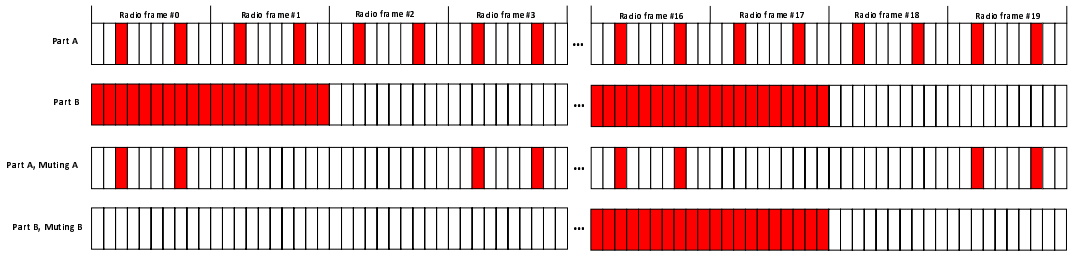


Figure 8.3.2-2: Illustration of Part A bitmap [0010000100], Part B with period 160 ms, 20 NPRS subframes per occasion and zero starting offset. Muting A = [1001], muting B = [01].

E-CID

Core requirements are defined for E-CID. The UE only needs to make NRSRP and NRSRQ measurements in RRC_IDLE mode.

B. Multicast

Multicast is introduced based on SC-PTM, with simplifications to suit the low complexity of an NB-IoT UE. Similar to LTE, SIB20-NB configures the transmission of the single SC-MCCH per cell which in turn configures up to 64 SC-MTCHs. The transmissions can be on anchor or non-anchor NB-IoT carriers. The modification and repetition periods of SC-MCCH are extended to account for the repetitions used for coverage extension on NPDCCH and NPDSCH. To keep UE complexity low, the NB-IoT UE is only required to receive SC-PTM in RRC_IDLE mode, and it is not required to process SC-MCCH at the same time as SC-MTCH, nor is it required to process any SC-PTM transmission at the same time as paging or RAR. Differently to LTE, there is no SC-N-RNTI. Instead, notification of SC-MCCH change is indicated directly in the DCIs which schedule SC-MCCH and SC-MTCH to avoid the need to send change notification separated in time from the scheduling DCIs.

C. Non-anchor carrier operation

There can be up to 15 DL and UL non-anchor carriers configured in a new NB-IoT SIB, used by paging, RAR, or SC-PTM, each identified by its centre frequency. For paging purposes, POs are distributed across the non-anchor carriers in a configurable uneven manner so that the eNB can decide what paging load each carrier should have. For random access, each non-anchor UL carrier has a probability with which the UE may randomly select it for Msg1&3, and corresponds to a DL carrier for Msg2&4; or for ordered random access the carrier for Msg1&3 is indicated by DCI. Contention free random access is supported for NPDCCH ordered random access.

On non-anchor carriers for receiving paging and RAR, the subframes which the UE can assume contain NRS are reduced, to benefit network power consumption and co-existence with LTE and NR in future. In addition to spanning a few valid subframes either side of the NPDSCH carrying paging or RAR, the NRS are reduced to start a few valid subframes before the paging NPDCCH search space or RAR window, and continue until a few valid subframes after the NPDCCH candidate that contains the paging DCI, or after the RAR window respectively.

D. Mobility enhancements

For the Control Plane CIoT EPS optimizations, RRC Connection Re-establishment and S1 eNB CP Relocation Indication procedures are introduced, to allow maintaining the S1 connection and retransmissions of the NAS PDUs by MME and UE NAS in case of radio rink failure. Since AS security is not supported by these UEs, a security token based on NAS security is included in the RRC Connection Re-establishment Request and RRC Connection Re-establishment messages to allow authentication of the UE by the MME and authentication of the eNB by the UE. In case of successful UE authentication, the MME initiates a newly introduced S1 UE Context Release procedure to release the UE's S1-connection in the old eNB. The MME may initiate MME CP Relocation procedure before the release procedure in order to trigger the old eNB to return non-delivered NAS PDUs to the MME.

For User Plane CIoT EPS optimizations, the legacy handover procedure of with data forwarding at handover is used at radio link failure.

E. Power consumption and latency reduction

To reduce the time and UE power required to transfer larger messages in more favourable coverage, the range of transport block sizes (TBS) the NB-IoT UE can support is increased from a maximum of 680 bits DL and 1000 bits UL to 2536 bits on both links. This establishes a Category NB2 UE. The Cat NB2 UE may optionally have 2 HARQ processes for UL and DL (compared to 1 each in Rel-13), allowing further peak rate increases, in which case the time

spacing between transmissions is reduced on the assumption the UE decoding capability has been increased. The use of 2 HARQ processes by a UE has to be activated by the eNB. The peak rate on a standalone non-anchor carrier is increased from 25 DL / 60 UL kbps to approximately 80 DL / 105 UL kbps for 1 HARQ UEs, and 125 DL / 140 UL kbps for 2 HARQ UEs.

F. Lower power class

RF requirements are introduced for a UE with a maximum transmit power of 14 dBm. The intention is to allow the use of small form-factor batteries which provide a low peak current. Signalling is introduced to allow the network to control if and how these UEs can access a cell. There is not compensation by additional repetitions for control and data to account for the power class reduction, as these UEs are assumed to be in normal or extended (rather than extreme) coverage, but the UE selection of a coverage level for NPRACH transmission is adjusted according to the UE's maximum power.

8.3.3 Non-IP for Cellular Internet of Things (CIoT) for 2G/3G-GPRS(EC-EGPRS)

Summary based on the input provided by Ericsson in SP-17xxx.

710023	**Non-IP for Cellular Internet of Things (CIoT) for 2G/3G-GPRS(EC-EGPRS)**	NonIP_GPRS	1		SP-160196
710024	**Non-IP for Cellular IoT for EC-EGPRS**	NonIP_GPRS	2	S2	SP-160196
710025	**CT aspects for Non-IP for Cellular Internet of Things for EC-EGPRS**	NonIP_GPRS-CT	2		CP-160293
710026	CT1 aspects for Non-IP for Cellular Internet of Things for EC-EGPRS	NonIP_GPRS-CT	3	C1	CP-160293
720069	CT3 aspects for Non-IP for Cellular Internet of Things for EC-EGPRS	NonIP_GPRS-CT	3	C3	CP-160293
710027	CT4 aspects for Non-IP for Cellular Internet of Things for EC-EGPRS	NonIP_GPRS-CT	3	C4	CP-160293

The work item introduces support for PDN/PDP Type Non-IP for 2G/3G-GPRS/EC-GSM-IoT including support for Non-IP Data Delivery (NIDD) using SCEF and SGi.

The base for this WI is the Cellular IoT WIs in Rel-13/14 (CIoT and CIoT_Ext).

The key functionalities of this WI are:

- Support for PDN/PDP Type Non-IP;
- Adaptations of GGSN IP address allocation for PDP Contexts of PDP Type Non-IP;
- Support for Inter-RAT mobility with PDN connections of PDN/PDP Type Non-IP;
- A CIoT Optimization support indication is included in the SGSN Context Request message;
- SGSN made part of CIoT Optimizations for relevant procedures e.g. NIDD;
- Introduction of the T6b reference point between SGSN and SCEF;
- Configuration possibility of SCEF in the default APN subscription information;
- APN rate control for CIoT Optimization.

8.3.4 Radio Interface Enhancements for Extended Coverage GSM for support of Cellular Internet of Things

Summary based on the input provided by Nokia in RP-171321.

730077	Radio Interface Enhancements for Extended Coverage GSM for support of Cellular Internet of Things	CIoT_EC_GSM_radio_enh	1	R6	RP-161806
730177	Core part: Radio Interface Enhancements for Extended Coverage GSM for support of Cellular Internet of Things	CIoT_EC_GSM_radio_enh-Core	2	R6	RP-161806
730277	Perf. part: Radio Interface Enhancements for Extended Coverage GSM for support of Cellular Internet of Things	CIoT_EC_GSM_radio_enh-Perf	2	R6	RP-161806

EC-GSM-IoT is an evolution of EGPRS as to provide a streamlined protocol implementation, reducing the MS complexity while supporting energy efficient operation with extended coverage compared to GPRS/EGPRS.

EC-GSM-IoT improves the coverage performance of Cellular IoT devices by 20 dB compared to EGPRS along and enables long battery life time achieved by energy efficient methods over the radio interface. The extended coverage is achieved by a high number of blind physical layer transmissions along with modified channel coding schemes.

In Release 13, the base station supporting EC-GSM-IoT requires a minimum of 4 consecutive timeslot resources reserved for packet data operation to support extended coverage operation. Furthermore, the coverage improvement for low power EC-GSM-IoT devices with 23 dBm output power is limited to 10 dB in this release.

As part of radio interface enhancements introduced in Release 14, Extended Coverage (EC) operation with a reduced number of 2 consecutive timeslot resources both on DL and UL is enabled. In addition, a new uplink coverage class CC5 is added to improve the MCL performance in uplink by 4 dB compared to Release 13, which is specified both for 4 and 2 consecutive time slot resources.

The two aspects (EC operation with reduced number of PDCH resources) and (New uplink coverage class for improved uplink MCL performance) are developed below.

A. EC operation with reduced number of PDCH resources

An additional coverage class mapping of blind physical layer transmissions is introduced for higher coverage classes CC2 to CC4 where only 2 consecutive timeslot resources per TDMA frame are available for extended coverage operation. The new coverage class mapping will have increased (i.e. doubled) BTTI compared to existing coverage classes as blind physical layer transmissions need to be extended over twice the number of TDMA frames compared to 4 consecutive timeslot resources.

The reference sensitivity performance of the new coverage class mapping is comparable to that for the corresponding higher coverage class with 4 PDCH mapping. This feature allows the network to deploy EC-GSM-IoT services by allocating a minimum number of timeslots (i.e. 2) for EC traffic channel operation. This is illustrated in Fig. 1 below.

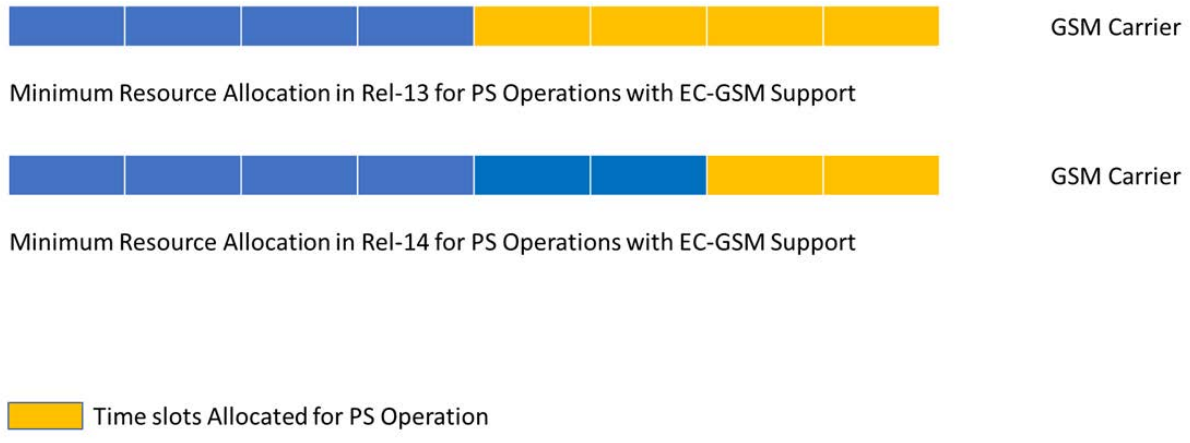


Figure 8.3.3-1: Radio resources for EC traffic channel operation for Rel-13 and Rel-14.

B. New uplink coverage class for improved uplink MCL performance

With introduction of the new uplink coverage class CC5, the uplink MCL performance for a EC-GSM-IoT device improves by additional 4 dB. This feature allows the low power EC-GSM-IoT devices with output power of 23 dBm to

operate in further extended coverage condition upto 14 dB compared to EGPRS. The new coverage class CC5 is specified both for 4 and 2 consecutive timeslot resources on UL with comparable MCL performance.

On CC5 uplink traffic channel the coverage improvement is achieved by increasing the number of bits for channel estimation along with a higher number of blind physical layer transmissions. The CC5 random access channel uses one of 2 specified extended access burst formats spanning across 2 timeslots: one format is based on an extended synchronization sequence whereas the other format is based on two successive bursts using partially blind physical layer transmission of bursts within a TDMA frame. The used format in a cell is broadcasted by the network, whilst the EC-GSM-IoT device supports both formats.

8.3.5 Dedicated Core Networks for GERAN

Summary based on the input provided by Ericsson in RP-170194.

721002	Dedicated Core Networks for GERAN	DECOR_GERAN	1	R6	RP-161029
721102	**Core part: Dedicated Core Networks for GERAN**	DECOR_GERAN-Core	2	R6	RP-161029

Dedicated Core Networks for GERAN introduces means for ensuring that devices with certain characteristics such as machine type devices or belonging to a certain MVNO can be handled by a preferred Dedicated Core Network (one or more core network nodes). This is achieved through an update of the TS 48.018 Rerouting procedure wherein the selection of the Dedicated Core Network is based on UE usage type obtained from subscription data in the HSS/HLR.

The selection of a Dedicated Core Network to serve a certain type of devices such as machine type devices or devices belonging to a certain Mobile Virtual Network Operator is based on a rerouting procedure wherein the BSS and the SGSNs on a high level performs the following procedure at initial attach (see Figure 8.3.5-1 below where the procedure is illustrated):

1) The BSS sends the initial attach request message to one of the SGSN serving the BSS and includes a "Redirect Attempt Flag" IE.

2) The SGSN subsequently retrieves the "UE Usage type" from the HSS/HLR and maps it to a Dedicated Core Network (addressed with "Null-NRI/SGSN Group ID") and if it cannot serve the corresponding MS it returns the initial attach message to the BSS and includes the "Redirection Indication" IE as well as the "Null-NRI/SGSN Group ID" and possibly the "Additional P-TMSI".
   If the SGSN determines that it can serve the device, it returns an initial attach accept message to the BSS and includes the Redirection Completed" IE with outcome value set to "MS is accepted" or "MS is already registered"

3) When the BSS receives an initial attach request message including the "Redirection Indication" IE it continues the rerouting procedure by sending the initial attach message to an SGSN identified by the "Null-NRI/SGSN Group ID" and possibly the "Additional P-TMSI" and includes the "UE usage type" IE and "Redirect Attempt Flag" IE.

4) The SGSN determines that it can serve the device and returns an initial attach accept message to the BSS and includes the Redirection Completed" IE with outcome value set to "MS is accepted" or "MS is already registered"
   If the SGSN determines that it cannot serve the MS the SGSN has to return the initial attach message to the BSS and includes a Redirection Indication IE containing Reroute Reject Cause. No further Rerouting has to be initiated.

Note that the feature is only applicable to the PS domain and that the feature doesn't require any MS specific functionality.

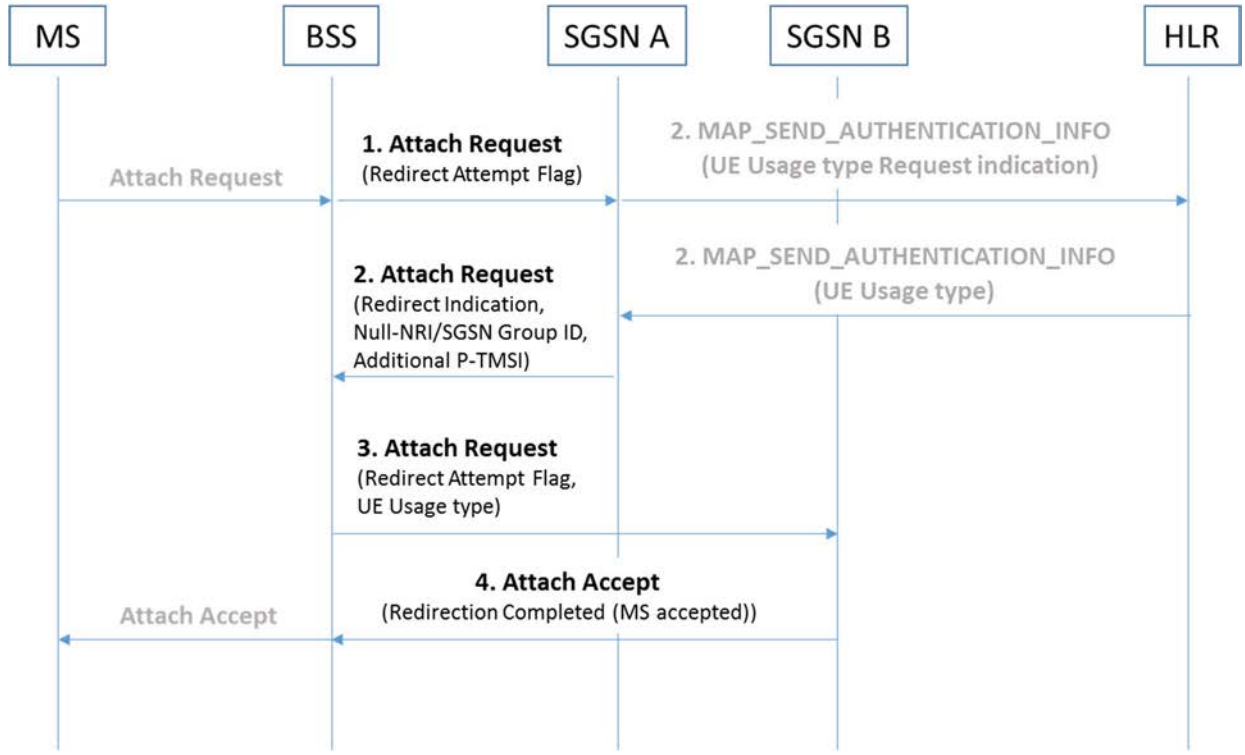


Figure 8.3.5-1: Illustration of Rerouting procedure for Dedicated Core Networks

9 Voice and Multimedia related items

9.1 VoLTE related items

9.1.1 S8 Home Routing Architecture for VoLTE

Summary based on the input provided by NTT DOCOMO in SP-170522.

710048	**S8 Home Routing Architecture for VoLTE**	V8	1		SP-160315
680053	**Study on S8 Home Routing Architecture**	FS_V8	2	S2	SP-150255
690049	**Study on LI in S8 Home Routing Architecture for VoLTE**	FS_LIV8	2	S3	SP-150461
720017	**S8 Home Routing Architecture for VoLTE**	V8	2	S2	SP-160315
730023	**CT Aspects of V8**	V8-CT	2	CT	CP-160479
730024	CT1 Aspects of V8	V8-CT	3	C1	CP-160479
730025	CT3 Aspects of V8	V8-CT	3	C3	CP-160479
720050	**Charging Aspects of S8 Home Routing Architecture for VoLTE**	CH14-V8	2	S5	SP-160838

This Work Item supports the new GSMA's VoLTE architecture option called "S8 Home Routed (S8HR)". S8HR is an architecture for IMS voice roaming where, even though the UE is roaming in a VPLMN, all the following entities are located in the HPLMN: PGW, PCRF, ATCF, ATGW, P-CSCF, S-CSCF and TAS.

One of the main implications is that the S8HR roaming architecture is not using the Local Breakout anymore and, therefore, the IMS APN is resolved to point to a PGW in the HPLMN. So the IMS NNI between Home and Visited PLMN for VoLTE roaming will be different whether the S8HR architecture is used or not.

The standardization of VoLTE roaming with S8HR architecture impacts several areas, and was then handled by a number of 3GPP groups:

- Architectural aspects (SA2 Work Item "V8"). This covers three main topics:
  - Emergency call: For Local breakout roaming architecture, the home and visited PLMN connect via the IMS NNI. The connection will provide all essential information to establish emergency call. However, the S8HR architecture has no IMS NNI.
  - Location determination at IMS entities in the HPLMN: the HPLMN IMS needs to identify the subscriber's location for two main purposes: "charging" and "restriction and barring".
  - Local number translation: Geo –local service number has been supported in legacy CS network and IMS network to allow the user to access services in visited network without dialling the national code or regional code of the visited network. This procedure was available because all related network node was located in VPLMN for legacy CS and Local Breakout, but not S8HR.
- Core network aspects (CT Work Item "V8-CT"). Most of the CT groups work was to add the new procedure to fetch and provide necessary information to establish emergency call.
- Security aspects (SA3-LI Study Item "FS_LIV8"). For S8HR VoLTE roaming architecture, the SGW is the only network node that locates in the VPLMN. Based on architectural assumption, the VPLMN need to access VoLTE for lawful interception purpose. The study Item "FS_LIV8" identifies new network deployment to make this procedure possible.
- OAM aspects (SA5 Work Item "CH14-V8"). The traffic path for VoLTE roaming with S8HR and Local Breakout architecture is different. The Local Breakout charging principles are already stated on the 32-series specifications. "CH14-V8" provides the additions of charging principle for S8HR roaming architecture.

9.1.2 Robust Call Setup for VoLTE subscriber in LTE

Summary based on the input provided by Huawei in SP-170762.

720084	Robust Call Setup for VoLTE subscriber in LTE	RobVoLTE	1		SP-160312
700044	**Study on Robust Call Setup for VoLTE subscriber in LTE**	FS_RobVoLTE	2	S2	SP-150632
720301	**Robust Call Setup for VoLTE subscriber in LTE**	RobVoLTE	2	S2	SP-160312
730022	**CT Aspects of RobVoLTE**	RobVoLTE-CT	2	C1	CP-160478
730078	**Voice and Video Enhancement for LTE**	LTE_VoLTE_ViLTE_enh	2	R2	RP-161856
730178	Core part: Voice and Video Enhancement for LTE	LTE_VoLTE_ViLTE_enh-Core	3	R2	RP-161856
740010	**RAN-Assisted Codec Adaptation in MTSI**	LTE_VoLTE_ViLTE_enh-S4	2	S4	SP-160778

Introduction

VoLTE may require better LTE RSRP compared to data service, which means the LTE radio signal may be good enough for pure data session but may not good enough for VoLTE (i.e, QCI-1). When radio network is configured in such a manner, eNB may trigger SRVCC handover as soon as EPS bearer with QCI-1 is setup, for example the HO threshold for voice is RSRP = -118 dbm while for data service is RSRP = -124 dbm.

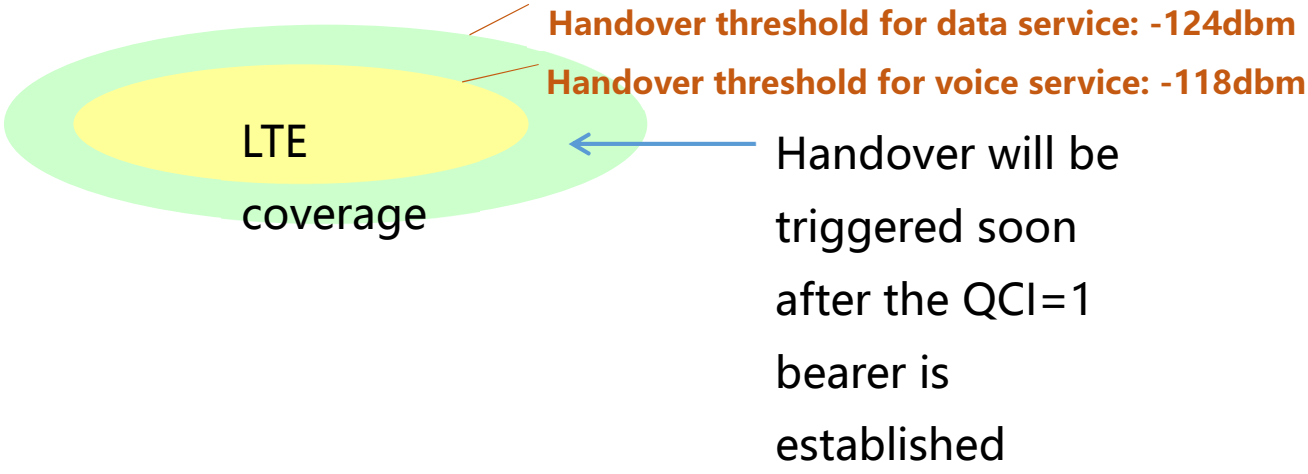


Figure 9.1.2-1: handover threshold for voice and data

At this point, the VoLTE setup may fail if either UE or IMS does not support bSRVCC or aSRVCC. As a result, call drop rate is increased due to call setup failure.

Robust Call Setup for VoLTE subscriber in LTE (RobVoLTE) are key features for LTE to provide voice service over 2/3G CS domain when the UE is located in the area where the LTE radio signal may be good enough for pure data session but may not good enough for VoLTE (i.e, QCI-1).

Description

Mobile originating handling in LTE weak coverage:
For originating session, P-CSCF send a response to UE and UE performs CSFB if QCI=1 bearer setup request for VoLTE is rejected by E-UTRAN e.g. due to LTE weak coverage

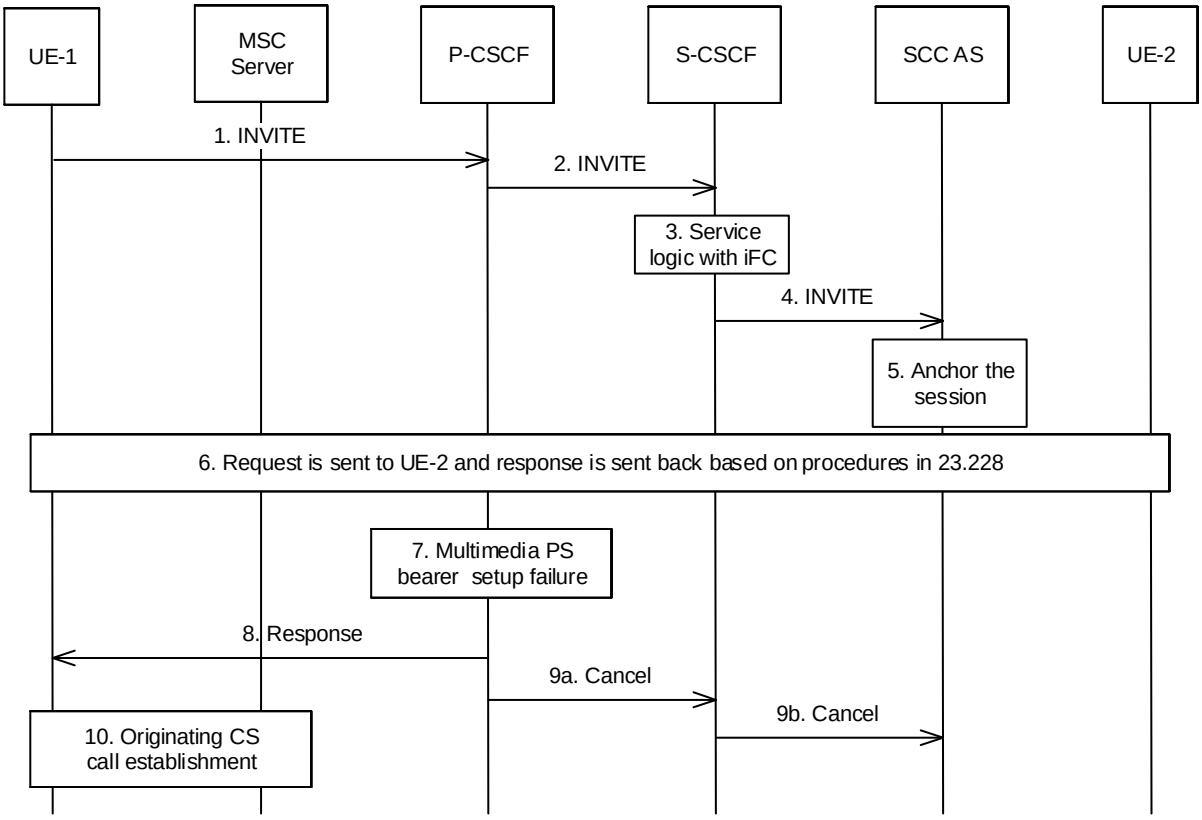


Figure 9.1.2-2: Originating session that uses only PS media – fallback to CS domain in pre-alerting phase

Mobile terminating handling in LTE weak coverage:

For terminating session, P-CSCF send a response to SCC AS and SCC AS reattempts the terminating call establishment over CS domain if QCI=1 bearer setup request for VoLTE is rejected by E-UTRAN e.g. due to LTE weak coverage.

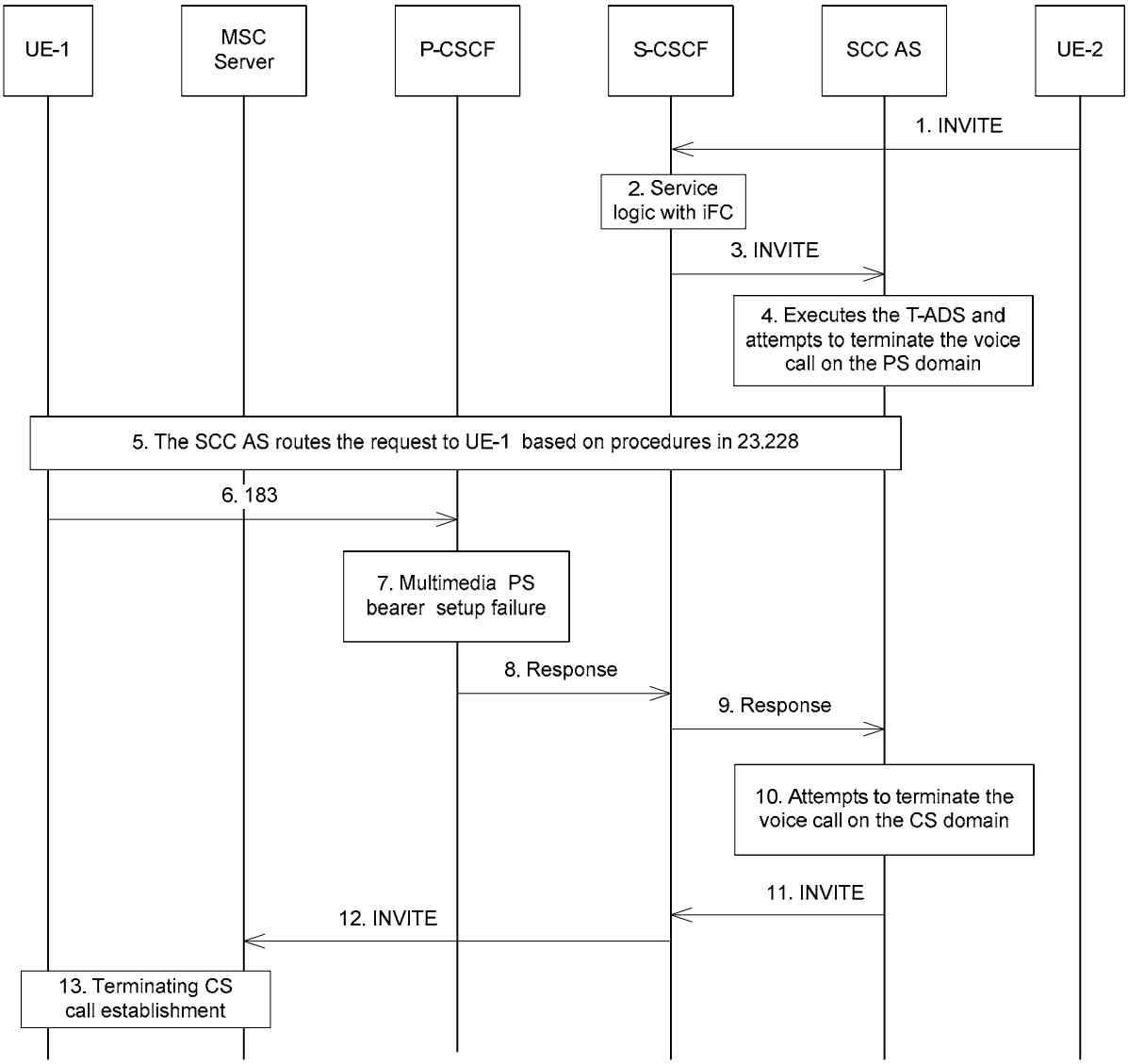


Figure 9.1.2-3: Terminating session that uses only PS media – fallback to 2/3G in pre-alerting phase

References

[1] TR 23.750: "Study for robust call setup for VoLTE subscriber in LTE ".

RAN aspects:

The LTE Rel-14 Work Item Voice and Video enhancement for LTE achieves the objectives of VoLTE quality/coverage enhancements, VoLTE/ViLTE signalling optimization and provides the mechanism for the codec mode/rate selection and adaptation based on the Study Item outputs.

Voice and Video over LTE (VoLTE/ViLTE) are key features for LTE to provide voice and video service. With the quick migration from 2G/3G to LTE and the increasing marketing requirement for high-quality voice/video services, voice and video over LTE has being deployed and launched by operators over the world, which makes voice and video over LTE capability extremely important for operators [1]. For this reason, to improve voice/video coverage performance, PUSCH enhancement mode is introduced involving the following main components in RAN1.

The main purpose of the eVoLTE CE technologies is to reuse as much as possible the existing CE technologies in eMTC CE mode A, while keeping independent of eMTC "CE mode A" capability.

Support UL asynchronous HARQ transmission:
UL asynchronous HARQ transmission is supported for fully utilization of transmission time. In the new PUSCH enhancement mode, HARQ process ID of PUSCH is indicated by a 3-bit field in the new format DCI.

Specification of enhanced TTI bundling:

Different repetition levels of scheduled PUSCH is supported re-using eMTC repetition scheme, with the repetition set {1, 2, 4, 8, 12, 16, 24, 32}. 12 and 24 are new introduced repetition number compared to Rel-13 CE mode A in eMTC. In the new PUSCH enhancement mode, the number of repetitions of PUSCH is indicated by a 3-bit field and the maximum of the repetition number is signalled by RRC.

Specification of bundle frequency hopping enabling multi-subframe channel estimation:

Bundle frequency hopping is supported reusing eMTC hopping scheme enabling multi-subframe channel estimation, with hopping interval and offset specified separately.

In RAN2 and RAN3, voice and video enhancements are focused on the three aspects, including the RAN-assisted codec adaptation, VoLTE/ViLTE signalling optimization and VoLTE quality/coverage enhancement.

The RAN-assisted codec adaptation:

RAN-assisted codec adaptation provides a means for the eNB to send codec adaptation indication with recommended bitrate to assist the UE to select or adapt to a codec rate for MMTEL voice or MMTEL video. The RAN-assisted codec adaptation mechanism supports the uplink/downlink bitrate increase or decrease.

For uplink/downlink bitrate adaptation, eNB sends the recommended bitrate to the UE, which the UE may use in combination with other information to adapt the bitrate, e.g. the UE may send a rate request to the peer UE via application layer messages, which the peer UE may use in combination with other information to adapt the codec bit rate.

The recommended bitrate for UL and DL is conveyed as a MAC Control Element (CE) from the eNB to the UE as shown in figure1, and which is presented by an index value.

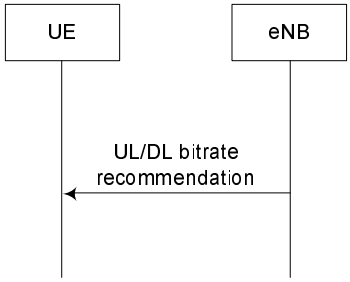


Figure 9.1.2-4: UL/DL bitrate recommendation

Based on the recommended bitrate from the eNB, a UE may initiate an end-to-end rate adaptation with the peer UE. The eNB may inform the UE on the currently admissible transport bit rate on the local uplink and downlink. The UE may also send a query message to its local eNB to check if a bit rate recommended by its peer can be provided. A prohibit timer can be configured by the network to limit UEs sending frequent query messages, so UE will be allowed to triggered a rate recommendation query message only when the network configures the prohibited timer and the timer is not running. The UE is not expected to go beyond the recommended bitrate from the eNB.

The recommended bitrate query message is conveyed as a MAC Control Element (CE) from the UE to the eNB as shown in figure2. SR will not be triggered by the query MAC CE.

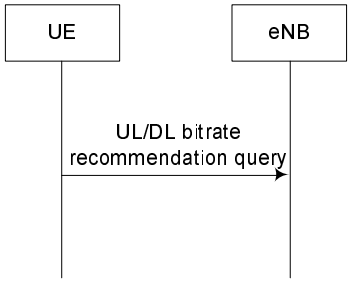


Figure 9.1.2-5: UL/DL bitrate recommendation query

VoLTE/ViLTE signalling optimization:
In case of network congestion (e.g. maximum number of users that can be connected, poor radio conditions, etc), an operator may want to prioritize MMTEL voice/MMTEL video access. For both type of accesses, the MO voice call cause value is used.

"Inter-RAT Redirection" cause in the UE CONTEXT RELEASE REQUEST message with updating the meaning of the cause is reused for redirection of VoLTE. When eNB decides to perform redirection to another E-UTRAN frequency, the eNB sends UE CONTEXT RELEASE REQUEST message with this cause value. Upon receiving UE CONTEXT RELEASE REQUEST message with this cause value, the MME should suspend the GBR bearer for the voice service for a while. The time of keeping the voice GBR bearer should be long enough to allow the UE to recover after redirection. On the UE side, if the UE receives the RRC Connection Release message with redirection and the voice call is ongoing, the UE keeps the call in the application layer. After the UE re-accesses the network, the voice GBR bearer can be recovered immediately.

VoLTE quality/coverage enhancement:

VoLTE coverage can be effectively enhanced by relaxing the air interface delay budget. UE uses RRC signalling to report the delay budget information. Based on the reported delay budget information, when a UE is in good coverage, the eNB can configure longer DRX for power saving purpose or the eNB can reduce DRX cycle in order to help peer side; when the UE is in bad coverage, the eNB can increase the retransmission times in order to reduce the packet loss.

SA4 specific aspects:

This summary reports on the normative specification progress accomplished during the course of the LTE_VoLTE_ViLTE_enh-S4 work item [1]. This is the SA4 building block of the LTE_VoLTE_ViLTE_enh feature, where the core feature LTE_VoLTE_ViLTE_enh-Core [2] has been specified by RAN2. The WI summary for the core part has already been submitted to RAN plenary in March 2017, and can be found in RP-170323 [3].

Media handling aspects of RAN-assisted codec adaptation in MTSI were specified in TS 26.114 including the following aspects: (i) Adaptation requirements, recommendations and guidelines for speech and video adaptation mechanisms, in response to the availability of RAN-recommended UL/DL bitrate information at the MTSI client (on both MTSI sender and receiver sides), including impacts on adaptation triggers, sender behaviors and receiver behaviors, (ii) Utilization of RAN-recommended UL/DL bitrate information in generation of RTCP-APP or RTP CMR messages for speech rate adaptation, (iii) Utilization of RAN-recommended UL/DL bitrate information in generation of RTCP feedback (e.g., TMMBR, TMMBN messages of CCM, etc.) messages for video rate adaptation. (iv) Use with dynamic bitrate adaptation, including adaptation of sent and received media utilizing RAN-recommended UL/DL information and recommended bitrate query messages, (v) Impact of availability of RAN-recommended UL/DL bitrate information on SDP offer/answer session re-negotiation procedures in MTSI. The support of this feature for MTSI was specified based on a more generalized "access network bitrate recommendation" (ANBR) framework to allow for usage for both LTE access and non-LTE access, while also establishing the clear connections to LTE access and associated mappings between ANBR messages and RAN-specified MAC level messages for LTE access. The related agreed CR can be found in Tdoc S4-170450, CR26114-0410.

[1] Tdoc SP-160778, New work item on "RAN-Assisted Codec Adaptation (LTE_VoLTE_ViLTE_enh-S4)"

[2] Tdoc RP-161856, New work item on "New Work Item on Voice and Video enhancement for LTE"

[3] Tdoc RP-170323, "Summary for WI: Voice and Video enhancement for LTE"

[4] Tdoc S4-170450, CR26114-0410 rev1 "RAN Bitrate Recommendation"

9.1.3 Enhancements to Domain Selection between VoLTE and CDMA CS

Summary based on the input to be provided by China Telecom at SA#78.

670005	Enhancements to Domain Selection between VoLTE and CDMA CS	eDSVCC	1	S1	SP-150045

This work item clarifies the requirements for domain selection between VoLTE and CDMA CS for terminating calls when the terminating UE is attached only to one domain (LTE or CDMA CS).

Voice over LTE (VoLTE) is set to become mainstream technology for IP-based telecommunications.

During the transition time where VoLTE deployments and coverage areas will co-exist with CS voice coverage areas, a selection problem will occur.

CDMA uses different UE domain registration databases for CDMA CS and LTE.

For a terminating call to subscriber with multi mode terminal that is only attached to one domain (LTE or CDMA CS), and when using the same Mobile Directory Number (MDN, i.e. the CDMA's equivalent to MSISDN), the CDMA operator will have to select which voice domain to use between LTE and CDMA CS.

In order to make the correct decision on which domain to select for mobile terminated calls the requirements needed to be clarified, which is what was done by this Work Item.It can be noted that so there is no corresponding stage 2 work since this work item deals only with clarifying some requirements.

9.2 MBMS improvements

9.2.1 MBMS Transport Protocol and APIs

Summary based on the input provided by Qualcomm and Samsung in SP-170744.

700054	MBMS Transport Protocol and APIs	TRAPI	1	S4	SP-150851

TS26.347[2], as developed during this work item, defines APIs to allow the development of MBMS-aware applications (MAA) that leverage the functionality provided by an MBMS Client in the UE to access 3GPP MBMS User services as defined in TS 26.346[3]. The purpose of this new specification is the definition of enablers in order to simplify the usage of MBMS in web-centric as well as app-based service environments. TS26.347 defines several APIs to access MBMS User Services and a URL scheme to access resources available as part of an MBMS User Service.

MBMS Application Programming Interfaces (MBMS-APIs) were introduced primarily for developers of web and user applications with the objective of abstracting complex MBMS procedures by the use of simple methods and interfaces. MBMS client vendors can implement the service APIs to simplify the integration of third party MBMS-aware applications with MBMS User Services as shown in Figure 1.

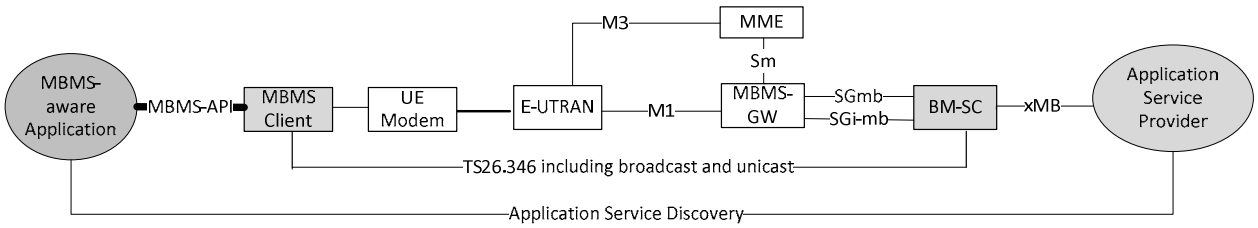


Figure 9.2.1-1: End-to-end Architecture for Application Service Providers using eMBMS for Delivery

Figure 1 shows a general service architecture including a reference client. The content provider provides media formats to a BM-SC, typically through the xMB interface and initiates services and sessions through the xMB interface. The BM-SC establishes MBMS User Services and the lower layers support the delivery of the data through regular 3GPP unicast as well as MBMS broadcast bearers. The MAA initiates the communication with the MBMS client using the MBMS-API. The MBMS client identifies the relevant services and provides access to the data of the requested

broadcast service to the MAA. The media formats typically conform to well-defined media delivery formats provided through existing interfaces such as HTTP or IP sockets. The MAA controls the media client.

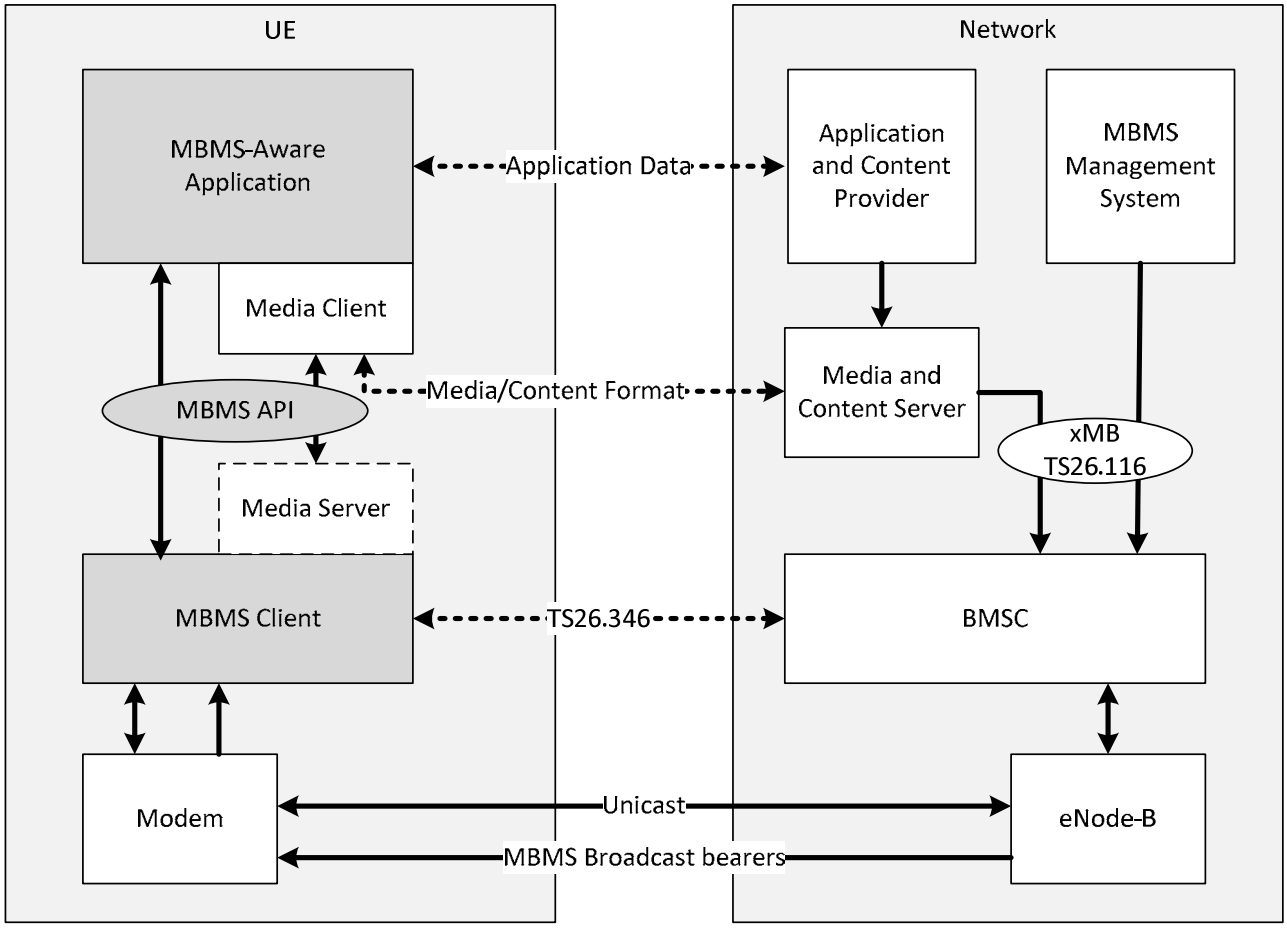


Figure 9.2.1-2 TRAPI Architecture

The MBMS-Aware Application (MAA) queries the MBMS client to provide a list of services associated with a type and an application. Based on the list of available services, the MAA uses the APIs to initiate the service. The MBMS client provides the service acting as a server or router for the media service. The MAA can control the service consumption through control APIs, for example to stop the service and possibly switch to a different one. The media client is basically unaware that the content is delivered over MBMS which enables reuse of existing media clients.

In addition, TS 26.347 now also defines a URL scheme for MBMS User services. The URL handling is designed to refer to a single resource, just like HTTP (or FTP), and hence can be used in the myriad places that resources are referred to by URLs. Indeed the 'threads' of the world-wide web are the URL pointers that link resources together.

Using MBMS URLs in the formats that reference resources by URLs enables services using those formats to use MBMS delivery of resources. Many of those services also use ‘fallback lists', where the origin format (for example, the <video> element in HTML) embeds a series of alternatives, giving, for each, a URL pointer and some information (MIME type, codecs used, and so on) about the resource at that location. Platforms not supporting the resource type, or URL type, of an alternative would skip past it, moving down the fallback list. This could, for example, enable a content distributor to offer high bitrate, high quality, content via MBMS, and a lower-quality, lower bitrate fallback over HTTP, in a backwards-compatible way.

Note that the TRAPI framework is not applicable when the MBMS bearer services are used according to the principles defined within the framework of GCSE. In the particular case of GCSE, the BM-SC does not initiate any unicast communication to any entity in the UE. Work on Mission Critical applications or based on the GCSE architecture is handled via a different study item [4] and will be covered in a different specification (TR 23.792).

References

[1] Tdoc SP-150851, "New work item on "MBMS Transport Protocol and APIs"

[2] 3GPP TS 26.347, "Multimedia Broadcast/Multicast Service (MBMS); Application Programming Interface and URL"

[3] 3GPP TS 26.346, "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs"

[4] Tdoc SP-170598, "Study on MBMS APIs for Mission Critical Services"

9.2.2 eMBMS enhancements for LTE

Summary based on the input provided by Ericsson in RP-171628.

710081	**eMBMS enhancements for LTE**	MBMS_LTE_enh2	1	R1	RP-160675
710181	**Core part: eMBMS enhancements for LTE**	MBMS_LTE_enh2-Core	2	R1	RP-162231
710281	**Perf. part: eMBMS enhancements for LTE**	MBMS_LTE_enh2-Perf	2	R4	RP-162231

This work item specifies core and UE performance requirement for eMBMS enhancements for LTE.

This work item specifies the following eMBMS enhancements for LTE:

- New numerology with cyclic prefix (200 μs) and subcarrier spacing of 1.25kHz, designed to cover 15km Inter-Site-Distance (ISD) at a spectral efficiency of 2 bps/Hz with rooftop antennas, and signalling for the numerology with 33 μs CP and 7.5 kHz subcarrier spacing.
- Means of using subframes 0, 4, 5, 9 (FS1) for MBSFN.
  - MBMS-dedicated cell supporting 100% MBSFN subframe allocation. UEs not supporting FeMBMS are not supported on these cells. Paging is not supported on an MBMS-dedicated cell. A periodic Cell Acquisition Subframe with 15kHz numerology is specified for MBMS-dedicated cell.
- The necessary system information for MBMS reception, including the case of MBMS-dedicated cell.
- A new type of MBSFN subframe without unicast control region and cell-specific reference signals to reduce overhead in MBMS transmissions.
- UE RF core requirements, BS RF core requirements and RRM requirements for the above eMBMS procedures.
- RRM performance requirements including MBSFN measurement report mapping for new numerologies.
- UE demodulation requirements related to the above eMBMS procedures.

9.3 IMS related items

9.3.1 Evolution to and Interworking with eCall in IMS

Summary based on the input provided by Qualcomm Incorporated in SP-170538.

700020	**Evolution to and Interworking with eCall in IMS**	EIEI	1		SP-150275
680004	**Stage 1 of Evolution to and Interworking with eCall in IMS**	EIEI	2	S1	SP-150275
700021	**Stage 2 of Evolution to and Interworking with eCall in IMS**	EIEI	2	S2	SP-150623
710020	**CT aspects of evolution to and interworking with eCall in IMS**	EIEI-CT	2		CP-160053
710021	CT1 aspects of evolution to and interworking with eCall in IMS	EIEI-CT	3	C1	CP-160053
720068	(IETF) Next-Generation Pan-European eCall (draft-ietf-ecrit-ecall)	EIEI-CT	3	C1-IETF	CP-160053
710022	CT6 aspects of evolution to and interworking with eCall in IMS	EIEI-CT	3	C6	CP-160053

This feature introduces the support of end-to-end eCall over IMS. It requires all the involved parties and entities to be upgraded to support eCall over IMS emergency calling: the In-Vehicle System (IVS), the Mobile Network Operator (MNO), and the Primary Safety Answering Point (PSAP).

This features allows some improvements in the handling of the eCall functionality and improves the user experience. For instance, it removes some limitations due to the previous use of an in-band modem as to transfer the minimum set of data in a TS12 call. It also allows, in the long-term, the phase out of the CS core and access networks.

The service requirements is defined in TS 22.101 [1].

Based on stage-1 requirements, the following functionality was introduced in Stage 2:

- TS 23 401 [2]: introduce eCall for EPS over E-UTRAN and define its impact on the procedures.
- TS 23.167 [3]: provide architectural and other stage 2 support in emergency call procedures
- TS 23.237 [4]: provide procedures for interworking of eCall over IMS to CS domain

The "Support of eCall on IMS Emergency Services using the PS domain" is only supported over LTE.

References

[1] TS 22.101, "Service Principles"

[2] TR 23.401, "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access"

[3] TS 23.167, "IP Multimedia Subsystem (IMS) emergency sessions"

[4] TS 23.237, "IP Multimedia Subsystem (IMS) Service Continuity"

9.3.2 Password-based service activation for IMS Multimedia Telephony service

Summary based on the input provided by Ericsson in SP-170536.

720074	Password based service activation for IMS Multimedia Telephony service	PWDIMS	1		SP-150041
670012	**Stage 1 for PWDIMS**	PWDIMS	2	S1	SP-150041
720034	**CT aspects for PWDIMS**	PWDIMS-CT	2	CT	CP-160295
720035	CT1 aspects for PWDIMS	PWDIMS-CT	3	C1	CP-160295
720036	CT3 aspects for PWDIMS	PWDIMS-CT	3	C3	CP-160295

Barring services and possibly other supplementary services settings of the IMS (IP Multimedia Subsystem) multimedia telephony service may be sensitive information. The subscriber may wish to protect the service setting so that the user (which can be different from the subscriber) cannot change the service setting. This work item introduces password protection for activation of supplementary services in IMS as is available for Circuit Switched (CS) telephony supplementary services defined on TS 22.030.

This WI provides the following functionalities:

a) XML Configuration Access Protocol (XCAP) procedures to protect service configuration by a password, including:

   1) password change procedure; and

   2) format to include the current password in the SIP URI in the XCAP User Identity;

b) specific procedures to use a password for barring services;

c) mapping functions to map the CS procedures to the new XCAP procedures, generally implemented by the MSC server enhanced for IMS Centralized Services.

The format of the new password is the same as in the CS networks, i.e. a four digit PIN code.

This Work Item was covered by Change Requests to existing specs (no new specs created), in particular to TSs 22.173, 24.238, 24.611, 24.623 and 29.292.

9.3.3 Media Handling Extensions of IMS-based Telepresence

Summary based on the input provided by Intel in SP-170515.

710010	Media Handling Extensions of IMS-based Telepresence	IMS_TELEP_EXT	1		SP-160081
721005	**S4 aspects of Media Handling Extensions of IMS-based Telepresence**	IMS_TELEP_EXT	2	S4	SP-160081
720061	**(IETF) Other IETF aspects of IMS_TELEP_EXT**	IMS_TELEP_EXT	2	S4-IETF	

This Work Items introduces in TS 26.223 the various media handling extensions needed for IMS-based telepresence (TP).

This includes the introduction of:

- the Multi-Stream MTSI (MS-MTSI) client capability for TP UEs and associated updates on media configuration,
- the SDP offer-answer procedures and examples,
- the HEVC Screen Content Coding extension codec support for TP, with a recommendation that TP UEs should support "H.265 (HEVC) Screen-Extended Main, Main Tier, Level 4.1" and "H.265 (HEVC) Screen-Extended Main 4:4:4, Main Tier, Level 4.1".

Additional guidelines on the use of the CLUE protocol for IMS-based telepresence, end-to-end QoS handling and media adaptation were also specified in TS 26.223.

9.3.4 SIP Reason header extension

Summary based on the input provided by Orange in CP-171175.

730031	SIP Reason header extension	REAS_EXT	1	CT	CP-160481
730032	**CT1 aspects of SIP Reason header extension**	REAS_EXT	2	C1	CP-160481
730033	**CT3 aspects of SIP Reason header extension**	REAS_EXT	2	C3	CP-160481

This work item ensures consistency of all the possible extensions of the "SIP Reason" header field.

The "Reason" header field was indeed extended for ITU-T Q.850 cause codes (RFC 6432), preemption (RFC 4411) and more recently release-cause (CR#5612 to TS 24.229). Instead of studying extensions on a case-by-case basis, that would not consider the whole context of the "Reason" header usage, it has been decided to create this work item, which defines a generic and future-proof mechanism for protocol extension of the "Reason" header.

The extensions of the "Reason" header field were discussed within this WID to maintain a global consistency on the header format and to make decisions concerning the way it has been extended, and in which standardization body (3GPP or IETF), with a complete view of the benefit it could yield for all 3GPP requirements.

The "Reason" header has been extended with:

- a new protocol value FAILURE_CAUSE to be used in SIP error responses; and
- a new header field parameter to provide the Q.850 location parameter in SIP (new IETF Internet-Draft).

9.3.5 Diameter Load Control Mechanism

Summary based on the input provided by Nokia in CP-171049.

730002	Diameter Load Control Mechanism	DLoCMe	1	CT	CP-160645

730041	**CT3 aspects of Diameter Load Control Mechanism**	DLoCMe	2	C3	CP-160645
730042	**CT4 aspects of Diameter Load Control Mechanism**	DLoCMe	2	C4	CP-160645
740058	**(IETF) Diameter Load Information Conveyance (draft-ietf-dime-load-03)**	DLoCMe	2	C4-IETF	CP-160645

The Diameter Load Control Mechanism as developed by IETF (draft-ietf-dime-load-09 [1]) allows Diameter nodes to send "load" information which may be used by recipient nodes e.g. for dynamic load balancing or overload prevention. Following the conclusion from TR 29.810 [2] CT3 and CT4 have specified in their 3GPP Diameter applications the option to make use of the IETF mechanism on various Diameter based 3GPP core network interfaces.

The key functionalities are specified by IETF in draft-ietf-dime-load-09 [1]. Load information can be conveyed by piggy-backing IETF-defined information elements on 3GPP Diameter application specific answer commands. The conveyed load information can be used end-to-end and/or hop-by-hop indicating the current load of the answering target node and/or next hop agent. Load information receiving nodes can use the conveyed information e.g. by replacing a preconfigured static weight with the actual received load value. The means how load is calculated by the reporting node is implementation specific.

References

[1] IETF draft-ietf-dime-load-09: "Diameter Load Information Conveyance".

[2] TR 29.810: " Study on Diameter load control mechanisms ".

9.3.6 Diameter Base Protocol Specification Update

Summary based on the input provided by Huawei in CP-172127.

740012	Diameter Base Protocol Specification Update	DBPU	1		CP-160823
740054	**CT aspects of Diameter Base Protocol Specification Update**	DBPU	2	CT	CP-160823
740055	CT3 aspects of Diameter Base Protocol Specification Update	DBPU	3	C3	CP-160823
740056	CT4 aspects of Diameter Base Protocol Specification Update	DBPU	3	C4	CP-160823
740013	**Charging aspects for Diameter Base Protocol Specification Update**	DBPU-CH	2	S5	SP-160837

Starting with Rel-5 in 3GPP the Diameter base protocol defined in RFC 3588 is used. This RFC is replaced by RFC6733 and RFC 3588 was marked as obsolete by IETF in October 2012.

In TR 29.819 the differences between the two diameter base protocol versions and the impacts to 3GPP specifications were analysed and recommendations were provided what should be taken into account when the new diameter base protocol version is referenced.

To align 3GPP specifications with the newest RFC 6733 it is decided that starting with Release 14 new reference points using diameter will refer to RFC 6733 and in specification on reference points referring to RFC 3588 the reference is replaced by a reference to RFC 6733 in the Rel-14 versions of these specifications.

For backward compatibility it is considered that existing application for which nothing has been specified regarding the presence of the Vendor-Specific-Application-Id AVP in the command's CCF specification, it is assumed that the requirement on the mandatory presence of the Vendor-Specific-Application-Id AVP applies. For those applications, if the command's CCF specifications are not updated, an informative note is added to indicate that the Vendor-Specific-Application-Id AVP is present in any command supported by the application.

In line with the agreement in TR 29.819 the following TS's are modified and refer to RFC 6733 in TS 29 series:
TS 29.061, TS 29.109, TS 29.128, TS 29.153, TS 29.154, TS 29.172, TS 29.173, TS 29.212, TS 29.214, TS 29.215, TS 29.217, TS 29.219, TS 29.228, TS 29.229, TS 29.272, TS 29.273, TS 29.283, TS 29.328, TS 29.329, TS 29.336, TS 29.337, TS 29.338, TS 29.343, TS 29.344, TS 29.345, TS 29.368, TS 29.468, TS 29.213, TS 29.155, TS 29.201.

The TS 32.299 (Diameter charging applications) is now referring to the new IETF RFC 6733 for the Diameter Base protocol, including the Accounting functionality as before.

The impacts on TS 32.299 resulting from this new version for the Diameter Base Protocol are:

- Explicit reference to TS 33.210, which is the common reference for Diameter transport security, to ensure IPsec is kept as mandatory to support (for backward compatibility), in addition to TLS/DTLS mandated by IETF RFC 6733.
- The new Command Code Format (CCF) for several commands re-used from Diameter Base protocol.
- Information related to end-to-end security has been removed from the 3GPP specific AVPs table description since E2E security framework is deprecated by IETF RFC 6733.

The reference to the Diameter Base Protocol is removed from the TS 32.2xx series charging specifications which are protocol independent.

References

[1] TR 29.819: " Study on Impacts of the Diameter Base Protocol Specification Update ".
[2] IETF RFC 3588: "Diameter Base Protocol".
[3] IETF RFC 6733: "Diameter Base Protocol".

9.3.7 Determination of Completeness of Charging Information in IMS

Summary based on the input provided by Deutsche Telekom AG in CP-171048/SP-170344.

740019	Determination of Completeness of Charging Information in IMS	CH14-DCCII	1	S5	SP-160398
720045	**Determination of Completeness of Charging Information in IMS**	CH14-DCCII	2	S5	SP-160398
740059	**CT Aspects of Determination of Completeness of Charging Information in IMS**	CH14-DCCII-CT	2	CT	CP-160697
740020	CT1 Aspects of Determination of Completeness of Charging Information in IMS	CH14-DCCII-CT	3	C1	CP-160697
740021	CT3 Aspects of Determination of Completeness of Charging Information in IMS	CH14-DCCII-CT	3	C3	CP-160697

This feature allows the correlation of charging relevant information by concatenation of applications or specific interconnection and roaming scenarios by providing a method to identify all network elements (including applications) generating CDR for offline charging within an IMS.

It specifies the principle to determine the completeness of charging information in IMS architecture and for roaming architecture for voice over IMS with home routed traffic, and adds related CDR parameters and AVPs. The information taken is a new dedicated SIP parameter within the "P-Charging-Vector" header for tracking all Network Elements (NEs) and Application Server (AS) (including one or more related application ID's) on the call path for which a CDR will be written.

Within the Billing Domain, this information helps to correlate the charging information collected from the IMS entities.

The principles for Determination of Completeness of Charging Information in IMS is specified in TS 32.240.

The support of Determination of Completeness of Charging Information in IMS and the additional SIP Content (FE Identifier List) to the CDR content is specified in TS 32.260.

ASN.1 definition for the FE Identifier List is specified in TS 32.298.

The AVP definition for the FE Identifier List is specified in TS 32.299.

9.3.8 SCC AS Restoration

Summary based on the input provided by China Telecom in CP-170xxx.

710003	SCC AS Restoration	SCCAS_RES	1	C4	CP-160118

Following the conclusions of the TR 29.812 [1], the purpose of this Work Item is to include the SCC-AS restoration mechanism in the TS 23.380 [2].

In the IMS environment, the Service Centralization and Continuity Application Server (SCC-AS) provides two important functionalities: Terminating Access Domain Selection (T-ADS) for routing of incoming sessions requests to IMS user and Single Radio Voice Call Continuity (SRVCC) between different radio access networks for voice calls that are anchored in the IMS. If the SCC-AS fails, either the incoming sessions request is rejected or the session is established and the voice call will be dropped when moving from one access network to another, leading to a bad user experience.

TR 29.812 [1] has investigated possible solutions for SCC AS restoration procedure and concluded on a preferred solution in which the SCC AS stores extra SRVCC related information in the HSS, information that can be retrieved and used by a backup SCC-AS taking over from a failed SCC-AS.

This purpose of this Work Item is to describe the solution identified in TR 29.812 [1] into TS 23.380 [2], specifying the IMS Restoration procedures. This was covered by a unique change request (CP-160216 [3]).

References

[1] TR 29.812: "Study on SCC AS Restoration".
[2] TS 23.380: "CR pack on Shared Subscriber Data Update"
[3] CP-160216: "SCC AS restoration Mechanism"

9.4 Other Voice and Multimedia related items

9.4.1 Multimedia Priority Service Modifications

Summary based on the input provided by Singh, Ray P [rsingh@vencorelabs.com] in SP-170xxx.

670003	Multimedia Priority Service Modifications	MPS_Mods	1	S1	SP-150043

Introduction

This work item updated TS 22.153 to align with Stage 2 and 3 capabilities that have been specified for Multimedia Priority Services (MPS) but were not completely reflected in the Stage 1 requirements. The updates provided clarifications and corrections to the existing text and requirements, and inclusion of requirements for missing capabilities.

Previous work was completed under the following WIs: PRIOR, ePRIOR, TEI10, and TEI11.

Description

The following is a summary of the key clarifications, corrections and functionalities included in the Release 14 update of TS 22.153:

- The general description of MPS in clause 4 was clarified and additions were included to describe the different aspects of priority treatment needed for end-to-end MPS support such as service invocation, authorization, end-to-end priority treatment, invocation-to-release priority treatment, and network interconnection and protocol interworking. In addition, an explicit list of end-to-end network scenarios covered under the scope of MPS was added.
- Text in Subclause 5.4 (Priority session treatment in terminating network) was corrected to allow operator option to provide MPS based on the terminating party priority information, even when the calling party is not subscribed to MPS service.
- Added text in Subclause 5.4a to clarify the scope of the" priority data bearer service" applies to data and video services which are not under IMS control.
- Explicit requirement to have at least 5 levels of user priority was added in Subclause 5.5 (Priority levels) for Stage 1 aligned with Stage 3.

- Subclause 5.9 on handover was clarified to align Stage 1 requirements on resource allocation during handover with Stage 3 procedures. These provide for priority for both the signaling and bearer resource allocation.
- A new Subclause 5.10.3 on CS Fallback from LTE was added to include Stage 1 requirements to align with specified Stage 2 and 3 capabilities. Priority is given within the LTE system to signaling required to transfer the call to the CS domain.
- The Stage 1 requirement in clause 5.11 (Network Management Functions) was corrected to also provide an exemption from load rebalancing (in addition to existing exemptions for congestion control, overload control, and load balancing) to align with the Stage 2 specifications.
- A new Subclause 5.12 (Policy Control) was added to include requirements to make and enforce relative priority decision between different MPS application services subject to regional/national regulatory requirements and operator policy.
- A new Subclause 5.13 (Priority before service invocation) was added to include requirements to provide advance priority treatment in radio access networks, that is, subscription-based priority is provided in advance of service invocation to provide priority in support of the service invocation signaling. It was made explicit that this subscription-based begins at the time of attach even before subscription information is downloaded from the HSS to the MME, and includes procedures in the UE associated with RRC Connection Establishment as per Subclause 5.3.3 of [TS 36.331]. A reference is added to the requirement in [TS 22.011] Subclause 4.4a in which MPS is allocated exclusive use of a special access class in the range AC 11-15. The network can control UE-behaviour though SIB2 indications on the required access.
- A new Subclause 5.14 (Recovery/Restoration) was added on operational measures to expedite service recovery and restoration (i.e., service restoration after failure/unavailability).
- A new Subclause 5.15 (Quality of Service) was added to align with Stage 2 and 3 procedures specified for QoS handling of QoS rules that are specific to MPS voice, MPS video, and MPS data service.
- Text and requirements were added to clause 6 (MMI aspects) to reflect the need for a service code for the 3GPP network to support on-demand invocation of MPS.
- Clause 7 (Security and privacy) was updated to include requirements on general security protection, confidentiality/privacy, and use of encryption.

References

[1] TS 22.011, Service Accessibility, Clause 4

[2] TS 23.203, Policy and charging control architecture, Subclause 6.1.11

[3] TS 23.401, General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access, Subclause 4.3.18

[4] TS 36.331, Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification, Subclause 5.3.3

9.4.2 Enhancements to Multi-stream Multiparty Conferencing Media Handling

Summary based on the input provided by Qualcomm Incorporated in SP-170528.

720060	Enhancements to Multi-stream Multiparty Conferencing Media Handling	MMCMH_Enh	1		SP-160272
720029	**Overall aspects of MMCMH_Enh**	MMCMH_Enh	2	S4	SP-160596
720064	**CT aspects of MMCMH_Enh**	MMCMH_Enh-CT	2	CT	CP-160369
720065	CT1 aspects of MMCMH_Enh	MMCMH_Enh-CT	3	C1	CP-160369
720066	CT3 aspects of MMCMH_Enh	MMCMH_Enh-CT	3	C3	CP-160369
720067	CT4 aspects of MMCMH_Enh	MMCMH_Enh-CT	3	C4	CP-160369

This Work Item enhanced the feature developed in the previous Rel-13 Work Item on MMCMH to provide a richer teleconferencing experience by enabling optimal use of better quality media codecs in a more efficient manner across the terminals, MRF, and radio access network.

The Work Item introduces the following functions to the feature:

- Specified a new SDP attribute ‘ccc_list' that allows terminals and the MRF to communicate and negotiate their concurrent codec capabilities in a compact format that significantly reduces the amount of signalling needed
- Specified usage of common codecs which are necessary to guarantee that all terminals can communicate with one another, and preferred codecs which can support higher quality communication between a subset of the terminals.
- Provided guidelines on how to use the simulcast and RTP level pause/resume functions to enable the MRF to minimize transcoding and other resource usage
- Provided guiding examples of the QoS reservations needed to support MMCMH sessions

These enhancements were needed to improve the user experience while making the service more viable as the richer and immersive nature of the MMCMH feature can demand significant resources from the system in terms of bandwidth and processing.

References

TR 26.980 Multimedia telephony over IP Multimedia Subsystem (IMS); Media handling aspects of multi-stream multiparty conferencing for Multimedia Telephony Service for IMS (MTSI)

9.4.3 Enhancement for TV service

Summary based on the input provided by Qualcomm Incorporated in SP-170532.

700032	Enhancement for TV service	EnTV	1		SP-150756
670010	**Study on 3GPP Enhancement for TV Video service**	FS_EnTV	2	S1	SP-150052
720015	**System Architecture Enhancements to eMBMS for TV Video Service**	AE_enTV	2		SP-160730
710046	Study on System Architecture Enhancements to eMBMS for TV Video Service	FS_AE_enTV	3	S2	SP-160225
730058	System Architecture Enhancements for TV service	AE_enTV	3	S2	SP-160730
730052	**Mobile Network Interface for MBMS Delivery of Media and TV services**	AE_enTV-MI_MTV	2	S4	SP-160731
740060	**Codec aspects for eMBMS Delivery of Media and TV Services**	AE_enTV-S4	2	S4	SP-160956
740049	**Stage 3 of system architecture enhancements for TV service**	AE_enTV-CT	2	CT	CP-160816
740050	CT1 aspects of system architecture enhancements for TV service	AE_enTV-CT	3	C1	CP-160816
740051	CT3 aspects of system architecture enhancements for TV service	AE_enTV-CT	3	C3	CP-160816
740052	CT4 aspects of system architecture enhancements for TV service	AE_enTV-CT	3	C4	CP-160816
740053	CT6 aspects of system architecture enhancements for TV service	AE_enTV-CT	3	C6	CP-160816

This work item improves the "enhanced Multimedia Broadcast Multicast Service" (eMBMS) feature as to directly address the requirements of TV broadcasters, in order to make the 3GPP broadcast and unicast platforms better suited to distribute live, on-demand, free-to-air, and premium TV content.

More precisely, it enables the following features in order to make the 3GPP content deliver platform attractive to established TV content providers:

- Support for Free-to-air services

- Support for receive-only eMBMS mode
- Support for eMBMS reception with no operator subscription
- Specification of Xmb reference point to enable content providers to access BM-SC functionality
- Flexible usage of an MBMS carrier ranging up to 100%
- Modifications to the service layer to align codecs and define a transparent pass-through mode
- Decoupling of MBMS transport from content and service layers

The combination of the features help 3GPP network operators meet the regulatory, efficiency, and quality requirements from the TV broadcast industry and help position the 3GPP as a content transport platform for future evolution of TV distribution.

References

[1] TS 23.246, "Multimedia Broadcast/Multicast Service (MBMS); Architecture and functional description", clause 7.5
[2] TS 26.346, "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs"
[3] TS 24.116, "Stage 3 aspects of system architecture enhancements for TV services"

9.4.4 Improved Streaming QoE Reporting in 3GPP (IQoE)

Summary based on the input provided by Huawei Technologies Ltd in SP-170521.

710011	Improved Streaming QoE Reporting in 3GPP	IQoE	1	S4	SP-160082

Since Rel-10, TS 26.247 [1] specifies how a streaming client reports the QoE metrics, which can give useful information on how users are experiencing their video streaming quality.

This Work Item improves the QoE reporting concept, including the possible use of the newly published ITU-T P.1203 standard [3] to estimate the final user experience of video streaming quality, thus offering the 3GPP operator better possibilities for controlling the QoE reporting.

The following new functionalities are described in the related study TR 26.909 [2], and implemented in TS 26.247:

- Add new device-related QoE metrics (such as screen size etc.) to enable use of P.1203 standard model.
- Add QoE control and reporting possibilities via the control plane, so that the 3GPP operator can handle these measurements in a similar way as existing MDT [4] radio measurements.
- Add geographical filtering, as well as filtering due to streaming source provider, so that the 3GPP operator can enable QoE measurements more selectively.

References

[1] TS 26.247, Transparent end-to-end Packet-switched Streaming Service (PSS); Progressive Download and Dynamic Adaptive Streaming over HTTP (3GP-DASH)

[2] TR 26.909, Study on improved streaming Quality of Experience (QoE) reporting in 3GPP services and networks

[3] ITU-T P.1203, Parametric bitstream-based quality assessment of progressive download and adaptive audiovisual streaming services over reliable transport

[4] TS 32.421, Subscriber and equipment trace; Trace concepts and requirements

9.4.4a Quality of Experience (QoE) Measurement Collection for streaming services in UTRAN

Summary based on the input provided by China Unicom in RP-170259.

730079	Quality of Experience (QoE) Measurement Collection for streaming services in UTRAN	UMTS_QMC_Streaming	1	R2	RP-161917
660037	**Study on KQIs for Service Experience**	FS_KQISE	2	S5	SP-150676
730179	**Core part: Quality of Experience (QoE) Measurement Collection for streaming services in UTRAN**	UMTS_QMC_Streaming-Core	2	R2	RP-161917

In current UMTS networks, operators can estimate the end user experience based on legacy ways, e.g. throughput, data loss, latency. For streaming services, ITU-T P.NATS has released the standards on the model and evaluation of MOS models and in SA4's WI on "Improved Streaming QoE Reporting in 3GPP Services and Networks", SA4 agreed to support MDT enhancements option for both QoE metrics configuration and QoE metrics reporting [1].

Based on the above information, the QoE Measurement Collection feature could provide means for operators to better understand the user perception, and thus operators could choose the appropriate way for network optimization and enhance user experience.

With this feature, the network can configure collection of measurements from the UE. The feature defines QoE measurement configuration and measurement reporting containers, and the feature uses the MDT framework [1]. QoE measurement configuration received from OAM or CN is encapsulated in a container, which is inserted in a Measurement Control message and forwarded to the UE transparently. QoE measurements received from UE higher layer are inserted in a container in a Measurement Report message and sent over SRB4.

The QoE measurement configuration is supported in CELL_DCH and CELL_FACH states, whereas the QoE measurement reporting is supported in CELL_DCH state only.

Both signalling based and management based initiation cases are allowed. For the signalling based case, the QoE Measurement Collection is initiated towards a specific UE from CN nodes using the MDT mechanism as described in clause 5.1.3 [1]; for the management based case, the QoE Measurement Collection is initiated from OAM targeting an area (without targeting a specific UE).

References

[1] TS 37.320 Universal Terrestrial Radio Access (UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRA); Radio measurement collection for Minimization of Drive Tests (MDT); Overall description; Stage 2

9.4.5 Development of super-wideband and fullband P.835

Summary based on the input provided by Knowles Inc. in SP-170346.

680050	Development of super-wideband and fullband P.835	DESUDAPS	1	S4	SP-150215

The primary purpose of this Work Item [1] is to develop test methods and performance objectives for 3GPP mobile devices featuring Enhanced Voice Services (EVS), regarding the voice call performance when transmitting from noisy locations.

It defines a framework for collecting listening test data per ITU-T Recommendation P.835 [2]. Then, it organizes a collection of 27 listening test databases for the training and validation of a fullband speech quality prediction model. It subsequently defines test methods and performance objectives for devices regarding super-wideband and fullband speech quality in background noise.

Prior to this work item, the only available predictor of speech quality in background noise operated at narrowband and wideband. There was a need for an analogous predictor, but operating at super-wideband and fullband. The products of this work item facilitated the development, training, and validation of such a predictor in ETSI TC STQ.

One major output of this WI is the subjective framework [3], which define specifics for conducting subjective listening tests according to ITU-T Rec. P.835. These specifics include: references to methodologies for laboratory reproduction of realistic background noise scenarios including noise file recordings; specifications for creating the required fullband reference test signal set (anchors) for the listening tests; requirements on configuration and levels for target speech.

The framework was used by several companies to collect and report on a total of 27 ITU-T Rec. P.835 listening tests [4].

The databases (listening files and corresponding scores per ITU-T Rec. P.835) were then used by delegates to ETSI TC Speech and Multimedia Transmission Quality (STQ) to develop, train, and validate predictors of P.835 scores operating in the fullband context [5].

A CR to TS 26.132 [6] now references the new fullband predictor for purposes of predicting speech quality in noise for new super-wideband and fullband test cases. A corresponding CR to TS 26.131 [7] now references the new test method to define new performance objectives for super-wideband and fullband use cases.

References

[1] SP-150215 Development of super-wideband and fullband P.835 test framework, databases, and performance specification, 17-19 June 2015, Malmö, Sweden

[2] ITU-T Recommendation P.835 (11/2003) – Subjective test methodology for evaluating speech communication systems that include noise suppression algorithm

[3] S4-160548 DESUDAPS-1: Common subjective test framework for training and validation of SWB and FB P.835 test predictors (V1.2), 26-30 October 2015, San Jose del Cabo, Mexico.

[4] S4-170302 DESUDAPS-4: P.835 training databases (V0.3), 24-28 April 2017, Busan, Korea

[5] ETSI TS 103 281 V1.1.1 (05/2017). Speech quality in the presence of background noise: Objective methods for super-wideband and fullband terminals.

[6] S4-170439 Addition of SWB and FB noise suppression test methods, Source: Qualcomm Incorporated, 24-28 April 2017, Busan, Korea

[7] S4-170438 Addition of SWB and FB noise suppression performance objectives, Source: Qualcomm Incorporated, 24-28 April 2017, Busan, Korea

[8] S4-160761 DESUDAPS-2: Requirements for SWB/FB P.835 objective predictor model(s) (V1.0), 27 June – 01 July 2016, Kista, Sweden.

10 Location and positioning related items

See also "Positioning Enhancements for GERAN" under GERAN

10.1 Enhancements to User Location Reporting Support

Summary based on the input provided by China Unicom in SP-171018.

690034	Enhancements to User Location Reporting Support	eULRS	1	S1	SP-150540

This work item introduces a mechanism of enhanced user location reporting based on the study use cases and propose potential requirements. It mainly concerns the ability of 3GPP networks to support enhanced user location reporting when LCS is not deployed on the network. The results of the work item were reflected on the additional requirements for enhancements on user location reporting capabilities of TS 22.101 14.1.0.

This WI specifies requirements of the enhanced user location reporting include:

a) take the cell-level location at pre-configured time points into account;

b) considering the common users characteristics within defined cell or cells;

c) define the focus area, with which the 3GPP core network will be notified when the user enters or leaves the focus area.

The support of enhanced user location reporting is mainly focus on the LCS is not deployed on the network.

References

[1] 3GPP TR 22.899, " Study on Enhancements to User Location Reporting Support"

10.2 Enhancing Location Capabilities for Indoor and Outdoor Emergency Communications

Summary based on the input provided by Sprint in SP-170553.

670004	Enhancing Location Capabilities for Indoor and Outdoor Emergency Communications	ELIOT	1	S1	SP-150044

This WI addresses new FCC regulations in the United States which increased location accuracy requirements to identify a caller's location both indoors and outdoors when making an emergency service call (911).

The following location requirements for emergency calls, required by regional regulations, have been added:

- Z-axis
- Civic location reporting

Also, the summary of the FCC regulations covering emergency service location accuracy requirements has been updated.

Finally, the support for the following positioning technologies has been added:

- Terrestrial Beaconing Systems (TBS)
- Sensor based positioning such as barometric pressure, accelerometers and gyroscopes
- WiFi Access Point and Bluetooth Low Energy (BLE) beacon identity reporting

This feature was covered by CRs to TS 22.071 (3GPP Location Services (LCS); Service description; Stage 1) and TS 36.355 (3GPP LTE Positioning Protocol (LPP)).

10.3 Further Indoor Positioning Enhancements for UTRA and LTE

Summary based on the input from Huawei and NextNav provided in RP-162506.

710072	Further Indoor Positioning Enhancements for UTRA and LTE	UTRA_LTE_iPos_enh2	1	R2	RP-160538
710172	Core part: Further Indoor Positioning Enhancements for UTRA and LTE	UTRA_LTE_iPos_enh2-Core	2	R2	RP-162026
710272	Perf. part: Further Indoor Positioning Enhancements for UTRA and LTE	UTRA_LTE_iPos_enh2-Perf	2	R4	RP-162026

This work item further improves indoor positioning accuracy in a LTE network by introducing OTDOA/E-CID enhancements and network assistance data for WLAN, Barometric Sensor, and TBS positioning based on Metropolitan Beacon System (MBS) signals. Indoor positioning was already enhanced in Release 13 to meet the increasing demand of commercial applications, as well as to address the US FCC Enhanced 911 requirements. The Release 14 work item addresses many of the specification impacts of the positioning enhancements studied and described in technical reports 36.855[1] and 37.857[2] for the aspects of the study that were not completed in the Release 13 work item.

Part 1: OTDOA enhancements:

The following features are used to enhance OTDOA (observed time of arrival difference) positioning technology.

1) **OTDOA enhancements in shared physical cell identity scenario:**

   A Release 13 UE cannot distinguish PRS (positioning reference signal) transmitted by transmission points (remote radio heads, a remote antenna of a base station) that shared the same physical cell identity.

This feature enables UE to identify different transmission points with shared the same physical cell identity, thus the positioning accuracy can be improved.

2) **PRS based Beacon:** This feature introduces a new type of transmission point that only transmits PRS (PRS based Terrestrial Beacon System (TBS)). This feature enables UE to identify additional PRS transmitted by PRS based beacon, thus the positioning accuracy can be improved.

3) **PRS plus CRS measurement for OTDOA:** This feature enables a UE to combine PRS and CRS (cell specific reference signal) together for RSTD measurement. Thus, the positioning accuracy can be improved.

4) **Multipath Time of Arrival (ToA):**

   A Release 13 UE reports a single RSTD measurement value (reference signal time of arrival difference) of every PRS to the E-SMLC (positioning server) for OTDOA positioning calculation. However, the RSTD measurement will be impaired by multipath fading channel. Multipath time of arrival may occur and it is difficult for UE to decide which path is the first path that can reflect the distance between UE and transmission point.

   This feature enables the UE to report time of arrival information of multiple paths. The E-SMLC can use this information to compensate the measurement error caused by multipath fading channel. Thus, the positioning accuracy can be improved.

5) **Reduced quantization error:** The granularity of RSTD reporting is enhanced. Thus, the positioning accuracy can be improved.

Part 2: Network assistance data for WLAN, Barometric Pressure Sensor, and TBS based positioning:

The following features for further RAT-independent indoor positioning enhancements were introduced in this work item:

1) **Barometric Pressure Sensor based positioning:** In Release 13, Barometric pressure sensor-based positioning does not have support for UE-based positioning mode and there is no network assistance data defined between the E-SMLC and the UE. In Release 14, this feature enhanced the existing signaling and procedures in LPP (LTE positioning protocol) to enable E-SMLC network assistance and UE-based positioning mode for barometric pressure sensors.

2) **TBS (based on MBS signals) positioning:** In Release 13, TBS positioning based on MBS signals does not have support for UE-based positioning mode and there is no network assistance data defined between the E-SMLC and the UE. In Release 14, this feature enhanced the existing signaling and procedures in LPP to enable E-SMLC network assistance and UE-based positioning mode for TBS based positioning.

3) **WLAN-based positioning:** In Release 13, WLAN-based positioning does not have support for UE-based positioning mode and there is no network assistance data defined between the E-SMLC and the UE. In Release 14, this feature enhanced the existing signaling and procedures in LPP to enable E-SMLC network assistance and UE-based positioning mode for WLAN-based positioning.

References

[1] TR 36.855, "Feasibility of positioning enhancements for E-UTRA (Release 13)"

[2] TR 37.857, "Study on indoor positioning enhancements for UTRA and LTE (Release 13)"

10.4 Improvements of awareness of user location change

Summary based on the input provided by China Unicom in SP-170524.

720020	Improvements of awareness of user location change	AULC	1		SP-160308
690050	**Study on improvement of awareness of user location change**	FS_AULC	2	S2	SP-150517
720021	**Improvements of awareness of user location change**	AULC	2	S2	SP-160308
730034	**CT Aspect of AULC**	AULC-CT	2	CT	CP-160466
730035	CT3 Aspect of AULC	AULC-CT	3	C3	CP-160466
730036	CT4 Aspect of AULC	AULC-CT	3	C4	CP-160466

730054	**Charging Aspects of Improvements of AULC**	AULC-CH	2	S5	SP-160609

The Feature "Improvements of awareness of user location change" (AULC) is an improvement of the Release 12 Feature "Core Network Overload - User Location Information reporting improvement" (CNO_ULI).

With CNO_ULI, only one Presence Reporting Area (PRA) is possible per IP-CAN Session. AULC extends this PRA mechanism by allowing multiple PRAs per IP-CAN session, while maintaing the reduced CN load gained by CNO-ULI. Moreover, it provides a mechanism to avoid an MME overload in case of too many PRA monitoring subscriptions.

Finally, AULC offers to decouple the subscription between the PCRF and the Online Charging System (OCS), which means that the PCRF and the OCS can subscribe multiple PRAs reporting separately.

Three kinds of PRAs have been defined, which can be mixed:

1) UE dedicated PRA: those PRAs information are provisioned by the PCRF/OCS to the MME each time the IP-CAN session is established. The PRA information includes both the PRA ID and the PRA list.

2) Predefined PRA: the PRA list has been predefined in the MME, and the PCRF only needs to indicate the PRA IDs so as to activate the corresponding PRAs in the MME.

3) PRA set: The PCRF can indicate one PRA set ID to activate a group of PRAs predefined in the MME.

The PCRF can subscribe PRAs monitoring for a given UE in term of event trigger and the MME will report to PCRF via S/P-GW as soon as the UE enters/leaves the subscribed PRAs.

Since multiple PRAs reporting is supported, this leads to the updating of the "attach" and "handover" procedures.

The MME can select and activate only a part of PRAs indicated from PCRF and return the result to PCRF.

The figure below shows how does the PRA id and the list is provisioned to the MME and the triggering for MME to report PRA change to PCRF.

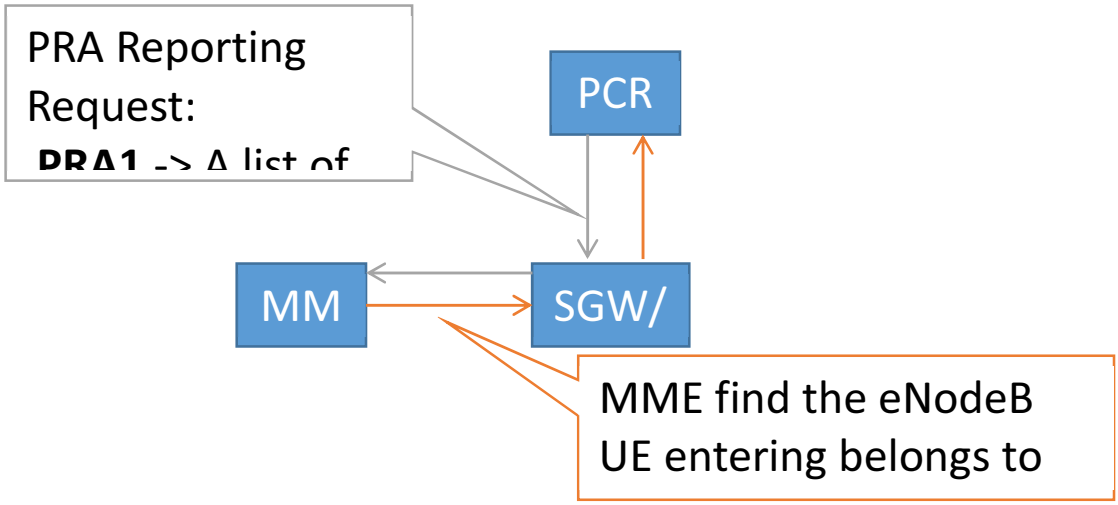


Figure 10.4-1 multiple PRA reporting

From a Stage 3 pespective, the GTP-C and Diameter protocols in S11, S5/S8 and Gx interface have been modified to support the multiple PRA feature.

One more event trigger named "Multiple PRA Feature" has been added in TS29.212 while keeping Rel-12 CNO_ULI feature for backward compatibility.

The charging aspects have also been updated to support multiple PRAs and to allow OCS to subscribe PRAs for charging while decoupling from the PCRF behavior (in CNO_ULI, the PRA subscription is coupled between PCRF and OCS, which means PCRF and OCS have to subscribe the same PRA for event trigger).

11 Radio improvements

11.1 WLAN and unlicensed spectrum related items

11.1.1 EIR check for WLAN access to EPC

Summary based on the input provided by Nokia in SP-170906.

720031	EIR check for WLAN access to EPC	EWE	1		SP-150624
700039	**Stage 2 of EWE**	EWE	2	S2	SP-150624
720002	**CT aspects of EWE**	EWE-CT	2	CT	CP-160244
720032	CT1 aspects of EWE	EWE-CT	3	C1	CP-160244
720033	CT4 aspects of EWE	EWE-CT	3	C4	CP-160244

This feature allows the network to perform IMEI checking when an UE is requesting access to EPC via Trusted / Untrusted WLAN e.g. for stolen devices. It uses the Rel13 CT feature "MEI_WLAN" that consists in the retrieval of the IMEI by the network. On its turn, EIR check for WLAN access to EPC is used in particular by the Rel-14 SA2 "SEW2" feature, which introduces extensions needed for emergency calls over WLAN for unauthenticated UEs.

A new interface S13a, enabling IMEI check from the 3GPP AAA server/proxy, is added between the home 3GPP AAA server and the EIR for non-roaming cases, and between the 3GPP AAA Proxy and the EIR for roaming cases.

The IMEI check over WLAN procedures are optionally used during the initial attach over untrusted and trusted WLAN access, as follows:

- The 3GPP AAA server (if the ePDG/TWAN is in the HPLMN) or the 3GPP AAA proxy (if the ePDG/TWAN is in the VPLMN) is the entity that determines whether to trigger the IMEI check for the UE, and whether to continue or stop the procedure.
- For untrusted WLAN, if required by local regulations, the ePDG is configured for retrieving the IMEI from the UE and to forward it to the AAA server/proxy. The AAA server/proxy directly accesses the EIR used in the same PLMN for IMEI checking.
- For trusted WLAN in non-roaming cases, the 3GPP AAA server retrieves the IMEI from the UE and directly accesses the EIR used in the same PLMN for IMEI checking.
- For trusted WLAN in roaming cases, the 3GPP AAA proxy requests the 3GPP AAA server in the HPLMN to retrieve the IMEI from the UE. The AAA server then forwards the retrieved IMEI to the TWAN, which relays it to the AAA proxy. As for untrusted WLAN, the AAA proxy directly accesses the EIR used in the same PLMN for IMEI checking.

11.1.2 Support of EAP Re-authentication Protocol for WLAN Interworking

Summary based on the input provided by Orange in SP-17XXXX.

730048	Support of EAP Re-authentication Protocol for WLAN Interworking	ERP	1		SP-160568
730049	**Support of EAP Re-authentication Protocol for WLAN Interworking**	ERP	2	S3	SP-160568
730003	**CT aspects of ERP**	ERP-CT	2	CT	CP-160413
730045	CT1 aspects of ERP	ERP-CT	3	C1	CP-160413
730046	CT4 aspects of ERP	ERP-CT	3	C4	CP-160413

The procedures for access to 3GPP Evolved Packet Core (EPC) via non-3GPP access networks have been enhanced in Rel-14 to enable an EPC network to optionally support the EAP Re-authentication Protocol (ERP). ERP allows efficient re-authentication between the UE and a dedicated server that can be located in the TWAP or the 3GPP AAA proxy/server and provides optimized link-setup delay after handover between access points.

The Extensible Authentication Protocol (EAP) (IETF RFC 6696 [1]) is used for authentication of user accessing EPC using non-3GPP access networks. To avoid full EAP authentication when moving from one access point to another one of the same access network, ERP has been defined to ensure efficient re-authentication between the UE and an EAP re-authentication server through any access point.

In SA2, TS 23.402, which specifies the procedures for access to EPC via non-3GPP access networks, has been enhanced in Rel-14 to enable an EPC network to optionally support ERP. By using ERP, UEs can connect to EPC via trusted or untrusted non-3GPP access and utilize EPC services with enhanced performances provided by an optimized link-setup delay after handover between access points.

The security aspects were covered by the WI "ERP" under the responsibility of SA3 (730048). The stage 3 was covered by the WI "ERP-CT" under the responsibility of CT4 (730003) for core network impacts and CT1 (730045) for UE impacts.

The main actions to complete the Work Items were to:

- Include a functional description of the use of ERP for EAP re-authentication into the 3GPP TS 33.402 [2], including a specific ERP key derivation;
- Enhance the functionalities the 3GPP AAA server/proxy and the related procedures over STa, SWa and SWd interfaces specified in TS 29.273 to support related ERP procedures as specified in TS 33.402. Specific data used in ERP (Authorization rights, ERP keying material, etc.)
- Enhance the functionalities of the UE described in the 3GPP TS 24.302 to indicate that an UE may support ERP.

References

[1] IETF RFC 6696: "EAP Extensions for the EAP Re-authentication Protocol (ERP)"
[2] 3GPP TS 33.402

11.1.3 Phase 2 of the Support of Emergency services over WLAN

Summary based on the input provided by Nokia in SP-170907.

720019	**Phase 2 of the Support of Emergency services over WLAN**	SEW2	1		SP-160307
690033	**Study on Phase 2 of the Support of Emergency services over WLAN**	FS_SEW2	2	S2	SP-160173
720018	**Support of Emergency services over WLAN - phase 2**	SEW2	2	S2	SP-160307
730017	**CT aspects of SEW2**	SEW2-CT	2	CT	CP-160694
730018	CT1 aspects of SEW2	SEW2-CT	3	C1	CP-160694
730019	CT4 aspects of SEW2	SEW2-CT	3	C4	CP-160694
730020	Deleted - CT6 aspects of SEW2	SEW2-CT	3	C6	CP-160694

This feature enhances the support of emergency services over WLAN beyond the cases supported in 3GPP Rel-13 by SEW1 (Support of Emergency services over WLAN – phase 1) feature, which were limited to authenticated UEs over untrusted WLAN access in non-roaming scenario.

This feature includes:

- The support of emergency services for unauthenticated UE's, with or without USIM.
- The roaming scenario, by which the UE accesses an emergency PDN GW in the visited country. This includes the determination by the UE of the country it is located in.
- The support of S2a/Trusted WLAN access: the UE includes an emergency request in EAP-AKA' signalling to the 3GPP AAA server, which uses this information to give precedence to this session in case of signalling congestion and unauthorized UEs to not carry out certain checks.
- The selection a proper access node in case of emergency service. In case of untrusted WLAN, the prioritized selection of an ePDG supporting emergency services in the country the UE is located in. For Trusted WLAN, the

addition of an emergency services support indication by the TWAN, relayed by the AAA server, which enables the UE to select a proper WLAN Access Point.

- Seamless mobility between WLAN and E-UTRAN: the selected PDN GW is used as an anchor at handovers between 3GPP and non-3GPP accesses. In the case of un-authenticated UE's or roamers, a static PDN GW is configured in the ePDG or the Trusted WLAN and in the MME. In the case of non-roaming authenticated UE's, it is possible to use a dynamically selected PDN GW by the HSS being notified of the PDN GW identity at session establishment and the retrieval of this identity by the target system during the handover procedure. The WLAN to CS session continuity for Emergency call over WLAN is also supported using the Dual Radio VCC procedure, however the other direction is not supported.
- The EIR check (e.g. to verify whether the device has not been stolen), per feature "EIR check for WLAN access to EPC" (EWE).
- The prioritized determination of the emergency numbers by the UE, including emergency numbers preconfigured in the UE, emergency numbers being provided to the UE over 3GPP access of the last registered PLMN, or received over WLAN via DNS or ANQP IEEE procedures.
- Mechanisms to provide the PSAP with the UE location, provided by the network and/or by the UE.

However, this feature does not include the support of QoS differentiation, as this is part of another feature (Rel-15 VoWLAN: Complementary Features for Voice services over WLAN).

References

[1] TR 23.771, Phase 2 of the Study on the Support of Emergency services over WLAN

11.1.4 T-ADS supporting WLAN Access

Summary based on the input provided by China Mobile in SP-170519.

720076	T-ADS supporting WLAN Access	TADS_WLAN	1	S2	SP-160488

This Work Item enhances the Terminating Access Domain Selection (T-ADS) mechanism as to support IMS voice over WLAN. Indeed, the pre-Rel-14 T-ADS does not take into account IMS voice over WLAN, which may lead to a wrong decision of call when the UE moves between WLAN and UTRAN/GERAN.

The T-ADS mechanism contains two aspects: the definition of the information considered for the domain determination, and the way for the SCC AS to determine the terminating domain, based on this information.

The key information used by the T-ADS mechanism is the time stamp at which the UE attached to a given access network. More precisely, this Work Item introduces (in the Insert-Subscriber-Data-Answer (IDA) command) two time stanp values: the one of the most recent IMS registration or re-registration via WLAN, and the one of the 3GPP access network that had the most recent radio contact with the UE. These two time stamps are then taken into account by the SCC AS to determine the access domain.

11.1.5 Enhanced LTE-WLAN Aggregation (LWA)

Summary based on the input provided by Intel Corporation in RP-170330.

710075	Enhanced LTE-WLAN Aggregation (LWA)	LTE_WLAN_aggr	1	R2	RP-160600
710175	**Core part: Enhanced LTE-WLAN Aggregation (LWA)**	LTE_WLAN_aggr-Core	2	R2	RP-160923

In Rel-14, the following LTE-WLAN Aggregation (LWA) enhancements have been introduced: UL aggregation on LTE and WLAN, mobility enhancements (handover without WT change), 60GHz band support, neighbour eNB reporting for ANR and WLAN suspend/resume.

Release-14 Enhanced LWA builds on top of the baseline Release-13 functionality, adding the following enhancements:

- Uplink transmission on WLAN, including uplink aggregation

- Mobility enhancements, specifically support for handover without WT change
- Support for 60GHz 802.11 band
- Automatic Neighbour Relation (ANR)
- WLAN suspend/resume

Release-13 LWA supports uplink transmission on LTE only. Uplink support added in Release-14 is conceptually similar to Dual Connectivity (DC) uplink support, with some adjustments made for WLAN: the eNB may configure an uplink data split threshold and if the data available for transmission in the UE is above that threshold, the UE submits PDCP PDUs to either AM RLC entity or WLAN. The selection of which PDCP PDUs to send via LTE or WLAN is left of UE implementation. If the data available for transmission is below the configured threshold, the UE sends PDCP PDUs via LTE or WLAN, as configured by the eNB using another IE.

In Release-13, LWA configuration is released upon handover. In Release-14, an enhancement has been added, allowing the UE to retain the LWA configuration and therefore to remain associated to the current WLAN AP (if in coverage) during handover. Therefore, during LTE HO, WLAN transmission and reception can continue. To support this functionality, a new procedure referred to as "Handover without WT change" has been defined. In this procedure, during the handover, the target eNB initiates the WT Addition procedure (to the same WT the UE is associated with) and the source eNB may postpone the WT Release Request, so that the data may be sent/received via WLAN during the HO. As the UE may need to temporary use two keys to decipher PDCP PDUs received from the target eNB and from the source eNB (via the WT), the end marker approach has been agreed, in which the source eNB sends the end marker after sending the last PDCP PDU. The UE uses the end marker indication to switch to the target eNB security key.

To support IEEE 802.11 operating in the 60GHz band (aka WiGig), this band has been added into RRC and Xw-AP protocols.

For ANR, measurement enhancements have been defined, allowing reporting of WLANs outside the list of WLAN IDs in the WLAN measurement object. Additionally, Xw-AP enhancements have been agreed, to allow WT reporting of neighbour eNBs – which allows the eNB to deduce the information about the WLAN network topology, thus reducing the OAM effort required for LWA deployment.

Additionally, WLAN suspend/resume indication from the UE has been added. This enhancement allows the UE which needs to temporary connect to another WLAN (e.g. a smart watch) not to tear down LWA connection.

11.1.6 Enhanced LTE WLAN Radio Level Integration with IPsec Tunnel (eLWIP)

Summary based on the input provided by Nokia in R3-170706.

730086	Enhanced LTE WLAN Radio Level Integration with IPsec Tunnel (eLWIP)	LTE_WLAN_eLWIP	1	R3	RP-161929
730186	**Core part: Enhanced LTE WLAN Radio Level Integration with IPsec Tunnel (eLWIP)**	LTE_WLAN_eLWIP-Core	2	R3	RP-161929

This Work Item enhances LTE-WLAN Radio Level Integration with IPsec Tunnel (LWIP) by:

- Defining LWIP flow control e.g. via reuse of the LWA framework;
- Defining improvements to WLAN measurement framework e.g. as defined within the eLWA WID;

The solution supports legacy WLAN deployments without any need for modifications to the deployed WLAN nodes.

This was achieved by standardizing the interface between the eNB and the SeGW supporting LWIP (the LWIP-SeGW).

This interface was decided to be based on Xw. This indeed allows to reach the two objectives above by reusing existing Xw procedures: Xw flow control and Xw resource reporting.

LWIP flow control: the flow control for LWIP will be per UE and will concern data transmitted from the SeGW towards the UE.

LWIP resource reporting: Resource reporting is based on the information provided from APs, but it is not mandatory for legacy APs to support the feature.

The key aspects of the Xw-based connectivity between the eNB and the LWIP-SeGW (which thus became a 3GPP node, offering limited WT functionality to handle the needed Xw procedures) are:

- The common XwAP procedures are to be used for both LWA and LWIP;
- UE-specific XwAP procedures are to be defined separately for LWA and LWIP; the new procedures are:
  - LWIP Addition Preparation procedure (class 1)
  - eNB initiated LWIP Modification Preparation procedure (class 1)
  - eNB initiated LWIP Release procedure (class 2)
  - LWIP-SeGW initiated LWIP Release procedure (class 1)
- WLAN identifiers for LWIP are to be enabled at Xw setup and WT configuration update; this is achieved by adding a flag to the WLAN Information IE;
- Separate E-RABs and QoS are not supported over Xw in the version of the specification; the transport layer and Xw UP specifications has been extended to handle LWIP traffic;
- The same XwAP UE IDs are used for both LWA and LWIP.

11.2 GERAN and GPRS related items

11.2.1 Positioning Enhancements for GERAN

Summary based on the input provided by Ericsson LM in RP-170920.

721003	Positioning Enhancements for GERAN	ePOS_GERAN	1	R6	RP-161260
721103	**Core part: Positioning Enhancements for GERAN**	ePOS_GERAN-Core	2	R6	RP-161260
721203	**Perf. part: Positioning Enhancements for GERAN**	ePOS_GERAN-Perf	2	R6	RP-161260

Positioning Enhancements for GERAN introduces means for an improved ability to estimate the position of a mobile station operating in normal GSM as well as in EC-GSM-IoT coverage without using satellite positioning such as GPS, GLONASS, Beidu or Galileo. This is achieved by introducing a new base station centric Multilateration Timing Advance procedure and a new mobile station centric Multilateration Observed Time Difference procedure. The Multilateration Timing Advance procedure enable positioning as accurate as 50 m in 67% of the positioning attempts when using only three base stations (see R6-160235, "Enhanced Positioning – Positioning performance evaluation", Source Ericsson LM).

Multilateration Timing Advance Procedure

This positioning procedure is based on one or more base stations acquiring timing advance information from a set of cells selected by the mobile station (corresponding to a set of distances to each cell). The position of the device is then determined using so called multilateration where the position of the mobile station correspond intersection of three or more arcs, see Figure 1.

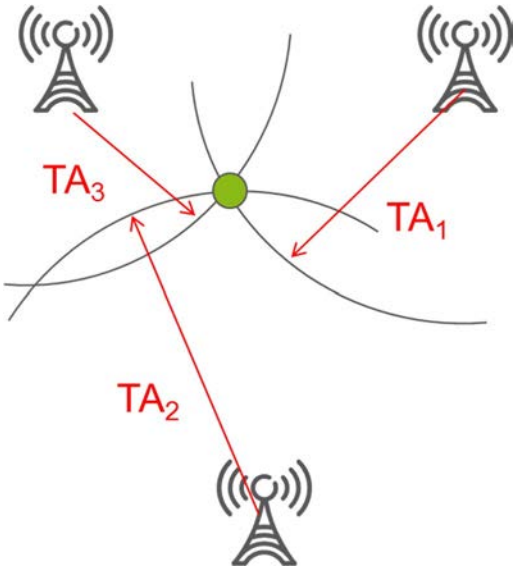


Figure 11.2.1-1: Illustration of Multilateration Timing Advance Procedure

Multilateration Observed Time Difference Procedure

This positioning procedure is based on the same multilateration principles as the Multilateration Timing Advance procedure with a difference that in the neighbour cells the distance to the bases stations instead are based on so called observed time difference measurements made by the mobile station.

11.2.2 New GPRS algorithms for EASE

Summary based on the input from Vodafone in SP-170759.

710085	New GPRS algorithms for EASE	EASE_ALGOs_SA3	1	S3	SP-160203

This WI delivered 6 new TS's adding 2 new strong algorithms (GIA4 and GEA5/GIA5) for cyphering and integrity protection of GSM CIoT data, each algorithm having an algorithm specification, an implementer's test specification and a conformance specification.

This work item delivered the following:

- TS 55.241 [1] – The design specification for GIA4 which is an integrity protection algorithm intended for use with GSM based on KASUMI [2].
- TS 55.242 [3] – The implementer's test data specification for GIA4 integrity protection algorithm specified in TS 55.241 [1].
- TS 55.243 [4] – The conformance test data specification for GIA4 integrity protection algorithm specified in TS 55.241 [1].
- TS 55.251 [5] – The design specification for GEA5 (cyphering algorithm) and GIA5 (integrity protection algorithm) intended for use with GSM based on SNOW 3G.
- TS 55.252 [6] – The implementer's test data specification for GIA4 integrity protection algorithm specified in TS 55.251 [5].
- TS 55.253 [7] – The conformance test data specification for GIA4 integrity protection algorithm specified in TS 55.251 [5].

These algorithms can be selected by GSM terminals and networks using the current algorithm selection mechanisms.

Each Algorithm has a trio of documents: a design specification detailing how the algorithm works, an implementer's test specification that has test values for both the final calculations and the intermediate steps to allow implementers to prove their developments and a conformance test specification for final testing by the developers or by a third party,

Due to the security nature of these specifications and the strength of the algorithms, these specs are only issued under licence from 3GPP.

References

[1] TS 55.241: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the GIA4 integrity algorithm for GPRS; GIA4 specification".

[2] TS 35.202: "3G Security; Specification of the 3GPP Confidentiality and Integrity Algorithms; Document 2: KASUMI Specification".

[3] TS 55.242: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the GIA4 integrity algorithm for GPRS; Implementers' test data".

[4] TS 55.243: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the GIA4 integrity algorithm for GPRS; Design conformance test data".

[5] TS 55.251: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the GEA5 encryption and GIA5 integrity algorithms for GPRS; GEA5 and GIA4 algorithm specification".

[6] TS 55.252: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the GEA5 encryption and GIA5 integrity algorithms for GPRS; Implementers' test data".

[7] TS 55.253: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Specification of the GEA5 encryption and GIA5 integrity algorithms for GPRS; Design conformance test data".

11.2.3 Positioning Enhancements for GERAN

11.2.4 Other GERAN items

See DECOR_GERAN

11.3 UMTS related items

11.3.1 RRC optimization for UMTS

Summary based on the input from Ericsson in RP-172758.

700062	RRC optimization for UMTS	UTRA_RRCopt	1	R2	RP-152267
700162	**Core part: RRC optimization for UMTS**	UTRA_RRCopt-Core	2	R2	RP-160287

The RRC optimization for UMTS work item contained two enhancements: "Simultaneous RAB/RB Setup and Release" and "Generic UPH Reporting".

In earlier releases of UMTS the setup, release and reconfiguration of radio bearers have been done using different RRC messages, namely the messages Radio Bearer Setup, Radio Bearer Release and Radio Bearer Reconfiguration. In cases where e.g. one radio bearer has been setup at the same time as another radio bearer has been modified, it has been necessary to send two different RRC messages. The "simultaneous RAB/RB setup and release" enhancement allows setup, release and reconfiguration of radio access bearers and radio bearers in the same RRC message. The RRC message is the Radio Bearer Reconfiguration message.

In MAC layer, the UE may report the Uplink Power Headroom (UPH). The UPH of a frequency indicates the ratio of the maximum UE transmission power and the corresponding DPCCH code power of that frequency. In the enhancement for Generic UPH Reporting, the option to configure RRC events for UPH reporting is introduced. The RRC events allow the UE to perform measurements on UE Power Headroom (UPH) and signal the RRC events 6h and 6i when the UPH becomes larger or less than an absolute threshold respectively. The thresholds are configurable, as well as hysteresis, time-to-trigger, filter coefficient and pending time after trigger for each of the events.

11.3.2 Multi-Carrier Enhancements for UMTS

Summary based on the input from Huawei in RP-162129.

720094	Multi-Carrier Enhancements for UMTS	UTRA_MCe	1	R2	RP-161259
700059	**Study on Multi-Carrier Enhancements for UMTS**	FS_UTRA_MCe	2	R1	RP-152290
720194	**Core part: Multi-Carrier Enhancements for UMTS**	UTRA_MCe-Core	2	R2	RP-162453

In UMTS Rel-9, Dual Cell E-DCH operation feature was introduced and only 2ms TTI can be configured on both primary and secondary uplink frequencies. The uplink coverage of cells deployed in different carriers may be different, as for example when the primary carrier uses a lower frequency, e.g. 900 MHz, and the secondary carrier uses a higher frequency, e.g. 2.1 GHz. Dual Cell E-DCH operation can be enhanced by allowing 10ms TTI on either primary or secondary uplink frequency or both.

The WI "Multi-Carrier Enhancements for UMTS" introduces additional combinations of TTI length on Dual Cell E-DCH operation and the enhanced TTI switching mechanism:

- For the TTI length combinations:
  - 10ms TTI is supported on both primary and secondary uplink frequency (10 ms + 10 ms TTI configuration)
  - a combination of 2 ms TTI and 10 ms TTI is supported (2 ms + 10 ms TTI configuration)
- For the enhanced TTI switching mechanism:
  - it allows switching TTI either on primary or secondary uplink frequency or on both, and
  - the UE can send the filtered UPH report in MAC control information on either primary or secondary uplink frequency to the network.

11.3.3 DTX/DRX enhancements in CELL_FACH

Summary based on the input from Huawei in RP-162132.

700063	DTX/DRX enhancements in CELL_FACH	FACH_DTXDRX	1	R2	RP-152286
700163	**Core part: DTX/DRX enhancements in CELL_FACH**	FACH_DTXDRX-Core	2	R2	RP-162513

This Work Item introduces DTX/DRX enhancements for smart phones in CELL_FACH state as a way to improve their battery life.

HS-DSCH/E-DCH transmission in CELL_FACH was introduced in Releases 7 and 8, and is currently deployed. This feature is useful for smart phone services to improve resource utilization and latency of state transition between CELL_FACH and CELL_DCH.

Considering the increasing number of users and the amount of traffic for small data applications, the UE will be in CELL_FACH state more often, and the introduction of HS-SCCH DRX is a way to save UE battery life.

With this functionality, the UTRAN indicates an inactivity time, a HS-SCCH DRX cycle length and a HS-SCCH RX burst length. This information is stored by the UE for use when in CELL_FACH state. If HS-SCCH DRX is configured through dedicated RRC signalling, the UE has to follow HS-SCCH DRX operation in CELL_FACH state.

The feature is initialized when the inactivity timer expires. The inactivity timer is triggered whenever no data transmission activities are ongoing. When the inactivity timer expires, the UE has to only monitor HS-SCCH order for the HS-SCCH DRX burst length. If the UE receives the HS-SCCH order, it starts receiving HS-DSCH continuously with an offset after the HS-SCCH order.

11.4 LTE related items

11.4.1 LTE radio improvements

11.4.1.1 Radiated performance requirements for the verification of multi-antenna reception of UEs in LTE

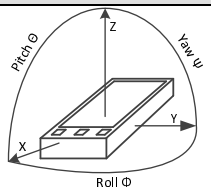
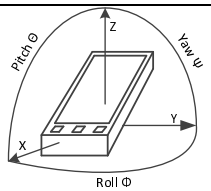
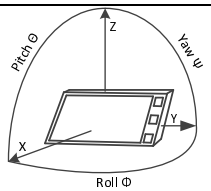
Summary based on the input provided by Intel Corporation in RP-171826.

710076	Radiated performance requirements for the verification of multi-antenna reception of UEs in LTE	LTE_MIMO_OTA	1	R4	RP-160603
710176	Core part: Radiated performance requirements for the verification of multi-antenna reception of UEs in LTE	LTE_MIMO_OTA-Core	2	R4	RP-162306
730071	UE Conformance Test Aspects - Radiated Performance of Multiple-antenna Receivers in the LTE UE	LTE_MIMO_OTA-UEConTest	2	R5	RP-161474

The total radiated MIMO sensitivity (TRMS) requirements for the verification of multi-antenna reception performance of UEs in LTE have been agreed (Clause 8 of TS 37.144), and the outcome of the harmonisation activity between the MPAC, RTS, and RC+CE methodologies has been agreed (Clause 10.3 of TR 37.977). This concludes the RAN4 effort to develop MIMO OTA test methodologies and to define the UE requirements spanning the following prior study and work items: Rel-11 SI on Measurement of radiated performance for MIMO and multi-antenna reception for HSPA and LTE terminals, Rel-12 WI on Verification of radiated multi-antenna reception performance of UEs in LTE/UMTS, and Rel-13 WI on Radiated requirements for the verification of multi-antenna reception performance of UEs. A corresponding RAN5 WI on Conformance Test Aspects – Radiated Performance of Multiple-antenna Receivers in the LTE UE is tasked with completing the MIMO OTA testing specification (TS 37.544). This work item has addressed the GCF request to develop OTA requirements for MIMO-capable LTE UEs.

As part of the class of over the air (OTA) requirements, the TRMS metric seeks to quantify the radiated performance of a handheld UE when receiving a rank-2 MIMO transmission. This metric is intended to verify the performance of the UE antenna subsystem, RF processing, and demodulation in baseband. The TRMS metric is measured for handheld UEs in free space utilizing three testing conditions, as shown in Table below.

Table 11.4.1.1-1: UE testing conditions for TRMS

DUT type and dimensions	Testing condition	DUT orientation angles	Diagram
Handset, tablet, CTIA reference antennas	Free space data mode screen up (FS DMSU) or YZ plane or Face Up	Ψ=0; Θ=-90; Φ=0	
Handset, tablet	Free space data mode portrait (FS DMP)	Ψ=0; Θ=-45; Φ=0	
Handset, tablet	Free space data mode landscape (FS DML)	Ψ=90; Θ=-45; Φ=0 – left tilt	

The test equipment measures the sensitivity levels over the air (OTA) at the specified throughput levels for each UE testing condition and UE angular rotation relative to the test equipment antennas. During the measurement the test equipment emulates the SCMe urban micro-cell (UMi) fading profile, as defined in clause 8.2 of TR37.977.

The harmonisation part of the work item has selected the multi-probe anechoic chamber (MPAC) methodology as the reference methodology and has concluded that one other methodology, the radiated two-stage (RTS), is capable of producing the same propagation conditions of the specified fading profile within certain scope and conditions. The detailed analysis and outcome of the harmonisation effort are captured in clause 10.3 of TR 37.977. MPAC and RTS methodologies are defined in clauses 6.3.1.1 and 6.3.1.3, respectively; their diagrams are provided in the figure below.

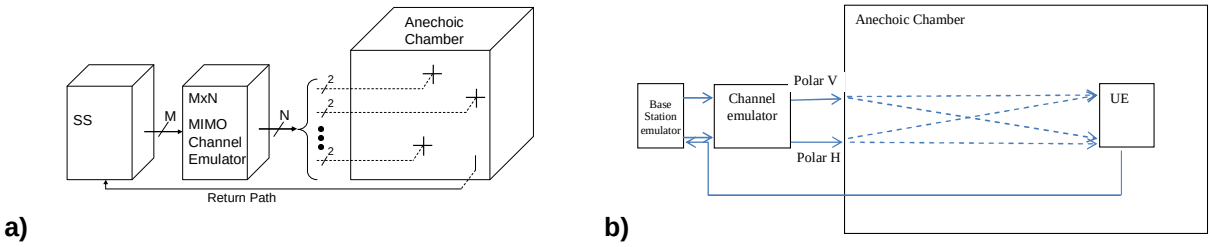


Figure11.4.1.1-1: Diagrams of MPAC (a) and RTS (b) methodologies

RAN4 has developed a framework for determining the MIMO OTA performance requirements based on a statistical analysis of measured device data. The TRMS metric for handheld UEs in free space is defined in clause 8.1.1, and the summary of the agreed requirements is provided in the table below.

Table 11.4.1.1-2: Handheld UE TRMS minimum requirements for E-UTRA FDD and TDD roaming bands in free space and the primary mechanical mode

		Test 1	
Channel Model as defined in clause 8.2 in [7]		SCME urban micro-cell	
Operating band	Unit	<REFÎ$_{or}$>	
		Average, 70	Average, 95
1 (FDD)	dBm/15 kHz	-94.25	-92.25
7 (FDD)	dBm/15 kHz	-92.5	-90.5
38 (TDD)	dBm/15 kHz	-95.5	-93.5
41 (TDD)	dBm/15 kHz	-95.5	-93.5

References

[1] TS37.144 v14.4.0, "UE and MS over the air performance requirements," 3GPP, September 2017
[2] TR37.977 v14.5.0, "Verification of radiated multi-antenna reception performance of UEs," 3GPP, September 2017
[3] TR36.978 v13.2.0, "UE antenna test function definition for two-stage MIMO OTA test method," 3GPP, June 2017
[4] RP-0900352, "Proposed new study item: Measurement of radiated performance for MIMO and multi-antenna reception for HSPA and LTE terminals," Vodafone, RAN #43, March 2009
[5] RP-120368, "New WID proposal: Verification of radiated multi-antenna reception performance of UEs in LTE/UMTS," Vodafone, RAN #55, March 2012
[6] RP-141325, "New SI proposal: Study on MIMO OTA antenna test function for LTE," Keysight Technologies, RAN#65, December 2014
[7] RP-142221, "New WI proposal: Radiated requirements for the verification of multi-antenna reception performance of UEs," Intel Corporation, RAN#66, December 2014
[8] RP-160603, "New WID: Radiated performance requirements for the verification of multi-antenna reception of UEs," Intel Corporation, RAN #71, March 2016
[9] RP-161474, "New Work Item Proposal: UE Conformance Test Aspects – Radiated Performance of Multiple-antenna Receivers in the UE," Intel Corporation, RAN #73, September 2016
[10] RP-171834, "Status report: Radiated performance requirements for the verification of multi-antenna reception of UEs," Intel Corporation, RAN #77, September 2017

11.4.1.2 Enhancements on Full-Dimension (FD) MIMO for LTE

Summary based on the input provided by Samsung in RP-170173.

710077	Enhancements on Full-Dimension (FD) MIMO for LTE	LTE_eFDMIMO	1	R1	RP-160623
710177	**Core part: Enhancements on Full-Dimension (FD) MIMO for LTE**	LTE_eFDMIMO-Core	2	R1	RP-160623
710277	**Perf. part: Enhancements on Full-Dimension (FD) MIMO for LTE**	LTE_eFDMIMO-Perf	2	R4	RP-160623

This WI specifies the reaping of the potential system throughout gain from large Active Antenna (AA) arrays (comprising up to 64-128 TXRUs) in wider deployment scenarios (including high speed UEs and higher-order MU spatial multiplexing) by enhancing pertinent reference signals (RSs), CSI (Channel State Information) reporting mechanism, and transmission schemes.

Based on the conclusion from the EB/FD-MIMO study item (captured in TR36.897), some relevant specification support was developed for EB/FD-MIMO in Rel-13 by enhancing DL CSI and DL Demodulation Reference Signals (DMRS) as well as CSI reporting mechanism. However, only a part of the proposals resulting from the study have been specified. First, only up to 16 antenna ports are supported. Therefore, the benefit from AA arrays with more than 16 TXRUs is limited. Second, there is no enhancement on CSI reporting to enable efficient MU (multi-user) spatial multiplexing. Lastly, there is no support for providing higher robustness against CSI impairments (such as inter-cell interference or higher-speed UEs). The eFD-MIMO WI for Rel-14 was proposed to address these Rel-13 limitations.

The following new functionalities have been specified:

- Enhanced non-precoded CSI-RS: New non-precoded CSI-RS patterns for 20, 24, 28, and 32 ports intended to aid CSI measurement and reporting for base stations (transmission points) equipped larger AA arrays. The frequency density of these new patterns can be configured between normal and reduced density values.

- Enhanced beamformed CSI-RS: Three mechanisms to enable more efficient usage of UE-specific beamformed CSI-RS resources (e.g. to allow more UEs to share a pool of CSI-RS resources) – aperiodic CSI-RS (where a UE is configured to measure CSI-RS in a given subframe for reporting aperiodic CSI), multi-shot CSI-RS (where a UE is configured to measure periodic CSI-RS and report periodic/aperiodic CSI in a limited time period), and configurable frequency density reduction.

- Enhanced UL DMRS: To increase the number of orthogonal UL DMRS ports (to increase multiplexing capacity), UL DMRS patterns with lower IFDM/comb density

- Precoding codebook extension for non-precoded CSI-RS: Since non-precoded CSI-RS design is extended to additional number of ports (20, 24, 28, and 32), the precoding codebook designed in Rel-13 for 8, 12, and 16-port CSI-RS is extended to support these four additional number of ports.

- Joint utilization of different CSI-RS types: Two mechanisms to facilitate efficient joint utilization of two distinct types of CSI-RS – first mechanism between non-precoded CSI-RS and one-resource beamformed CSI-RS, second between multi-resource beamformed CSI-RS and one-resource beamformed CSI-RS. Relevant enhancements include CSI reporting optimization and the associated DL signalling support.

- Advanced (high-resolution) CSI for MU spatial multiplexing: High-resolution dual-stage codebook for facilitating 1- and 2-layer DL transmission per UE and improving MU precoding at the base station. The codebook is designed based on the concept of beam (precoder basis) combination and allows finer quantization of channel eigenvectors at the UE.

- DMRS-based semi-open-loop transmission: A diversity-based transmission scheme aided by partial reporting of PMI (Precoding Matrix Indication) for 1- and 2-layer transmission. The partial PMI reporting enables the base station to perform diversity operation combined with wideband/long-term beamforming. Compared to a typical DMRS-based precoding, this transmission scheme tends to be more robust for high-speed UEs and against inter-cell interference.

11.4.1.3 Further mobility enhancements in LTE

Summary based on the input provided by ZTE Corporation in RP-170369.

710078	Further mobility enhancements in LTE	LTE_eMob	1	R2	RP-160636
710178	**Core part: Further mobility enhancements in LTE**	LTE_eMob-Core	2	R2	RP-162503

This work item includes two phases of work. In phase 1, several solutions for reducing the mobility interruption time are evaluated and studied. In phase 2, two solutions (i.e. Make_Before_Break and RACH-less) are decided to minimize the mobility interruption including handover and SeNB change.

RACH-less:

The RACH-less solution is to reduce the mobility interruption time by removing the RACH procedure during the mobility events including handover and SeNB change. The RACH-less solution is determined only by the target eNB, and only applicable for the scenarios where the uplink transmission timing does not change (i.e. intra-site) or equals to "0" (i.e. small cell). The following components are specified to support the RACH-less solution:

- Indicate the uplink timing (i.e. NTA) to be used for the target cell in the handover command
- Provide the pre-allocated uplink grant in the handover command. The minimal interval of the pre-allocated uplink grant is 2ms. The non-adaptive retransmission in the pre-allocated uplink grant is prioritized over the new transmission. The redundancy version of the HARQ retransmission in the pre-allocated uplink grant is fixed to "0". The pre-allocated uplink grant is released upon the successful completion of the mobility event.

Make-Before-Break:

The Make-Before-Break solution is to reduce the mobility interruption time by keeping the source connection after the reception of the handover/SeNB change command and before the first transmission/reception on the target cell. The Make-Before-Break solution is only applicable for the intra-frequency scenario. The following components are specified to support the Make-Before-Break solution:

- Delay the layer-2 reset after stopping the transmission and reception on the source cell(s)
- The source eNB (or source MeNB for the SeNB change) determines the Make-Before-Break handover/SeNB change by requesting the target eNB to add the make-before-break indication in the RRC message which is used for the mobility event. The target eNB adds the make-before-break indication in the RRC message which is sent to the UE via the source eNB when the handover/SeNB change is accepted.

11.4.1.4 Uplink Capacity Enhancements for LTE

Summary based on the input provided by Ericsson and CMCC in RP-170115.

710079	Uplink Capacity Enhancements for LTE	LTE_UL_CAP_enh	1	R1	RP-160664
710179	**Core part: Uplink Capacity Enhancements for LTE**	LTE_UL_CAP_enh-Core	2	R1	RP-162488
710279	**Perf. part: Uplink Capacity Enhancements for LTE**	LTE_UL_CAP_enh-Perf	2	R4	RP-162488

This work item covers two independent improvements: support for 256QAM in UL and support for PUSCH in UpPTS.

Uplink 256QAM is introduced by extending the current LTE design and takes in learnings from the design of DL 256QAM in Rel-13. With the support of UL 256QAM came also the introduction of new UL UE categories that would utilize the newly added modulation order in UL.

PUSCH transmission in UpPTS is introduced in frame structure 2. This enables the introduction of TTI bundling for TDD UL/DL configurations #2 and #3. The PUSCH transmission within UpPTS can be sent by the UE with an associated DM-RS within UpPTS or not.

11.4.1.5 L2 latency reduction techniques for LTE

Summary based on the input from Ericsson in RP-172559.

710080	L2 latency reduction techniques for LTE	LTE_LATRED_L2	1	R2	RP-160667
710180	**Core part: L2 latency reduction techniques for LTE**	LTE_LATRED_L2-Core	2	R2	RP-160667

In an LTE system there are multiple components contributing to the total end to end delay for connected UEs. The limitations in performance are in general use case dependent; for which e.g. UL latency may influence the DL application performance and vice versa.

In general, a UE with data to send has to send a Scheduling Request (SR) to receive a UL scheduling grant before transmitting the data packet. In order to send a SR, a UE has to wait for a SR-valid PUCCH resource and a corresponding scheduling grant transmitted on PDCCH to the UE in response. When the grant on PDCCH is decoded, the data transmission can start over PUSCH.

As an alternative to reduce the grant request delay in the above, the network (i.e. eNB) may choose to pre-schedule a UE by either issuing a dynamic grant via PDCCH without apriori buffer status information, or alternatively, use a Semi Persistent Grant (SPS). By doing so, the NW may avoid additional delay in the grant request procedure given that the time to the next grant opportunity is short.

In the WI for Latency reductions, enhancement to pre-scheduling and SPS have been defined and specified, in order to increase the latency reduction gains, reduce UL interference and increase the effectiveness of available scheduling tools.

The following enhancement to SPS in FDD and TDD are introduced:

- Introduction of short periodic UL SPS grant intervals in order to reduce the latency of the first UL transmission compared to legacy intervals using RRC configured UL SPS grants;
- Introduction of the UE to skip padding transmissions in SPS UL grant if there is no UL data in the UE buffer in order to decrease UL interference and improve UE battery efficiency;
- Introduction of the transmission of a SPS activation and de-activation confirmation from UE, triggered as new MAC Control Element (MAC CE) to increase robustness in SPS when UL grants are skipped by UE;
- Introduction of non-adaptive retransmission on SPS resource (prioritized over new data transmission) to allow configured SPS UL grant resources in subsequent TTIs.
- In the WI, the following enhancement to dynamic scheduling (PDCCH) in FDD and TDD are introduced:
- Introduction of a RRC configurable option to mandate UE to skip padding transmissions on a dynamic grant received on PDCCH if there is no UL data in the UE buffer in order to decrease UL interference and improve UE battery efficiency.

11.4.1.6 SRS (sounding reference signal) switching between LTE component carriers

Summary based on the input from Huawei and HiSilicon in RP-162137.

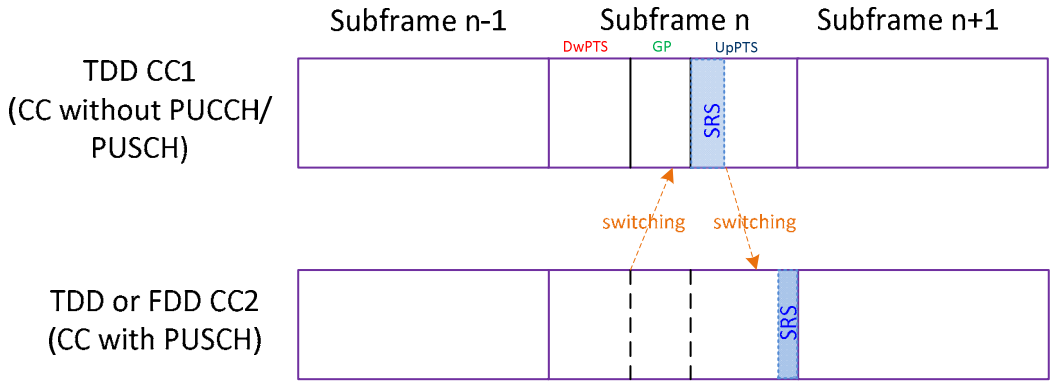
710082	SRS (sounding reference signal) switching between LTE component carriers	LTE_SRS_switch	1	R1	RP-160676
710182	**Core part: SRS (sounding reference signal) switching between LTE component carriers**	LTE_SRS_switch-Core	2	R1	RP-160935
710282	**Perf. part: SRS (sounding reference signal) switching between LTE component carriers**	LTE_SRS_switch-Perf	2	R4	RP-160935

This work item provides mechanisms for user equipment (UE) with limited or no uplink (UL) carrier aggregation (CA) capability to perform switching to a time division duplex (TDD) secondary component carrier (i.e., secondary cell or SCell) for sounding reference signal (SRS) transmission without PUCCH/PUSCH configured on that carrier. This improves downlink (DL) performance by exploiting DL/UL channel reciprocity on that carrier, and is useful for a UE supporting aggregating more DL carriers than UL carrier(s).

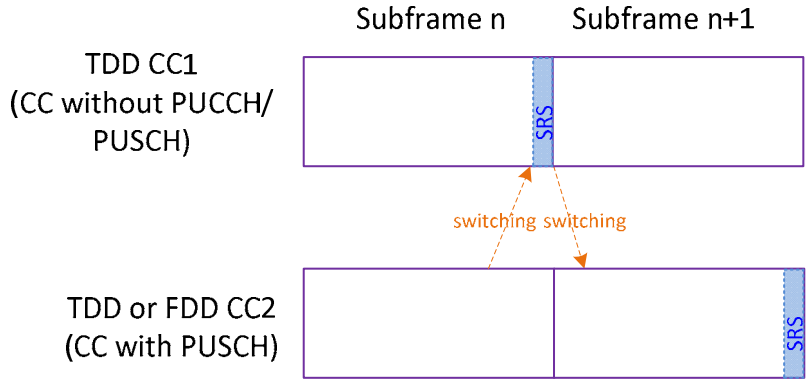
A CA-capable UE can receive simultaneously on a number of component carriers (CCs) in DL, but in general the UE can transmit simultaneously on only a much smaller number of carriers in UL (typically one) for the transmissions of physical uplink control channel (PUCCH), physical uplink shared channel (PUSCH), and SRS. For this reason, before Release 14, a TDD CC of the UE may be configured as a DL-only CC and not have corresponding SRS in UL (which may be referred to as PUSCH-less TDD CC), and hence DL beamforming on this CC cannot exploit channel reciprocity based on sounding.

To improve the DL beamforming performance, support for SRS transmissions on all configured TDD CCs, including on PUSCH-less TDD CCs, is allowed in Release 14 via the introduction of SRS switching, while ensuring that the UE's UL CA capability is not exceeded at any point in time. In addition to the configuration of PUCCH/PUSCH/SRS on CCs

with full UL, the network also configures SRS on PUSCH-less TDD CCs. When such SRS needs to be transmitted, the UE temporarily suspends the UL transmission on a CC configured with PUSCH, switches to a PUSCH-less TDD CC, transmits SRS on the CC, and then switches back, as shown in the figures below.



SRS switching and transmission on a TDD PUSCH-less CC in a special subframe



SRS switching and transmission on a TDD PUSCH-less CC in an UL subframe

Figure 11.4.1.6-1. Illustration of SRS carrier-based switching

The following components are specified to support the SRS switching feature.

Configuration of SRS on possibly all TDD CCs: SRS can be configured on possibly all TDD CCs. Each "switching-to" CC (a PUSCH-less TDD CC) is configured with a "switching-from" CC with full UL. The "switching-from" CC can be a TDD CC or a FDD CC, and it suspends its transmission when the "switching-to" CC is transmitting.

Power control of SRS: New power control formulas are introduced so that the UE can set SRS power without referring to PUSCH. The higher layers configure open-loop power control parameters for SRS transmission, and the physical layer signals transmit power control (TPC) command for closed-loop SRS power control. The TPC command is sent in a new group downlink control information (DCI) called format 3B.

Timing advance (TA) of SRS: SRS TA needs to be determined for each "switching-to" CC. This CC first has to be configured with a TA group (TAG). If TA is not available for a TAG with all PUSCH-less TDD CCs, then a non-contention based random access procedure needs to be performed, which also requires the UE to switch from a CC with PUSCH to a PUSCH-less CC for transmitting random access preamble. After the TA is acquired, TA command can provide finer adjustment of the SRS TA.

Periodic SRS and aperiodic SRS: Periodic SRS and aperiodic SRS can be configured on a PUSCH-less CC. The configurations and operations are generally similar to those for legacy SRS but with the additions that the "switching-from" CC needs to be configured and SRS switching needs to be performed. In addition, aperiodic SRS transmission on a PUSCH-less CC can be triggered by DCI format 3B.

RF retuning for SRS switching: A UE may need to perform RF retuning for switching among two CCs. This feature supports UEs with RF retuning time in the range of {0, 0.5, 1, 1.5, …, 6.5, 7} OFDM symbol durations. The RF retuning time is part of UE capability and is reported to the network.

Collision handling: SRS switching can cause collision to other transmission/reception operations. Priority/dropping rules are defined so that higher priority operations are kept and lower priority ones are dropped. In cases when SRS switching may constantly collide with ACK/NACK, the network may also configure the UE with modified ACK/NACK timing and/or flexible SRS switching so that the SRS switching and ACK/NACK transmission do not overlap in time, avoiding the collision.

11.4.1.7 Downlink Multiuser Superposition Transmission for LTE

Summary based on the input from MediaTek Inc. in RP-162504.

710084	**Downlink Multiuser Superposition Transmission for LTE**	LTE_MUST	1	R1	RP-160680
710184	**Core part: Downlink Multiuser Superposition Transmission for LTE**	LTE_MUST-Core	2	R1	RP-161019
710284	**Perf. part: Downlink Multiuser Superposition Transmission for LTE**	LTE_MUST-Perf	2	R4	RP-161019

The Work Item "Downlink Multiuser Superposition Transmission" (MUST) achieves the objectives of developing enhancements of downlink multiuser transmission schemes within one cell and assisting UE to cancel or suppress intra-cell interference by the provision of assistance information for interference cancellation. Although MUST and the LTE Rel-12 Work Item Network-Assisted Interference Cancellation and Suppression (NAICS) both rely on receivers to perform interference cancellation, the latter targets the inter-cell interference and is typically used when the user is at the cell edge, while the former aims at the intra-cell interference.

The key functionalities of MUST are described as follows. A UE is signalled by RRC if it is to be configured for potential MUST operation. When a UE is higher-layer configured to have MUST, some bits are added into the downlink control information (DCI) as MUST assistance information. The UE monitors some bit field in the DCI to see whether MUST is enabled in a transmit time interval.

In MUST, there are three cases featured by the mechanisms of PDSCH superposition:

- **Case 1:** Superposed PDSCHs are transmitted using the same transmission scheme and the same spatial precoding vector
- **Case 2:** Superposed PDSCHs are transmitted using the same transmit diversity scheme
- **Case 3:** Superposed PDSCHs are transmitted using the same transmission scheme, but their spatial precoding vectors are different

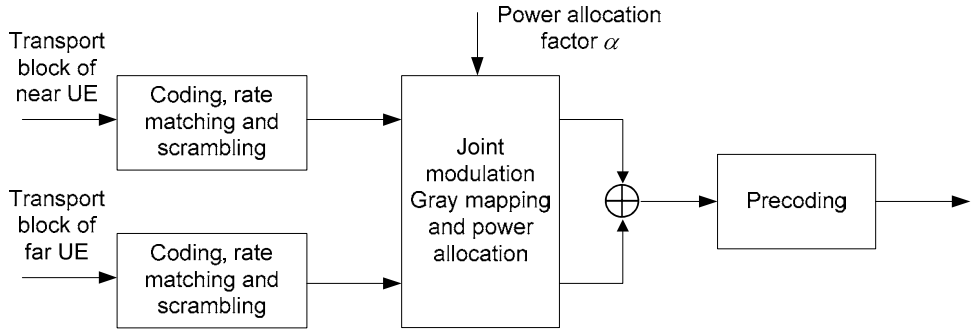


Figure 11.4.1.7-1: An example of Case 1 and Case 2 transmit side processing when both near and far UEs have 1 data layer. In the figure, layer mapping is omitted since both UEs have single data layer.

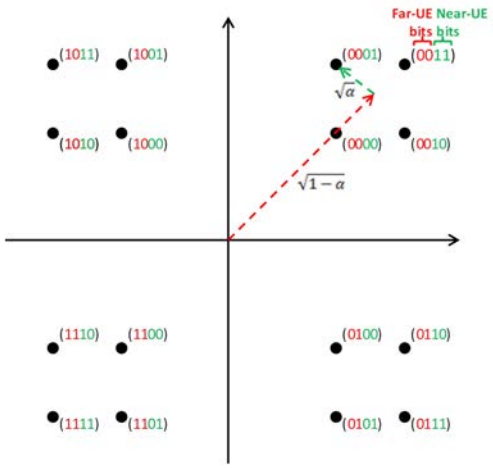


Figure 11.4.1.7-2: An example of composite constellation of Case 1 and Case 2

Case 1 and Case 2 are supported in transmission mode (TM) 2/3/4 using up to 2 transmit antenna ports. The PDSCH of two UEs are superposed using MUST Category 2 in TR 36.859 [1], in which one of the UE (called the near UE) has a better received signal quality than the other UE (called the far UE). An example of transmit side processing for Case 1 and Case 2 is shown in Figure 1. After channel coding, rate matching and scrambling, the coded bits for near and far UEs are jointly mapped to modulation symbols of a composite constellation. Gray mapping is kept for the label bits of the composite constellation. Figure 2 gives an example for a composite constellation.

The near UE cancels the signal intended for the far UE before detecting its own signal, while the far UE treats the signal intended for the near UE as noise. This is feasible since the signal-to-noise ratio (SNR) at the near UE tends to be high, while the far UE has a low SNR with the modulation order always QPSK and easy to be cancelled. Flexible power partition (denoted as α in Figures 1 and 2) between near and far UEs is chosen to maximize the sum-rate under certain fairness criterion. The network assisted information signalled in DCI for the near UE includes the indication of whether MUST is enabled in the TTI and the power allocation.

Figure 11.4.1.7-3: An example of Case 3 transmit side processing when two UEs are paired, and each has 1 data layer. In the figure, layer mapping is omitted since both UEs have single data layer.

Case 3 is supported in TM 8/9/10 using up to 8 transmit antenna ports. The PDSCH superposition is the same as in MU-MIMO. There is no concept of near UE and far UE as in Case 1 and Case 2; each UE cancels the interference located at spatial layers other than the desired signal when assistance information about the knowledge of interference is provided. An example of transmit side processing for Case 3 is shown in Figure 3. The maximal number of interfering spatial layers signalled in the assistance information is configured by RRC. The assistance information of interference signalled in DCI includes the modulation order of interference and the antenna port of each interfering layer.

References

[1] TR 36.859, "Study on Downlink Multiuser Superposition Transmission (MUST) for LTE."

11.4.1.8 Flexible eNB-ID and Cell-ID in E-UTRAN

Summary based on the input provided by China Telecom and Huawei in RP-170478.

730080	Flexible eNB-ID and Cell-ID in E-UTRAN	LTE_FNBID	1	R3	RP-161896

710056	**Study on flexible eNB-ID and Cell-ID in E-UTRAN**	FS_LTE_FNBID	2	R3	RP-160534 -
730180	**Core part: Flexible eNB-ID and Cell-ID in E-UTRAN**	LTE_FNBID-Core	2	R3	RP-161896

This work item provides effective solutions to support of the number of eNB beyond 1.04 million in one PLMN and to support cells beyond 256 in an eNB. These solutions are no impact on UE operations and air interface, and useful for operators to extend the space of eNB-ID and Cell-ID.

There are only two types of eNB IDs supported in Rel-13 specification:

- Macro eNB: 20 bits eNB-ID, 8 bit Cell-ID in one eNB
- Home eNB: 28 bits eNB-ID, only one cell in an eNB

For Macro eNB, the capacity of eNB-ID is about 1.04 million and the capacity of Cell-ID in an eNB is 256. With the deep LTE deployment, there is a request from operators to support more than 1.04 million eNBs in a PLMN and also support more than 256 cells in an eNB [1]. Therefore, one long and one short extended eNB ID are introduced in Rel-14 specifications without any UE impacts [2]:

- short Macro eNB ID: 18bits eNB-ID and 10 bits Cell-ID in one eNB
- long Macro eNB ID: 21 bits eNB-ID and 7 bits Cell-ID in one eNB

With the long Macro eNB ID, the number of eNB in a PLMN can be up to 2.04 million. While with the short Macro eNB ID, 1024 cells can be supported in one eNB.

When to choose 21 bits or 18 bits Macro eNB-ID is up to the operator deployment. Upon the new type eNB-ID is applied in the network, all the nodes (e.g. CN, eNB, UTRAN, GSM, Wi-Fi and etc) have to be upgraded to understand the new types of eNB-ID.

11.4.1.9 Four receiver (4Rx) antenna ports with Carrier Aggregation (CA) for LTE downlink (DL)

Summary based on the input from Ericsson in RP-162059.

730084	**4 receiver (4Rx) antenna ports with Carrier Aggregation (CA) for LTE downlink (DL)**	LTE_4Rx_AP_DL_CA	1	R4	Sep-17	RP-161897
730184	**Core part: 4 receiver (RX) antenna ports with Carrier Aggregation (CA) for LTE downlink (DL)**	LTE_4Rx_AP_DL_CA-Core	2	R4	Dec-16	RP-161897
730284	**Perf. part: 4 receiver (RX) antenna ports with Carrier Aggregation (CA) for LTE downlink (DL)**	LTE_4Rx_AP_DL_CA-Perf	2	R4	Sep-17	RP-161897

This Work Item defines the UE RF requirements for 4Rx + 2 UL CA.

This has been achieved by introducing REFSENS requirements for UL CA and 4Rx AP in Rel-14 TS 36.101.

The modification of the UL CA REFSENS (MSD) follows the agreed procedure from Rel-13 4Rx WI, i.e. to improve the reference sensitivity for 2RX by the delta between the 2RX and 4RX requirements for non-CA.

The 4Rx UEs are verified with RF requirements covering 2 UL CA and DC.

Note that 4Rx+DC are covered by 4Rx +2UL CA.

11.4.1.10 Requirements for a new UE category with single receiver based on Category 1 for LTE

Summary based on the input provided by Qualcomm in RP 171317.

730085	**Requirements for a new UE category with single receiver based on Category 1 for LTE**	LTE_UE_cat_1RX	1	R4	RP-161898
730185	**Core part: Requirements for a new UE category with single receiver based on Category 1 for LTE**	LTE_UE_cat_1RX-Core	2	R4	RP-162570

730285	**Perf. part: Requirements for a new UE category with single receiver based on Category 1 for LTE**	LTE_UE_cat_1RX-Perf	2	R4	RP-162570

This work item defines the requirements and signaling support for a new UE category called "1bis" that has the same data rate capabilities as LTE category 1 but just a single receiver chain.

This work item is targeting devices that have a very small form factor (e.g. wearables) such that the number of components has to be minimized while requiring higher data rates than categories M1/N1. New RAN4 requirements based on a single receiver were introduced.

The following new features/requirements were introduced in this work item:

- A new UE category 1bis was defined in order to differentiate these devices from UE category 1
- Support for the following bands will be introduced: 1, 2, 3, 4, 5, 7, 8, 12, 13, 18, 20, 26, 28, 39, 41, and 66
- RRM core and performance requirements for intra-frequency and inter-frequency mobility
- RRM core and performance requirements for OTDOA positioning
- Demodulation and CQI tests as follows:
  - TM2 PDSCH demodulation test
  - TM4 rank 1 PDSCH demodulation test
  - TM9 rank 1 PDSCH demodulation test
  - PHICH demodulation test
  - PBCH demodulation test
  - TM1 CQI definition test
  - TM1 subband CQI test

11.4.1.11 Enhanced LAA for LTE

Summary based on the input provided by Ericsson, Huawei in RP-170269.

700060	Enhanced LAA for LTE	LTE_eLAA	1		RP-152272
700160	**Core part: Enhanced LAA for LTE**	LTE_eLAA-Core	2	R1	RP-162235
700260	**Perf. part: Enhanced LAA for LTE**	LTE_eLAA-Perf	2	R4	RP-162235
730075	**UE Conformance Test Aspects - Enhanced LAA for LTE**	LTE_eLAA-UEConTest	2	R5	RP-161774

This work item is needed to enable operation of an LAA SCell on the UL in unlicensed spectrum. It specifies UL support for LAA SCell operation in unlicensed spectrum by specifying UL carrier aggregation for LAA SCell(s) including channel access mechanisms, core and RF requirements for base stations and UEs, and RRM requirements.

It uses the study and work items on licensed-assisted access to unlicensed spectrum as the basis of the work.

The key functionalities include the following:

- UL carrier aggregation for LAA SCell(s) (with one or more UL carriers in unlicensed band) using Frame Structure type 3 which allows operation of an LAA SCell in unlicensed spectrum including:
  - A channel access mechanism for UL transmissions on an LAA SCell in unlicensed spectrum
  - Support for PUSCH and SRS transmissions on an LAA SCell
  - Support for both self-scheduling and cross-carrier scheduling from licensed spectrum on an LAA SCell.

- Support for 10 MHz system bandwidth for an LAA SCell when the absence of IEEE 802.11 technologies using the carrier can be guaranteed

References

[1] TR 36.889, Feasibility Study on Licensed-Assisted Access to Unlicensed Spectrum V13.0.0

11.4.1.12 Performance enhancements for high speed scenario in LTE

Summary based on the input from NTT DOCOMO Inc. and Huawei in RP-162222.

700081	Performance enhancements for high speed scenario in LTE	LTE_high_speed	1	R4	RP-152263
700181	**Core part: Performance enhancements for high speed scenario in LTE**	LTE_high_speed-Core	2	R4	RP-160172
700282	**Perf. part: Performance enhancements for high speed scenario in LTE**	LTE_high_speed-Perf	2	R4	RP-160172

Although some vehicles move with the speed over than 300 km/h, most of requirements are specified under below 350 km/h in existing specifications. This work item improves the mobility and throughput performance under high speed up to and above 350 km/h by enhancing the requirements for UE RRM, UE demodulation and base station demodulation. The work item specifies enhanced RRM requirements, RRC signals for high speed scenarios and enhanced PRACH requirements in TS 36.133, TS 36.331 and TS 36.211, respectively.

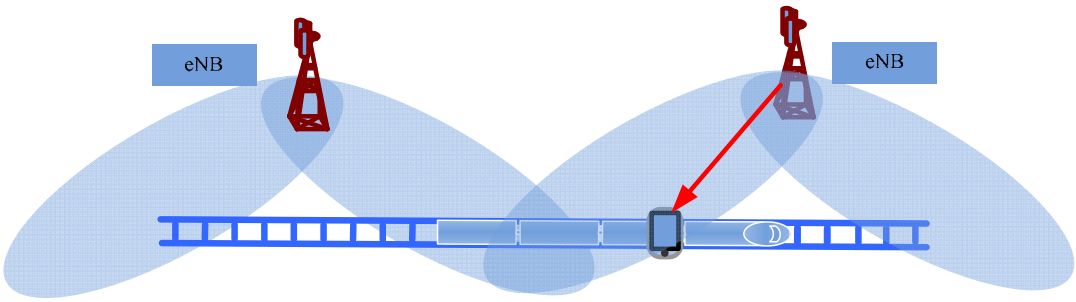
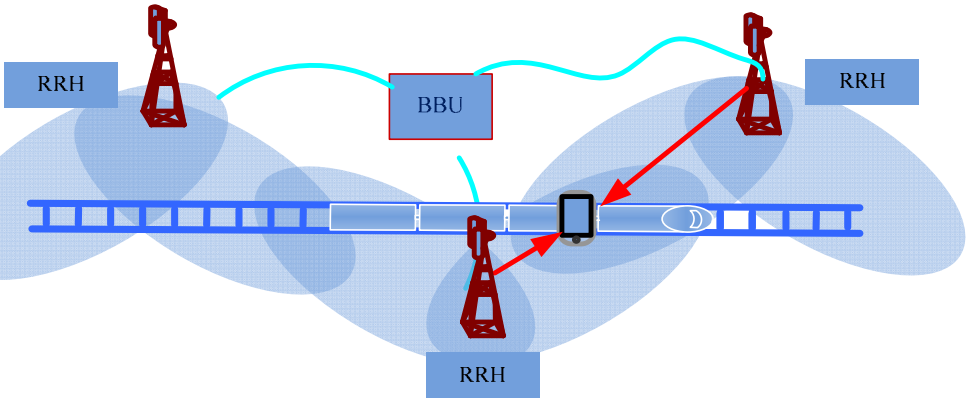


Figure 11.4.1.12-1. Non-SFN high speed scenarios



BBU: BaseBand Unit

RRH: Remote Radio Head

Figure 11.4.1.12-2: SFN high speed scenarios

Part 1: RRM requirements enhancements:

Up to Release 13 of LTE, the latency requirements under DRX configuration would result in performance degradation under high speed scenario. In order to achieve good mobility performance and less paging outage, the following enhanced requirements are introduced.

1) **Enhanced RRM requirements in DRX in connected mode:**

The cell identification delay and measurement period are reduced in DRX.

2) **Enhanced RRM requirements in idle mode:**

The cell detection delay, measurement period and evaluation time are reduced in idle mode.

Part 2: Demodulation enhancements

3) **For UE demodulation enhancements**

For UE demodulation requirements, significant performance gap is observed under 350km/h and 30km/h in SFN scenario because of the impact of opposite Doppler shifts associated with separate paths on the UE demodulation. This feature enables UE to use an enhanced receiver for SFN scenario (Figure 2) to handle the Doppler shift issue. Note that performance requirement itself will be specified in performance part.

Part 3: PRACH enhancements

Under high speed, for PRACH, the high Doppler shift would cause detection ambiguity. The feature introduces a PRACH sequence for high speed scenario.

11.4.1.13 LTE Measurement Gap Enhancement

Summary based on the input provided by Intel in RP-171330.

710083	LTE Measurement Gap Enhancement	LTE_meas_gap_enh	1	R4	RP-160678
710183	**Core part: LTE Measurement Gap Enhancement**	LTE_meas_gap_enh-Core	2	R4	RP-160912
710283	**Perf. part: LTE Measurement Gap Enhancement**	LTE_meas_gap_enh-Perf	2	R4	RP-160912

This work item specifies LTE measurement gap configurations with shorter measurement gap length (MGL=3ms).

The key functionalities of this work item are:

- Specify measurement gap configurations with shorter measurement gap length (MGL=3ms)
  - Define the corresponding requirements, including
    - E-UTRAN Inter-frequency measurement requirements
    - E-UTRAN inter-frequency OTDOA measurement requirements
  - Define the corresponding signalling to enable the new gap configurations
- Specify per-CC based measurement gap configurations
  - Define per-CC based measurement gap configurations and requirements depending on UE measurement capability
    - Define the following requirements of monitoring of multiple layers using gaps including Rel-12 IncMon
      - E-UTRAN Inter-frequency measurement requirements
      - E-UTRAN inter-frequency OTDOA measurement requirements
  - Define the corresponding signalling to enable the new gap configurations
- Specify network controlled small gap (NCSG)
  - Define new gap pattern configurations and the corresponding requirements
  - Define the corresponding signalling to enable the new gap configurations
- Specify non-uniform gap configurations

- Define new gap pattern configurations and the corresponding requirements
- Define the corresponding signalling to enable the new gap configurations

11.4.2 LTE bands related items

11.4.2.1 Multi-Band Base Station testing with three or more bands

Summary based on the input from Nokia in RP-162032.

700080	Multi-Band Base Station testing with three or more bands	MB_BS_test_3B	1	R4	RP-152205
700180	**Core part: Multi-Band Base Station testing with three or more bands**	MB_BS_test_3B-Core	2	R4	RP-162442
700280	**Perf. part: Multi-Band Base Station testing with three or more bands**	MB_BS_test_3B-Perf	2	R4	RP-162442

This work item identifies the necessary changes to the existing multi-band BS requirements for BS capable of operation in three or more bands, and specifies multi-band BS testing with three or more bands, using the existing multi-band BS testing with two bands as a base.

Numerous Work Items to support the LTE Advanced 3, 4 or 5 Band Carrier Aggregation (3DL/1UL or 4DL/1UL or 5DL/1UL) have been approved in RAN. One of the objectives of these WIs is to specify the band-combination specific RF requirements and testing with three or more bands.

On the other hand, new operating bands continue to be added, and the transmit/receive frequency ranges of some of those are sufficiently close such that implementation of a common radio supporting simultaneous transmission / reception of three or more bands become a feasible option. Example includes Bands (8+20+28) in Europe for multi-RATs (GSM and LTE) operation. The advantages of this implementation option may include dynamic power sharing between different bands and hence allow operators more flexibility in the network deployment, reduced installation complexity for different bands at the same site, and reduced insertion loss for multi-band antenna sharing since no combiner is needed.

The BS testing for multi-band BS capable of operation in three or more bands has been discussed in RAN4 under TEI for nearly 2 years. It was concluded that a work item was needed to conduct this work in a structured manner.

The objectives of this work item are to identify the necessary changes to the existing multi-band BS requirements for BS capable of operation in three or more bands, and to specify multi-band BS testing with three or more bands in the RAN4 specifications, using the existing multi-band BS testing with two bands as a base. The work has been focused on the following steps:

1) The following band combinations are considered feasible for implementation of multi-band BS capable of operation in three or more bands:
    1) Bands (8+20+28) in Europe.
    2) Bands (1+3+7).
    3) Bands (25+4+7).
2) Conclude that a generic testing approach can be applied to all the identified band combinations.
3) Specify multi-band BS testing for all the identified band combinations. In particular, to decide:
    1) The RF bandwidth location and carrier placement within the operating bands and frequency ranges supported by the BS.
    2) Conclude on the multi-band combinations to be tested out of the supported ones for BS that supports multiple multi-band combinations.
    3) Other aspects of multi-band BS testing like test configurations that are necessary to complete the specification.

12 System improvements

12.1 Control and User Plane Separation of EPC nodes

Summary based on the input provided by Huawei in SP-170520.

720008	Control and User Plane Separation of EPC nodes	CUPS	1		SP-160316
690052	**Study on Control and User Plane Separation of EPC nodes**	FS_CUPS	2	S2	SP-150519
720009	**Control and User Plane Separation of EPC nodes**	CUPS	2	S2	SP-160316
730001	**CT aspects for CUPS**	CUPS-CT	2	CT	CP-160579
730039	CT3 aspects for CUPS	CUPS-CT	3	C3	CP-160579
730040	CT4 aspects for CUPS	CUPS-CT	3	C4	CP-160579

This Work Item separates the S/P-GW and the TDF functionality into user plane functions and control plane functions. This is provided as a solution to the ever-growing data traffic while maintaining a low latency for services such as social networks or web browsing.

In addition, a flexible placement of user plane functions (e.g. centrally or closer to the RAN) is enabled, while the control plane functions could still remain centralized and continue to support the interfaces to the other network entities (like MME, PCRF, Charging Systems).

TS 23.214 [1] specifies the stage 2 level functionality for control and user plane separation of EPC's SGW, PGW and TDF. Updates to procedures in other specifications (TS 23.401 [2], TS 23.203 [3], TS 23.402 [4] and TS 23.060 [5]) are described therein as well.

The overall functionality provided by the SGW, PGW and TDF is not changed and none of the other EPC entities is affected, which means:

- Interworking with networks not applying control and user plane separation works as without it (i.e. in case of roaming scenarios);
- Separated network entities can be deployed together with network entities that are not separated within the same network;
- Deployment of Separated network entities does not require any updates for UE or Radio Access Network.

The following figure shows the architecture reference model in the case of separation between control plane and user plane and covers non-roaming as well as home routed and local breakout roaming scenarios. Only the complementary aspects of the architecture reference models specified in TS 23.401 [2] clause 4.2 and TS 23.402 [4] clauses 4.2.2 and 4.2.3 for GTP-based interfaces are shown in this figure.

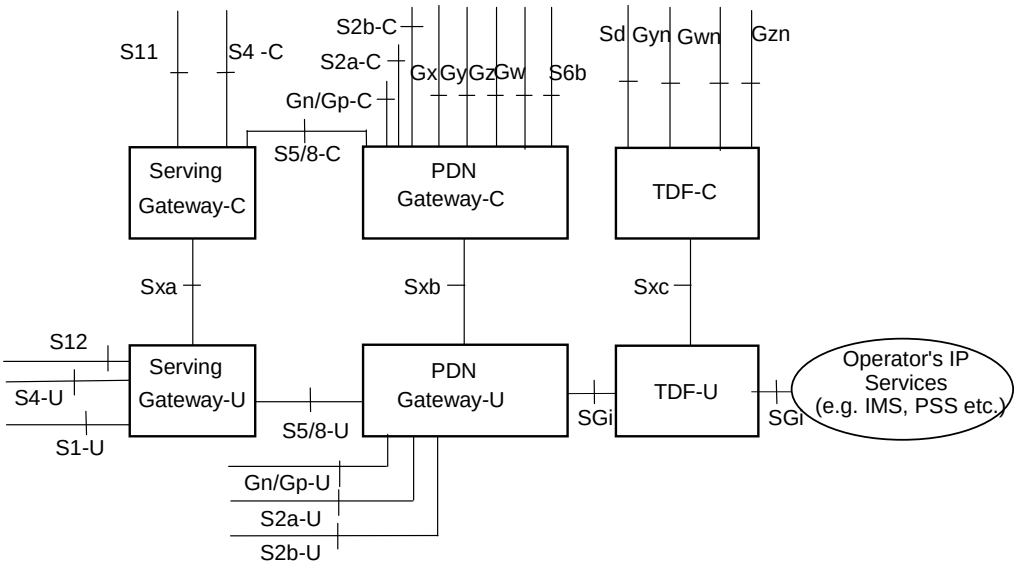


Figure 12.1-1: Architecture reference model with separation of user plane and control plane for non-roaming and roaming scenarios

NOTE 1: The -C or -U suffix appended to S2a, S2b, S5 and S8 reference points refer to the control plane and user plane components of those interfaces.

NOTE 2: For S2a, S2b, S5 and S8 reference points, this architecture reference model is only supported with GTP-based interfaces. PMIP-based interfaces and S2c interface are not supported.

NOTE 3: The usage of a combined SGW/PGW documented in TS 23.401 [2] is also possible in a deployment with separated control and user planes.

The protocol for Sxa, Sxb and Sxc is described in TS 29.244 [6]. The protocol is a 3GPP owned protocol using UDP as transport. Restoration scenarios when an PGW, SGW are split and one node failes are studied in TR 29.844 [9] and the result is incorporated in TS 23.007 [7]. The CP function may select a UP function using DNS server this is documented in TS 29.303 [8].

References

[1] TS 23.214: "Architecture enhancements for control and user plane separation of EPC nodes ".
[2] TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".
[3] TS 23.203: "Policy and charging control architecture".
[4] TS 23.402: "Architecture enhancements for non-3GPP accesses".
[5] TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".
[6] TS 29.244: "Interface between the Control Plane and the User Plane of EPC Nodes; Stage 3".
[7] TS 23.007: "Restoration procedures".
[8] TS 29.303: "Domain Name System Procedures; Stage 3".
[9] TS 29.844: "Study on Control and User Plane Separation of EPC Nodes".

12.2 Paging Policy Enhancements and Procedure

Summary based on the input provided by China Unicom in SP-170549.

710004	Paging Policy Enhancements and Procedure	PPEPO_LTE	1	S1	SP-160113

This work item optimizes the paging policies as to reduce the paging signalling caused both by M2M devices and by smart phones' OTT (Over The Top) applications.

These optimizations are based on:

a) the movement of a device, i.e. taking into account whether the UE is static or moving;

b) the application characteristics, such as the application type, the application protocol, the application provider, and the delay sensitivity;

c) the location of the UE within the paging area.

With these optimizations, the network will assess the parameters above as to apply different paging policies.

Note that only Stage 1 has been defined for this feature (covered by CRs to 22.101, while the study is in the dedicated TR 22.838, "Paging Policy Enhancements and Procedure Optimizations in LTE"). There is no impact on Stage 2 nor on Stage 3 since the result of this feature is mostly a change of behaviour of some network entities, and this is not covered by 3GPP.

12.3 Shared Subscription Data Update

Summary based on the input provided by Nokia in CP-171050.

720001	Shared Subscription Data Update	eSDU	1	C4	CP-160644

CT4 have developed protocol optimizations for the Diameter based S6a/d and MAP based GR/D interfaces allowing (parts of) subscription data, which are shared by multiple UEs (e.g. MTC-UEs), to be modified by means of administrative actions without generating signalling floods on the interfaces between HSS/HLR and serving nodes (MME/SGSN/VLR).

The mechanism follows the conclusion from TR 29.813 [1] and makes use of a backward compatible extension of the reset mechanism. Instead of sending one Insert/Delete-Subscriber-Data message per UE sharing the modified data, only one extended Reset message per serving node is sent. Serving nodes supporting the mechanism will update the stored subscription data for all the sharing UEs while serving nodes not supporting the mechanism mark impacted UEs as "not confirmed", resulting in updating the data at the next radio contact.

References

[1] TR 29.813: "Study on S6a/S6d Shared Data Update".

[2] CP-160683: "CR pack on Shared Subscriber Data Update"

12.4 Service Domain Centralization

Summary based on the input from T-Mobile USA in SP-171020.

720022	Service Domain Centralization	SeDoC	1	S2	SP-160675
700040	**Study on Service Domain Centralization**	FS_SeDoC	2	S2	SP-160306
730044	**Service Domain Centralization**	SeDoC	2	S2	SP-160675

This work item updates 23.292 (IMS Centralized Services) to introduce optional interworking functionality that enables networks supporting both ICS and IMS to use only the IMS service domain (eliminating service logic and databases in the CS domain); the feature addresses both the service logic execution and the authentication of a network's own subscribers, and also the necessary functionality to support roaming without requiring any functional support in the other network.

In some networks, it is an overhead to maintain two separate service domains, and ensure constancy of user experience when user devices move between the domains either due to coverage, capacity, roaming, or service requirements. This work item enhances the existing ICS capabilities and introduces two new functional entities to the network that enable all the services of a subscriber to be supported by only the IMS service domain. The new functional entities that are introduced are a MSC Server enhanced for SeDoC and a ICS interworking function (ICS IWF).

The MSC Server Enhanced for SeDoC is used in place of a MSC Server (or MSC Server enhanced for ICS), and provides some of the same functions of these systems; the most notable differences are:

- Call control solely done in IMS (no CS services are supported)
- No VLR functionality (since all services are now provided by the IMS domain)

- Mapping between CS procedures and IMS procedures for
  - Call control
  - Supplementary services management
  - Authentication and transport of encryption keys
  - Emergency Services
- Support for SMS and location services typically provided by the MSC

The ICS IWF provides support for inbound and outbound roamers in networks that do not support IMS or ICS such that the other network does not need any support for IMS or ICS (including no support for SeDoC). For an outbound roamer (i.e. a SeDoC subscriber), the ICS IWF maps the procedures between the VPLMN and the HLR into IMS procedures. For an Inbound roamer, the ICS IWF maps the procedures between the HPLMN and the MSC into IMS procedures. The ICS IWF may be used independently from SeDoC to enhance ICS roaming scenarios.

The MSC Server Enhanced for SeDoC uses the IMS domain for authentication and subscription management interacting with the HSS, a new procedure is introduced to authenticate the subscriber and obtain the CS encryption keys. In the roaming case, the ICS IWF function maps the parameters between IMS authentication and MSC/HLR authentication procedures, presenting only the MSC/HLR procedure to the roaming partner network. The subscriber's service and authentication information is now only required in the HSS and any profile in the HLR is no longer used (and may be eliminated).

To support Emergency Services via the MSC Server enhanced for SeDoC, a requirement that ICS use CS capabilities for emergency calling is relaxed, allowing for IMS to provide the emergency services for the subscriber (as already defined in TS 23.167[2]); accordingly, the ICS architectures are updated to include the E-CSCF and references to the IMS procedures for emergency services support using the IMS E-CSCF are added.

References

[1] TR 23.719 – Service Domain Centralization

[2] TS 23.167 IP Multimedia Subsystem (IMS) emergency sessions

12.5 Control of Applications when Third party Servers encounter difficulties

Summary based on the input from KDDI Corporation in SP-170338.

680002	Control of Applications when Third party Servers encounter difficulties	CATS	1	S1	SP-150273

When a third party server becomes congested or fails, the traffic from UE-based applications that make use of that server needs to be controlled, so that resulting unproductive use of 3GPP network resource is avoided/mitigated, as not to affect other applications and their associated servers that are functioning normally.

This WI is a set of service features to control traffic from UE-based applications to the affected application(s) on the third party server(s) or the third party server itself while not affecting other traffic.

It specifies service equirements to control traffic from UE-based applications to the affected application(s) on the third party server(s) or the third party server itself and identify the application or its associated traffic according to operator policy. These requirements have been studied in TR 22.818 [1], then introduced in TS 22.011 (CR #0209) [2].

References:

[1] TR 22.818 Feasibility Study on Control of Applications when Third party Servers encounter difficulties

[2] TS 22.011 Service accessibility

12.6 PS Data Off Services

Summary based on the input from Orange in SP-170708.

720080	PS Data Off Services	PS_Data_Off	1		SP-150823
700033	**PS Data Off Services**	PS_Data_Off	2	S1	SP-150823
720079	**Study on Stage 2 of PS Data off function**	FS_PS_DATA_OFF	2	S2	SP-160318
740004	**Stage 2 of PS Data Off**	PS_DATA_OFF	2	S2	SP-160831
740041	**Stage 3 of PS Data Off**	PS_DATA_OFF-CT	2	CT	CP-160702
740042	CT1 aspects of PS Data Off	PS_DATA_OFF-CT	3	C1	CP-160702
740043	CT3 aspects of PS Data Off	PS_DATA_OFF-CT	3	C3	CP-160702
740044	CT6 aspects of PS Data Off	PS_DATA_OFF-CT	3	C6	CP-160702
740014	**Charging Aspect for 3GPP PS Data off Function**	PS_DATA_OFF-CH	2	S5	SP-160839

"PS Data Off Services" (PS_DATA_OFF) is a new feature coming in 3GPP Rel-14 which when configured by the HPLMN and activated by the user prevents transport via PDN connections in 3GPP access of all IP packets except IP packets required by 3GPP PS Data Off Exempt Services. A set of operator services that are allowed even if the 3GPP PS Data Off feature has been activated in the UE by the user.

Stage 1 is covered by the Rel-14 Work Item PS_DATA_OFF concluded at SA#71 (March 2016) which made changes into TS 22.011 to define requirements and the list of PS Data Off Exempt Services:

- 3GPP PS Data Off feature shall be applicable to multiple PDN connections.
- 3GPP PS Data Off feature shall be supported for both roaming (i.e. LBO & HR architecture) and non-roaming configuration.
- 3GPP PS Data Off feature shall apply on all 3GPP accesses (2G/3G/LTE) for all existing and newly PDNs connections.

Stage 2 is covered by the Rel-14 Study Item FS_PS_DATA_OFF approved at SA#72 (June 2016) – TR 23.702. Based on the study and its conclusions, SA2 has completed the Work Item PS_DATA_OFF with CRs to update TS 23.060, TS 23.203, TS 23.221, TS 23.228, TS 23.401 for the normative work. The scope is to provide architecture enhancements to introduce 3GPP PS Data Off feature in the stage 2 specifications based on the stage 1 requirements defined in TS 22.011:

- Making the CN aware of the activation/deactivation of the 3GPP PS Data Off feature by the UE whenever required to allow appropriate policy enforcement in the network for downlink traffic.
- Making the UE aware of the list of services configured to be part of the 3GPP PS Data Off Exempt Services to allow appropriate policy enforcement in the UE for uplink traffic.

Stage 3 is covered by

- CT1 with the Work Item PS_DATA_OFF-CT completed at CT#76 with CRs to update TS 24.008, TS 24.301, TS 27.007, TS 24.229, TS 24.368, TS 24.167, TS 24.173, TS 24.275, TS 24.341, TS 24.390, TS 24.391.
- CT3 with the Work Item PS_DATA_OFF-CT completed at CT#76 with CRs to update TS 29.212 and TS 29.213 to extend protocols and procedures for the support of 3GPP PS Data Off functionality over Gx interface.
- CT6 with CRs to update TS 31.102, TS 31.103, TS 31.111.

Charging aspect for 3GPP PS Data off Function is covered by SA5 with the Work Item PS_DATA_OFF-CH approved at SA#74 (December 2016) and completed at SA#76 (June 2017) with CRs to update TS 32.251, TS 32.298, TS 32.299, TS 32.260.

12.7 Enhancement to Flexible Mobile Service Steering

Summary based on the input to be provided by China Mobile at SA#78.

720077	Enhancement to Flexible Mobile Service Steering	eFMSS	1		SP-160115
680003	**Study on enhancement to FMSS for Rel 14**	FS_eFMSS	2	S1	SP-150280

710005	**Stage 1 of Enhancement to Flexible Mobile Service Steering**	eFMSS	2	S1	SP-160115
720078	**Stage 2 of Enhancement to Flexible Mobile Service Steering**	eFMSS	2	S2	SP-160314

This Work Item enhances the feature developed in the previous Rel-13 Work Item on FMSS for supporting third party owned (S)Gi-LAN service.

Stage 1 is covered by the Rel-14 Study Item FS_eFMSS. Based on the study and its conclusions, SA1 has completed the Work Item eFMSS with CRs to update TS 22.101, TS 22.115 for the normative work. The scope is to define the following major requirements:

- The 3GPP core network shall be able to apply traffic steering policies for the third party owned (S)Gi-LAN service functions.
- The 3GPP core network shall be able to generate accounting information to support accounting between operator and the third party service provider.

Stage 2 is covered by the Rel-14 Work Item eFMSS which made changes into TS 23.203 to provide architecture enhancements to introduce eFMSS feature in the stage 2 specifications based on the stage 1 requirements defined in TS 22.011 and TS 22.115:

- Ensure that traffic steering is supported via operator owned as well as third party provided (S)Gi-LAN service functions
- Specify how the 3GPP core network is able to collect accounting information to distinguish the traffic steering to third party service enablers.

References

[1] 3GPP TR 22.808, Study on Flexible Mobile Service Steering (FMSS)

[2] 3GPP TS 22.101, Service aspects; Service principles

[3] 3GPP TS 22.115, Service aspects; Charging and billing

[4] 3GPP TS 23.203, Policy and charging control architecture

12.8 Sponsored data connectivity improvements

Summary based on the input provided by China Unicom in SP-170523.

720014	Sponsored data connectivity improvements	SDCI	1		SP-160309
700041	**Study on sponsored data connectivity improvements**	FS_SDCI	2	S2	SP-150627
720024	**Sponsored data connectivity improvements**	SDCI	2	S2	SP-160309
730037	**CT Aspects of SDCI**	SDCI-CT	2	CT	CP-160580
730038	CT3 Aspects of SDCI	SDCI-CT	3	C3	CP-160580

The Work Item "Sponsored data connectivity improvements" (SDCI) is an improvement of the Rel-10 Feature "Policy Enhancements for Sponsored Connectivity and Coherent Access to Policy related Databases" (PEST).

"Sponsored Connectivity" relates to the context where the connectivity cost is not paid by the end user but by a third party, the Sponsor, so it is seen as "free" by the end user. The Sponsor has a business relationship with the operator: he reimburses the operator for the user's data connectivity in order to allow the user access to an associated Application Service Provider's (ASP) services.

SDCI aims at solving the problem of heavy load occurred when too many sponsored data related rules are transmitted via the Rx interface (between the AF and the PCRF) and/or the Gx interface (between the PCRF and the PCEF/TDF), as shown in the figure below.

SDCI introduces one new entity, the PFDF (Packet Flow Description Function) and three new interfaces: Gw, Gwn, Nu.

The PFDF is used to store and manage the PFDs (Packet Flow Descriptions) and charging rules for sponsored data services.

The new interfaces link the PFDF to existing entities, as shown in the figure below. They enable the PFDs and the corresponding charging rules to be provisioned dynamically to the PCEF and/or the TDF by PULL mode, PUSH mode, or a combined mode. The PFDs and charging rules for sponsored services can be stored in PCEF and/or PFDF according to implementation.

The following figure shows the SDCI entity and its related interfaces.

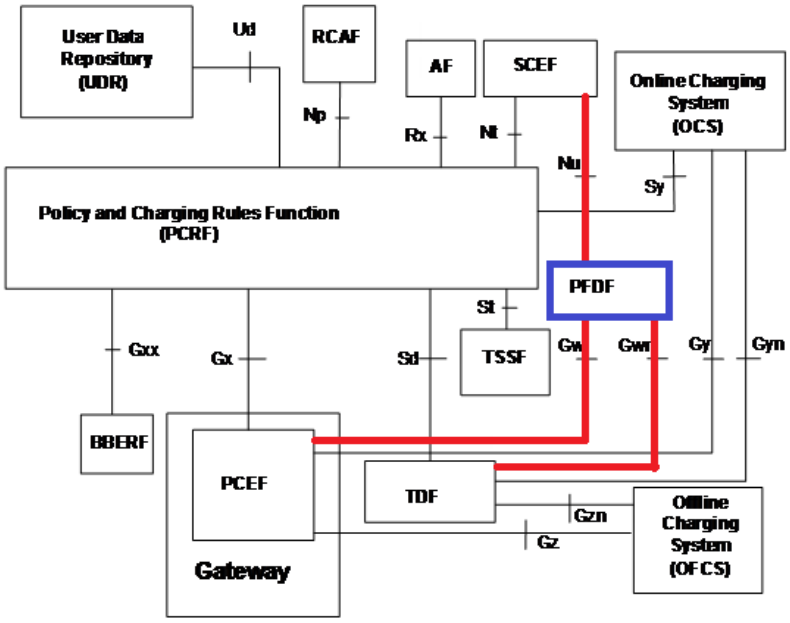


Figure-12.8-1 Overall PCC logical architecture in Rel-14

Stage 2 is covered by TR 23.721 for the study and by CRs on TS 23.203 and TS 23.682 for the normative work.

Stage-3 fully defines these interfaces and their related protocol, namely HTTP Restful protocol, where all the functionalities are realized via GET/PUT/POST/DELETE operations. Stage 3 work is covered by CRs on TS 29.212, TS 29.213 and TS 29.214 on by two new specs, TS 29.250 and TS 29.251, which specify how to realize the SDCI functionalities using HTTP RESTful.

12.9 Group based enhancements in the network capability exposure functions

Summary based on the input provided by Samsung in SP-170517.

720012	Group based enhancements in the network capability exposure functions	GENCEF	1	S2	SP-160311
700043	**Study on group based enhancements in the network capability exposure functions**	FS_GENCEF	2	S2	SP-160311
720013	**Group based enhancements in the network capability exposure functions**	GENCEF	2	S2	SP-160311

Thanks to this work item, the network capability exposure function can be performed on a per-group basis. When dealing with a high number of UEs, such as IoT devices, this reduces the signalling burden compared to a handling on a per-UE basis.

It introduces in TS 23.682 the group handling of the following aspects:

- Monitoring Event Configuration/Reporting via the HSS

- Monitoring Event Configuration/Reporting via the PCRF
- Communication Pattern Parameter Provisioning

A group identifier, called "External Group ID", is used by the SCS/AS (Service Capability Server/Application Server) and the SCEF (Service Capability Exposure Function) to identify the group of UEs.

The HSS or PCRF resolves the group ID to individual UE ID and continue to process as individual procedure.

For the Monitoring Event Configuration/Reporting via the HSS, if the Monitoring Request is for a group of UEs, the HSS includes the UE ID (which can be understood by the SCS/AS) in the monitoring event configuration parameter and sends an Insert Subscriber Data Request message per UE to all the MME/SGSN(s) serving the members of the group.

When the HSS or the MME/SGSN detects the monitoring event, the UE ID is included in the monitoring report message toward SCEF.

In order to reduce signalling for sending the event report of a number of group members of UEs, the HSS or the SCEF aggregates received monitoring report for the group member of UEs, and then send the aggregated report to the SCS/AS. From this point of view, "Group Reporting Guard Time" is introduced to indicate the time for which the monitoring event reporting detected by the UEs in a group can be aggregated before sending them to the SCS/AS or the SCEF.

12.10 Improved operator control using new UE configuration parameters

Summary based on the input provided by Ericsson in CP-171176.

720037	Improved operator control using new UE configuration parameters	IOC_UE_conf	1		CP-160828
720038	**CT1 aspects of IOC_UE_conf**	IOC_UE_conf	2	C1	CP-160828
720039	**CT6 aspects of IOC_UE_conf**	IOC_UE_conf	2	C6	CP-160828

This work item defines new UE configuration parameters (in UICC, in ME or both) that improve the operator control of a UE for the following features:

- voice and SMS, where the UE uses EPS to access IMS;
- voice and SMS and video, where the UE uses EPS to access IMS;
- voice and SMS, where the UE uses EPC via WLAN to access IMS; and
- voice and SMS and video, where the UE uses EPC via WLAN to access IMS.

Also in the context of this work item, a mechanism is defined to enable the operator to provide to the UE, for several use cases, the maximum time between sending of a SIP request and receiving a SIP response.

12.11 Charging and OAM stand alone improvements

12.11.1 OAM14 Rel-14 Operations, Administration, Maintenance and Provisioning (OAM&P)

Summary based on the input provided by China Mobile, ZTE, Huawei, Intel, Nokia in SP-170764.

690048	OAM14 Rel-14 Operations, Administration, Maintenance and Provisioning (OAM&P)	OAM14	1	S5	
680035	**Management of mobile networks that include virtualized network functions**	OAM14-MAMO_VNF	2	S5	SP-150362
680036	Management concept, architecture and requirements for mobile networks that include virtualized network functions	OAM14-MAMO_VNF-MCAR	3	S5	SP-160023

690039	Configuration Management for mobile networks that include virtualized network functions	OAM14-MAMO_VNF-CM	3	S5	SP-160401
690040	Fault Management for mobile networks that include virtualized network functions	OAM14-MAMO_VNF-FM	3	S5	SP-160403
690041	Performance management for mobile networks that include virtualized network functions	OAM14-MAMO_VNF-PM	3	S5	SP-160402
690042	Lifecycle management for mobile networks that include virtualized network functions	OAM14-MAMO_VNF-LCM	3	S5	SP-160427

Introduction

This work item is a Building Block, including the following 5 WIs, which specify the management standard of mobile networks that include virtualized network functions, when introducing NFV technology.

UID	Acronym	WI Name	Related specifications
680036	OAM14-MAMO_VNF-MCAR	**Management concept, architecture and requirements for mobile networks that include virtualized network functions**	TS 28.500, TS 32.101
680039	OAM14-MAMO_VNF-CM	**Configuration Management for mobile networks that include virtualized network functions**	TS 28.513, TS 28.512, TS 28.511, TS 28.510, TS 28.621, TS 28.622
680040	OAM14-MAMO_VNF-FM	**Fault Management for mobile networks that include virtualized network functions**	TS 28.515, TS 28.516, TS 28.517, TS 28.518, TS 32.111-1, TS 32.111-2
680041	OAM14-MAMO_VNF-PM	**Performance Management for mobile networks that include virtualized network functions**	TS 28.523, TS 28.522, TS 28.521, TS 28.520, TS 32.426, TS 32.409
680042	OAM14-MAMO_VNF-LCM	**Lifecycle Management for mobile networks that include virtualized network functions**	TS 28.525, TS 28.526, TS 28.527, TS 28.528, TS 28.704, TS 28.705

Description

This Building Block specifies the management concepts, architecture, requirements and procedures for CM, FM, PM, LCM, and the solutions for above all areas. And all work items have been 100% completed.

For 680036, the following concepts and requirements for mobile network that includes virtualized network functions are defined in TS 28.500:

- Clarify the network management concept and relationship of NE and VNF/PNF
- Specify business level requirements and use cases for CM, FM, PM and LCM
- Specify management architecture and interfaces/reference points for mobile network that includes virtualized network functions

For 680039, the following functions and solutions related to Configuration Management (CM) of virtualized network functions are defined in TS 28.510, TS 28.511, TS 28.512 and TS 28.513:

- Specify the functions and solutions of MOI operation (e.g. creation/deletion/update)
- Specify the functions and solutions of VNF information exchange and modification between 3GPP management system and NFV-MANO
- Specify the functions and solutions of Enabling/disabling the auto-scaling triggered by 3GPP management system

For 680040, the following functions and solutions related to Fault Management (FM) of virtualized network functions are defined in TS 28.515, TS 28.516, TS 28.517 and TS 28.518:

- Specify the functions and solutions of NE alarm correlation/reporting in the context of NFV

- Specify the functions and solutions of VNF Healing triggered by EM.
- Specify the functions and solutions of virtualization-specific aspect failure detection and notification

For 680041, the following functions and solutions related to Performance Management (PM) of virtualized network functions are defined in TS 28.520, TS 28.521, TS 28.522 and TS 28.523:

- Specify the functions and solutions of PM measurement operation related to VR
- Specify the functions and solutions of threshold monitoring operations
- Specify the functions and solutions of performance measurement notifications and subscription

For 680042, the following functions and solutions related to Life Cycle Management (LCM) of virtualized network functions are defined in TS 28.525, TS 28.526, TS 28.527 and TS 28.528:

- Specify the functions and solutions of VNF instance and NS instance LCM
- Specify the functions and solutions of VNF package operation triggered by 3GPP management system
- Specify the functions and solutions of NSD operation triggered by 3GPP management system
- Specify the functions and solutions of PNFD operation triggered by 3GPP management system

12.11.2 Filtering of PM measurements and data volume

Summary based on the input in SP-170203.

710009	**Filtering of PM measurements and data volume**	OAM14-FILMEAS	2	S5	SP-160610

This WI makes cross-operator accounting possible between a Master Operator and Participating Operator(s), based on the consumed data volume, using statistical measurements when a RAN is shared. This solution is based on input from WI RAN Aspects of RAN Sharing Enhancements for LTE.

This WI specifies:

- Use cases and requirements for management of measurements for cross-operator accounting based on data volume and QoS profiles.
- Subscription of data volume measurements that can be filtered on uplink and downlink QoS profiles (QCI, ARP and GBR) for cross-operator accounting.
- Statistical measurements for data volume for cross-operator accounting based on data volume and QoS profiles.

It is based on TR 32.817 on "Study on management of measurement collection in network sharing context".

12.11.3 OAM support for Licensed Shared Access (LSA)

Summary based on the input from Nokia in SP-171010.

720044	**OAM support for Licensed Shared Access (LSA)**	OAM14-LSA	2	S5	SP-160397

LSA is a licensing method allowing spectrum owners (Incumbents) to share their spectrum with Mobile Network Operators (LSA Licensees) according to a regulatory framework (sharing framework) issued by a National Regulatory Authority (NRA). This Work Item specifies a solution for the required OAM support.

The LSA Architecture Reference Model is described in [7]. It is based on a LSA Repository (LR) and LSA Controller (LC) with the LSA1 reference point between them. The WI OAM support for Licensed Shared Access (LSA) provides functionality for connecting the LC to the 3GPP Management System. Two deployment scenarios are considered:

- Deployment scenario 1: The LSA controller (LC) communicates LSA spectrum resource availability information (LSRAI) received from the LR to the NM.

- Deployment scenario 2: The LSA controller performs planning decisions (some or all) based on the LSRAI received from the LR internally and communicates the calculated constraints on configuration attributes (max TX power, allowed down tilt range, allowed azimuth range, maximum antenna height, etc…) to the NM.

For communication on the LSA1 reference point the Licensed Shared Access (LSA) Controller (LC) Integration Reference Point (IRP) has been defined in [4], [5] and [6].

12.11.4 Rel-14 Charging

710012	Rel-14 Charging	CH14	1	S5	SP-160021
710008	**Resource Optimization for PS Domain Online**	CH14-ROPOCH	2	S5	SP-160021
740015	**Charging for SMS via T4**	CH14-SMST4	2	S5	SP-160840
720049	**Charging Aspects of Enhanced Proximity-based Services**	CH14-ProSe	2	S5	SP-160428

No summary provided for the three items above. For the other charging-related sumamries, see individual summaries below.

710008		**Resource Optimization for PS Domain Online**	CH14-ROPOCH

Input expected from S5 rapporteur.

740015	**Charging for SMS via T4**	CH14-SMST4	2	S5	SP-160840

Summary based on the input provided by Nokia in SP-170765.

This work item provides solutions for charging from SMS-SC, the SMS deliveries using T4 (between MTC-IWF and SMS-SC) according to TS 23.682 "Device Triggering" and "MSISDN-less MO-SMS via T4" functionalities.

The Rel-11 SIMTC had the corresponding charging done under SIMTC-CH (although re-using the Feature description SP-120848) with limited scope (e.g. Device Trigger was not covered), and the charging SMS from MME was introduced.

The Rel-12 SMS-SC-CH (under CH2 Feature) introduced Offline charging from SMS-SC and completed some charging aspects of Rel-11 SIMTC (Device trigger).

The Rel-14 CH14-SMST4:

- covers some charging part of Rel-12 feature MTCe-SDDTE (Device trigger replace/recall), but also introduces online charging for Device trigger.

- covers the charging part of a Rel-14 stage 2 introduced under TEI14 (CR# 0220 TS 23.682): MSISDN-less MO-SMS via T4.

720049	**Charging Aspects of Enhanced Proximity-based Services**	CH14-ProSe	2	S5	SP-160428

Summary based on the input from Huawei in SP-170408.

The functionality addresses the charging aspect of enhancement to Proximity-based Service, including restricted ProSe Discovery for ProSe-enabled UE, ProSe Discovery on Model B, ProSe Discovery for public safety use, ProSe direct one-to-one communication and ProSe direct communication via UE-to-Network Relay.

This work item specifies the enhancement to the charging architecture, triggers for online/offline charging events, the contents and formats of the CDR and diameter application for enhanced ProSe services.

In TS 32.277 the charging principles, charging information, the triggers for online and offline charging, the online and offline message flows for the following scenarios were added.

- ProSe Restricted Discovery

- ProSe Direct Discovery in Model B
- ProSe Direct Discovery for public safety use
- ProSe one-to-one Communication
- ProSe one-to-one Communication via UE-to-Network relay

In TS 32.298 ASN1 definition for charging aspects of enhanced ProSe was added.

In TS 32.299 the AVP definition for charging aspects of enhanced ProSe was added.

12.12 Extension of UE Delay test methods and requirements

Summary based on the input from Orange in SP-170345.

720028	Extension of UE Delay test methods and requirements	EXT_UED	1	S4	SP-160600

This Work Item continues the work on terminal delay tests from previous Releases, as shown below:

Rel-11: Introduction of terminal delay testing for UMTS/3G (Ext_ATS)

Rel-12: Extension of terminal delay testing in narrowband and wideband for LTE (ART_LTE-UED)

Rel-13: Extension of terminal delay testing in super-wideband/fullband for LTE (E_LTE_UED)

It extends the 3GPP acoustic test specifications (TS 26.131 and TS 26.132) to support Voice over Wifi (VoWifi) acoustic terminal testing and enhance the existing speech delay measurement. The following functionalities for MTSI-based speech services are added:

- Support of acoustic testing for VoWifi radio access - this applies to all acoustics tests (incl. delay tests).
- Specification of clock accuracy aspects (incl. a recommendation on terminal clock skew in send direction).
- Addition of an optional test to characterize the behaviour of jitter buffer management (JBM) in terminals, under more realistic conditions.

In addition, a new Technical Report (TR 26.954, "Test plan for speech quality and delay through a headset electrical interface") has been produced to provide guidance on testing of speech quality and delay through a terminal headset electrical interface, including both analog and digital headset interfaces. This TR includes test set-up configurations and measurement scenarios, and it is expected to serve as a reference for terminal vendors and Mobile Network Operators wishing to conduct such tests. It provides a unified methodology for delay/quality tests over the electrical interface of mobile terminals (e.g. headset jack or USB-C).

12.13 Security Assurance Specification for 3GPP network products

Summary based on the input from NTT DOCOMO sent directly to MCC without submission to SA.

620062	Security Assurance Specification for 3GPP network products	SCAS	1	S3	SP-150292
620162	STOPPED - TR on Pilot development of Security Assurance Specification for MME network product class	SCAS-SA3Pil_TR	2	S3	SP-130718
620362	TR on Security Assurance scheme for 3GPP network products	SCAS-SA3TR	2	S3	SP-150716
620262	Security Assurance Specification for 3GPP network product classes	SCAS-SA3	2	S3	SP-150716

This work item defines the security assurance requirements and the corresponding test cases for network elements.

Prior to this work item, security stanardization in 3GPP was limited to the interface definitions, focussing on interoperability. Many security issues in real networks are not caused by the interface definitions, but by the network elements themselves.

In particular, the following topics have been worked on:

- a methodology to be followed when defining a security assurance specification [1]
- the threats that the security asurance specifications consider [2]
- a catalogue of general security assurance requirements and corresponding test cases [3]
- security assurance specifications (so called SCAS), referring to the general catalogue and introducing MME specific requirements and test cases, for the following product classes
  - MME product class [4]
  - PGW product class [5]

With the security assurance specifications, it is possible to have reproducable tests for security of network products which can be executed by independent test labs. GSMA has taken this as input to define an organiziational framework, the network equipment security assurance scheme, cf. e.g. GSMA FS.13 [6].

References

[1] 3GPP TR33.916 "Security Assurance Methodology (SCAS) for 3GPP network products"

[2] 3GPP TR33.926 "Security Assurance Specification (SCAS) threats and critical assets in 3GPP network product classes"

[3] 3GPP TS33.117 "Catalogue of general security assurance requirements"

[4] 3GPP TS33.116 "Security Assurance Specification (SCAS) for the MME network product class"

[5] 3GPP TS33.250 "Security assurance specification for the PGW network product class"

[6] GSMA FS.13 "FS.13 Network Equipment Security Assurance Scheme Overview"

13 Rel-14 Work Items not subject to summaries

13.1 Introduction

Some Rel-14 Features are not subject to a summary, for at least one of the following reasons:

- Generic improvement and maintenance.
- Performance-only work, without corresponding core part (some of the RAN4 tasks).
- Testing-only work, without corresponding core part (some of the RAN5 tasks).

They are listed in this clause.

13.2 Rel-14 Work Items without summary

13.2.1 Addition of band 25 and 26 to LTE MTC cat.0

This Feature encompasses the following Work Items:

740078	Addition of band 25 and 26 to LTE MTC cat.0	LC_MTC_LTE_cat0_B25_B26	1	R4	RP-162572

740178	**Core part: Addition of band 25 and 26 to LTE MTC cat.0**	LC_MTC_LTE_cat0_B25_B26-Core	2	R4	RP-162572

13.2.2 Addition of bands 25 and 40 to LTE MTC cat.1

This Feature encompasses the following Work Items:

740179	**Addition of bands 25 and 40 to LTE MTC cat.1**	LTE_MTCe2_L1_cat1_B25_B40-Core	1	R4	RP-162573

13.2.3 UE Conformance Test Aspects – IMS for Converged IP Communications

This Feature encompasses the following Work Items:

740999	**UE Conformance Test Aspects – IMS for Converged IP Communications**	IMS_CONV_IP_COM-UEConTest	1	R5	RP-162199

13.2.4 Citizens Broadband Radio Service (CBRS) 3.5GHz band for LTE in the United States

This Feature encompasses the following Work Items:

720095	**Citizens Broadband Radio Service (CBRS) 3.5GHz band for LTE in the United States**	LTE_TDD_3550_CBRS_US	1	R4	RP-161219
720195	**Core part: Citizens Broadband Radio Service (CBRS) 3.5GHz band for LTE in the United States**	LTE_TDD_3550_CBRS_US-Core	2	R4	RP-162007
720295	**Perf. part: Citizens Broadband Radio Service (CBRS) 3.5GHz band for LTE in the United States**	LTE_TDD_3550_CBRS_US-Perf	2	R4	RP-162007
740069	**UE Conformance Test Aspects – Citizens Broadband Radio Service (CBRS) 3.5GHz Band for LTE in the United States (Band 48)**	LTE_TDD_3550_CBRS_US-UEConTest	2	R5	RP-162254

13.2.5 LTE UE Total Radiated Power (TRP) and Total Radiated Sensitivity (TRS) and UTRA Hand Phantom related UE TRP and TRS Requirements

This Feature encompasses the following Work Items:

580037	**LTE UE Total Radiated Power (TRP) and Total Radiated Sensitivity (TRS) and UTRA Hand Phantom related UE TRP and TRS Requirements**	LTE_UTRA_TRP_TRS	1		RP-130703
580137	**Core part: LTE UE TRP and TRS and UTRA Hand Phantom related UE TRP and TRS Requirements**	LTE_UTRA_TRP_TRS-Core	2	R4	RP-162061
630011	**Test part: LTE UE TRP and TRS and UTRA Hand Phantom**	LTE_UTRA_TRP_TRS-UEConTest	2	R5	RP-150070

13.2.6 AWS-3/4 Band for LTE

This Feature encompasses the following Work Items:

700077	**AWS-3/4 Band for LTE**	LTE_AWS_3_4	1		RP-151731
700177	**Core part: AWS-3/4 Band for LTE**	LTE_AWS_3_4-Core	2	R4	RP-160783
700277	**Perf. part: AWS-3/4 Band for LTE**	LTE_AWS_3_4-Perf	2	R4	RP-160783
730072	**UE Conformance Test Aspects – AWS-3/4 Band for LTE (Band 70)**	LTE_AWS_3_4-UEConTest	2	R5	RP-162009

13.2.7 LTE FDD in the Bands 1980-2010 MHz and 2170-2200MHz for Region 3

This Feature encompasses the following Work Items:

700078	LTE FDD in the Bands 1980-2010 MHz and 2170-2200MHz for Region 3	LTE_1980_2170_REG3	1	R4	RP-152238
700178	**Core part: LTE FDD in the Bands 1980-2010 MHz and 2170-2200MHz for Region 3**	LTE_1980_2170_REG3-Core	2	R4	RP-152238

13.2.8 Addition of 1.4 and 3 MHz Channel Bandwidth to E-UTRA operating band 65 for CGC (Complementary Ground Component) operations in Region 1

This Feature encompasses the following Work Items:

740073	Addition of 1.4 and 3 MHz Channel Bandwidth to E-UTRA operating band 65 for CGC (Complementary Ground Component) operations in Region 1	LTE_1980_2170_REG1_addBWs	1	R4	RP-162515
740173	**Core part: Addition of 1.4 and 3 MHz Channel Bandwidth to E-UTRA operating band 65 for CGC (Complementary Ground Component) operations in Region 1**	LTE_1980_2170_REG1_addBWs-Core	2	R4	RP-162515

13.2.9 LTE 2.6 GHz FDD Supplemental DL band (2570-2620 MHz) and LTE Carrier Aggregation (2DL/1UL) with Band 3 for region 1

This Feature encompasses the following Work Items:

700079	LTE 2.6 GHz FDD Supplemental DL band (2570-2620 MHz) and LTE Carrier Aggregation (2DL/1UL) with Band 3 for region 1	LTE_FDD_2600_CA_B3	1	R4	RP-152253
700179	**Core part: LTE 2.6 GHz FDD Supplemental DL band (2570-2620 MHz) and LTE Carrier Aggregation (2DL/1UL) with Band 3 for region 1**	LTE_FDD_2600_CA_B3-Core	2	R4	RP-161200
700279	**Perf. part: LTE 2.6 GHz FDD Supplemental DL band (2570-2620 MHz) and LTE Carrier Aggregation (2DL/1UL) with Band 3 for region 1**	LTE_FDD_2600_CA_B3-Perf	2	R4	RP-161200

13.2.10 LTE Band 41 UE power class 2 operation

This Feature encompasses the following Work Items:

720096	LTE Band 41 UE power class 2 operation	LTE_B41_UE_PC2	1	R4	RP-161221
720196	**Core part: LTE Band 41 UE power class 2 operation**	LTE_B41_UE_PC2-Core	2	R4	RP-161221
720296	**Perf. part: LTE Band 41 UE power class 2 operation**	LTE_B41_UE_PC2-Perf	2	R4	RP-161221
730076	**UE Conformance Test Aspects – LTE Band 41 UE power class 2 operation**	LTE_B41_UE_PC2-UEConTest	2	R5	RP-161789

13.2.10 Introduction of new band support for 4Rx antenna ports for LTE

This Feature encompasses the following Work Items:

740071	Introduction of new band support for 4Rx antenna ports for LTE	LTE_4Rx_AP_DL_bands	1	R4	RP-162496
740171	**Core part: Introduction of new band support for 4Rx antenna ports for LTE**	LTE_4Rx_AP_DL_bands-Core	2	R4	RP-162496

13.2.11 LTE Carrier Aggregation

13.2.12.1 Rel-14 LTE Carrier Aggregation

This Feature encompasses the following Work Items:

709998	Rel-14 LTE Carrier Aggregation	LTE_CA_Rel14	1	R4	-
690086	**LTE Advanced 4 Band Carrier Aggregation (4DL/1UL) of Band 4, Band 5, Band 12 and Band 12**	LTE_CA_B4_B5_B12_B12	2	R4	RP-151521
690186	Core part: LTE Advanced 4 Band Carrier Aggregation (4DL/1UL) of Band 4, Band 5, Band 12 and Band 12	LTE_CA_B4_B5_B12_B12-Core	3	R4	RP-151521
690286	Perf. part: LTE Advanced 4 Band Carrier Aggregation (4DL/1UL) of Band 4, Band 5, Band 12 and Band 12	LTE_CA_B4_B5_B12_B12-Perf	3	R4	RP-151521
690087	**LTE Advanced 4 Band Carrier Aggregation (4DL/1UL) of Band 4, Band 4, Band 12 and Band 12**	LTE_CA_B4_B4_B12_B12	2	R4	RP-151522
690187	Core part: LTE Advanced 4 Band Carrier Aggregation (4DL/1UL) of Band 4, Band 4, Band 12 and Band 12	LTE_CA_B4_B4_B12_B12-Core	3	R4	RP-151522
690287	Perf. part: LTE Advanced 4 Band Carrier Aggregation (4DL/1UL) of Band 4, Band 4, Band 12 and Band 12	LTE_CA_B4_B4_B12_B12-Perf	3	R4	RP-151522
690088	**LTE Advanced 4 Band Carrier Aggregation (4DL/1UL) of Band 2, Band 4, Band 12 and Band 12**	LTE_CA_B2_B4_B12_B12	2	R4	RP-151523
690188	Core part: LTE Advanced 4 Band Carrier Aggregation (4DL/1UL) of Band 2, Band 4, Band 12 and Band 12	LTE_CA_B2_B4_B12_B12-Core	3	R4	RP-151523
690288	Perf. part: LTE Advanced 4 Band Carrier Aggregation (4DL/1UL) of Band 2, Band 4, Band 12 and Band 12	LTE_CA_B2_B4_B12_B12-Perf	3	R4	RP-151523

13.2.12.2 Rel-14 LTE Advanced inter-band Carrier Aggregation

This Feature encompasses the following Work Items:

709999	Rel-14 LTE Advanced inter-band Carrier Aggregation	LTE_AIBCA_Rel14	1	R4	-
700069	**LTE Advanced inter-band Carrier Aggregation Rel-14 for 5DL/1UL**	LTE_CA_R14_5DL1UL	2	R4	RP-151671
700169	Core part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 5DL/1UL	LTE_CA_R14_5DL1UL-Core	3	R4	RP-162005
700269	Perf. part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 5DL/1UL	LTE_CA_R14_5DL1UL-Perf	3	R4	RP-162005
700070	**LTE Advanced inter-band Carrier Aggregation Rel-14 for 2DL/1UL**	LTE_CA_R14_2DL1UL	2	R4	RP-152196
700170	Core part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 2DL/1UL	LTE_CA_R14_2DL1UL-Core	3	R4	RP-161996
700270	Perf. part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 2DL/1UL	LTE_CA_R14_2DL1UL-Perf	3	R4	RP-161996
700071	**LTE Advanced inter-band Carrier Aggregation Rel-14 for 2DL/2UL**	LTE_CA_R14_2DL2UL	2	R4	RP-152237

700171	Core part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 2DL/2UL	LTE_CA_R14_2DL2UL-Core	3	R4	RP-162148
700271	Perf. part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 2DL/2UL	LTE_CA_R14_2DL2UL-Perf	3	R4	RP-162148
700072	**LTE Advanced inter-band Carrier Aggregation Rel-14 for 3DL/3UL**	LTE_CA_R14_3DL3UL	2	R4	RP-152241
700172	Core part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 3DL/3UL	LTE_CA_R14_3DL3UL-Core	3	R4	RP-152241
700272	Perf. part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 3DL/3UL	LTE_CA_R14_3DL3UL-Perf	3	R4	RP-152241
700073	**LTE Advanced inter-band Carrier Aggregation Rel-14 for xDL/2UL with x=3,4,5**	LTE_CA_R14_xDL2UL	2	R4	RP-152246
700173	Core part: LTE Advanced inter-band Carrier Aggregation Rel-14 for xDL/2UL with x=3,4,5	LTE_CA_R14_xDL2UL-Core	3	R4	RP-162036
700273	Perf. part: LTE Advanced inter-band Carrier Aggregation Rel-14 for xDL/2UL with x=3,4,5	LTE_CA_R14_xDL2UL-Perf	3	R4	RP-162036
700074	**LTE Advanced inter-band Carrier Aggregation Rel-14 for 4DL/1UL**	LTE_CA_R14_4DL1UL	2	R4	RP-152249
700174	Core part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 4DL/1UL	LTE_CA_R14_4DL1UL-Core	3	R4	RP-162022
700274	Perf. part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 4DL/1UL	LTE_CA_R14_4DL1UL-Perf	3	R4	RP-162022
700075	**LTE Advanced intra-band Carrier Aggregation for xDL/yUL including contiguous and non-contiguous spectrum**	LTE_CA_R14_intra	2	R4	RP-152250
700175	Core part: LTE Advanced intra-band Carrier Aggregation for xDL/yUL including contiguous and non-contiguous spectrum	LTE_CA_R14_intra-Core	3	R4	RP-162023
700275	Perf. part: LTE Advanced intra-band Carrier Aggregation for xDL/yUL including contiguous and non-contiguous spectrum	LTE_CA_R14_intra-Perf	3	R4	RP-162023
700076	**LTE Advanced inter-band Carrier Aggregation Rel-14 for 3DL/1UL**	LTE_CA_R14_3DL1UL	2	R4	RP-152278
700176	Core part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 3DL/1UL	LTE_CA_R14_3DL1UL-Core	3	R4	RP-162146
700276	Perf. part: LTE Advanced inter-band Carrier Aggregation Rel-14 for 3DL/1UL	LTE_CA_R14_3DL1UL-Perf	3	R4	RP-162146
720098	**UE Conformance Test Aspects – Rel-14 CA configurations**	LTE_CA_R14-UEConTest	2	R5	RP-161528

13.2.12 Stage-3 SAE Protocol Development - Phase 5

This Feature encompasses the following Work Items:

710017	Stage-3 SAE Protocol Development - Phase 5	SAES5	1	C1	CP-160052
710018	**SAES5 CS Fallback in EPS**	SAES5-CSFB	2	C1	CP-160052
710019	**SAES5 for support for non-3GPP accesses**	SAES5-non3GPP	2	C1	CP-160052
720073	**SAE Protocol Development (Stage 3) - Phase 5**	SAES5	2	C1	CP-160052

13.2.13 AT Commands for CIoT

This Feature encompasses the following Work Items:

730021	AT Commands for CIoT	AT_CIoT	1	C1	CP-160477

The CIOT functionality can also be reported/initiated using AT commands. This WID introduces these commands.

13.2.14 Protocol enhancements for MCPTT over LTE

This Feature encompasses the following Work Items:

730008	Protocol enhancements for MCPTT over LTE	MCPTTProtoc1	1	CT	CP-160581
730009	**CT1 aspects of MCPTTProtoc1**	MCPTTProtoc1	2	C1	CP-160581
730010	**CT3 aspects of MCPTTProtoc1**	MCPTTProtoc1	2	C3	CP-160581
730011	**CT4 aspects of MCPTTProtoc1**	MCPTTProtoc1	2	C4	CP-160581
730012	**CT6 aspects of MCPTTProtoc1**	MCPTTProtoc1	2	C6	CP-160581

13.2.15 IMS Signalling Activated Trace

This Feature encompasses the following Work Items:

630007	IMS Signalling Activated Trace	ISAT	1		CP-150091
630107	**CT1 part of IMS Signalling Activated Trace**	ISAT	2	C1	CP-150091
651003	**(IETF) IMS Signalling Activated Trace (draft-dawes-sipping-debug)**	ISAT	2	C1-IETF	CP-150091
651103	**(IETF) IMS Signalling Activated Trace (draft-dawes-sipping-debug)**	ISAT	2	C3-IETF	CP-150091
651203	**(IETF) IMS Signalling Activated Trace (draft-dawes-sipping-debug)**	ISAT	2	C4-IETF	CP-150091
630207	**CT3 part of IMS Signalling Activated Trace**	ISAT	2	C3	CP-150091
630307	**CT4 part of IMS Signalling Activated Trace**	ISAT	2	C4	CP-150091

13.2.16 Lawful Interception Rel-14

This Feature encompasses the following Work Items:

721004	Lawful Interception Rel-14	LI14	1	S3LI	SP-1570038

13.2.17 User Controlled Spoofed Call Treatment

This Feature encompasses the following Work Items:

740017	User Controlled Spoofed Call Treatment	SPECTRE	1		SP-160898
730004	**Stage 1 of User Controlled Spoofed Call Treatment**	SPECTRE	2	S1	SP-160898
740018	**Stage 3 of User Controlled Spoofed Call Treatment**	SPECTRE-CT	2	C1	CP-160696

13.2.18 IMS Stage-3 IETF Protocol Alignment

This Feature encompasses the following Work Items:

720040	IMS Stage-3 IETF Protocol Alignment	IMSProtoc8	1	C1	CP-160294
720070	**CT1 aspects of IMS Stage-3 IETF Protocol Alignment**	IMSProtoc8	2	C1	CP-160294
720071	**(IETF) CT1 aspects of IMS Stage-3 IETF Protocol Alignment**	IMSProtoc8	2	C1-IETF	CP-160294
720072	**CT3 aspects of IMS Stage-3 IETF Protocol Alignment**	IMSProtoc8	2	C3	CP-160294

Annex A:
Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2017-03	CT#75					Initial draft	0.1.0
2017-03	SA#75	SP-170229				Instructions added on how to contribute and who is expected to contribute	0.2.0
2017-03	SA#75	SP-170242/ RP-170833				List of expected contributors detailed for each Feature. Slight revision of the template to contribute.	0.2.1
2017-03	-					Material from TSG#75 included. Overall restructuring and clean-up performed by the editor.	0.3.0
2017-05	SA#76	SP-170434				Inclusion of TSG#76 material available on May 29th 2017. Status: 28 summaries provided, 65 summaries to be provided, 5 summaries partially provided.	0.4.0
2017-08	SA#76					Inclusion of material available on July 14th 2017. Status: 54 summaries provided, 37 summaries to be provided, 6 summaries partially provided.	0.5.0
2017-09	SA#77					Inclusion of material available on September 7th	0.6.0
2017-09	SA#77					New material available on September 11th 2017. Clarification that Performance-only, Testing-only and generic Work Items do not need summary.	0.7.0
2017-09	SA#77					CT#77 comments taken into account: 3 Features not to summarize.	0.8.0
2017-12	SA#78					1 INPUT MISSING	1.0.0
2018-03	SA#79					All input summaries included, including SCAS, added to Rel-14. Re-writing of the document.	1.1.0
2018-03	SA#79					Clean-up done.	2.0.0
2018-05	SA#79					Raised to version 14.0.0 following SA's approval	14.0.0

History

Document history		
V14.0.0	June 2018	Publication