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1 LTE2: S1 Flex

1.1 Introduction to the feature

The S1 Flex allows the eNB to establish multiple S1 links. The Flexi Multiradio BTS can be connected to a maximum of 32 MMEs.

A load balancing algorithm is used to balance the load between the MMEs. UEs entering the MME pool are distributed to the different MMEs.

1.2 Benefits

The S1 Flex feature provides network redundancy and traffic load sharing.

With S1 Flex the eNB is allowed to connect to a maximum of 32 MMEs. The operator can increase the overall network availability.

1.3 Functional description

The eNB supports multiple S1 links when feature S1 Flex is activated.

1.3.1 S1 interface

With S1 Flex support, the eNB may be connected to a maximum of 16 MMEs. When an associated IP address for the MME is available, the eNB considers that specific MME as allowed. If an additional MME becomes configured, eNB performs the S1 link activation procedure for this MME. When the MME is removed from the set of configured MMEs, the eNB performs the S1 link deactivation procedure for this MME. An S1 interface modification occurs each time when the set of available MMEs changes.

If the S1 Flex feature is deactivated, the eNB performs the S1 link deactivation procedure for each MME except for the MME that is considered as the main MME. The main MME is configured in LNMME-0.

SCTP associations

The eNB starts/terminates all associations towards any MME at one eNB SCTP endpoint. That means that the eNB supports at one S1-MME SCTP endpoint up to 16 SCTP associations towards peer MMEs (one SCTP association for each MME). Each MME peer endpoint is identified with the peer MME primary IP address.

When the S1 Flex is deactivated, the eNB keeps only the SCTP association towards the main MME.

For more information on SCTP, see subchapter *SCTP layer* in LTE Datapath Management.

1.3.2 MME selection

During the UE connection establishment, eNB selects MME from the set of active MMEs. The choice is based on:

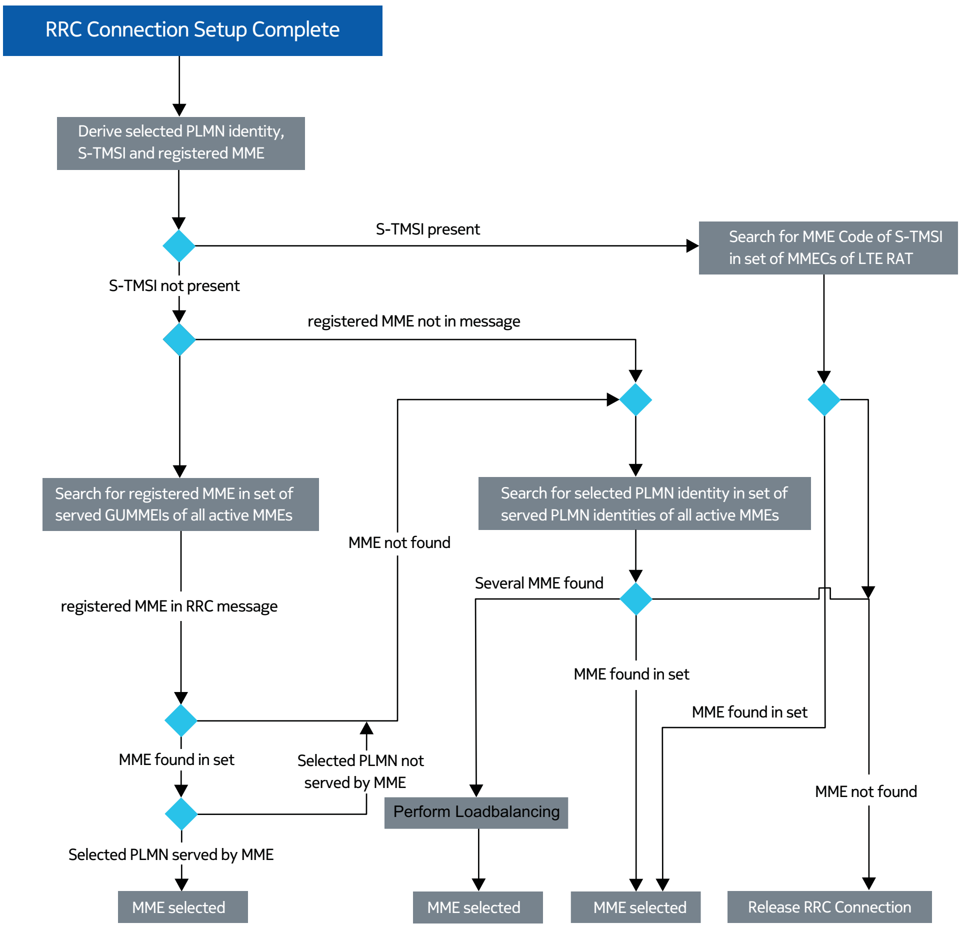
- PLMN IDs (MME support of PLMNs, which UE wants to connect to)
- *registeredMME* value (available if the UE has already registered with a MME)
- SAE Temporary Mobile Subscriber Identity (S-TMSI)

Value of *registeredMME* parameter is provided by one of the following messages:

- RRC CONNECTION SETUP COMPLETE
- RRC CONNECTION REQUEST, within the optional S-TMSI

The Figure 1: MME selection procedure provides an overview of MME selection procedure after the RRC connection setup is completed.

Figure 1 MME selection procedure



1.3.2.1 Load balancing

A load-balancing algorithm balances the load between MMEs.

UEs entering the MME pool are distributed to different MMEs with probabilities that correspond to the assigned weights.

The eNB performs the S1 connection setup load-balancing among the MMEs. Only active MMEs for which the PLMN ID is one of the served PLMNs are considered.

Selection is based on weighting information provided by each MME during the S1 setup. Relative MME capacity is included in S1AP: S1 SETUP RESPONSE message.

Algorithm is re-initialized by the following triggers:

- successful S1 setup
- S1 reset
- S1- MME failure

1.4 LTE2 reference data

Requirements

Table 1 LTE2 hardware and software requirements

	FDD	TDD
System release	RL20	RL15
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Not supported	TD-LBTS4.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10 CD2	NS10 CD2
SAE GW	NG10 CD4	NG10 CD4
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE2: S1 Flex* feature.

BTS faults and reported alarms

There are no faults related to the *LTE2: S1 Flex* feature.

Commands

There are no commands related to the *LTE2: S1 Flex* feature.

Measurements and counters

There are no measurements or counters related to the *LTE2: S1 Flex* feature.

Key performance indicators

There are no key performance indicators related to the *LTE2: S1 Flex* feature.

Parameters

Table 2 New parameters introduced by LTE2

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Activation status of S1 flex feature	actS1Flex	LNBTS	-	common
Primary IPv4/v6 address	ipAddrPrim	LNMME	-	common
LTE mobility management entity identifier	lnMmeId	LNMME	-	common

Table 3 Existing parameters related to LTE2

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Administrative state	administrative State	LNMME	-	common
Transport network identifier	transportNwId	LNMME	-	common

For parameter descriptions, see *LTE Radio Access Operating Documentation/Reference/Parameters*.

Sales information

Table 4 LTE2 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

1.5 Activating the LTE2: S1 Flex using BTS Site Manager

Purpose

Follow this procedure to activate and configure the LTE2: S1 Flex feature using BTS Site Manager.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

The eNB restart is not needed after the activation of this feature.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

The configuration elements related to the *LTE2: S1 Flex* feature are found on page “Radio network configuration”:

- On page “Radio network configuration”, from the left upper corner select “LNBTS” in the navigation tree. The "LNBTS Properties" will be shown on the right side of the page.
- In "LNBTS Properties" select the `Activation status of S1 Flex feature` parameter from the drop-down list and set the value to **enabled**, this will set the `actS1Flex` flag to **enabled**.

The *LTE2: S1 Flex* feature allows to create in addition to LNMME-0 up to 31 further LNMMEs. LNMME-0 is already created and mandatory. If only one LNMME is configured, the `Activation status of S1 Flex feature` can be set to **disabled**.

There are two methods to create and configure additional LNMMEs:

method a):

- Expand the navigation tree under the **LNBTS** object and select **LNMME-0**.
- Click on **Copy LNMME-0**. A new LNMME will be created.

method b):

- Right-click the **LNBTS** object in the navigation tree.
- Click **New** and select **LNMME** from the drop-down list. A new LNMME will be created.

Specify the LNMME Properties:

- Specify the **LTE mobility management entity identifier** (`lnMmeId`) to a value of **0...31**.
- Set the **Administrative state** (`administrativeState`) in the selection field to **unlocked**.

- Specify the **Primary IPv4/v6 address** (`ipAddrPrim`). The values of the parameter are **7...45** characters.
- Select in the **Transport network identifier** (`transportNwId`) selection field the value **0...1**.

Perform the steps as listed above to create further LNMMEs if needed.

4 Send the commissioning plan file to the eNB.

- Open the **Commissioning - Send parameters** page.
- Click **Send**.

5 The new commissioning plan file is automatically activated in the eNB.

The BTSSM automatically sends an activation command after finishing the file download.

Expected outcome

The activation of *LTE2: S1 Flex* allows the eNB to establish multiple S1 links. The eNB performs the S1 link activation procedure for the created and configured LNMMEs, excepted LNMME-0.

1.6 Deactivating the LTE2: S1 Flex using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE2:S1 Flex feature using BTS Site Manager.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

See *BTS Site Manager Online Help* for details.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Go to the set of pages at the top right of the BTSSM screen to find the feature-related settings. It is recommended to read carefully the pages that contain the full eNB configuration information.

The only configuration element related to the *LTE2: S1 Flex* feature is on ”Radio Network Configuration” page:

- Set the parameter `Activation status of S1 Flex feature` from drop-down list to **Disabled**.

4 Send the commissioning plan file to the eNB.

- Open the **Commissioning - Send parameters** page.
- Click **Send**.

5 The new commissioning plan file is automatically activated in the eNB.

After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

The eNB performs the S1 link deactivation procedure for the LNMMEs, excepted LNMME-0.

1.7 Abbreviations

1.7.1 0 – Z

GUMMEI

Global Unique Mobility Management Entity Identifier

PLMN

Public Land Mobile Network

RAT

Radio Access Technology

S-TMSI

SAE Temporary Mobile Subscriber Identity

2 LTE5: Radio bearer and S1 bearer establishment and release

2.1 Introduction to the feature

The *LTE5: Radio bearer and S1 bearer establishment and release* feature for end-user services is a part of the basic user data management functionality.

Bearer management procedures establish the default Evolved Packet System (EPS) bearer that provides an always-on service for a user offered data services.

2.2 Benefits

The feature provides the basic user data management to the end-user.

2.3 Functional description

When attached, the default EPS bearer is established between a UE and Evolved Packet Core (EPC). The application IP address and default EPS bearer are maintained with the state transition from ECM_IDLE to ECM_CONNECTED between UE and EPC. Currently, one default EPS bearer is supported so that a single data radio bearer and a single S1 bearer is needed per UE in ECM_CONNECTED state. The default EPS bearer is a non-GBR bearer from LTE point of view.

The following eNB-related functions are included:

- UE context setup and release between EPC and eNB
- S1 bearer establishment and release between EPC and eNB
- Radio bearer establishment and release between eNB and UE

The MME applies semi-static UE-AMBR values during the default EPS bearer setup:

- The AMBR has a global value without UE or subscription differentiation.
- The AMBR must be configured below the UE capabilities.
- The eNB applies the AMBR as maximum bit rate setting for the packet scheduler.

2.4 System impact

2.5 LTE5 reference data

Requirements

Table 5 LTE5 hardware and software requirements

	FDD	TDD
System release	RL09	RL05TD
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Not supported	TD-LBTS4.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Flexi Zone Controller	FL15A	TL15A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10	NS10
SAE GW	NG10 CD2	NG10 CD2
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE5: Radio bearer and S1 bearer establishment and release* feature.

BTS faults and reported alarms

There are no faults related to the *LTE5: Radio bearer and S1 bearer establishment and release* feature.

Commands

There are no commands related to the *LTE5: Radio bearer and S1 bearer establishment and release* feature.

Measurements and counters

There are no measurements or counters related to the *LTE5: Radio bearer and S1 bearer establishment and release* feature.

Key performance indicators

There are no key performance indicators related to the *LTE5: Radio bearer and S1 bearer establishment and release* feature.

Parameters

Table 6 Existing parameters related to LTE5

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
`DRB Downlink Scheduling Priority`	`drbPrioDl`	LNBTS	-	FDD
`Downlink Pathloss Change`	`dlPathlossChg`	LNCEL	-	common

Table 6 Existing parameters related to LTE5 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Periodic BSR Time	tPeriodicBsr	LNCEL	-	common
Periodic PHR Timer	tPeriodicPhr	LNCEL	-	common
Prohibited PHR Timer	tProhibitPhr	LNCEL	-	common
Retransmission BSR Timer	tReTxBsrTime	LNCEL	-	common

Table 7 Parameters related to the AM RLC profile for DRBs

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
RLC Profile Id	rlcProfileId	LNBTS	-	common
AM RLC Poll PDU DRB	pollPdu	LNBTS	-	common
AM RLC Timer Poll Retransmit DRB	tPollRetr	LNBTS	-	common
AM RLC Timer Reordering DRB	tReord	LNBTS	-	common
AM RLC Timer Status Prohibit DRB	tProhib	LNBTS	-	common

Table 8 AM RLC pollByte table

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
UE category	ueCategory	LNBTS	-	common
UL poll byte	ulPollByte	LNBTS	-	common
DL poll byte	dlPollByte	LNBTS	-	common

Table 9 Parameters related to the PDCP profile

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
PDCP profile	pdcpProf	LNBTS	-	
PDCP profile ID	pdcpProfileId	LNBTS	-	common
AM RLC Poll PDU DRB	pollPdu	LNBTS	-	common
PDCP Timer Discard	tDiscard	LNBTS	-	common
PDCP status report required	statusRepReq	LNBTS	-	common

For parameter descriptions, see *LTE Operating Documentation/ Reference/ Parameters*

Sales information

Table 10 LTE5 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

3 LTE7: Support of multiple EPS bearer

3.1 Introduction To The Feature

The eNB supports a number of bearer combinations. The operator can offer and the customer can use a combination of different services for one UE. With this feature “LTE7: Support of multiple EPS bearer” it is possible to support of up to 4 AM DRB (acknowledged mode data radio bearer) bearers per UE. Furthermore there can be two signaling bearers (SRB) combined.

Each combinations of SRB1, SRB2 and up to the 4 AM DRBs are allowed.

3.2 Benefits

The operator can offer attractive service combinations as multiple services, that can be used at one UE.

3.3 Functional Description

An EPS-bearer (Evolved packet system bearer) is an information transmission path of defined capacity , delay and bit error rate. It is used between MME, eNB and the UE.

LTE distinguishes between two types of bearers:

- *default bearer*
  One default bearer is established when the UE connects to the MME (and the backbone PDN (packet data network)) and remains established throughout the lifetime of the connection to provide the UE with always-on IP connectivity to that PDN.
- *dedicated bearer*
  Any additional EPS bearer that is established for the same packet data network connection is referred to as dedicated bearer.

Multiple DRBs (data radio bearers) can be either multiple default EPS bearers or a combination of default and dedicated bearers. The type of the bearer is transparent to the eNB.

The radio admission is extended by additional check of the total number of DRB per cell and maximum number of DRB per UE.

The different bearers per UE can have the same or different QCIs (Quality of Service Class identifiers). The QCI is an index that idenitifies the QoS attributes: priority, delay and loss rate.

The eNB supports the following scenarios for establishing and releasing EPS bearers:

- establish individual EPS bearers,
- release individual EPS bearers,

- add multiple EPS bearers to existing EPS bearers,
- release multiple EPS bearers from existing EPS bearers.

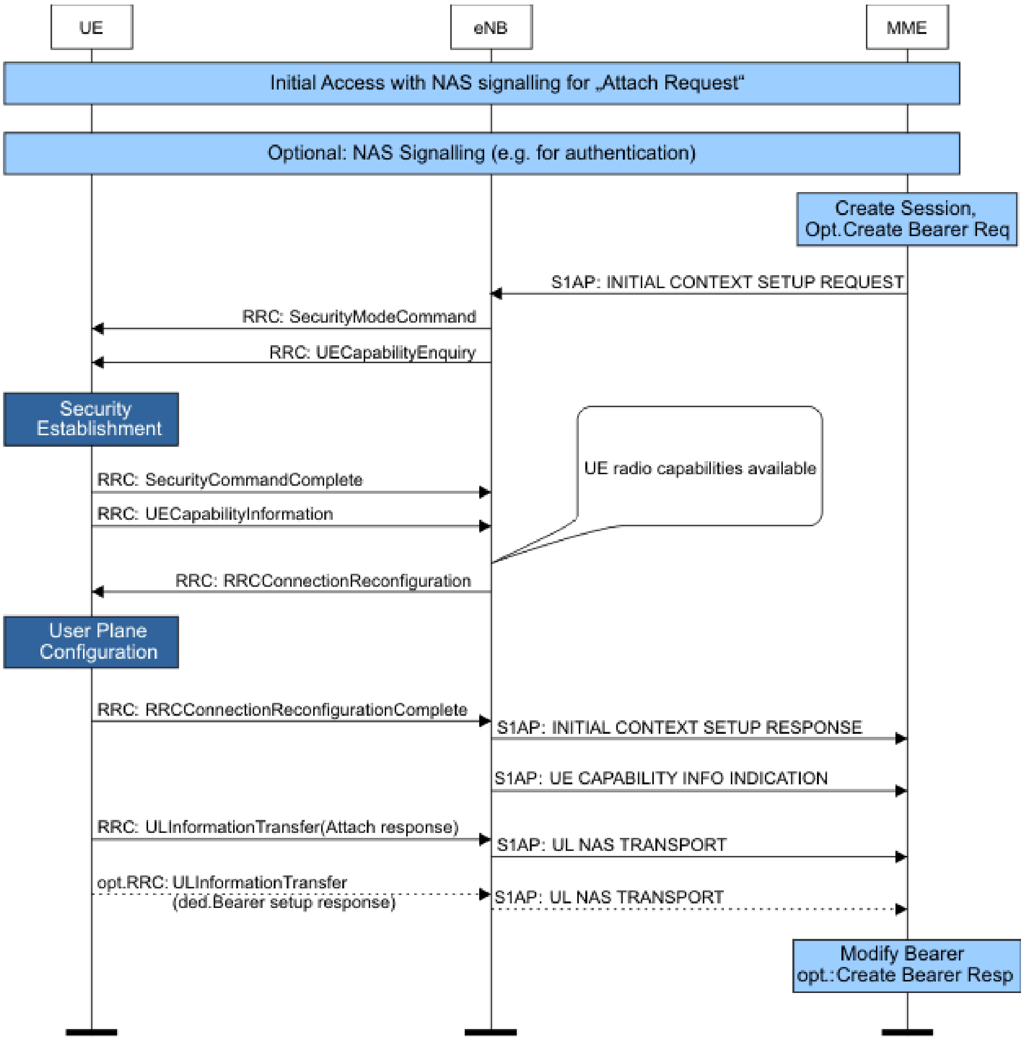
There is one restriction regarding bearers having the same QCI, i.e. there can only be one bearer of a certain QCI per PDN; multiple traffic flows requiring the same QCI are already merged into a single bearer in EPC. Bearers of the same QCI can exist to different bearers.

The downlink scheduler provides prioritization among multiple non-GBR (non Guaranteed Bit Rate) EPS-bearers in order to avoid starvation of downlink traffic.

The single or multiple EPS bearers are established or released by the according S1AP procedure.

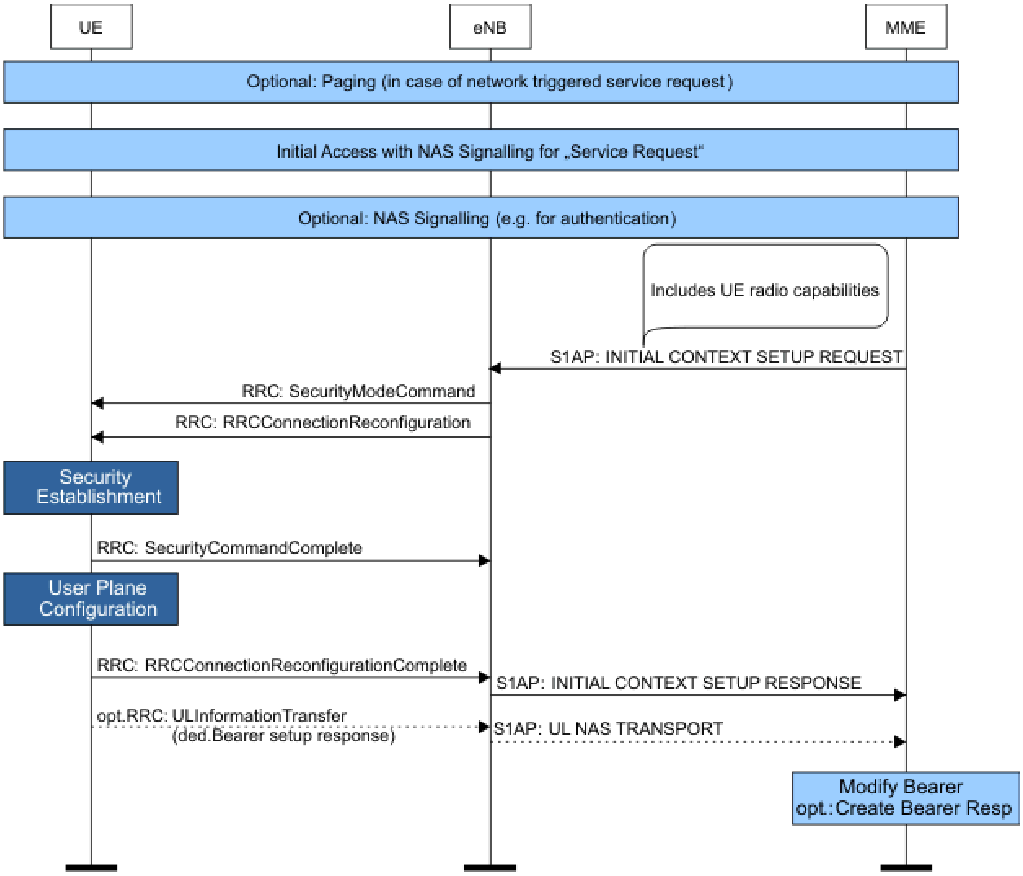
In Figure 2: EPS bearer establishment by S1AP: Initial context setup procedure (Attach) a message flow is shown for the establishing of one or more EPS bearers with the S1AP: Initial Context Setup Request (Attach). This procedure is taken for the first action. The operator can establish one default + optional additional bearers. This message can contain UE context data (e. g. UE radio capabilities, security information).

Figure 2 EPS bearer establishment by S1AP: Initial context setup procedure (Attach)



The message flow for an EPS bearer establishment with the S1AP: Initial Context Setup Request (Service Request).is shown in Figure 3: EPS bearer establishment by S1AP: Initial context setup procedure (Service).

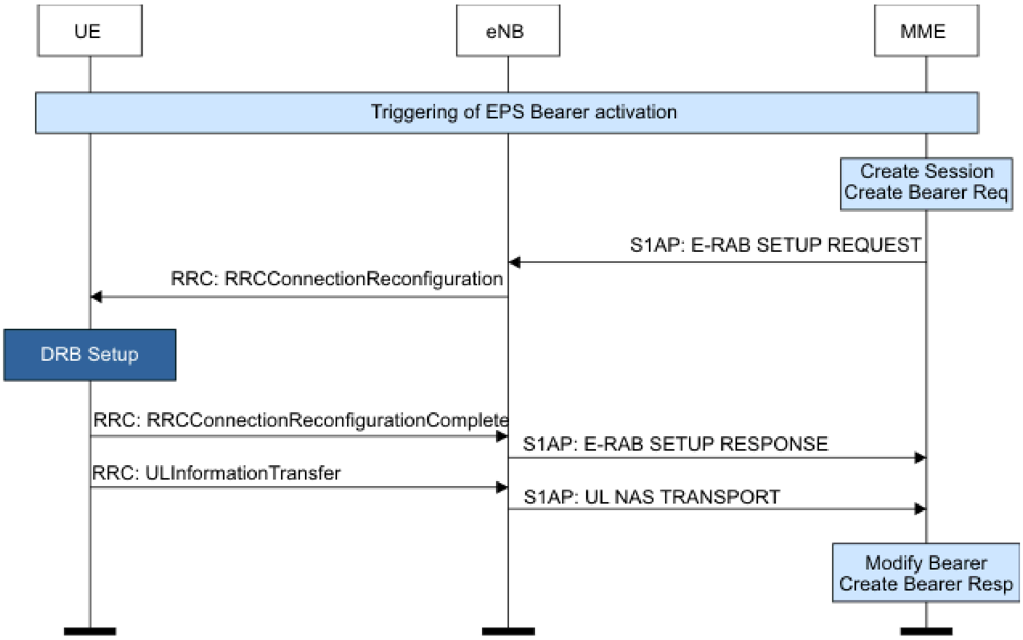
Figure 3 EPS bearer establishment by S1AP: Initial context setup procedure (Service)



The message flow for the establishment of an additional single or multiple EPS bearer with the S1AP: E-RAB setup request (E-RAB: E-UTRAN Radio ACCESS) is shown in Figure 4: EPS bearer establishment by S1AP:E-RAB setup request. The E-RAB Setup procedure supports:

- Check of activation of the multi-bearer feature.
- Check of the support of the new bearer configuration.
- Reconfiguration of the rate capping function, if a new UE-AMBR (aggregated maximum bit rate) has been provided by MME.
- Setup of an additional single or multiple DRBs by the RRC Connection Reconfiguration procedure.

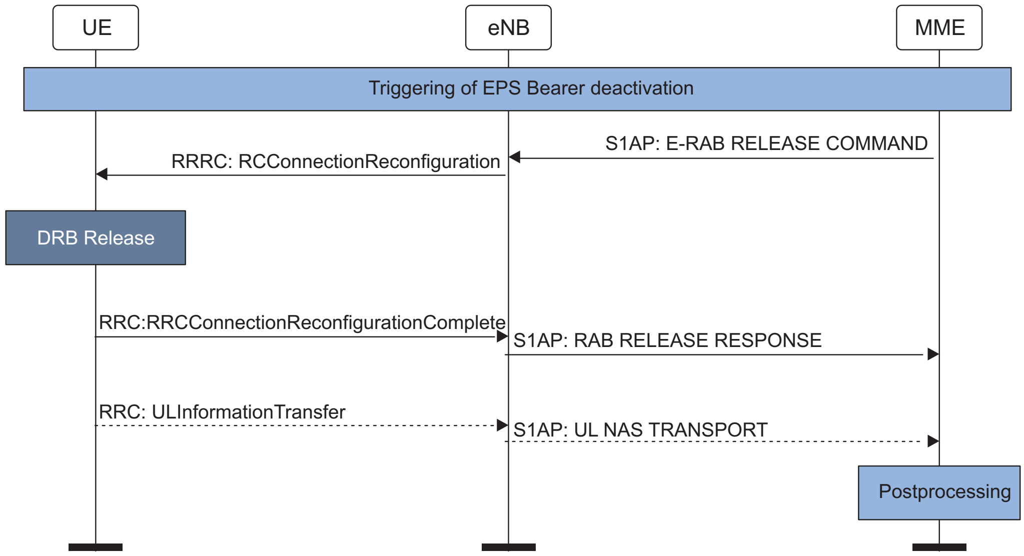
Figure 4 EPS bearer establishment by S1AP:E-RAB setup request



In Figure 5: EPS bearer release procedure by S1AP:E-RAB release procedure another message sequence chart is shown: The release of a bearer with the S1AP: E-RAB release procedure. This S1AP: E-RAB release procedure supports the release of a single or multiple EPS bearers. This includes:

- Check, whether at least one non-GBRremains.
- Reconfiguration of the rate capping functions if a new UE-AMBR(aggregated maximum bitrate) has been provided by MME,
- Release of a single or multiple DBRs by the RRC Connection Reconfiguration procedure.

Figure 5 EPS bearer release procedure by S1AP:E-RAB release procedure



This feature has influence on different functions as listed below:

- Radio Admission Control (RAC)
  RAC checks the threshold maxNumActDrb per cell. Therefore the counter NumActDrb counts the total number of DRBs. The RAC will be involved when DRBs are setup, when setups are aborted, when DRBs are released or UEs leave the cell. Each admission request is processed within RAC according to the “all or nothing” principle, e.g. if n (n > 1) DRBs shall be admitted and at least one DRB cannot be admitted, the complete request is rejected.
  To meet the right decisons RAC must maintain counters from Table 11: Counters maintained by RAC and must compare them to system internal thresholds.

  Table 11 Counters maintained by RAC

counter	description
NumRRC	counter for SRB1 connected UEs
NumActUE	counter for active UEs (having signalling connection and a default DRB)
NumActDrb	counter for all user DRBs (QCI independant) in the cell

  The above mentioned threshold maxNumActDrb (and others like maxNumActUe, maxNumRrc..) are retrieved from the OAM database at system setup.
- UL / DL Scheduler
  The UL / DL Scheduler is extended by the followíng functions:
  - The UL / DL Scheduler considers up to four DRBs (GBR or not-GBR) per UE.
  - DRBs of one UE can have the same or different QCI.
  - The UL/ DL Scheduler supports proportional fair treatment of different UEs depending on data availability of (multiple) radio bearers (inter UE fairness).
  - The UL / DL Scheduler suppports proportional fair treatment of different UEs depending on radio channel quality.
- AS (Access Stratum) Security
  Ciphering and integrity protection for multiple DRBs are supported.
- Initial Context Setup Procedure
  The eNB supports the establishment of multiple EPS bearers at the Initial Context Setup - Procedure (see Figure 2: EPS bearer establishment by S1AP: Initial context setup procedure (Attach) and Figure 3: EPS bearer establishment by S1AP: Initial context setup procedure (Service)).
- E-RAB Setup and E-RAB Release
  The eNB supports the establishment and release of additional single or multiple EPS bearers (see Figure 4: EPS bearer establishment by S1AP:E-RAB setup request and Figure 5: EPS bearer release procedure by S1AP:E-RAB release procedure).
- Handover
  The handover procedures (intra eNB and inter eNB) support the handover for multiple non GBR bearers.
  If the decision is made to perform an intra eNB handover while a bearer management procedure (i.e. bearer setup or release) is ongoing, the bearer management continues. The intra eNB - handover is delayed and will be started after the completion of the bearer management procedure.
- PDCP functionality
  The new timer S1 retard timer is introduced.

- MAC Multiplexing
  The eNB supports the multiplexing of data of multiple logical channels (corresponding to data radio bearers as well as to signalling radio bearers) into a single MAC PDU in DL direction.
  In UL direction the eNB supports the reception and demultiplexing of MAC PDUs containing multiplexed data from multiple logical channels.

3.4 System Impacts

This feature is precondition for the feature LTE10: EPS bearers for conversational voice.

3.5 LTE7 reference data

Requirements

Table 12 LTE7 hardware and software requirements

	FDD	TDD
System release	RL20	RL15TD
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS4.0
Flexi Multiradio 10 Indoor BTS	Not supported	TD-LBTS2.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	NS20	NS10CD4
SAE GW	NG20	NG10CD4
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE7: Support of multiple EPS bearer* feature.

BTS faults and reported alarms

There are no faults related to the *LTE7: Support of multiple EPS bearer* feature.

Commands

There are no commands related to the *LTE7: Support of multiple EPS bearer* feature.

Measurements and counters

Table 13 New counters introduced by LTE7

Counter ID	Counter name	Measurement
M8000C 17	E-RAB setup completions (E_RAB_SETUP_SUCC)	-
M8000C 18	E-RAB setup failures due to radio network layer problems (E_RAB_SETUP_FAIL_RNL)	-
M8000C 19	E-RAB setup failures due to transport layer problems (E_RAB_SETUP_FAIL_TRANSPORT)	-
M8000C 20	E-RAB setup failures due to resource problems (E_RAB_SETUP_FAIL_RESOURCE)	-
M8000C 21	E-RAB setup failures due to other reasons (E_RAB_SETUP_FAIL_OTHER)	-
M8000C 22	E-RAB setup requests (E_RAB_SETUP_ATT)	-
M8006C 16	EPS Bearer setup failures due to Pending Handover (EPS_BEARER_SETUP_FAIL_HO)	-
M8006C 17	Initial EPS Bearer setup attempts for QCI1 (EPS_BEARER_STP_ATT_INI_QCI_1)	-
M8006C 18	Initial EPS Bearer setup attempts for non-GBR (EPS_BEAR_STP_ATT_INI_NON_GBR)	-
M8006C 26	Additional EPS Bearer setup attempts for QCI1 (EPS_BEARER_STP_ATT_ADD_QCI_1)	-
M8006C 35	Initial EPS Bearer setup completions for QCI1 (EPS_BEARER_STP_COM_INI_QCI1)	-
M8006C 36	Initial EPS Bearer setup completions for non-GBR (EPS_BEAR_STP_COM_INI_NON_GBR)	-
M8006C 44	Additional EPS Bearer setup completions for QCI1 (EPS_BEAR_SET_COM_ADDIT_QCI1)	-

Table 13 New counters introduced by LTE7 (Cont.)

Counter ID	Counter name	Measurement
M8006C89	EPC initiated EPS Bearer Release requests for QCI1 due to Normal release by UE(EPC_EPS_BEAR_REL_REQ_N_QCI1)	-
M8006C98	EPC initiated EPS Bearer Release requests for QCI1 due to Detach procedure by UE or MME (EPC_EPS_BEAR_REL_REQ_D_QCI1)	-
M8006C107	EPC initiated EPS Bearer Release requests per QCI1 due to Radio Network Layer cause (EPC_EPS_BEAR_REL_REQ_R_QCI1)	-
M8006C116	EPC initiated EPS Bearer Release requests for QCI1 due to Other causes (EPC_EPS_BEAR_REL_REQ_O_QCI1)	-
M8006C125	eNB initiated EPS Bearer Release requests for QCI1 due to normal release (ENB_EPS_BEAR_REL_REQ_N_QCI1)	-
M8006C134	eNB initiated EPS Bearer Release requests for QCI1 due to Radio Network Layer cause (ENB_EPS_BEAR_REL_REQ_R_QCI1)	-
M8006C143	eNB initiated EPS Bearer Release requests for QCI1 due to Other causes (ENB_EPS_BEAR_REL_REQ_O_QCI1)	-
M8006C152	eNB initiated EPS Bearer Release requests for QCI1 due to Transport Layer Cause (ENB_EPS_BEAR_REL_REQ_T_QCI1)	-
M8006C161	eNB initiated EPS Bearer Release requests for QCI1 due to Radio Network Layer cause Redirect (ENB_EPS_BEAR_REL_REQ_RD_QCI1)	-

For counter descriptions, see LTE Operating Documentation/ Reference/ Counters and Key Performance Indicators.

Key performance indicators

There are no key performance indicators related to the *LTE7: Support of multiple EPS bearer* feature.

Parameters

Table 14 New parameters introduced by LTE7

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
End-Tag maximum AM	tagMaxAM	LNBTS	-	common
End-Tag maximum UM	tagMaxUM	LNBTS	-	common
Activate Multiple Bearers	actMultBearers	LNBTS	-	common
UL Scheduler FD Type	ulsFdPrbAssignAlg	LNCEL	-	common
Add number DRB radioReasHo	addNumDrbRadioReasHo	LNCEL _FDD/ LNCEL_ TDD	-	common
Add number DRB timeCriticalHo	addNumDrbTimeCriticalHo	LNCEL _FDD/ LNCEL_ TDD	-	common
Max number act DRB	maxNumActDrb	LNCEL _FDD/ LNCEL_ TDD	-	common

For parameter descriptions, see LTE Operating Documentation/ Reference/ Parameters.

Sales information

Table 15 LTE7 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

3.6 Activating the LTE7: Support of Multiple EPS Bearer

Purpose

Follow this procedure to activate the LTE7: Support of Multiple EPS Bearer feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *actMultBearers* to true.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter actMultBearers no restart is needed. But, if other additonal parameters are modified a restart may be needed.

3.7 Deactivating the LTE7: Support of Multiple EPS Bearer Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE7: Support of Multiple EPS bearer feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *actMultBearers* to false.

Before setting the parameter *actMultBearers* to false, take sure that the parameter *actConfVoice* is set to false, too.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter actMultBearers no restart is needed. If more addtional parameters are changed, a restart my be needed.

4 LTE9: Service Differentiation

4.1 Introduction to the feature

Table 16 Summary of changes

Date	Section	Description
14.11.2017	Reference data	`DL Scheduling weight`and `UL Scheduling weight` parameters were added.

This feature introduces differentiation of five different non Guaranteed Bit Rate (**GBR**) QoS Class Indicator (**QCI**) classes with relative scheduling weights.

4.2 Benefits

Different non-GBR QoS classes can be efficiently supported.

4.3 Functional description

With the Flexi Multiradio BTS service differentiation functionality, it is possible to assign relative scheduling weights for each non GBR QCI on BTS level. The relative weight will be considered by the uplink and the downlink scheduler. It also brings in the possibility to define three different Radio Link Control (**RLC**) / Packet Data Convergence Protocol (**PDCP**) profiles per BTS which can be assigned to different QCIs. The operator can enable/disable the support of individual QCIs.

The *LTE9: Service Differentiation* feature is one of the Quality of Service features. It depends on the framework that comes with the support of multiple bearers, see *LTE7: Support of multiple EPS bearer*. Service differentiation of non-GBR bearers supports the following functionalities:

- Configurable weight values per QCI
- Consideration of weight values in UL and DL scheduling
- Consideration of weight values in MAC multiplexing in DL

Feature characteristics

Characteristics for the QoS features are mainly determined by the network deployment scenarios of features and UE mobility.

With *LTE9: Service Differentiation* feature, the differentiation of non-GRB bearers with QCI from {5, 6, 7, 8, 9} via configurable weight values is introduced. Support of each QCI can be enabled and disabled by O&M. If the feature is not activated, all bearers are considered with the same default value. The default values are taken from the parameter set of QCI9. Characteristics of the feature are described below:

- **Non-GBR service differentiation for different UEs**
  Several UEs become active in one cell under identical radio conditions such that the cell is under load. Each UE has a single (or multiple) non-GBR bearer established but the QCI(s) of the single (or the multiple) bearer(s) is different between different UEs. There are no limitations to the traffic arrival for the established bearers. Service differentiation between UEs is performed by considering scheduling weights in schedulers (uplink and downlink).
- **Non-GBR service differentiation in downlink for a single UE**
  In a cell under load, multiple bearers with different QCIs are established for a UE. Service differentiation is performed by using a weighted round robin approach in logical channel prioritization in DL (logical channel prioritization in UL is defined by 3GPP standard and UE responsibility, prioritized bit rate setting, is used to prevent bearer starvation). There are no limitations to the traffic arrival for the established bearers.
- **Establishment of a bearer when specific QCI is disabled**
  Service requests for QCI which are disabled are rejected. EPC requests for a connected UE establishment of a bearer with a specific QCI different from the default QCI.
- **Modification of QCI specific weight values**
  A set of QCI specific weight values is configured in the eNodeB. Bearers of the same or of different UEs are served according to the configured weight values. The specific weight value for one or several QCIs is/are modified to a different value via the management tool (NetAct). Weight values for already established bearers remain unchanged. Modified QCI specific weight values are applied for new UEs in the cell or for establishment of new bearers for existing UEs.

UL Scheduler and DL Scheduler

The UL Scheduler and DL Scheduler introduce service dependent weights being used in the scheduling metric to differentiate between different UEs or different bearers of the same UE.

The eNodeB supports service differentiation for non-GBR data radio bearers in UL and DL scheduling:

- UL/DL scheduler considers (configurable) QCI-specific relative weight values as provided by the control plane in scheduling
- UL/DL scheduler supports relative fair treatment of different UEs depending on weight values and data availability of a single or multiple data radio bearer

MAC Multiplexing

The eNodeB supports multiplexing of data of multiple logical channels (corresponding to data radio bearers as well as to signalling radio bearers) into a single MAC PDU in DL.

The eNodeB supports service differentiation for Non-GBR data radio bearers in MAC multiplexing and logical channel prioritization in DL:

- For multiple bearers for one UE, MAC multiplexing and logical channel prioritization in DL considers (configurable) QCI-specific relative weight values as being provided by control plane
- Logical channel prioritization in DL supports long term relative fair treatment of multiple bearers of one UE depending on bearers data availability (intra-UE fairness)

Priority handling between logical channels of one UE

The priority handling between logical channels of a UE is performed in a subframe in which the UE is allocated resources for a new transmission. The following input parameters are required:

- QCI weight (or scheduling weight) for logical channels of Non-GBR type
- The transport block size (TBS) in bits allocated to the UE. TBS is determined by the number of PRBs/RBGs allocated to the UE and MCS used.

The scheduling procedure of logical channels of a UE is initialized as soon as a UE is admitted and a bearer is established in a cell.

Allocate resources to Non-GBR bearers of the UE according to scheduling weights

All the Non-GBR logical channels (QCI6-9, or QCI5 with schedulType="NON-GBR") are served according to a weighted round robin (WRR) method. A scheduling sequence is generated of all the established Non-GBR logical channels according to the QCI weights of each non-GBR logical channel of UE using WRR method. The WRR method determines which bearer to select for filling the transport block, whereas the amount of data taken from one bearers is not limited which in turn leads to a WRR like allocation of resources to bearers (given same traffic arrival behaviour for the bearers) in averge in the long term.

4.4 System impacts

The feature has no additional impacts on the system.

4.5 LTE9 reference data

Requirements

Table 17 LTE9 hardware and software requirements

	FDD	TDD
System release	RL20	RL15TD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	RL50FZ	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	NS20	NS10 CD4
SAE GW	NG20	NG10 CD4
UE	3GPP release 8	3GPP release 8

Alarms

There are no alarms related to the *LTE9: Service Differentiation* feature.

BTS faults and reported alarms

There are no faults related to the *LTE9: Service Differentiation* feature.

Commands

There are no commands related to the *LTE9: Service Differentiation* feature.

Measurements and counters

Table 18 New counters introduced by LTE9

Counter ID	Counter name	Measurement
M8001C270	Mean PDCP SDU delay on DL DTCH for non-GBR DRB	-
M8001C420	UEs with buffered UL data for non-GBR DRB	-
M8006C18	Initial EPS Bearer setup attempts for non-GBR	-
M8006C36	Initial EPS Bearer setup completions for non-GBR	-

For counter descriptions, see LTE Operating Documentation/ Reference/ Counters and Key Performance Indicators.

Note: Additional counters can be derived from the existing counters:

- Additional EPS Bearer setup attempts for non-GBR
- Additional EPS Bearer setup completions for non-GBR
- EPC initiated EPS Bearer Release requests for non-GBR per cause
- eNB initiated EPS Bearer Release requests for non-GBR per cause

Key performance indicators

There are no key performance indicators related to the *LTE9: Service Differentiation* feature.

Parameters

Table 19 New parameters introduced by LTE9

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Activate NonGBR Service Differentiation	actNonGbrServiceDiff	LNBTS	-	common

Table 19 New parameters introduced by LTE9 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Prioritized Bit Rate NonGBR	pbrNonGbr	LNBTS	-	common
AM RLC Poll Byte Table 1	amRlcPBTab1	LNBTS	AM RLC Poll Byte	common
DL Poll Byte	dlPollByte	LNBTS	AM RLC Poll Byte	common
UE Category	ueCategory	LNBTS	AM RLC Poll Byte	common
UL Poll Byte	ulPollByte	LNBTS	AM RLC Poll Byte	common
AM RLC Poll Byte Table 2	amRlcPBTab2	LNBTS	AM RLC Poll Byte	common
DL Poll Byte	dlPollByte	LNBTS	AM RLC Poll Byte	common
UE Category	ueCategory	LNBTS	AM RLC Poll Byte	common
UL Poll Byte	ulPollByte	LNBTS	AM RLC Poll Byte	common
AM RLC Poll Byte Table 3	amRlcPBTab3	LNBTS	AM RLC Poll Byte	common
DL Poll Byte	dlPollByte	LNBTS	AM RLC Poll Byte	common
UE Category	ueCategory	LNBTS	AM RLC Poll Byte	common
UL Poll Byte	ulPollByte	LNBTS	AM RLC Poll Byte	common
AM RLC Poll Byte Table 4	amRlcPBTab4	LNBTS	AM RLC Poll Byte	common
DL Poll Byte	dlPollByte	LNBTS	AM RLC Poll Byte	common
UE Category	ueCategory	LNBTS	AM RLC Poll Byte	common
UL Poll Byte	ulPollByte	LNBTS	AM RLC Poll Byte	common
AM RLC Poll Byte Table 5	amRlcPBTab5	LNBTS	AM RLC Poll Byte	common
DL Poll Byte	dlPollByte	LNBTS	AM RLC Poll Byte	common
UE Category	ueCategory	LNBTS	AM RLC Poll Byte	common
UL Poll Byte	ulPollByte	LNBTS	AM RLC Poll Byte	common
QCI Translation Table QCI 5	qciTab5	LNBTS	QCI Translation Table	common
DSCP	dscp	LNBTS	QCI Translation Table	common

Table 19 New parameters introduced by LTE9 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Logical Channel Group Identifier	lcgid	LNBTS	QCI Translation Table	common
PDCP Profile Index	pdcpProfIdx	LNBTS	QCI Translation Table	common
Priority	prio	LNBTS	QCI Translation Table	common
QCI	qci	LNBTS	QCI Translation Table	common
QCI Support	qciSupp	LNBTS	QCI Translation Table	common
Resource Type	resType	LNBTS	QCI Translation Table	common
RLC Mode	rlcMode	LNBTS	QCI Translation Table	common
RLC Profile Index	rlcProfIdx	LNBTS	QCI Translation Table	common
Scheduling Bucket Size Duration	schedulBSD	LNBTS	QCI Translation Table	common
Scheduling Priority	schedulPrio	LNBTS	QCI Translation Table	common
Scheduling Type	schedulType	LNBTS	QCI Translation Table	common
Scheduling Weight	schedulWeight	LNBTS	QCI Translation Table	common
QCI Translation Table QCI 6	qciTab6	LNBTS	QCI Translation Table	common
DSCP	dscp	LNBTS	QCI Translation Table	common
Logical Channel Group Identifier	lcgid	LNBTS	QCI Translation Table	common
PDCP Profile Index	pdcpProfIdx	LNBTS	QCI Translation Table	common
Priority	prio	LNBTS	QCI Translation Table	common

Table 19 New parameters introduced by LTE9 (Cont.)

Full name	Abbreviated name	Manage d object	Parent structure	FDD/TDD
QCI	qci	LNBTS	QCI Translation Table	common
QCI Support	qciSupp	LNBTS	QCI Translation Table	common
Resource Type	resType	LNBTS	QCI Translation Table	common
RLC Mode	rlcMode	LNBTS	QCI Translation Table	common
RLC Profile Index	rlcProfIdx	LNBTS	QCI Translation Table	common
Scheduling Bucket Size Duration	schedulBSD	LNBTS	QCI Translation Table	common
Scheduling Priority	schedulPrio	LNBTS	QCI Translation Table	common
Scheduling Weight	schedulWeight	LNBTS	QCI Translation Table	common
QCI Translation Table QCI 7	qciTab7	LNBTS	QCI Translation Table	common
DSCP	dscp	LNBTS	QCI Translation Table	common
Logical Channel Group Identifier	lcgid	LNBTS	QCI Translation Table	common
PDCP Profile Index	pdcpProfIdx	LNBTS	QCI Translation Table	common
Priority	prio	LNBTS	QCI Translation Table	common
QCI	qci	LNBTS	QCI Translation Table	common
QCI Support	qciSupp	LNBTS	QCI Translation Table	common
Resource Type	resType	LNBTS	QCI Translation Table	common
RLC Mode	rlcMode	LNBTS	QCI Translation Table	common

Table 19 New parameters introduced by LTE9 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
RLC Profile Index	rlcProfIdx	LNBTS	QCI Translation Table	common
Scheduling Bucket Size Duration	schedulBSD	LNBTS	QCI Translation Table	common
Scheduling Priority	schedulPrio	LNBTS	QCI Translation Table	common
Scheduling Weight	schedulWeight	LNBTS	QCI Translation Table	common
QCI Translation Table QCI 8	qciTab8	LNBTS	QCI Translation Table	common
DSCP	dscp	LNBTS	QCI Translation Table	common
Logical Channel Group Identifier	lcgid	LNBTS	QCI Translation Table	common
PDCP Profile Index	pdcpProfIdx	LNBTS	QCI Translation Table	common
Priority	prio	LNBTS	QCI Translation Table	common
QCI	qci	LNBTS	QCI Translation Table	common
QCI Support	qciSupp	LNBTS	QCI Translation Table	common
Resource Type	resType	LNBTS	QCI Translation Table	common
RLC Mode	rlcMode	LNBTS	QCI Translation Table	common
RLC Profile Index	rlcProfIdx	LNBTS	QCI Translation Table	common
Scheduling Bucket Size Duration	schedulBSD	LNBTS	QCI Translation Table	common
Scheduling Priority	schedulPrio	LNBTS	QCI Translation Table	common
Scheduling Weight	schedulWeight	LNBTS	QCI Translation Table	common

Table 19 New parameters introduced by LTE9 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
QCI Translation Table QCI 9	qciTab9	LNBTS	QCI Translation Table	common
DSCP	dscp	LNBTS	QCI Translation Table	common
Logical Channel Group Identifier	lcgid	LNBTS	QCI Translation Table	common
PDCP Profile Index	pdcpProfIdx	LNBTS	QCI Translation Table	common
Priority	prio	LNBTS	QCI Translation Table	common
QCI	qci	LNBTS	QCI Translation Table	common
QCI Support	qciSupp	LNBTS	QCI Translation Table	common
Resource Type	resType	LNBTS	QCI Translation Table	common
RLC Mode	rlcMode	LNBTS	QCI Translation Table	common
RLC Profile Index	rlcProfIdx	LNBTS	QCI Translation Table	common
Scheduling Bucket Size Duration	schedulBSD	LNBTS	QCI Translation Table	common
Scheduling Priority	schedulPrio	LNBTS	QCI Translation Table	common
Scheduling Weight	schedulWeight	LNBTS	QCI Translation Table	common
DL Scheduling weight	schedulWeightDl	LNBTS	QCI Translation Table	common
UL Scheduling weight	schedulWeightUl	LNBTS	QCI Translation Table	common
Profile 1 of RLC Parameters	rlcProf1	LNBTS	-	common
Poll PDU	pollPdu	LNBTS	-	common
RLC Profile Id	rlcProfileId	LNBTS	-	common

Table 19 New parameters introduced by LTE9 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Timer Poll Retransmit	tPollRetr	LNBTS	-	common
Timer Status Prohibit	tProhib	LNBTS	-	common
Timer Reordering	tReord	LNBTS	-	common
Profile 2 of RLC Parameters	rlcProf2	LNBTS	-	common
Poll PDU	pollPdu	LNBTS	-	common
RLC Profile Id	rlcProfileId	LNBTS	-	common
Timer Poll Retransmit	tPollRetr	LNBTS	-	common
Timer Status Prohibit	tProhib	LNBTS	-	common
Timer Reordering	tReord	LNBTS	-	common
Profile 3 of RLC Parameters	rlcProf3	LNBTS	-	common
Poll PDU	pollPdu	LNBTS	-	common
RLC Profile Id	rlcProfileId	LNBTS	-	common
Timer Poll Retransmit	tPollRetr	LNBTS	-	common
Timer Status Prohibit	tProhib	LNBTS	-	common
Timer Reordering	tReord	LNBTS	-	common
Profile 1 of PDCP parameters	pdcpProf1	LNBTS	-	common
PDCP profile ID	pdcpProfileId	LNBTS	-	common
Status report required	statusRepReq	LNBTS	-	common
Timer discard	tDiscard	LNBTS	-	common
Profile 2 of PDCP parameters	pdcpProf2	LNBTS	-	common
PDCP profile ID	pdcpProfileId	LNBTS	-	common
Status report required	statusRepReq	LNBTS	-	common
Timer discard	tDiscard	LNBTS	-	common

Table 19 New parameters introduced by LTE9 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Profile 3 of PDCP parameters	pdcpProf3	LNBTS	-	common
PDCP profile ID	pdcpProfileId	LNBTS	-	common
Status report required	statusRepReq	LNBTS	-	common
Timer discard	tDiscard	LNBTS	-	common

For parameter descriptions, see LTE Operating Documentation/ Reference/ Parameters.

Sales information

Table 20 LTE9 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

4.6 Activating the LTE9: Service Differentiation Feature Using BTS Site Manager

Purpose

Follow this procedure to activate the *LTE9: Service Differentiation* feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

All parameters are online modifiable.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

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3 Modify the eNB configuration settings.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

The configuration elements related to the **LTE9** feature are found in the following tabs:

- On page “Radio network configuration”, from the left upper corner select “LNBTS” in the navigation tree.
- In “LNBTS Properties” list select the `Activate NonGBR Service Differentiation` parameter and set the **True** value.
- In “LNBTS Properties” list the `Prioritized Bit Rate NonGBR` parameter is set to default value. Setting of this parameter is only necessary if a different value is required.

The LTE9: Service Differentiation feature allows to differentiation of 5 different non-GBR QCI classes (QCI 5-9) with relative scheduling weights. It is possible to enable/disable the support of individual QCIs.

- On page “Radio network configuration” select “QCI Translation Table QCIx” under “LNBTS” category in the navigation tree on the left side of the page, and drop the list down. Note that there are 5 “QCI Translation Table QCIx” structures that can be modified. The variable “x” can take values: 5, 6, 7, 8, 9.
- Select “QCI Translation Table QCIx-1” and on the right side of this page there is the list of configurable parameters listed below:
  - `DSCP` - this parameter configures the Differentiated Services Code Point value associated with the QCI
  - `Logical Channel Group Identifier` - this parameter is used for configuration of the buffer status reports of UE
  - `PDCP Profile Index` - this parameter specifies the ID of the corresponding PDCP profile
  - `Priority` - this parameter gives the priority of the EPS bearer. This parameter is not configurable.
    - QCI5 has the highest `Priority` value **1**
    - for QCI6 `Priority` = **6**
    - for QCI7 `Priority` = **7**
    - for QCI8 `Priority` = **8**
    - for QCI9 `Priority` = **9**
  - `QCI` - QoS Class Identifier. This parameter is not configurable.
  - `QCI Support` - this parameter indicates whether the given QCI is supported and enabled. If this QCI is supported, the value of this parameter is **ENABLE**.
  - `RLC Mode` - this parameter configures the RLC Mode of the data radio bearer. This parameter is not configurable and set to **RLC_AM** for all QCIs.

- `RLC Profile Index` - this parameter specifies the ID of the corresponding RLC profile
- `Resource Type` - the Resource Type indicates whether the bearer is a GBR or NON-GBR bearer. In this case for all QCI the Resource Type parameter is not configurable and set to **nonGBR** value.
- `Scheduling Bucket Size Duration` - this parameter is used to configure the Bucket Size Duration (BSD) of the UL scheduler
- `Scheduling Priority` - this parameter describes Logical Channel Priority for the UE scheduler. Increasing priority values indicate lower priority.
- `Scheduling Type` - this parameter exsist only for QCI5. This parameter specifies how the EPS bearer with QCI5 is scheduled. For the scheduling type **SIGNALLING** the bearer is handled like SRBs. For the scheduling type **NON-GBR** the bearer is handled like other non-GBR bearers.
- `Scheduling Weight` - this parameter specifies the scheduling weight for eNB schedulers.

With the *LTE9: Service Differentiation* functionality, it is possible to define three different RLC/PDCP profiles per BTS which can be assigned to different QCIs.

- To define RLC profiles, on the page “Radio network configuration”, select “Profile x of RLC parameters” under “LNBTS” category, and drop the list down. Select “Profile x of RLC parameters-1” and on the right side on this page there is a list of parameters that can be set. Note that variable x in this case can take values: 1, 2, 3.
  - `Poll PDU` - this parameter defines the number of RLC PDUs that are sent on a logical channel before the RLC polling bit is set.
  - `RLC Profile Id` - this parameter identify of the RLC profile and is not configurable.
  - `Timer Poll Retransmit` - this timer is used by the transmitting side of an AM RLC entity in order to retransmit a poll. The value of the timer needs to be larger than twice the value of the `Timer Reordering` parameter.
  - `Timer Status Prohibit` - this timer is used by the receiving side of an AM RLC entity in order to prohibit transmission of a STATUS PDU
  - `Timer Reordering` - this timer is used by the receiving side of an AM RLC entity for reordering, PDU loss detection and delay of STATUS PDU transmission. This timer depends on HARQ RTT and number of HARQ retransmissions.
- To define PDCP profiles, on the page “Radio network configuration”, select “Profile x of PDCP parameters” under “LNBTS” category, and drop the list down. Select “Profile x of PDCP parameters-1” and on the right side on this page there is a list of parameters that can be set. Note that variable x in this case can take values: 1, 2, 3.
  - `PDCP profile ID` - this parameter Identifies the PDCP profile and is not configurable
  - `Status report required` - this parameter determines whether a PDCP status report is sent from the PDCP receiver to the PDCP transmitter. The PDCP status report may be sent from eNB to UE (eNB PDCP status report) or from UE to eNB (UE PDCP status report). Possible settings: **00**: no status report **01**: eNB status report **10**: UE status report **11**: eNB and UE status report.

- `Timer discard` - this parameter indicates the delay before a PDCP PDU along with the corresponding PDCP SDU is discarded from the buffer. This timer should be set in a way that the packet delay defined by the QCI characteristics is kept. The timer can be disabled by setting the parameter to disabled.

During configuration of the *LTE9: Service Differentiation* functionality the parameters for AM RLC Poll Byte structure needs to be configured.

On the “Radio network configuration” page, select “AM RLC Poll Byte Table x” under “LNBTS” category, and drop the list down. Select “AM RLC Poll Byte Table x-1” and on the right side on this page there is a list of parameters that can be set. Note that variable x in this case can take values: 1, 2, 3, 4, 5.

- `DL Poll Byte` - this parameter identify AM RLC Poll Byte value in DL direction for UE
- `UE Category` - this parameter defines category of the UE and is not configurable
- `UL Poll Byte` - this parameter identify AM RLC Poll Byte value in UL direction for UE

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page

b) Select option **All parameters (requires reset)**

c) Click **Send Parameters**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

Expected outcome

The *Service Differentiation* feature is enabled. The individual QCIs with relative scheduling weights are set.

4.7 Deactivating the LTE9 Feature Using BTS Site Manager

Purpose

Follow this procedure to deactivate the *LTE9: Service Differentiation* feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

All parameters are online modifiable.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

The configuration elements related to the **LTE9** feature are found in the following tabs:

- On page “Radio network configuration”, from the left upper corner select “LNBTS” in the navigation tree. On the right site of this page there is “LNBTS Properties” list with listed parameters.
  Select `Activate NonGBR Service Differentiation` parameter and set the **false** value.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page

b) Select option **All parameters (requires reset)**

c) Click **Send Parameters**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

Expected outcome

The *Service Differentiation* feature is disabled.

5 LTE10: EPS Bearers for Conversational Voice

5.1 Introduction to the feature

The *LTE10: EPS bearers for conversational voice* feature allows to introduce high-quality managed IMS-based conversational voice services in LTE. A service is a bi-directional traffic stream, or equivalently, a set of several associated traffic streams between a **UE** and a remote endpoint. This creates the need to support multiple data radio bearers (as provided by the LTE7: Support of multiple EPS bearer feature), and to support appropriate data radio bearer combinations per UE. For IMS-based conversational voice, this bearer combination consists of one **UM DRB** which carries the voice data, and one **AM** DRB which carries the associated **IMS** signaling.

The following radio bearer combinations per UE are supported by the evolved Node B (eNB) in LTE10:

- SRB1 + SRB2 + 1 x AM DRB + 1 x UM DRB
- SRB1 + SRB2 + 2 x AM DRB + 1 x UM DRB
- SRB1 + SRB2 + 3 x AM DRB + 1 x UM DRB
- SRB1 + SRB2 + 4 x AM DRB + 1 x UM DRB

Thus it is possible to use simultaneously two signaling radio bearers (**SRB**s), up to four AM DRBs and additionally one UM DRB.

Conversational voice service support is restricted to dynamic scheduling. Dynamic scheduling for UL/DL in the user plane considers **QoS** requirements and performs proper prioritization to meet them, which might result in some downgrading of the service for non-GBR bearers.

Conversational voice is assigned the QoS Class Indicator (**QCI**) =1. The requirements associated with this QCI are met by assigning a GBR bearer to the voice data stream. Therefore, the eNodeB evaluates corresponding UE capabilities and the requested bit rate value, as indicated via **S1AP** procedures, and admits GBR bearers if neither the supported maximum GBR for QCI=1, nor the specific admission limits for GBR bearers are exceeded. Any other traffic that is also mapped to QCI=1 will experience the same QoS, while the traffic handling is still optimized for conversational voice traffic. To fully account for the prioritization requirements of conversational traffic, the associated IMS signaling packet stream has to be assigned a data radio bearer with an appropriate QCI. QCI=5 is expected to provide sufficient properties. The eNodeB assumes that a DRB of sufficient properties is already established when it receives the request for establishing the conversational voice service. The eNodeB does not perform any checks in this respect.

The upper throughput limit of the GBR service in downlink direction is enforced by the **PDN** gateway. In uplink the eNodeB assumes that the GBR throughput limit is enforced in the UE.

5.2 Benefits

This feature enables the operator to offer conversational voice over LTE.

5.3 Functional description

The *LTE10: EPS bearers for conversational voice* feature introduces a range of new functions to user-plane radio resource management:

- Delay-based scheduling in DL and in UL for bearers with QCI=1
- Outer loop delay target control in DL
- Head of Line (HOL) estimation in UL
- Consideration of **GBR** bearer in **MAC** multiplexing in DL
- New scheduler type: exhaustive UL Frequency Domain scheduler
- Packet aggregation in UL/DL

Admission Control in the eNodeB ensures that a configurable number of active GBR-**DRB**s in a radio cell is not exceeded. An incoming handover is rejected if this number would be exceeded by a new UE entering a radio cell.

5.3.1 Delay based scheduling in DL and in UL for bearers with QCI=1

The **PDCP** layer in the eNodeB provides all **IP** packets received via **S1** with a timestamp that is taken from the local (system) time of the eNodeB. All IP packets received from a source node are provided with a timestamp constructed from the local time of the target eNodeB, reduced by a configurable correction value. These timestamps are forwarded to the MAC layer and taken into account by the scheduler, in order to meet **QoS** requirements with respect to maximum packet delay.

In uplink, the scheduler:

- assumes that conversational voice traffic is identified by QCI=1
- performs prioritization of conversational voice data, based on the (configurable) packet delay budget as provided by control plane, and on the experienced waiting time in UE,
- provides specific treatment of the separate data radio bearer that carries **IMS** signaling and is associated with the QCI=1 bearer. This specific treatment requires that QCI=5 is set for the bearer.

In downlink, the scheduler:

- provides specific treatment of the separate data radio bearer that carries IMS signaling. This specific treatment requires that QCI=5 is set for the bearer.
- assumes that the maximum admitted guaranteed data rate for conversational voice service is limited to 250 kbit/s per UE.
- assumes that the guaranteed data rate of admitted bearers with QCI=1 is already enforced in the **EPC**, and that timely transmission of corresponding data packets is sufficient.
- handles traffic with QCI=5 either with priority corresponding to signaling data or as regular non-GBR data radio bearers (with corresponding relative weight, if applicable) depending on indication from the control plane.

- considers GBR in addition to UE AMBR when determining the maximum resource allocation for a UE.

5.3.2 Outer loop delay target control in DL

Delay-based prioritization does not explicitly control the probability of packets being received correctly within a given delay target value. Therefore, a mechanism called Outer Loop Delay Target Control (OLDTC) or Outer Loop Delay Budget Control (OLDBC) is provided. This mechanism can be activated using the `dlsOldtcEnable` parameter. OLDTC modifies the delay-based prioritization values in dependence of the delay target excess rate, on a per-UE basis. So, if packets belonging to a bearer with QCI=1 established towards a UE are transferred correctly within the delay target, the prioritization values are decreased by a small amount. Conversely, if the packets exceed the delay target, the prioritization value is increased.

5.3.3 HOL packet delay estimation in UL

The head of line (HOL) packet represents the oldest packet that has arrived in a transmission buffer of the UE. The delay experienced by this HOL packet is estimated by the eNodeB, in order to maintain the required QoS and also to find an estimation of the data volume in the UE buffer that might be transmitted together using packet aggregation. In the UE, in UL direction, the arrival of a packet in a higher priority logical channel triggers a scheduling request (SR) if no UL grant from eNodeB is available, whereas if an UL grant is available, a “Regular BSR” (Buffer Status Report) is sent. The eNodeB evaluates the BSRs that are related to the logical channel groups (LGC) to which the bearer with QCI is mapped.

The estimated HOL packet delay is based on a set of data which includes:

- The UL **TTI** in which a BSR (related to the LGC of interest) was transmitted. This instance of time is calculated from the value found in the BSR, and the GBR.
- The UL TTI in which an uplink transmission is made which contains data from the UE's VoIP transmission buffer. This value is estimated from the last UL grant which contains a GBR portion.
  This estimate is corrected as soon as the expected packet is correctly received by the eNodeB.
- The UL TTI in which an SR is transmitted by the UE. Receiving such an SR immediately after a BSR with filling value 0 indicates that the last received packet represented the head of line.
  Other relations between SR transmission, BSR, and UL packet transmission yield further indication about the situation of the current HOL packet in the UE's transmission buffer.

The derived value for HOL packet delay in the UE's transmission buffer is taken into account by the UL scheduler in the eNodeB.

5.3.4 Consideration of GBR bearer in MAC multiplexing in DL

The MAC layer in the eNodeB is updated to support service differentiation for bearers with QCI=1 in DL, and to provide multiplexing of data from multiple logical channels into single MAC DL PDUs. Depending on the configuration, data from the bearer with QCI=5 is either interpreted as being control data or as being regular non-GBR data. This combined data takes second priority, after control elements, data from signaling bearers and other control data, and before data originating from non-GBR bearers, assuming that GBR bearers always have higher priority. Data originating from non-GBR bearers gets the residual capacity that is left unused by GBR bearers.

5.3.5 New scheduler type: exhaustive FD scheduler

In uplink, an alternative to the Round Robin scheduler is introduced, which is the exhaustive UL Frequency Domain scheduler.

The round-robin scheduler uses a two-step approach to create a list of UEs, which are candidates for being assigned UL resources in a TTI. From this list, the scheduler assigns **PRB**s to the UEs, starting with the entry of highest priority and walking through the list in round-robin fashion for as long as resources are available, as determined by the fast adaptive transmission bandwidth (fast **ATB**) function. The Round Robin scheduler allocates resources in a fixed size of one PRB per allocation, which means its packet allocation size is fixed to 1. Since the Round Robin scheduler may assign resources to a large number of UEs, it might run into a shortage of **PDCCH** space that is required to carry the associated signaling data.

The exhaustive Frequency Domain Scheduler selects a small number of UEs (fewer than are specified by the Max_#_UE_UL parameter) and assigns them all available PRBs for the TTI under consideration. This method creates less signaling load and therefore can avoid congestion on PDCCH. To take the full benefit of this, the exhaustive FD Scheduler allows the aggregation of transport blocks carrying **VoIP** samples.

The type of the uplink scheduler can be selected by the `ulsFdPrbAssignAlg` parameter.

5.3.6 Packet aggregation in UL/DL

Packet aggregation means that VoIP packets are collected in a buffer and then transmitted together. Packet aggregation therefore introduces some additional delay in the transmission of VoIP packets.

Packet aggregation in uplink requires that the exhaustive Frequency Domain Scheduler is chosen.

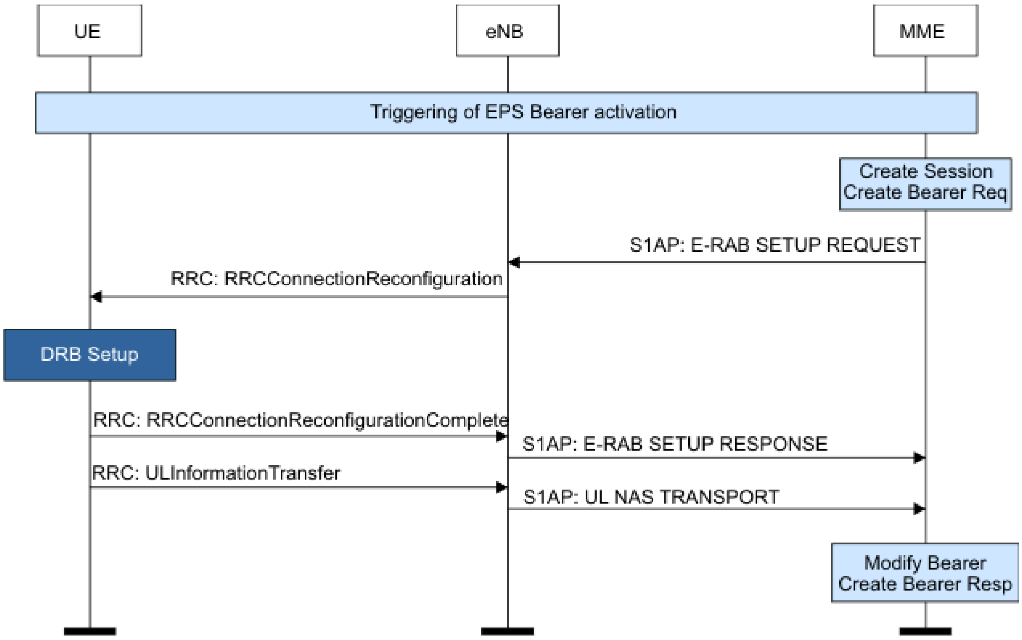
UEs with established bearer with QCI=1 are prioritized in scheduling such that data belonging to the QCI=1 bearer do not experience more delay than is specified in a configurable delay target. The quality experienced by non-GBR traffic may be reduced due to this prioritization. Prioritization is applied to all kinds of traffic mapped to QCI=1. No additional rate control of the GBR traffic is applied in eNodeB.

5.3.7 Bearer establishment

The voice service on the GBR EPS bearer with QCI=1 (QoS class indicator) is mapped to a DRB that works on RLC in unacknowledged mode.

Figure 6: EPS bearer establishment by S1AP: E-RAB setup request shows a message flow for creating this bearer. The evolved Node B (eNodeB) takes the GBR (guaranteed bit rate) into account, which is signaled on the S1 interface, for example in an S1AP: E-RAB SETUP REQUEST message.

Figure 6 EPS bearer establishment by S1AP: E-RAB setup request



The S1AP: E-RAB SETUP REQUEST message has to contain:

- QCI (separately for each EPS bearer)
  QCI is defined in the E-RAB Level QoS Parameters IE and is used for QCI interpretation.
- GBR (separately for each EPS bearer and each direction)
  If the GBR QoS Information IE is missing for a GBR bearer, the setup of this EPS bearer is rejected. Setup of any remaining bearers is continued.
- ARP (allocation and retention priority)
  ARP is stored in the eNodeB for later transfer to a target eNodeB during handover.

5.3.8 Radio admission control thresholds

Two new thresholds are introduced by radio admission control:

- GBR threshold for new calls
- GBR threshold for incoming calls.

These additional radio admission thresholds for GBR bearers can be configured by the operator on cell basis.

The uplink and downlink schedulers use the GBR delay budget for their scheduling decisions. The delay budget can be configured by the operator. Non-GBR data transmission might be reduced to achieve the GBR for voice users.

Dynamic scheduling is applied for EPS bearers with QCI=1.

The support of EPS bearers with QCI=1 can be enabled/disabled per eNodeB via **OAM**.

5.3.9 Higher value for maximum GBR downlink (maxGbrDl) and maximum GBR uplink (maxGbrUl) parameters for QCI1

In order to enable specific services over QCI1 (like national banking solutions), it is possible to admit QCI1 bearers with GBR higher value than 1024 kbps, provided that sufficient radio resources are available.

Note: Nokia recommends not to exceed the limit of 1024 kbps, as the general handling of QCI1 in eNB is optimized for VoLTE calls and corresponding data rates.

As a temporary solution, the LTE17A release introduces a specific treatment of `maxGbrDl` and `maxGbrUl` parameters setting: the value of 1 kbps is mapped internally by eNB to the value of 30720 kbps and this mapped value is used by related mechanisms/algorithms.

Setting `maxGbrDl` and `maxGbrUl` parameters to values higher than 1024kbps may result in performance degradation such us:

- For QCI1 bearer establishment and modification, the requested GBR will still be checked in dynamic admission control against available radio resource, and the request may be rejected if the bearer with the targeted data rate does not fit within the available resources; the probability of this increases the higher the requested GBR (if transport admission control is active, a similar behaviour may also occur there). This also applies to the mobility of UEs having a high data rate QCI1 bearer established in the target cell (mobility of UEs having high data rate bearers established should be avoided or at least controlled via specific mobility profiles). Due to the increased usage of radio resources with high rate bearers, also the admission probabilities of any lower priority GBR services may be negatively affected. Additionally, the admission probability of regular VoLTE calls may be negatively affected, as there is no differentiation in the handling of high data rate QCI1 bearers versus regular VoLTE calls on QCI1.
- If congestion handling for GBR beares is active either in layer 2 only (deprioritization in scheduling) or in layer 2 and layer 3 (deprioritization in scheduling, potentially followed by pre-emption of bearer), the probability of a GBR bearer to be affected increases the lower the bearers priority (for example, QCI2/3/4), and within the same priority level, the higher the resource consumption on the air interface. Ultimately, even the high data rate QCI1 bearer or a regular VoLTE call on QCI1 may be affected.
- High data rate QCI1 bearers being established concurrently to VoLTE calls on QCI1 may negatively affect the perceived service quality of those VoLTE calls.
- High data rate QCI1 bearers may negatively affect all QCI1 specific performance counters
- Scheduler efficiency may be negatively affected as handling of QCI1 bearers is optimized for VoLTE calls.
- It is recommended to consider potential side effects on high data rate QCI1 bearers or of high data rate QC1 bearers to regular VoLTE calls on QCI1 bearers prior to activation of features being intended specifically for handling of regular VoLTE calls on QCI1. For example, robust header compression should most likely not be activated if high data rate QCI1 bearers are planned to be used.

5.4 System impacts

This feature needs the LTE7: Support of multiple EPS bearerfeature to be enabled.

5.5 LTE10 reference data

Requirements

Table 21 LTE10 hardware and software requirements

	FDD	TDD
System release	RL20	RL15
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Not supported	TD-LBTS4.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	NS20	NS10 CD4
SAE GW	NG20	NG10 CD4
UE	3GPP release 8	3GPP release 8

Alarms

There are no alarms related to the *LTE10: EPS bearers for conversational voice* feature.

BTS faults and reported alarms

There are no faults related to the *LTE10: EPS bearers for conversational voice* feature.

Commands

There are no commands related to the *LTE10: EPS bearers for conversational voice* feature.

Measurements and counters

Table 22 New counters introduced by LTE10

Counter ID	Counter name	Measurement
M8001C419	UEs with buffered UL data for DRB with QCI 1	-

Table 22 New counters introduced by LTE10 (Cont.)

Counter ID	Counter name	Measurement
M8001C 420	UEs with buffered UL data for non-GBR DRB	-

For counter descriptions, see LTE Operating Documentation/ Reference/ Counters and Key Performance Indicators.

Key performance indicators

There are no key performance indicators related to the *LTE10: EPS bearers for conversational voice* feature.

Parameters

Table 23 New parameters introduced by LTE10

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Max Number QCI1 DRBs (GBRs)	maxNumQci1Drb	LNCEL_FDD/ LNCEL_TDD	-	common
Add Number QCI1 DRB for RadioReasHo	addNumQci1DrbRadioReasHo	LNCEL_FDD/ LNCEL_TDD	-	common
Add Number Drb TimeCriticalHo	addNumDrbTimeCriticalHo	LNCEL_FDD/ LNCEL_TDD	-	common
QCI Tab 1	QCITab1	LNBTS	-	common
delayTarget	delayTarget	LNBTS	-	common
Differentiated Services code point	DSCP	LNBTS	-	common
Logical channel group identifier	lcgid	LNBTS	-	common
Priority	prio	LNBTS	-	common
QoS Class Identifier	qci	LNBTS	-	common
QCI support	qciSupp	LNBTS	-	common
Scheduling Bucket Size Duration	scheduleBSD	LNBTS	-	common

Table 23 New parameters introduced by LTE10 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Scheduling Priority	schedulePrio	LNBTS	-	common
Scheduling Type	scheduleType	LNBTS	-	common
Profile101 of PDCP paramters	pdcpProf101	LNBTS	-	common
ROHC Maximum CID	rohcMaxCid	LNBTS	-	common
Sequence Number Size	SnSize	LNBTS	-	common
Timer Discard	tDiscard	LNBTS	-	common
Profile 101 of RLC Parameters	rlcProf101	LNBTS	-	common
SN Field Length Downlink	snFieldLengthDL	LNBTS	-	common
SN Field Length Uplink	snFieldLengthUL	LNBTS	-	common
Timer Reordering	tReord	LNBTS	-	common
Activate support of conversational voice bearer	actConvVoice	LNBTS_FDD/ LNBTS_TDD	-	common
Profile 1 of PDCP parameters	pdcpProf1	LNBTS	-	common
Activate DL OLDTC	actDlsOldtc	LNCEL	-	common
Activate DL voice packet aggregation	actDlsVoicePacketAgg	LNCEL	-	common
Add number QCI1 DRB for timeCriticalHo	addNumQci1DrbTimeCriticalHo	LNCEL	-	common
Cell scheduling request periodicity	cellSrPeriod	LNCEL	-	common
DL OLDTC target	dlsOldtcTarget	LNCEL	-	common
Dedicated SR transmission maximum	dSrTransMax	LNCEL	-	common
Max packet aggregation UL	ulsMaxPacketAgg	LNCEL	-	common
Activate support of conversational voice bearer	actConvVoice	LNBTS	-	common

Table 23 New parameters introduced by LTE10 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Profile 1 of PDCP parameters	pdcpProf1	LNBTS	-	common
Activate DL OLDTC	actDlsOldtc	LNCEL	-	common
Activate DL voice packet aggregation	actDlsVoicePacketAgg	LNCEL	-	common
Add number QCI1 DRB for timeCriticalHo	addNumQci1DrbTimeCriticalHo	LNCEL	-	common
Cell scheduling request periodicit	cellSrPeriod	LNCEL	-	common
DL OLDTC target	dlsOldtcTarget	LNCEL	-	common
Dedicated SR transmission maximum	dSrTransMax	LNCEL	-	common
Max packet aggregation UL	ulsMaxPacketAgg	LNCEL	-	common

For parameter descriptions, see LTE Operating Documentation/ Reference/ Parameters.

Sales information

Table 24 LTE10 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

5.6 Activating the LTE10: EPS Bearers for Conversational Voice Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE10:EPS Bearers for Conversational Voice feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *ActConvVoice* to true.

The cell concerned must be locked before.

The feature LTE7: Support of Multiple EPS Bearer must be activated before. If not, the Activation of this feature will be rejected.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter no restart is needed.

5.7 Deactivating the LTE10: EPS Bearers for Conversational Voice

Purpose

Follow this procedure to deactivate the LTE10: EPS Beares for Conversational Voice feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ▶ Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *ActConvVoice* to false.

The concerned cell must be locked before.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter no restart is needed.

6 LTE11: Robust header compression

6.1 Introduction To The Feature

The feature ” LTE11: Robust header compression” introduces the ROHC for EPS bearers with QCI = 1, these are bearers for voice over IP. For those bearers the payload of the IP packets is almost of the same size or even smaller than the header. Over the end-to-end connection, comprised of multiple hops, these protocol headers are extremely important, but over just one link (hop-to-hop) these headers will be compressed (and decompressed at the other end of the link). Application of ROHC over the air link is possible because IP/UDP/RTP header information is not required for relaying data over the air interface to the receiving UE.

This feature supports ROHC(Robust header compression) for IP/UDP and IP/UDP/RTP headers. It is described in the RFC 3095 and RFC4815.

The IP overhead of the IPv4 or IPv6 is 40 respective 60 bytes. ROHC reduces these values to 2..5 bytes (this is a typical average value).

6.2 Benefits

The main benefit for operator and customer is a considerable reduction of the overhead being transmitted over the air interface in UL/DL in addition to the voice data, i.e., the IP(v4/v6))/RTP/UDP headers

6.3 Functional Description

6.3.1 Short Description of ROHC

The ROHC algorithm establishes a common context at the compressor and decompressor by transmitting full header and then gradually transition to higher level of compression. ROHC is designed to be flexible to support several protocol stacks and each protocol stack defines a **profile** within the ROHC framework.

The following ROHC profiles are supported by this feature:

- ROHC uncompressed (RFC 4995),
- ROHC RTP (RFC 3095, RFC 4815),
- ROHC UDP (RFC 3095, RFC 4815)..

The protocol headers are compressed due to redundancy in the header fields of consecutive packets of the same packet stream. A packet classifier can identify different packet streams by the combination of parameters like protocol headers being carried in the packet, the source and destination addresses etc.

Initially, a few packets are sent uncompressed and are used to establish the context on both sides of the link.The context comprises information about static fields, dynamic fields and their change pattern in protocol headers . This information is used by the compressor to compress the packet as efficiently as possible and then by the decompressor to decompress the packet to its original state (see Figure 7: Principle of ROHC)

Figure 7 Principle of ROHC

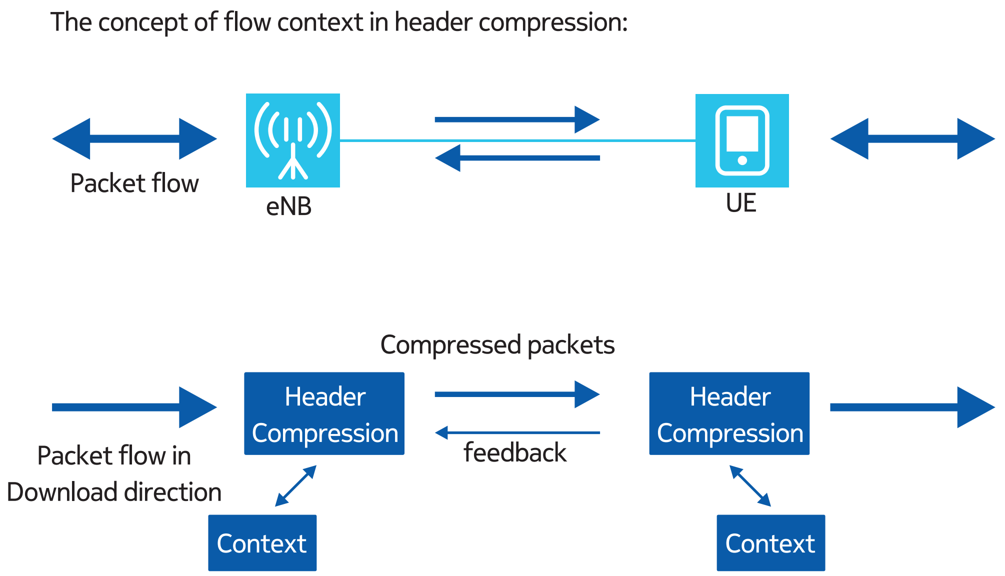
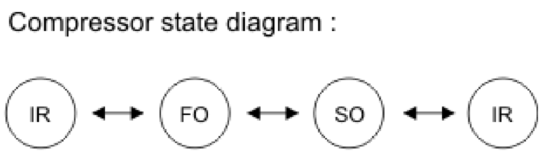


Figure 7: Principle of ROHC shows the download direction, there is also ROHC in the upload direction.

The ROHC compressor operates in 3 states: Initialization and Refresh (IR), First Order (FO) and Second Order (SO). The states describe the increasing level of confidence about the correctness of the context at the decompressor side. The confidence is reflected in the increasing compression of packet headers. In case of error conditions, as indicated by the decompressor using feedback packets, the compressor can move to a lower state to send packets that carry enough information to fix the error in the context of the decompressor.

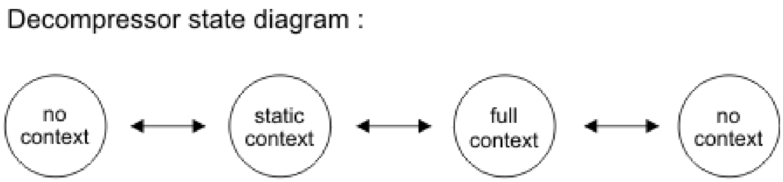
The compressor always starts in the IR state. In this state, it sends uncompressed packets to establish the context at the decompressor side. Once it gains confidence that the decompressor has the context information, it moves to higher states of operation, either via FO state to SO state or directly to SO state, Figure 8: Compressor States.

Figure 8 Compressor States



The decompressor states are shown in the following figure, Figure 9: Decompressor States

Figure 9 Decompressor States



ROHC can run in the following Modes:

Table 25 Modes of ROHC

Mode	Description
U-Mode	In Unidirectional mode, packets are sent in one direction, from the compressor to the decompressor. In cases where the return path of the reserve channels are not available it requires periodic refresh.
O-Mode	In Bidirectional Optimistic mode, a feedback channel is utilized. It does not require periodic refresh.
R-Mode	In Bidirectional Reliable mode, it issues feadback for all context updates.

6.3.2 Bearer Establishment

The next figures (Figure 10: EPS Bearer Establishment Procedure by S1AP: Initial Context Setup Procedure (Attach) and Figure 11: EPS Bearer Establishment Procedure by S1AP: Initial Context Setup Procedure (Service Request)) show the EPS Bearer Establishment procedure triggered by the S1AP message INITIAL CONTEXT SETUP REQUEST according 3GPP:

- Attach procedure, without included UE radio capabilities (Figure 10: EPS Bearer Establishment Procedure by S1AP: Initial Context Setup Procedure (Attach)),
- Service request, with included UE radio capabilities (Figure 11: EPS Bearer Establishment Procedure by S1AP: Initial Context Setup Procedure (Service Request))

The Initial Context Setup procedure supports the ROHC configuration for the conversational voice GBR EPS bearer. This includes:

- Check of the activation of the robust header compression feature,
- Check of the ROHC by the UE,
- Configuration of the ROHC based on the UE capabilities and the PDCP profile for conversational voice if a DRB shall be set up for conversational voice,
- Configuration of ROHC by the RRC: Connection Reconfiguration procedure, if a DRB shall be set up for conversational voice.

Figure 10 EPS Bearer Establishment Procedure by S1AP: Initial Context Setup Procedure (Attach)

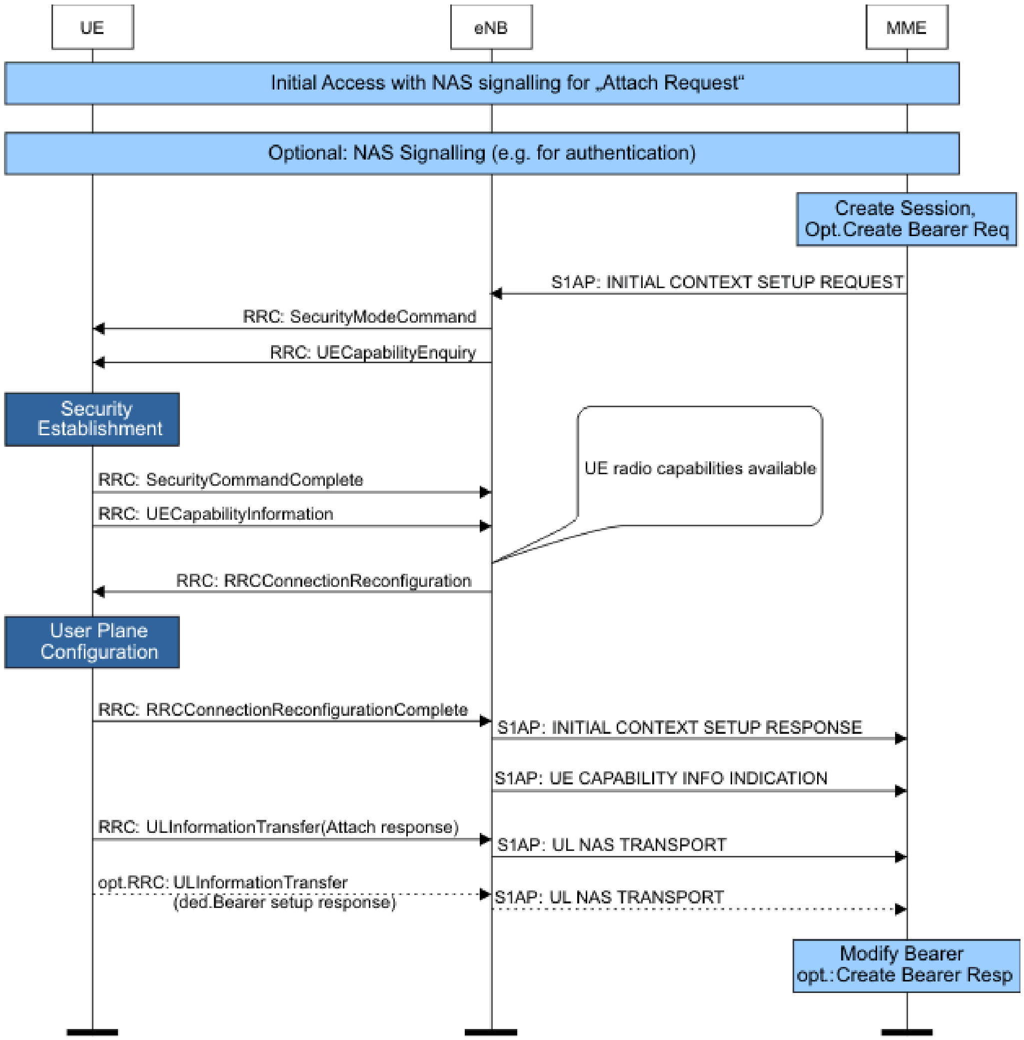
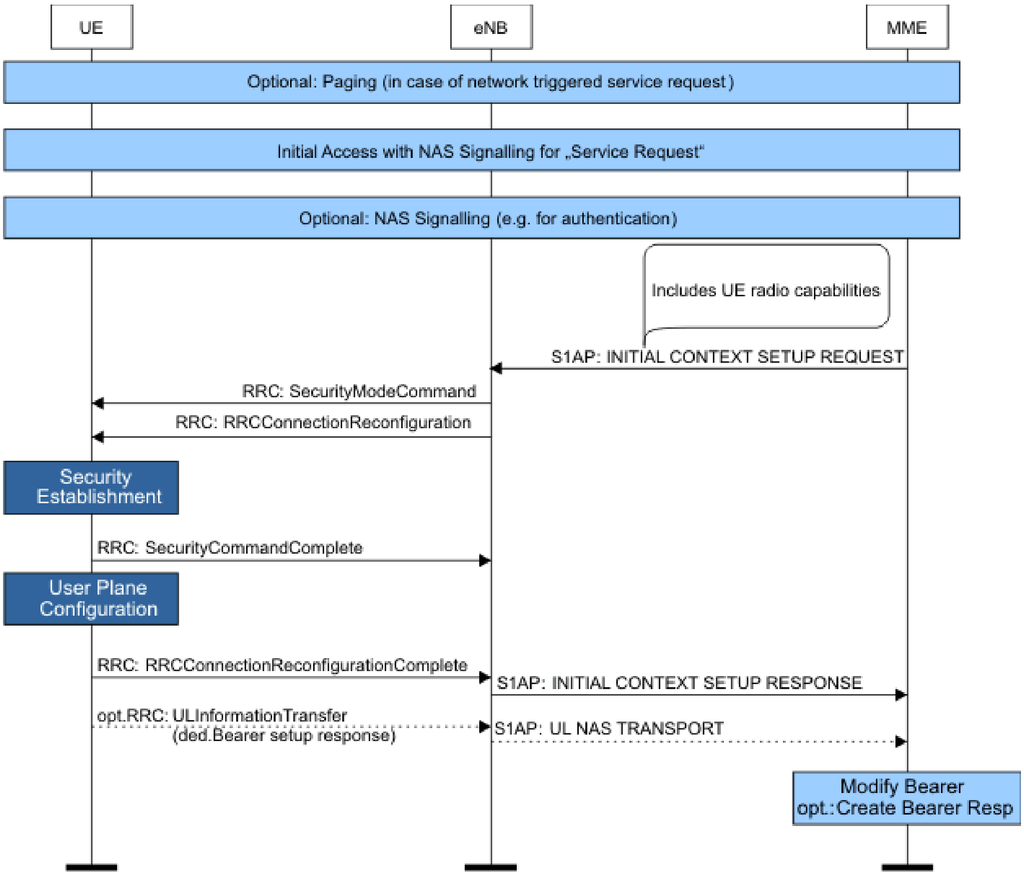


Figure 11 EPS Bearer Establishment Procedure by S1AP: Initial Context Setup Procedure (Service Request)



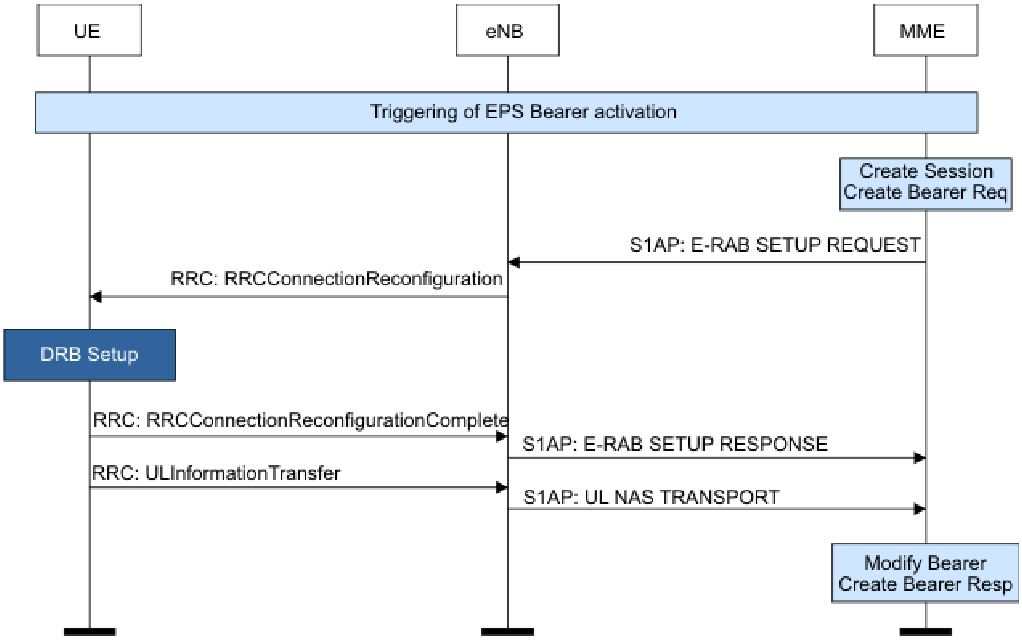
In Figure 12: EPS Bearer Establishment Procedure by S1AP: E-RAB Setup Procedure the establishment of a bearer by the S1AP E-RAB Setup procedure is shown. This procedure is initiated in the following cases:

- The PDN GW request the addition of a new dedicated EPS bearer ([3GPP 23.401), e.g.: the setup of a voice call by IMS
- The UE requests a resource modification that causes the addition of a new dedicated EPS bearer ([3GPP 24.301]:
- The UE requests the addition of a new PDN connection including a new default EPS bearer ([3GPP 23.401]), e.g. : start of an IMS based VoIP application or connecting a laptop to a mobile phone.
- Additionally to the UE requested PDN connectivity, PDN GW might request the addition of new dedicated EPS bearers in combination with the UE requested PDN connectivity procedure ([3GPP 23.401]

The E-RAB Setup procedure supports the ROHC configuration for the conversational voice GBR EPS bearer to be established. This includes

- Check of the activation of the robust header compression feature,
- Check of the support of conversational voice by the UE,
- Configuration of the ROHC based on the UE capabilities and the PDCP profile for conversational voice
- Configuration of ROHC by the RRC Connection Reconfiguration procedure.

Figure 12 EPS Bearer Establishment Procedure by S1AP: E-RAB Setup Procedure



6.3.3 PDCP Adaptation for ROHC

The eNB supports PDCP Control PDU for interspersed RoHC feedback packets. The ROHC feedback packet exchange is only needed for VoIP services which are subject of header compression profiles.

The compressor has the following attributes:

- It is configurable by the layer 3,
- It starts in U-mode operation,
- It transits between the different modes according to the feedback provided by the decompressor (UE side),
- It interprets and reacts according to information provided through feedback packets received by the decompressor (UE side),
- It transits (upward/downward) between compressor states, i.e. IR-/ FO-/ SO-state.

Furthermore the eNB supports a feedback channel for the ROHC. This channel is mandatory in O- mode or R - mode of operation.

The Header Refresh feature is a further attribute of the compressor:

- header refreshes according to RFC2507, considering the number of packets in one period and the number of transmitted full headers.
- the header refreshes apply for FO-state and SO-state (i.e. in IR-state full-headers are anyway transmitted).

The eNB supports timer based downward transition from SO-state to FO-state as well as timer based downward transition from SO-/FO-state to IR-state.

The eNB supports a header decompressor for UL data transfer:

- it is configurable by layer L3,

- it starts with U-mode of operation,
- it provides feedback (if applicable) which are relavant for the compressor on UE side (e.g. mode changes etc.),
- it transits (upward/downward) between decompressor states, i.e. no context, static context and full context.

The eNB supports the decompressor states:

- The no-context, static-context and full-context states,.
- The decompressor starts with the no-context and transits to higher states (no restriction for any kind of transit),
- The decompressor decides autonomously about any state transition,
- The decompressor can transit all the way to full-context once it has sucessfully decompressed a header.

6.4 System Impacts

The following features must be enabled:

- LTE7: Support of multiple EPS bearer,
- LTE10: EPS bearers for conversational voice..

6.5 LTE11 reference data

Requirements

Table 26 LTE11 hardware and software requirements

	FDD	TDD
System release	RL20	RL15TD
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Not supported	TD-LBTS4.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	3GPP release 8	3GPP release 8

Alarms

There are no alarms related to the *LTE11: Robust Header Compression* feature.

BTS faults and reported alarms

There are no faults related to the *LTE11: Robust Header Compression* feature.

Commands

There are no commands related to the *LTE11: Robust Header Compression* feature.

Measurements and counters

There are no measurements or counters related to the *LTE11: Robust Header Compression* feature.

Key performance indicators

There are no key performance indicators related to the *LTE11: Robust Header Compression* feature.

Parameters

Table 27 New parameters introduced by LTE11

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Activate PDCP Robust Header Compression	actPdcpRohc	LNBTS	-	common
ROHC Maximum CID	rohcMaxCid	LNBTS	-	common

For parameter descriptions, see *LTE Operating Documentation/ Reference/ Parameters.*

Sales information

Table 28 LTE11 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

6.6 Activating the LTE11: Robust Header Compression

Purpose

Follow this procedure to activate the *LTE11: Robust Header Compression* feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For deatils, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *ActPdcpROHC* to true.

To use this feature LTE10 must be already activated.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter no restart is needed.

6.7 Deactivating the LTE11: Robust header compression

Purpose

Follow this procedure to deactivate the *LTE11 Robust Header Compression* feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *ActPdcpROHC* to false.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter no restart is needed.

7 LTE13: Rate Capping (UL/DL)

7.1 Introduction to the feature

With the feature *LTE13: Rate Capping (UL/DL)* it is possible to restrict the maximum aggregated non GBR throughput in uplink and downlink.

The *LTE13: Rate Capping (UL/DL)* feature introduces throughput measurement filters in UL Scheduler (UL-S) and DL Scheduler (DL-S). UL-S and DL-S control the UE throughput according to the UE available aggregated maximum bit rate (UE-AMBR) values.

7.2 Benefits

DSL like charging models can be applied with LTE.

7.3 Functional description

The Flexi Multiradio BTS uses the parameter UE Aggregated Maximum Bit Rate (UE-AMBR) which is initially sent from the MME via the S1AP: INITIAL CONTEXT SETUP REQUEST message for its bit rate management. The UE-AMBR parameter is stored in the subscriber profile in the HSS.

The Flexi Multiradio BTS limits the uplink and downlink bit rate of all non-GBR EPS bearers per UE to the level of the signaled UE-AMBR. The Flexi Multiradio BTS considers the aggregated throughput as averaged over one second period.

The initially assigned QoS parameter UE-AMBR can be as well changed. It can be increased or decreased by the MME.

The Flexi Multiradio BTS supports the following S1AP messages for this:

- UE context modification request
- UE context modification response
- UE context modification failure

The MME may also change the UE-AMBR parameter at the following procedures (which are not in the scope of this document):

- E-RAB SETUP REQUEST
- E-RAB RELEASE REQUEST
- PATH SWITCH REQUEST

The following performance counters are supported in order to track the functionality:

- number of UE context modification request
- number of successful modification request
- number of unsuccessful modifications per cause

The change of the UE-AMBR parameter triggers a re-initialization of the UE-AMBR calculation procedure. The operator can enable/disable the functionality on cell basis by O&M settings.

eNB supports rate capping in UL and DL scheduling

Uplink and downlink scheduler is able to limit the bit rate of all non-GBR EPS bearers per UE to the level of the signaled UE-AMBR. The aggregate throughput of all non-GBR EPS bearers is averaged over time for comparison to UE-AMBR.

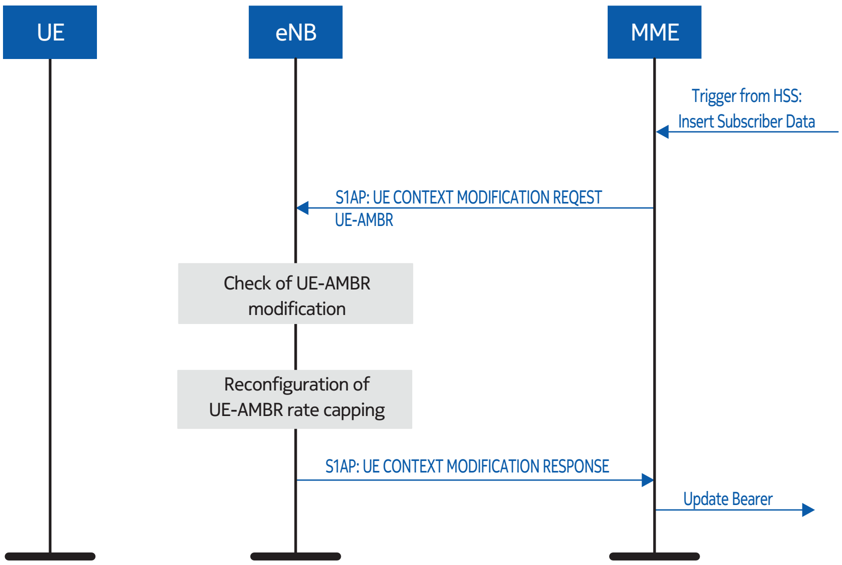
As soon as the average aggregate bit rate of all non-GBR bearers exceeds the signaled UE-AMBR, the maximum rate as scheduled to a UE is limited on a per-subframe basis until the average aggregate bit rate drops again below the value of the UE-AMBR.

Changes of the UE-AMBR resulting from changes to the bearer combination of a UE or from UE context modification are indicated to the rate capping functionality in schedulers immediately and considered accordingly.

UE-AMBR Modification by S1AP UE CONTEXT MODIFICATION REQUEST

The Figure 13: UE-AMBR Modification Procedure shows the UE-AMBR Modification procedure trigged by the S1AP message UE CONTEXT MODIFICATION REQUEST.

Figure 13 UE-AMBR Modification Procedure



The procedure for UE-AMBR modification is triggered by “Insert Subscriber Data” from HSS to MME. MME receives a new “Subscribed UE-AMBR”. The procedure starts in eNB when the eNB receives the S1AP message UE CONTEXT MODIFICATION REQUEST from the MME and the information element “UE Aggregate Maximum Bit Rate” is included. First eNB checks whether the feature “UE-AMBR modification” is activated and then informs the rate capping function of UL and DL schedulers about the modified UE-AMBR. The eNB sends a S1AP acknowledgement UE CONTEXT MODIFICATION RESPONSE to the MME. The MME may start an Update Bearer procedure towards the Serving Gateway or PDN Gateway.

7.4 System impacts

The *LTE13: Rate Capping (UL/DL)* feature has no additional impact on the system.

7.5 LTE13 reference data

LTE13: Rate Capping (UL/DL) requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 29 LTE13 hardware and software requirements

	FDD	TDD
System release	RL20	RL15
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Support not required	TD-LBTS4.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTS2.0	Support not required
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10 CD2	Support not required
SAE GW	Support not required	Support not required
UE	Support not required	Support not required

Alarms

There are no alarms related to the *LTE13: Rate Capping (UL/DL)* feature.

BTS faults and reported alarms

There are no faults related to the *LTE13: Rate Capping (UL/DL)* feature.

Measurements and counters

There are no measurements or counters related to the *LTE13: Rate Capping (UL/DL)* feature.

Key performance indicators

There are no key performance indicators related to the *LTE13: Rate Capping (UL/DL)* feature.

Parameters

Table 30 New parameters introduced by LTE13: Rate Capping UL

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Enable rate capping in uplink	rcEnableUl	LNCEL	-	common
Rate capping AMBR margin in uplink	rcAmbrMgnUl	LNCEL	-	common

Table 31 New parameters introduced by LTE13: Rate Capping DL

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Enable DL rate capping	rcEnableDl	LNCEL	-	common
Rate capping AMBR margin in uplink	rcAmbrMgnUl	LNCEL	-	common

For parameter descriptions, see *LTE Radio Access Operating Documentation/Reference/Parameters*.

Sales information

Table 32 LTE13 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

7.6 Activating the LTE13 Feature Using BTS Site Manager

Purpose

Follow this procedure to activate the *LTE13: Rate Capping (UL/DL)* feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

Restart of an eNB is not required after activation of this feature.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

The configuration elements related to the **LTE13** feature are found in the following tabs:

- On page "Radio network configuration", select *LNBTS* in navigation tree located on the left side of this page. Select *LNCEL* option and on the right side of this page you can choose parameters in *LNCEL Properties* card.
  - the UE-AMBR to be enforced by eNB is received via S1AP signalling
  - Make sure that the `Enable rate capping in uplink` parameter is set to **True**.
  - The `Rate capping AMBR margin in uplink` parameter can be set. If the `Enable rate capping in uplink` parameter is set to **True** the default value of the `Rate capping AMBR margin in uplink` should be used.
  - Make sure that the `Enable DL rate capping` parameter is set to **True**.
  - The `DL rate capping AMBR margin` parameter can be set. If the *Enable DL rate capping* parameter is **False** then `DL rate capping AMBR margin` parameter is not applicable.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Example

After successful transmission of the parameters, the new configuration is automatically activated. BTSSM automatically sends an activation command after finishing the file download.

7.7 Deactivating the LTE13 Feature Using BTS Site Manager

Purpose

Follow this procedure to deactivate the *LTE13: Rate Capping (UL/DL)* feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

Restart of an eNB is not required after activation of this feature.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

The configuration elements related to the **LTE13** feature are found in the following tabs:

- On page “Radio network configuration”, select *LNBTS* in navigation tree located on the left side of this page. Select *LNCEL* option and on the right side of this page you can choose parameters in *LNCEL Properties* card.
  - Set the `Enable rate capping in uplink` parameter to **False**.
  - Set the `Enable DL rate capping` parameter to **False**.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Example

After successful transmission of the parameters, the new configuration is automatically activated. BTSSM automatically sends an activation command after finishing the file download.

8 LTE20: Admission control

The feature introduces a mechanism that decides on the admission of incoming calls based on the number of RRC connections and the number of connected users per cell. Handover requests can be prioritized over initial access requests with individual thresholds.

Connection-based Radio Admission Control (RAC) maintains the eNB in stable operation and ensures a minimum service level for individual end users.

Radio admission control applies separate thresholds for the maximum number of RRC connections and the maximum number of connected users per cell.

8.1 Benefits

The operator-configured number of connection-based RAC maintains the eNB in stable operation, and it further manages a minimum service level per end user.

8.2 Functional description

An RRC connection is established when the Signaling Radio Bearers (SRB1s) have been successfully configured. The UE is considered as RRC connected when a signaling radio bearer is established. The SRB1 establishment is checked against the threshold maxNumRc, SRB2 is admitted together with the default DRB. The number of RRC connected users (only SRB1) includes the number of activated UEs, where the UE has an SRB1, SRB2 and at least 1 DRB. The `threshold maxNumRrc` is greater than the `threshold maxNumActUe`.

Radio admission control thresholds are operator-configurable. The upper limit for the maximum number of supported connections depends on the baseband hardware configuration of the eNB and on cell configuration parameters such as the cell bandwith.

Radio admission control is triggered with SRB1 establishment and for each DRB-Setup or DRB-Release to initial access or due to handover. Possible later resource congestion is handled by the packet scheduler. For more information on packet scheduler function, see *“Packet scheduler”* functional area description.

In RL20 it is possible to admit more than one DRB per UE if *LTE7: Support of Multiple EPS bearers* is activated.

8.2.1 Radio admission control

Radio admission control admits or rejects the requests for the establishment of Radio Bearers (RBs). The scope of radio admission control is cell level.

In case of TDD 3GPP information, see TS.36.300.

8.2.1.1 Basic RAC functions (RL10/TL15)

FDD solution

The RAC (Radio Admission Control) decision scheme bases on the following criteria:

- The number of RRC-connections established in the cell does not exceed an O&M configurative threshold (`Maximium Number of RRC Connections, maxNumRRC`). This criterion implies that RAC is invoked for the admission of SRB1 at RRC Connection Setup.
- The number of active UEs in the cell may not exceed an O&M configurative threshold (`Maximum Number of active UEs, maxNumActUE`) . This criterion implies that RAC is invoked for the admission of the single non-GBR DRB at S1AP Initial Context Setup.
- When a handover message is received, the mobility management function in the telecom control plane of the target eNB requests radio admission control to decide in an “all-or-nothing” manner on the admission/rejection of the resources used by the UE in the source cell prior to the handover. “All-or-nothing” manner means that either both signaling radio bearers AND (logical) all DRBs are admitted or rejected. For a HO (handover) both the number of RRC-connections and the number of active UEs in the cell may not exceed the respective O&M configurative thresholds (`Maximium Number of RRC Connections, Maximum Number of active UEs`) with the thresholds providing different priority depending on the handover cause indicated by mobility management. For the handover cause, the `maxNumRrc` and `maxNumActUe` thresholds are modified by the `additional active Ue with radio reason handover (addAUeRrHo)` and `additional active UE with reason time critical handover (addAueTcHo)`.

TDD solution

The basic function for radio admission control takes into account both the number of established RRC connections and the number of active UEs (users) per cell.

It is aware of scheduling weights and takes into account the UE capabilities. Information on the Quality of Service is provided by QCI parameters.

The `Maximum Bitrate Selector (mbrSelector)` parameter specifies whether the UE capability or the `Maximum Bitrate Downlink (maxBitrateDl)` and `Maximum Bitrate Uplink (maxBitrateUl)` parameters limit the maximum bitrate in UL and DL direction.

The radio access admission control algorithm is responsible for the admission of the Signaling Radio Bearers (SRB1s) and Data Radio Bearers (DBRs).

For UEs accessing the cell because of handover, different admission priorities can be set depending on the handover cause.

The basic non-QoS-aware radio admission control scheme is based on the following criteria:

- **Admission of SRB1 upon RRC connection setup**
  Upon RRC connection setup, the UE state handling function of the Telecom control plane requests radio admission control for the admission of the signaling radio bearer SRB1. Radio admission control compares the number of currently established

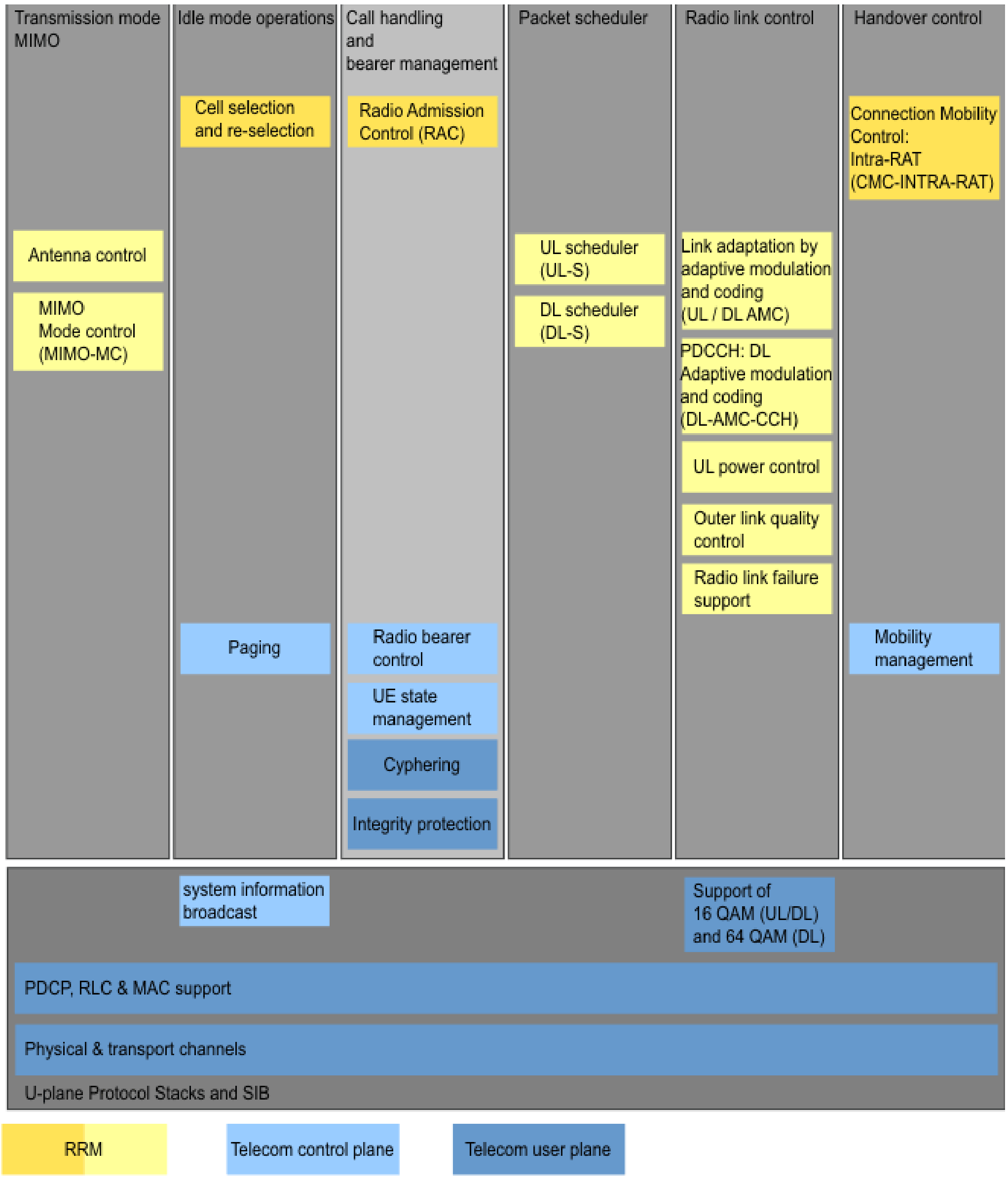
RRC connections in the cell with the `Maximum Number Of RRC Connections (maxNumRrc)` parameter `maxNumRrc` defining the maximum number of RRC connections allowed to be established in the cell.
An RRC connection is taken as established if the SRB1 is admitted and successfully configured. SRB2 is automatically admitted/rejected with the data radio bearer.

- **Admission of DRBs upon S1AP initial context setup**
  Upon S1AP initial context setup, the bearer management function of the Telecom control plane requests radio admission control to admit the DRB setup request for UEs for which the SRB1 and SRB2 have been successfully established.
  Radio admission control decides on the admission/rejection of the single or up to four non-GBR data radio bearers by comparing the number of the currently active UEs in the cell with the `Maximum Number Of Active UEs (maxNumActUE)`. `maxNumActUE` defines the maximum number of active UEs in the cell.
  A UE is active if at least one single non-GBR data radio bearer has been successfully configured for it.
- **Admission of radio bearers in the target cell of a handover**
  When a handover message is received, the mobility management function in the Telecom control plane of the target LBTS requests radio admission control to decide in an “all-or-nothing” manner on the admission/rejection of the resources used by the UE in the source cell prior to the handover. “All-or-nothing” manner means that either both signaling radio bearer AND (logical) all DRBs inclusive a possible GBR-DRBdata radio bearer are admitted or rejected.
  The SRB2 is automatically admitted/rejected with the first non-GBR data radio bearer. Radio admission control decides on the admission/rejection of the UE by comparing the number of already established GBR data rate bearers in the cell with a handover threshold for GRB data rate bearers, the number of established RRC connections `maxNumRrc` AND the number of active UEs in the target cell `maxNumActUE` with the thresholds providing different priority depending on the handover cause indicated by mobility management upon RB Setup Request.
  To ensure different admission priorities for UEs accessing the cell via handover depending on the handover cause, the `maxNumRrc` and `maxNumActUE` thresholds are modified by the `additional Active Ue with Reason Radio Reason Handover (addAUeRrHo)` and `additional Active Ue with Reason Time Critical Handover (addAUeTcHo)` margins associated with the respective handover cause.Mobility management will request handover admission only for a UE with allocated signaling radio bearers and one or more data radio bearers, that is handover is not requested for a UE with SRB1 allocated only. Radio admission is performs the checks only once and not in steps for admission of the UE (non-GBR-DBR) and afterward for a GRB-DRB check.

8.2.1.2 Interaction of radio admission control with other RRM functions

Radio admission control interacts with events driven functions of the Telecom control plane and associated parameters. This section provides an overview of the interactions between radio admission control and other functions. For TDD solution, see Figure 14: Interaction of TDD radio admission control with other functions.

Figure 14 Interaction of TDD radio admission control with other functions



UE State Handling (UE-SH)

Upon RRC connection setup, UE state handling triggers the SRB Setup. Radio admission control responds with the decision to admit or reject the SRB setup.

If the configuration of the admitted SRB1 fails in the Telecom control plane, UE state handling informs radio admission control of that by using the SRB Abort event. Upon RRC connection release, UE state handling informs radio admission control about that by using the UE Release event.

Bearer Management (BM)

Upon initial context setup, bearer management triggers the DRB Setup to request the establishment of the single non-GBR data radio bearer for a UE for which the RRC connection has been successfully established. Radio admission control responds with the radio admission control decision on admission or rejection of the bearer setup.

If the configuration of the admitted data radio bearer fails in the Telecom control plane, bearer management informs radio admission control about that by using the DRB Abort event.

Mobility Management (MM)

In the event of a handover, the admission of the radio bearers at the target cell is carried out in an “all-or-nothing” manner, using event-driven interactions with the mobility management function of the Telecom control plane.

Mobility management at the target eNB requests radio admission control of the target cell to admit the UE for which a handover has been requested. No difference is made between Intra-eNodeB and Inter-eNodeB handover.

Due the 'all-or-nothing' resource allocation principle, mobility management requests the establishment of both SRB1 AND the non-GBR DRB by using the HO RB Setup event.

If the configuration of the admitted radio bearers fails in the Telecom control plane, mobility management inform radio admission control by using the HO Abort event.

If a UE leaves the cell due to a successful handover, mobility management informs radio admission control about that by using the HO UE Release event.

Currently, a handover for a UE with SRB only is not supported.

UL Scheduler (UL-S)

If a DRB Setup or a HO RB Setup has been admitted, radio admission control provides the UL packet scheduler with the following parameters:

- Minimum bit rate required in UL `Minimum Bitrate Uplink (minBitrateUl)`
- Maximum bit rate allowed in UL `Maximum Bitrate Uplink (maxBitrateUl)`

DL Scheduler (DL-S)

If a DRB Setup or a HO RB Setup has been admitted, radio admission control provides the UL packet scheduler with the following parameters:

- Minimum bit rate required in DL `Minimum Bitrate Downlink (minBitrateDl)`
- Maximum bit rate allowed in DL `Maximum Bitrate Downlink (maxBitrateDl)`
- Structure containing the UE_EUTRA_capabilities

8.2.1.3 Radio admission control mechanism

Radio admission control decisions are based on the following criteria:

- TheSRB1 setup request is accepted if the number of established RRC connections in the cell is less than the `Maximum Number Of RRC Connections (maxNumRrc)`. There is no separate check for the SRB2 as it is automatically admitted/rejected with the data radio bearer.
  The SRB Setup, SRB abort, and UE Release event is issued by UE state handling.

- If the number of active UEs in the cell is less than the `Maximum Number Of Active UEs (maxNumActUE)`, the DRB setup request is accepted. Otherwise it is rejected.
  The DRB Setup, DRB Abort and DRB Release events are issued by bearer management.
- For incoming handover requests, the radio admission control decision at the target cell follows the 'all-or-nothing' principle. UEs entering the cell via handover are prioritized with respect to those requesting initial access.
  In addition, different priorities can be specified for individual handover cases. The handover request is accepted if all of the following criteria are true:
  - The number of established RRC connections in the cell is less than the sum of the`Maximum Number Of RRC Connections (maxNumRrc)` and the margin for the handover cause `additional Active Ue with Reason Radio Reason Handover (addAUeRrHo)` or `additional Active Ue with Reason Time Critical Handover (addAUeTcHo)`
  - The number of active UEs in the cell is less than the sum of the `Maximum Number Of Active UEs (maxNumActUE)` for native UEs and the respective bonus margin `additional Active Ue with Reason Radio Reason Handover (addAUeRrHo)` or `additional Active Ue with Reason Time Critical Handover (addAUeTcHo)`

  Otherwise the request is rejected.
  The HO Setup and HO Abort requests are issued by mobility management.

The `Maximum Number Of RRC Connections (maxNumRrc)` defines the upper bound for the sum of UEs with RRC connection (UEs with established SRB1 only) and active UEs (UEs with established SRB1, SRB2 and DRB). `Maximum Number Of RRC Connections (maxNumRrc)` is to be set to a higher value than `Maximum Number Of Active UEs (maxNumActUE).`

8.2.1.3.1 Margin for the maximum number of active UEs in the cell accessing the cell via handover

Two operator-configurable margins can be used to prioritize UEs accessing the cell via handover while at the same time allowing to set different admission priorities depending on the handover cause:

- **`additional Active Ue with Reason Radio Reason Handover (addAUeRrHo)`**
  Margin in terms of additional number of active UEs admitted in the cell on top of those defined by the `maxNumActUe` whenever mobility management requests cell access for a UE due to handover with the cause value "HO desirable for radio reasons".
- **`additional Active Ue with Reason Time Critical Handover (addAUeTcHo)`**
  Margin in terms of additional number of active UEs admitted in the cell on top of those defined by `maxNumActUe` whenever mobility management requests cell access for a UE due to handover with the cause value "Time critical HO".

Setting both parameters to **0** implies that no admission priority is granted for UEs accessing the cell due to handover.If `addAUeTcHo` is set to a higher value than `addAUeRrH`, UEs requesting cell access due to "Time critical HO" have a higher priority than those requesting cell access due to "HO desirable for radio reasons". Although it is recommended to give higher priority to time-critical handover it is up to the operator how to choose the settings for these attributes.

Since active UEs accessing the cell via handover have to be served first of the UEs requesting initial access, the total number of RRC-connected and active UEs in the cell must not exceed certain maximum values representing the system capability.

The maximum number of RRC-connected and active UEs per sector is scaled by the system (carrier) bandwidth.

Table 33: TDD solution System bandwidth dependent settings for admission control decisions due to handover provides recommendations for parameter settings depending on the system bandwidth. It has been assumed that 20% to 30% of the maximum active UEs supported per sector with the respective bandwidth access the cell via handover irrespective of the handover reason.

Table 33 TDD solution System bandwidth dependent settings for admission control decisions due to handover

Parameter	System bandwidth					
	20 MHz		10 MHz		5 MHz	
	range, step size	default value	range, step size	default value	range, step size	default value
`maxNumRrc`	0...800 step 1	760	0…400 step 1	380	0…200 step 1	190
`maxNumActUe`	0...800 step 1	160	0…400 step 1	80	0…200 step 1	40
`addAUeRrH`	0...800 step 1	30	0…400 step 1	15	0…200 step 1	5
`addAUeTcHo`	0...800 step 1	40	0…400 step 1	20	0…200 step 1	10

The `Uplink Channel Bandwidth (ulChBw)` and `Downlink Channel Bandwidth (dlChBw)` parameters specify the bandwidth for the LBTS transmission in a cell and the number of available Physical Resource Blocks (PRBs). The channel bandwidth mapping to the number of physical resource blocks is:

- 5.0 MHz = 25 PRBs
- 10.0 MHz = 50 PRBs
- 15.0 MHz = 75 PRBs
- 20.0 MHz = 100 PRBs

The consistency can be checked for the maximum number of RRC-connected and active use per sector in 3-sector sites as follows:

- **5 MHz bandwidth**
  `maxNumRrc`+max(`addAUeRrH`, `addAUeTcHo`) ≤ 200
  `maxNumActUe`+max(`addAUeRrH`, `addAUeTcHo`) ≤ 200
- **10 MHz bandwidth**
  `maxNumRrc`+max(`addAUeRrH`, `addAUeTcHo`) ≤ 400
  `maxNumActUe`+max(`addAUeRrH`, `addAUeTcHo`) ≤ 400
- **20 MHz bandwidth**
  `maxNumRrc` + max(`addAUeRrH`, `addAUeTcHo`) ≤ 800
  `maxNumActUe` + max(`addAUeRrH`, `addAUeTcHo`) ≤ 800.

8.2.1.3.2 Maximum bit rate in UL and DL

The `Maximum Bitrate Selector (mbrSelector)` parameter offers maximum flexibility in setting the maximum bit rate in UL and DL direction according to requirements from bearer management, mobility management, UL AMC, DL AMC, UL packet scheduler, DL packet scheduler and MIMO mode control.

The `Maximum Bitrate Selector (mbrSelector)` parameter has the following settings:

- **`mbrSelector = ueCapability (0)`**
  The maximum bit rate in UL and DL direction is specified by the throughput and MIMO capabilities of the UE included in the UE_RADIO_CAPABILITES structure provided by bearer management/mobility management.
  The maximum bit rate in UL and DL direction corresponds to the physical layer parameters for the UE category specified in Table 4.1-1 and Table 4.1-2 of 3GPP TS36.306.
  Example: UE of category 3
  - Maximum DL bit rate: 102.048 Mb
  - Maximum UL bit rate: 51.024 Maps
- **`mbrSelector = OaM (1)`**
  The maximum bit rate in UL and DL direction are specified by the minimum out of:
  - the throughput and MIMO capabilities of the UE
  - the `Maximum Bitrate Downlink (maxBitrateDl)` and `Maximum Bitrate Uplink (maxBitrateUl)` parameters

  Example: UE of category 3
  - `maxBitRateDl` = 120 Mbps
  - `maxBitRateUl` = 20 Mbps
  - Maximum DL bit rate: 102.048 Mbp (lower value coming from UE category)
  - Maximum UL bit rate: 51.024 Mbps (lower value coming from the operator-configurable parameters)

8.3 System impact

There is no impact to other features.

8.4 LTE20 reference data

LTE20: Admission control requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 34 LTE20 hardware and software requirements

	FDD	TDD
System release	RL10	RL15TD
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Not supported	TD-LBTS4.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	Support not required	Support not required

Alarms

There are no alarms related to the *LTE20: Admission control* feature.

BTS faults and reported alarms

There are no faults related to the *LTE20: Admission control* feature.

Commands

There are no commands related to the *LTE20: Admission control* feature.

Measurements and counters

There are no measurements or counters related to the *LTE20: Admission control* feature.

Key performance indicators

There are no key performance indicators related to the *LTE20: Admission control* feature.

Parameters

Table 35 Existing parameters related to LTE20

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Maximum Bitrate Downlink	maxBitrateDl	LNCEL	-	common
Maximum Bitrate Uplink	maxBitrateUl	LNCEL	-	common
Additional number of active handovered UEs with handover cause 'HO desirable for radio reasons'	addAUeRrHO	MPUCCH_FDD	-	FDD
		MPUCCH_TDD	-	TDD
Additional number of active handovered UEs with the handover reason 'Time critical Handover'	addAUeTcHo	MPUCCH_FDD	-	FDD
		MPUCCH_TDD	-	TDD
Threshold for the maximum number of UEs in the cell	maxNumActUE	LNCEL_FDD	-	FDD
		LNCEL_TDD	-	TDD
Maximum number of active signalling connections	maxNumRrc	MPUCCH_FDD	-	FDD
		MPUCCH_TDD	-	TDD
Maximum Bitrate Selector	mbrSelector	LNCEL	-	common
Minimum Bitrate in Downlink for DRB	minBitrateDl	LNCEL	-	common
Minimum bitrate in uplink for DRB	minBitrateUl	LNCEL	-	common

For parameters description, see *LTE Radio Access Operating Documentation/Reference/Parameters.*

Sales information

Table 36 LTE20 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

9 LTE27: Open-loop UL Power Control and DL Power Setting

9.1 Introduction to the feature

Open-loop uplink power control

The open-loop uplink power control is the basic power control functionality for uplink transmission. The UE adjusts its transmission power based on a downlink path loss estimate, broadcasted parameters, and uplink transmission configuration. This feature is fundamental for efficient air interface operation.

Downlink power setting

In the downlink direction only a semi-static power control mechanism is applied keeping the eNB's transmission power per unit bandwidth on the same level independently of the allocated downlink bandwidth (flat power spectral density).

9.2 Benefits

This feature offers basic power control functionality for efficient air interface operation.

9.3 Functional description

9.3.1 Functional details

Open-loop power control

Open-loop UL power control is applied on PUSCH, PUCCH and on PRACH. PUSCH can be configured for fractional path loss compensation. The random access procedure applies power ramp-up when multiple access attempts are needed.

The calculations of the UE's transmit power are a bit different for PUSCH, PUCCH and SRS (sounding reference symbol); these are described in 3GPP TS 36.213, also including the factors for closed loop power control. In this feature, only simplified versions are valid – excluding for example, closed loop effects.

Control channels and data channels are handled differently because for control full compensation is desired, while for data partial compensation may yield better performance.

This part includes naming as defined in 3GPP TS 36.213. O&M parameters are provided for the different components of the formulas determining the UE's transmit power.

Calculation of UE's UL transmission power for PUSCH

The UE's transmission power P_{PUSCH} for PUSCH transmission is limited by a configurable maximum value, and beneath this maximum P_{PUSCH} in a subframe i is defined by:

$P_{PUSCH}(i) = 10 \cdot \log_{10}(M_{PUSCH}(i)) + P_{0\_PUSCH}(i) + \alpha \cdot PL + \Delta_{TF}(i)$ [dBm]

with:

- $M_{PUSCH}(i)$: The bandwidth of the allocated PUSCH resources which the subframe i belongs to, expressed in numbers of resource blocks. A larger bandwidth results in an increase of the transmission power (in order to keep the transmission power per frequency in the subframe constant).
- $P_{0\_PUSCH}(i)$: An adjustable power offset used to control the averaged UL received signal power and thereby the UL signal-to-noise ratio. $P_{0\_PUSCH}(i)$ is the sum of a nominal value $P_{0\_NOMINAL\_PUSCH}(i)$ and the UE-specific value $P_{0\_UE\_PUSCH}(i)$.
- α: Fractional compensation factor enabling a flexible trade-off between capacity and fairness. Partial compensation of path loss ($\alpha < 1$) may be tolerable for data transmission and may yield better performance (for example, $\alpha = 0.8$).
- PL: The downlink path loss estimate in dB calculated in the UE. It is the difference between a reference signal power (related to the DL transmission power of the eNB, broadcast to the UE via PBCH) and the reference signal received power (RSRP) which is measured by the UE. The lower the RSRP value, the higher the path loss and the contribution of PL to the transmission power.
- $\Delta_{TF}(i)$: A correction factor taking into account details of the transport format (TF) used for the subframe i (for more details, see 3GPP TS 36.213).

Calculation of UE's UL transmission power for PUCCH

The UE's transmission power P_{PUCCH} for PUCCH transmission is limited by a configurable maximum value, and beneath this maximum P_{PUCCH} in a subframe i is defined by:

$P_{PUCCH}(i) = P_{0\_PUCCH}(i) + PL + h(n_{CQI},n_{HARQ}) + \Delta_{F\_PUCCH}(F)$ [dBm]

with:

- $P_{0\_PUCCH}(i)$: An adjustable power value used to control the averaged UL received signal power and thereby the UL signal-to-noise ratio. $P_{0\_PUCCH}(i)$ is the sum of a nominal value $P_{0\_NOMINAL\_PUCCH}(i)$ and the UE-specific value $P_{0\_UE\_PUCCH}(i)$.
- PL: The downlink path loss estimate in dB calculated in the UE. PL is given as for PUSCH. Note, that no fractional compensation factor α is applied because the path loss of control data signaling is fully compensated.
- $h(n_{CQI},n_{HARQ})$: A PUCCH format dependent value taking into account the different numbers of bits for CQI and HARQ (for more details, see 3GPP TS 36.213).
- $\Delta_{TF}(i)$: A correction factor taking into account details of the PUCCH format (F) used for the subframe i (for more details, see 3GPP TS 36.213).

Calculation of UE's UL transmission power for SRS

The calculation of the UE's transmission power P_{SRS} for sounding reference symbol (SRS) transmission in a subframe i is very similar to that for P_{PUSCH}:

$P_{SRS}(i) = P_{SRS\_OFFSET}(i) + 10 \cdot \log_{10}(M_{SRS}) + P_{0\_SRS}(i) + \alpha \cdot PL + \Delta_{TF}(i)$ [dBm]

with:

- $P_{SRS\_OFFSET}(i)$ defines the power offset for SRS in the UE uplink power control algorithm. Note that the actual power offset depends on the value of `deltaTfEnabled`.

The other naming and meaning of the parameters corresponds with those in the section for PUSCH.

Downlink power setting

Downlink power control is semi-static keeping the eNB's transmission power per bandwidth unit on the same level independently of the allocated downlink bandwidth (flat power spectral density). The flat power spectral density keeps the interference quite flat and tolerable; in the downlink direction, much less interference fluctuations occur than in the uplink direction. Hence, a dynamic downlink power control mechanism is not foreseen. Instead, the eNB's transmission power is used in the adjustment of the cell size (configurable by the `dlCellPwrRed` parameter for macro cell and `pMax` parameter for FZM) and for coverage control.

The downlink power control for PDSCH takes into account the effects of adaptive MIMO and diversity modes (MIMO compensation).

In FZM, the `pMax` parameter can be adjusted in increments of 1 dB, but requires an eNB restart.

In macro cell, anAn online change of `dlCellPwrRed` parameter is possible, but only up to 0.2dB. Every change of `dlCellPwrRed` results in the modification of the SI broadcast message SIB1 with respect to the *systemInfoValueTag* (++ mod32) and SIB2 with respect to the `referenceSignalPower` parameter, which provides the downlink reference signal EPRE, see TS 36.213 [23, 5.2].

The UE checks *systemInfoValueTag* when it returns from out of synchronization, to verify if the previously stored SI messages are unchanged. The UE assumes that its stored system information is valid if the value of *systemInfoValueTag* has not been changed and the time elapsed, since it was successfully confirmed as valid, is less than three hours. If the system information in the cell is modified more often than 31 times within three hours, the UEs may sporadically not recognize that the *systemInfoValueTag* has been changed during its absence (this tag has 5 bits and after 32 modifications it reaches again the same value - the UE then will not re-read the system information).

Anyway if a SIB parameter is modified more often than 31 times per three hours, the changes will be accepted, however, as stated above a temporary ambiguity may arise.

9.4 System impacts

9.4.1 Interdependencies between features

This chapter is divided into *Open-loop UL power control*, *Closed-loop UL power control*, and *Downlink power setting*.

Open-loop UL power control can efficiently compensate long-term variations of the radio conditions such as path loss and shadowing, but it typically suffers from errors in path loss estimations and the setting of the transmission power.

FDD

Closed-loop UL power control, which takes into account eNB measurements of the received uplink signals, and exchanges data between UE and eNB, is less sensitive to errors in path loss estimations and transmit power setting; however, it degrades performance when there is no available feedback due to UL transmission pauses or decoding errors. Thus a combination of open-loop and close-loop power control gives the best results. Based on the results of filtered eNB measurements, the eNB can send power-up or power-down commands to the UE via PDCCH.

TDD

Due to the symmetry between UL/DL of TDD, RL05TD adopt a pure open loop power control.

9.5 LTE27 reference data

Requirements

Table 37 LTE27 hardware and software requirements

	FDD	TDD
System release	RL10	RL15
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Not supported	TD-LBTS5.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	RL50FZ	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE27: Open-loop UL Power Control and DL Power Setting* feature.

BTS faults and reported alarms

There are no faults related to the *LTE27: Open-loop UL Power Control and DL Power Setting* feature.

Commands

There are no commands related to the *LTE27: Open-loop UL Power Control and DL Power Setting* feature.

Measurements and counters

There are no measurements or counters related to the *LTE27: Open-loop UL Power Control and DL Power Setting* feature.

Key performance indicators

There are no key performance indicators related to the *LTE27: Open-loop UL Power Control and DL Power Setting* feature.

Parameters

Table 38 New parameters introduced by LTE27

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Method for UL power control	actUlpcMethod	LNCEL	-	common
DeltaF PUCCH list	dFListPucch	LNCEL	-	common
Delta preamble random access message 3	deltaPreMsg3	LNCEL	-	common
Enabled TB size impact to UE PUSCH power calculation	deltaTfEnabled	LNCEL	-	common
Cell power reduce(for macro cell)/maximum Output Power (for FZM)	dlCellPwrRed /pMax	LNCEL	-	common
MIMO power compensation	dlpcMimoComp	LNCEL _FDD or LNCEL_TD D	-	common; or LNCEL_FDD or LNCEL_TDD for LTE17 onwards
Filter coefficient	filterCoeff	LNCEL	-	common
Nominal power for UE PUCCH TX power calculation	p0NomPucch	LNCEL	-	common
Nominal power for UE PUSCH TX power calculation	p0NomPusch	LNCEL	-	common
Power Offset For SRS Transmission Power Calculation	srsPwrOffset	LNCEL _FDD or LNCEL_TD D	-	common or LNCEL_FDD or LNCEL_TDD for LTE17 onwards
Alpha	ulpcAlpha	LNCEL	-	common
TPC command in Random Access response	ulpcRarespTpc	LNCEL	-	common

For parameter descriptions, see the LTE parameters reference document.

Sales information

Table 39 LTE27 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

10 LTE28: Closed loop UL power control

10.1 Introduction to the feature

Closed loop UL power control complements the basic open loop UL power control. It is based on eNodeB's measurements of UL signal level and quality. Of the measurement data the eNodeB determines an UL power increase or decrease step and commands the UE (user equipment) to increase or decrease the current UL transmit power by this step.

Open loop power control is based on pathloss estimations of the UE and mainly static system and O&M parameters; it compensates long-term variations of the radio conditions, but typically suffers from errors in pathloss estimations. The closed loop power control strongly improves the pathloss estimations and allows optimized UL power adaption. Hence, the UE is enabled to operate with optimum power levels under varying propagation and interference conditions.

Actually, open loop UL power control and closed loop UL power control are combined and one formula is used to calculate the UE's transmit power taking into account both open and closed loop power control components. Separate UL power adjustments are calculated for different PUCCH formats, SRSs (sounding reference symbols) and specific UL allocations on PUSCH. Closed loop UL power commands are sent on PDCCH.

The operator enables/disables and configures closed loop power control by O&M setting. The general cell specific parameters are delivered via system information broadcasting and the UE specific parameters are delivered via RRC signalling.

The Flexi Multiradio BTS supports slow closed loop uplink power control.

10.2 Benefits

10.2.1 End user benefits

The UE power consumption is reduced.

The reduction of interference by operation with closed loop UL power control optimizes the transmission conditions within the cell in terms of speech quality and/or data rates.

10.2.2 Operator benefits

Closed loop UL power control reduces intra-cell, inter-cell and inter-system interference. The results are improved cell edge behavior and a relaxation of requirements on intra-cell orthogonality.

10.3 Functional description

10.3.1 Functional details

Closed loop UL power control is done as follows:

1. The eNodeB measures every TTI (transmission time interval) for every PRB (physical resource block) and for all UEs, whose signals are received, the signal level (RSSI, received signal strength indicator) and quality (SINR, signal-to-interference plus noise ratio) from PUCCH and/or PUSCH depending on the O&M configuration.
2. The eNodeB processes the measurement data by
    - transforming it into a transport format independent format,
    - clipping the measurement data (a limitation of each value in a certain range between a O&M defined minimum and maximum threshold),
    - weighting the measurement data,
    - filtering the measurement data (averaging filters).
3. After that, the eNodeB makes a decision about PUCCH and/or PUSCH commands by using a decision matrix with a target window for signal quality and level configured by an operator. For example, if the signal quality and level is below the lower thresholds, a power increase is initiated.
4. The new UL power is calculated.
5. PUCCH/PUSCH/SRS power commands are then signalled to the UE via PDCCH. The command contains the power adjustments (e.g. +3 dB for PUSCH).

The UE uses the closed loop power correction values as additive term to the open loop component for the calculation of its total uplink transmit power.

The described UL power control scheme is applied separately for the physical uplink shared channel (PUSCH), physical uplink control channel (PUCCH) and sounding reference symbols (SRSs) with different parameter sets. The UL power control is performed independently for each particular UE in a cell.

Measurements

The eNodeB measures:

- RSSI (received signal strength indicator) of received signals for every UE transmitting on PUCCH or PUSCH or transmitting SRS
- Interference for every received PUCCH/PUSCH/SRS physical resource block (PRB)
- Interference for every UE transmitting via PUCCH or PUSCH

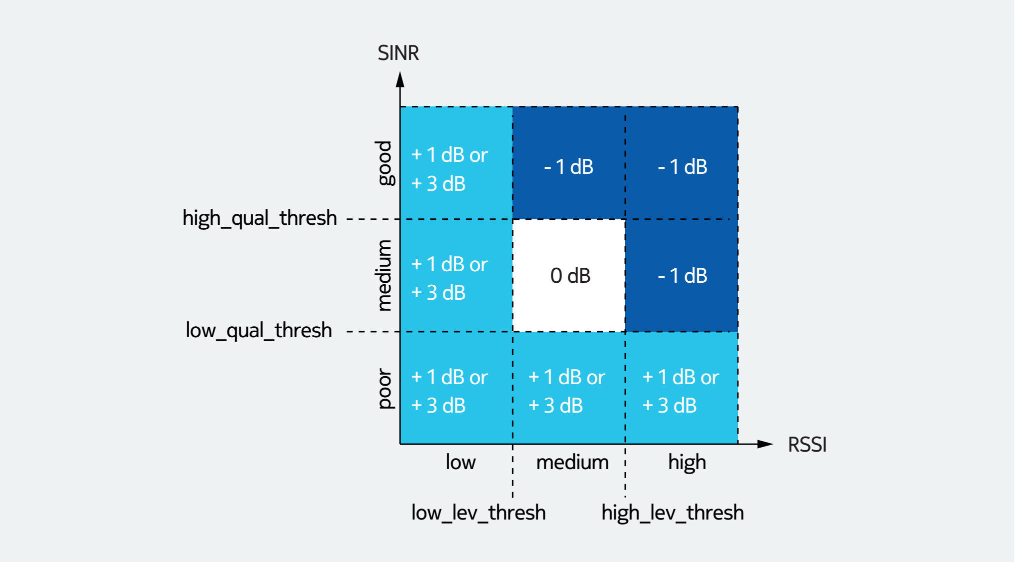
The eNodeB then calculates the related SINR values for the cell and for each UE.

Power adjustment decision and determination of the power adjustment value

Separate UL power control windows for the power adjustment decision are defined for the PUSCH, SRS and PUCCH components. The UL power control window is defined by upper and lower quality and level thresholds (in a two-dimensional quality-level space the thresholds define the fields of a decision matrix). Figure 15: Power control decision matrix schematically shows the UL power control decision matrix for PUSCH and for PUCCH.

The required power adjustment step to be sent to the UE is given in the fields of the matrix and is called δ_{PUSCH} or δ_{PUCCH}.

Figure 15 Power control decision matrix



In the formula for the UE's calculation of the UL transmission power, δ_{PUSCH} is an additive component. The UL transmission power for subframe i, $P_{PUSCH}(i)$, uses the power adaption value $\delta_{PUSCH}(i - 4)$ which was signalled via PDCCH 4 subframes before (according to 3GPP 36.213: $\delta_{PUSCH}(i - K_{PUSCH})$, and for FDD mode: $K_{PUSCH} = 4$).

δ is given as the current contribution to an accumulated power correction summand. In this case the summand is given by $f(i) = f(i - 1) + \delta_{PUSCH/PUCCH}(i - 4)$. Another possibility (described in 3GPP 36.213) would be to give δ as an absolute (standalone) power correction value. The eNodeB takes care that successive δ power up or power down commands do not exceed an upper and a lower absolute power limit.

Since closed loop UL power control takes into account the SINR conditions, SINR is not considered in open loop UL power control.

Transmit power control commands

The UL power adjustment value δ_{PUSCH} for PUSCH is carried within the transmit power control (TPC) command which is sent to the UE in combination with the uplink scheduling grant: Whenever a UE is scheduled, it gets a TPC command together with being informed which resources and transport format is assigned. The TPC command is included in the PDCCH with DCI format 0. Another possibility of conveying the TPC information – not implemented in the current solution – would be to use the TPC-PUSCH format, which is a special PDCCH payload and contains jointly coded UL TPC commands for a set of up to N users. In this case DCI format 3/3A would be used whose CRC parity bits are scrambled with TPC-PUSCH-RNTI.

Correspondingly, the UL power adjustment value δ_{PUCCH} for PUCCH is carried within the transmit power control (TPC) command which is also sent to the UE in combination with the uplink scheduling grant.

Possible values for $\delta_{PUSCH/PUCCH}$ in the accumulation case are -1 dB, 0 dB, 1 dB, 3 dB.

The UE attempts to decode a PDCCH of DCI format 0 with the UE's C-RNTI or SPS C-RNTI and a PDCCH of DCI format 3/3A with this UE's TPC-PUSCH-RNTI in every subframe except when in DRX mode. If DCI format 0 and DCI format 3/3A are both detected in the same subframe, then the UE uses the power value provided in DCI format 0.

10.3.1.1 Messages and information elements

Messages

UL UE specific power control parameters are included in the RRC: CONNECTION RECONFIGURATION message. It contains information elements described below.

Information elements

The IE “UplinkPowerControlCommon” and IE “UplinkPowerControlDedicated” are used to specify parameters for uplink power control in the system information and in the dedicated signalling, respectively; see 3GPP TS 36.331.

For example, the IE “UplinkPowerControlDedicated” is included in the “physicalConfigDedicated” IE which is included in the “radioResourceConfigDedicated” IE. The last one is a part of the RRC: CONNECTION RECONFIGURATION message.

The “physicalConfigDedicated” IE also contains the “TPC-PDCCH-Config” IE which is used to specify the RNTIs and indexes for PUCCH and PUSCH power control. The power control function can either be setup or released with the IE.

10.4 System impacts

10.4.1 Interdependencies between features

"Closed loop UL power control" complements the feature "Open loop UL power control and DL power setting".

“Closed loop UL power control” has effects on the packet scheduler. The combining of power control and resource allocation allows interference coordination to further enhance cell edge performance and allows higher overall spectral efficiency. For example, UEs with comparable pathloss in adjacent cells can be directed to transmit in the same time-frequency resource. On average, such a grouping of UEs with a similar channel quality in adjacent cells results in the best cell edge performance, because it avoids strong interference from UEs close to the eNodeB in adjacent cells. Vice versa, aligning UEs with different channel quality between cells results in a good channel quality for these UEs, hence the peak data rates and the average cell throughput can be increased.

10.4.2 Impacts on interfaces

Regarding the radio interface, the communication between eNodeB and UE is done via RRC signalling. Cell specific UL power control parameters are included in the system information block type 1 (SIB1). General power control parameters are sent to the UE during the Initial Context Setup Request procedure. UL UE specific power control parameters are included in the RRC: CONNECTION RECONFIGURATION message (includes the “radioResourceConfigDedicated” IE which includes the “physicalConfigDedicated” IE; the last one includes the”uplinkPowerControlDedicated” IE).

10.4.3 Impacts on performance and capacity

Since “Closed loop UL power control” is related to interference, the feature – combined with allocation of resources (by the packet scheduler) – improves the performance at cell edge and allows a higher overall spectral efficiency.

10.5 LTE28 reference data

Requirements

Table 40 LTE28 hardware and software requirements

	FDD	TDD
System release	RL10	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	RL50FZ	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Supported not required	Supported not required
NetAct	Supported not required	Supported not required
MME	Supported not required	Supported not required
SAE GW	Supported not required	Supported not required
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE28: Closed loop UL power control* feature.

BTS faults and reported alarms

There are no faults related to the *LTE28: Closed loop UL power control* feature.

Commands

There are no commands related to the *LTE28: Closed loop UL power control* feature.

Measurements and counters

There are no measurements or counters related to the *LTE28: Closed loop UL power control* feature.

Key performance indicators

There are no key performance indicators related to the *LTE28: Closed loop UL power control* feature.

Parameters

Table 41 New parameters introduced by LTE28

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Method for UL power control	actUlpcMethod	LNCEL	-	common
Alpha	ulpcAlpha	LNCEL	-	common
Enable Closed Loop Uplink Power Control	ulpcPucchConfig	LNCEL	-	common
Uplink power control PUSCH configuration	ulpcPuschConfig	LNCEL	-	common
Include PUCCH Measurements In CL Power Control	ulpcPucchEn	LNCEL	-	common
Include PUSCH Measurements In CL Power Control	ulpcPuschEn	LNCEL	-	common
Lower RSSI Threshold For PUCCH Power Command Decision	ulpcLowlevCch	LNCEL	- ulpcPucchConfig	common
Lower RSSI Threshold For PUSCH Power Command Decision	ulpcLowlevSch	LNCEL	- ulpcPuschEn	common
Lower SINR Threshold For PUCCH Power Command Decision	ulpcLowqualCch	LNCEL	- ulpcPucchConfig	common
Lower SINR Threshold For PUSCH Power Command Decision	ulpcLowqualSch	LNCEL	- ulpcPuschEn	common
Upper RSSI Threshold For PUCCH Power Command Decision	ulpcUplevCch	LNCEL	- ulpcPucchConfig	common
Upper RSSI Threshold For PUSCH Power Command Decision	ulpcUplevSch	LNCEL	- ulpcPuschEn	common
Upper SINR Threshold For PUCCH Power Command Decision	ulpcUpqualCch	LNCEL	- ulpcPucchConfig	common

Table 41 New parameters introduced by LTE28 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Upper SINR Threshold For PUSCH Power Command Decision	ulpcUpqualSch	LNCEL	- ulpcPuschEn	common
Time Interval For Power Command Decisions	ulpcReadPeriod	LNCEL	-	common

For parameter descriptions, see the LTE parameters reference document.

Sales information

Table 42 LTE28 sales information

Product structure class	License control	Activated by default
Application software (ASW)	SW Asset Monitoring	No

10.6 Activating the LTE28: Closed loop UL power control Feature Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE28:Closed loop UL power control feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View** ► **Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Enable Closed Loop uplink power control* to True.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter and sending the comissioning file to the eNB the eNB is resetting.

Expected outcome

The closed loop UL power control is enabled, that is, further commands to increase or decrease the UL power are possible.

10.7 Deactivating the LTE28: Closed Loop UL Power Control Feauture Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE28: Closed loop UL power control feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Enable Closed Loop uplink power control* to True.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter and sending the comissioning file to the eNB the eNB is resetting.

Expected outcome

It is not possible to change the UL power per command.

11 LTE30: CQI adaption (DL)

11.1 Introduction to the feature

CQI (channel quality indicator) is an indicator of the current downlink channel conditions as seen by the UE. In LTE, the user equipment (UE) reports CQIs to assist the eNodeB in selecting an appropriate modulation and coding scheme (MCS) to be used for the downlink transmission. A high CQI value is indicative of a channel with high quality. The UE determines the CQI value from the downlink received signal quality, typically based on measurements of the downlink reference signals.

A CQI value reported from the UE may not be reliable enough for the eNodeB selecting a modulation and coding scheme to achieve a certain (low) block error rate (BLER) for downlink data transmission. Therefore the eNodeB adjusts the reported CQI value by taking into account ACK/NACK (acknowledged / not acknowledged) reports from the UE for received downlink data blocks (e.g. NACK is sent if the UE could not successfully decode a received data block). This process is called CQI adaptation. The adjusted CQI value is used by the AMC (adaptive modulation and coding) algorithm, which is a component of the link adaptation functionality within the eNodeB, to select the optimum MCS for the following downlink data transmission.

11.2 Benefits

CQI adaptation compensates user equipment measurement errors (yielding to suboptimal CQI values reported to the eNodeB) and allows to achieve a configurable DL target block error rate (BLER).

11.3 Functional description

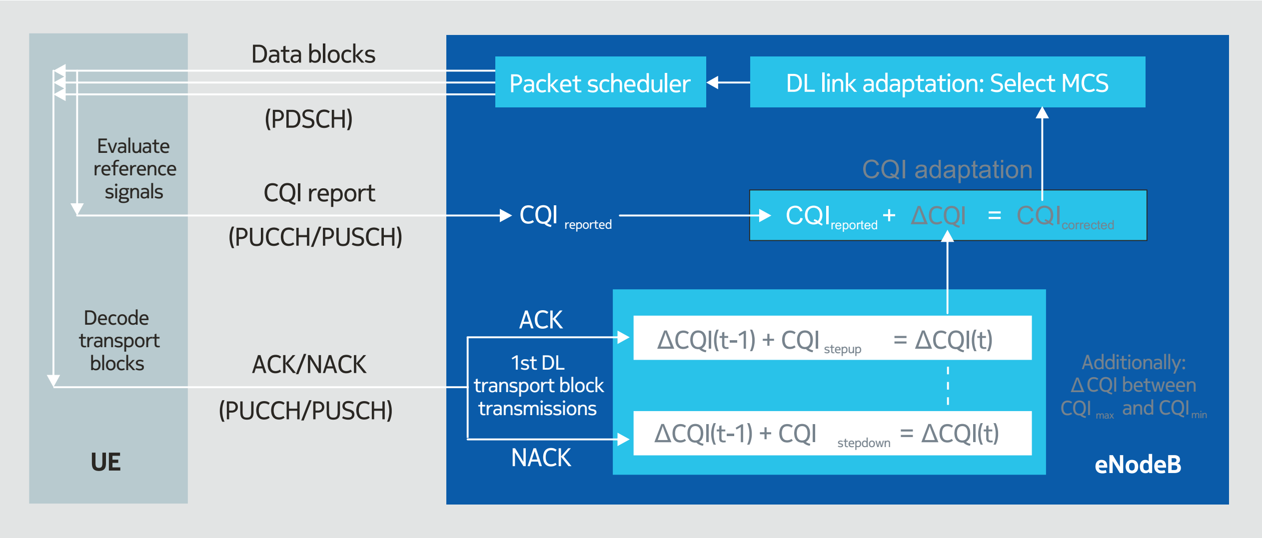
11.3.1 Functional details

CQI adaptation is the adjustment of the reported CQI value in the eNodeB with an adapted offset before link adaptation by AMC (adaptive modulation and coding) is applied in downlink direction.

This functionality compensates user equipment measurement errors and allows to achieve a configurable DL target block error rate (BLER).

Figure 16: Principle of CQI adaptation shows how the offset value ΔCQI is calculated and applied. CQI adaptation is also called outer loop quality control (OLQC): An UL ACK/NACK report and the following DL transmission, whose MCS is influenced by the previous ACK/NACK report and which determines the next UL ACK/NACK report, form a loop.

Figure 16 Principle of CQI adaptation



The CQI offset is determined in the eNodeB with the help of the incoming ACK/NACK responses from the UE (via L1/L2 control signaling) for the initial transmission of each transport block in DL direction. For a correct received transport block the offset value ΔCQI is increased by a step CQI_{stepup} whereas for an incorrect transport block the value is decreased by $CQI_{stepdown}$. No change is done when no ACK/NACK is available or in case of a retransmission of the corresponding transport block (there are some other specific conditions where ΔCQI is not changed).

The parameters CQI_{stepup} and $CQI_{stepdown}$ are chosen in a way that a certain block error rate target value ($BLER_{target}$) is reached. The offset value ΔCQI lies between a maximum and minimum value.

11.4 System impacts

11.4.1 Interdependencies between features

CQI adaptation is closely related to the feature LTE31 “Link adaptation by AMC (UL/DL)”: The selection of the appropriate modulation and coding scheme for DL transmission by the AMC (adaptive modulation and coding) algorithm is based on the adjusted CQI value. For more information, see the functional area description “Link control”.

11.5 LTE30 reference data

> *LTE30: CQI adaption (DL) requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information*

Requirements

Table 43 LTE30 hardware and software requirements

	FDD	TDD
System release	RL09	RL15
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Not supported	TD-LBTS4.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE30: CQI adaption (DL)* feature.

Measurements and counters

There are no measurements or counters related to the *LTE30: CQI adaption (DL)* feature.

Key performance indicators

There are no key performance indicators related to the *LTE30: CQI adaption (DL)* feature.

Parameters

Table 44 New parameter introduced by LTE30

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
`Multiplier M for periodic RI reporting period`	`riPerM`	MPUCCH _FDD/_TDD	-	common

Table 45 Existing parameters related to LTE30

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
`Enable OLQC`	`dlOlqcEnable`	LNCEL	-	common
`Default CQI`	`dlamcCqiDef`	LNCEL	-	common
`Maximum CQI offset for DL OLQC`	`dlOlqcDeltaCqiMax`	LNBTS_TDD	-	TDD

Other parameters for this feature are internal or vendor-specific.

For parameter descriptions, see *LTE Operating Documentation/ Reference/ Parameters*.

Sales information

Table 46 LTE30 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

11.6 Activating the LTE30: CQI Adaption Feature Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE30:CQI Adaption feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View** ► **Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Enable OLQC* to True.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

CQI link adaption is running.

11.7 Deactivating the LTE30: CQI Adaption Feature Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE30: CQI Adaption feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

---

3 Modify the eNB configuration settings.

Set the parameter *Enable OLQC* to False.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

---

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

---

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

No restart is needed.

Expected outcome

CQI Adaption is disabled.

12 LTE31: Link Adaptation by AMC (UL/DL)

12.1 Introduction to the feature

AMC (adaptive modulation and coding) dynamically adjusts the modulation and coding scheme for PDSCH and PUSCH in order to match the prevailing radio conditions for each user. AMC maintains the optimum working point for the hybrid automatic repeat request (HARQ) process under varying traffic load and radio propagation conditions. Furthermore, the adaptive transport bandwidth (ATB) function defines the maximum resource allocation for uplink in the constraint according to the reported power headroom in the UE.

AMC is an essential radio link control function for optimizing air interface efficiency.

12.2 Benefits

Link adaptation is the most essential radio link control function for optimizing air interface efficiency.

12.3 Functional description

12.3.1 Functional details

AMC link adaptation

Adaptive modulation and coding (AMC) dynamically matches the information data rate for each user to the variations in the received signal quality. AMC can select between different modulation schemes and code rates.

- *Modulation scheme:* Low-order modulation (that is few data bits per modulated symbol, for example, QPSK) is more robust and can tolerate higher levels of interference but provides a lower transmission rate. High-order modulation (that is more bits per modulated symbol, for example, 64QAM) offers a higher bit rate but is more prone to errors due to its higher sensitivity to interference, noise, and channel estimation errors. Thus, high-order modulation is useful only when the SINR is sufficiently high.
- *Code rate:* A lower code rate is used in case of poor channel conditions and a higher code rate in case of high SINR. Generally, a lower code rate is connected with a greater overhead for error correction.

The combination of modulation and code rate results in modulation and coding schemes (MCSs), which are standardized, see 3GPP TS 36.213 listing the MCSs (MCS0 – MCS28) and relating them to a modulation scheme and a transport block size. There are separate relations between MCS number, modulation scheme and transport block size for uplink and downlink direction. Hence, AMC means the dynamic optimization of the utilized MCS.

The same MCS is applied on all physical resource blocks belonging to one transport block (which is the data unit for one UE and one subframe after processing in the media access control (MAC) layer), that is the MCS is constant over the allocated frequency resources for a given user and time (subframe) and the MCS for this user can change only in the next subframe. In addition, when two transport blocks are transmitted to one user in a given subframe using multi-stream MIMO, each transport block can use an independent MCS.

AMC is performed independently in the uplink (for PUSCH) and downlink direction (for PDSCH).

Adaptive modulation and coding on PDSCH

The AMC algorithm for PDSCH is based on the UE's CQI reports and includes the following main characteristics:

- The O&M provides an initial modulation and coding scheme, which is used as the default modulation and coding scheme. In case AMC is not activated, the algorithm always uses this default MCS.
- Retransmissions are handled differently from initial transmissions. For a HARQ retransmission, the same MCS is used as for the corresponding initial transmission. The MCS determined for an initial transmission therefore is remembered as long as HARQ retransmissions are performed for the same block of data.
- An average channel state (that is an average CQI value) is internally determined from the received CQI information corresponding to the physical resource blocks having been assigned by the scheduler.
- CQI adaptation (adjustment of the reported CQI value in the eNB based on BLER measurements (ACK/NACK events)) is applied if enabled.
- The eNB interpolates the target code rate based on the averaged CQI over selected resource blocks for a UE with a new transmission. Afterwards, the eNB selects the suitable MCS based on the target code rate and the number of scheduled resource blocks. The basis for the MCS selection is a mapping table like in 3GPP TS 36.213.
- **FDD**
  For spatial multiplexing (dual stream MIMO mode), where separate CQI values are available for both transmission paths, the eNB separately determines the MCS for each transmission path and the two MCSs can be different.
  For diversity (single stream MIMO mode), the eNB determines one common MCS for both transmission paths, since the input is only one averaged CQI value.
- **TDD**
  For close loop spatial multiplexing, where separate CQI values are available for both transmission paths, the eNB separately determines the MCS for each transmission path and the two MCSs can be different. For open loop spatial multiplexing, the eNB determines one common MCS for both transmission paths, since the input is only averaged CQI value.
- If no new CQI value is received from a UE and the UE is scheduled nevertheless, the eNB multiplies the old CQI value by a configurable factor, and the MCS is determined as described above provided the latest available CQI information is not older than a configurable maximum time period; if this maximum period is already exceeded (or CQI values are not yet available), the initial MCS is applied.

MCSs called MCS0 and MCS2 to MCS28 are available in DL direction according to 3GPP TS 36.213. MCS0 to MCS9 have QPSK modulation, MCS10 to MCS16 have 16QAM modulation, and MCS17 to MCS28 have 64QAM modulation. So the most robust MCS is MCS0 and the least robust is MCS28.

From a more general view, DL AMC consists of an inner and an outer loop component. The inner loop component is formed by an UE's CQI report and the following eNB's downlink transmission whose MCS is influenced by the CQI report. The outer loop component is the CQI adaptation.

Adaptive modulation and coding on PUSCH

The following mechanisms are applied on PUSCH:

- A slow inner loop component based on the BLER of all transport blocks transmissions (first transmissions and also retransmissions) within a configurable time period derived from the HARQ process. ACK/NACK events (periodic information from L1/L2; UL HARQ process) are counted and the result is used to determine the BLER. An average BLER is calculated and from this an optimum MCS is derived. The inner loop AMC takes into account BLER thresholds for MCS upgrade and downgrade by configurable parameters.
- A fast outer loop component based on the ACK/NACK reports of 1st transport blocks transmission derived from the HARQ process. This part provides emergency downgrade and fast upgrade events. The target BLER for first transport blocks transmissions is configurable. In this part a compensation value is calculated. Whenever the compensation value reaches the related configurable threshold, the AMC immediately switches to the next lower/upper (that is more/less robust) MCS. The related parameters have to be configured carefully depending on the configured target BLER, so that a certain number of consecutive NACKS triggers the MCS upgrade/downgrade.
- The ATB functionality which takes into account both uplink power control related limitations (especially the UE power headroom report) as well as QoS related "minimum/maximum uplink bit rate" provided by admission control. Power headroom reports from the UE impact the ATB. ATB calculates UE-specific upper physical resource block allocation limits per transmission time interval (TTI) and reports them to the packet scheduler, which itself provides a very fast ATB within those boundaries.

MCSs called MCS0 and MCS2 to MCS20 are available up to 16QAM modulation in UL direction according to 3GPP TS 36.213. The 3GPP document provides further MCSs for 64QAM UL transmission. The feature *LTE829: Increased Uplink MCS Range* can extend the range of MCSs used for 16 QAM UEs (cat1- cat4) beyond MCS20 to MCS21-MCS24. In this case the UE uses the 16-QAM modulation with less coding. MCS0 to MCS10 have QPSK modulation and MCS11 to MCS24 have 16QAM modulation. The most robust MCS is MCS0 and the least robust is MCS24. The feature *LTE44: 64 QAM in UL* supports higher modulation and coding schemes (MCSs) that are extended up to MCS28. It introduces a 64QAM modulation scheme in the uplink for cat5 and cat8 UEs in which the uplink peak throughput is enhanced by the support of the additional MCS values, MCS21 to MCS28. For more details, see *feature description of LTE44*.

12.4 System impacts

12.4.1 Interdependencies between features

There are no interdependencies between this and any other feature.

12.5 LTE31 reference data

Requirements

Table 47 LTE31 hardware and software requirements

	FDD	TDD
System release	RL10	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	RL50FZ	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE31: Link Adaptation by AMC (UL/DL)* feature.

BTS faults and reported alarms

There are no faults related to the *LTE31: Link Adaptation by AMC (UL/DL)* feature.

Commands

There are no commands related to the *LTE31: Link Adaptation by AMC (UL/DL)* feature.

Measurements and counters

There are no measurements or counters related to the *LTE31: Link Adaptation by AMC (UL/DL)* feature.

Key performance indicators

There are no key performance indicators related to the *LTE31: Link Adaptation by AMC (UL/DL)* feature.

Parameters

Table 48 New parameters introduced by LTE31

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Periodic subband CQI cycles K	cqiPerSbCycK	LNCEL	-	common
Enable simultaneous CQI and ACK/NACK	cqiPerSimulAck	LNCEL	-	common
Enable OLQC	dlOlqcEnable	LNCEL	-	common
DL target BLER	dlTargetBler	LNCEL	-	common
Default CQI	dlamcCqiDef	LNCEL	-	common
Enable DL AMC	dlamcEnable	LNCEL	-	common
PDCCH aggregation level for preamble assignments	pdcchAggPreamb	LNCEL	-	common
Rank Indication Reporting Enable	riEnable	MPUCCH_FDD or MPUCCH_TDD	-	common or FDD/TDD in LTE17 onwards
UL AMC target BLER	ulTargetBler	LNCEL	-	common
Enable all TBs in UL AMC	ulamcAllTbEn	LNCEL	-	common
UL AMC MCS switch period	ulamcSwitchPer	LNCEL	-	common
UL ATB period	ulatbEventPer	LNCEL	-	common

For parameter descriptions, see the *LTE BTS Parameters* reference document.

Sales information

Table 49 LTE31 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

13 LTE37: Ciphering and LTE38: Integrity protection

13.1 Introduction to the feature

Security for the eNodeB (as a network element) is at first time specified by 3GPP for LTE. This means:*LTE is here the leading radio standard.* It is needed to protect the confidentiality of the user and mitigate the effects of attacks on the network. In this document, the security for the radio access network is described (in other words:The air link security). This feature description LTE37: Ciphering and LTE38: Integrity protection consists user data security between UE and eNodeB for radio layer 2 (u-plane data) and radio layer 3 (RRC, control plane data).

Two functions are provided for the maintenance of security: Ciphering and integrity protection.

- *Ciphering* is applied on both control plane data (RRC signalling) and user plane data and it is used in order to protect the data streams from being eavesdropped by a third party. Part of Ciphering is also the key derivation function (SHA-256 in RL 3 protocol)
- *Integrity protection* is applied on control plane data only and allows the receiver to detect packet insertion or replacement.

Ciphering and integrity protection within the access stratum is performed in the PDCP layer. The Flexi Multiradio BTS supports ciphering for the user plane PDUs and the RRC PDUs according to the 3GPP specifications TS 36.300, TS 36.323, TS36.331 and TS36.401.

The keys used for ciphering and integrity protection of traffic (data / control signalling) are established when a connection between UE and the eNodeB/network is built up and they are discarded after a session has been closed (sometimes keys can change within a session); UE and eNodeB establish the same keys. The keys have 128 bits length and are derived from superior keys which are organized in a hierarchical structure. The last joint key K_{ASME} used for derivation of AS keys is calculated in the Home Subscriber Server (HSS) and stored and used in the MME and in a secure part of the Universal Subscriber Identity Module (USIM) in the UE.

The eNode supports the following ciphering / integrity protection algorithms (EEA: EPS encryption algorithm; EIA: EPS integrity algorithm):

- Null algorithm (EEA0/EIA0 – providing no security)
- SNOW 3G (EEA1/EIA1)
- AES (EEA2/EIA2)

A ciphering algorithm uses a ciphering key (and other parameters) as input to create a key stream which is combined with the plaintext stream. The resulting ciphered data stream is transmitted and the receiver gets the plaintext back by applying the same key stream on the ciphered data stream in the same way as done during ciphering. Ciphering is an optional feature. If a customer decides not to buy a license for this feature, he can use a NULL-algorithminstead.

An integrity protection algorithm uses an integrity protection key (and other parameters) as input to create a message authentication code added to the message to be sent. The integrity protection is a mandatory feature. From3GPPview no integrity protection NULL-algorithm is available. But in extension to 3GPP- completely explained by the LTSI-forum there a IP-NULL-algorithm is implemented. This extension can only be used if the MME is configured to do so, such it can not be used by accident.

13.2 Benefits

Ciphering and integrity protection in the access stratum (AS) provides security of the air interface and protects against attacks and eavesdropper.

13.3 Functional description

13.3.1 Functional overview

Figure 17: C-plane security and Figure 18: U-plane security show the overall security concept within LTE. The security architecture is different for user plane traffic and control plane traffic. Here and in following sections, security aspects for the non-access stratum (NAS) are also included in order to show relations between NAS and AS security and for comprehensibility.

Figure 17 C-plane security

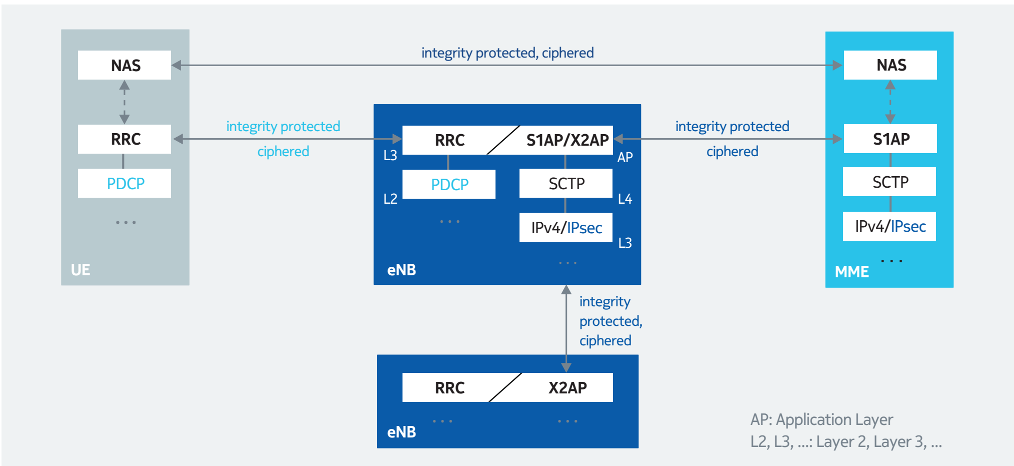
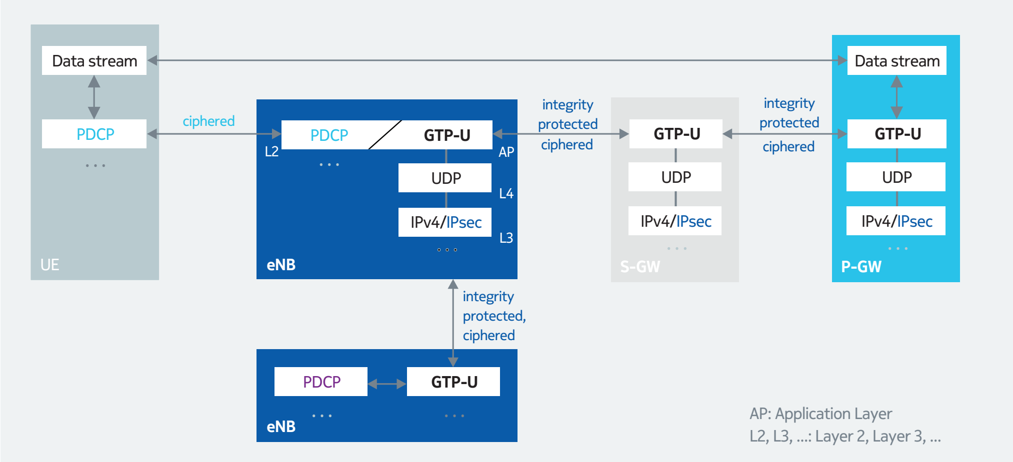


Figure 18 U-plane security



C-plane security includes the following characteristics:

- NAS signalling protection is transparent for the eNodeB.
- NAS signalling is ciphered and integrity protected between UE and MME.
- RRC integrity protection and ciphering is applied to NAS messages carried by RRC messages in addition to the NAS signalling security between MME and UE. This results in double protection of NAS signalling.
- RRC signalling is always integrity protected by PDCP in the eNodeB and in the UE.
- RRC signalling is ciphered between UE and eNodeB by PDCP.
- S1AP signalling is ciphered and integrity protected between eNodeB and MME by an underlying transport security mechanism. This is an seperate feature (LTE689) and describedt into FAD: IPsec operation. It is an optional feature.
- X2AP signalling is protected in the same way as S1AP signalling.

The security described by LTE:37/LTE38 is always between UE and eNodeB. If there is data forwarding from an source-eNodeB to a target eNodeB there will be transport security activated.

13.3.2 Security keys

Various security keys are used for ciphering and integrity protection of traffic depending on the type of traffic (user data / control signalling) and the related stratum (NAS/AS).

For the NAS (non access stratum) these are:

- K_{NASenc} for encryption of NAS messages between UE and MME
- K_{NASint} for integrity protection of NAS messages between UE and MME

For the AS (access stratum; transmission between UE and eNodeB) the following security keys are used:

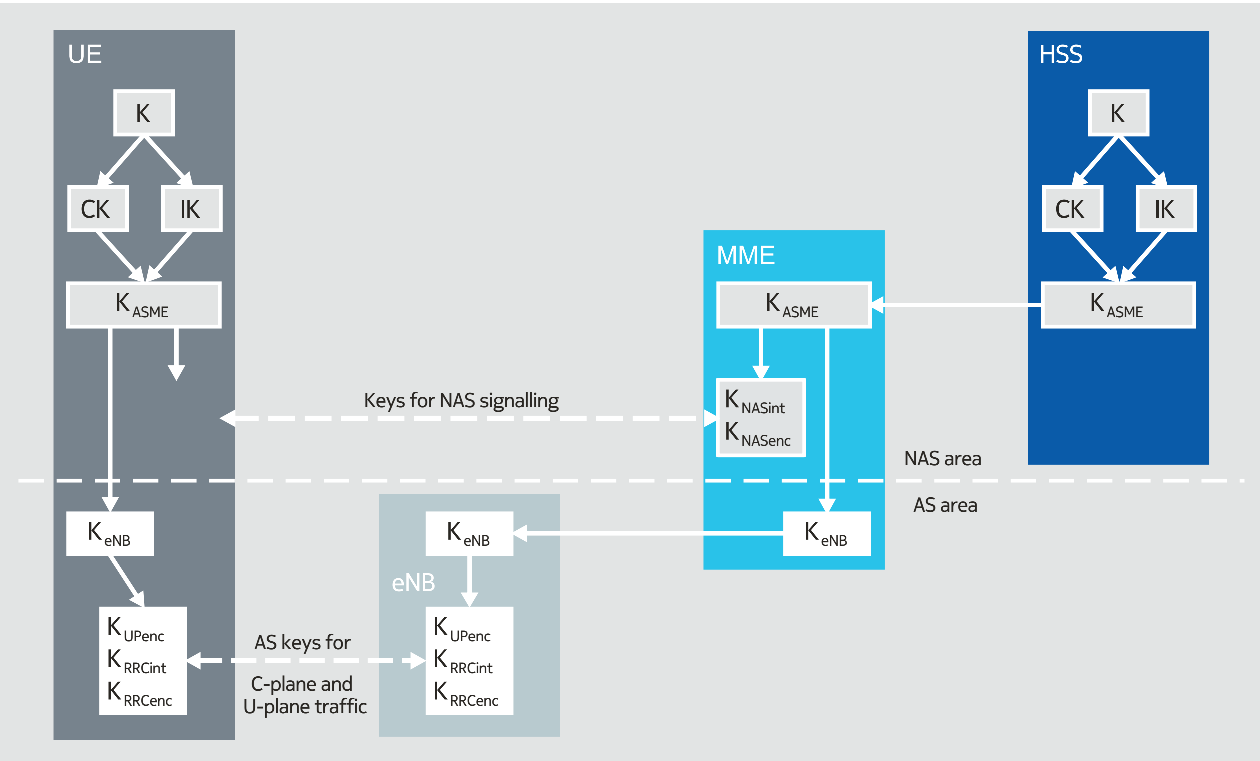
- K_{UPenc} for encryption of user plane traffic
- K_{RRCenc} for encryption of control plane traffic (which is RRC signalling)
- K_{RRCint} for integrity protection of control plane traffic

The keys are derived from superior keys organized in a hierarchical structure. The AS keys K_{UPenc}, K_{RRCenc} and K_{RRCint} are derived from K_{eNB} which is related to a certain eNodeB and which itself is derived from the superior key K_{ASME}. The NAS keys K_{NASenc} and K_{NASint} are also derived from K_{ASME}. Figure 19: Security key hierarchy shows the LTE security key hierarchy and key distribution concept.

K_{ASME} is available in the Authentication Center (AuC) which resides in the Home Subscriber Server (HSS) and in a secure part of the Universal Subscriber Identity Module (USIM) in the UE; UE and eNodeB use the same K_{ASME} for deriving their security keys. ASME is the Access Security Management Entity of the EPS (evolved packet system) and is located in the MME.

The key K which is the origin of all other keys and the keys CK (cipher key) and IK (integrity key) have no direct effect on RRM and are mentionened just for completeness. Other keys or structures for ciphering / integrity protection such as K_{eNB}* and NH are described in the related chapters.

Figure 19 Security key hierarchy



Lifetime of security keys

The existence of a key depends on the EMM/RRC state of a UE in respect of connection establishment (EMM: EPS mobility management; ECM: EPS connection management):

- K exists always; it is the only permanent key.
- The NAS keys K_{ASME}, K_{NASenc}, K_{NASint} and CK, IK exist while the EMM-REGISTERED state is ongoing.

- The AS keys K_{eNB}, K_{UPenc}, K_{RRCint}, and K_{RRCenc} are created on RRC-IDLE to RRC-CONNECTED transitions (correlated with ECM-IDLE to ECM-CONNECTED transitions) when in EMM-REGISTERED state (as the UE is in EMM-REGISTERED state, an EPS security context already exists in the UE and the MME) and they exist during RRC-CONNECTED state.
  The eNodeB deletes the keys after receiving the S1AP: UE CONTEXT RELEASE COMMAND message.

Key establishment and key distribution

The different security keys are established during specific key establishment procedures:

- *Authentication and Key Agreement (AKA):* This procedure is performed when a UE initially attaches to the network. The MME authenticates the subscriber, and the keys CK, IK, and K_{ASME} are established, once in the USIM/UE, and in the same way in the AuC/HSS. K_{ASME} is derived from CK, IK and the PLMN ID; the HSS transfers K_{ASME} to the MME. AKA is a NAS procedure and does not have any prerequisite besides the permanent key K.
- *NAS Security Mode Command (NAS SMC) procedure:* This procedure is performed when the UE has successfully been authenticated. MME and UE generate the NAS keys K_{NASenc} and K_{NASint} for NAS signalling security. NAS SMC needs a valid K_{ASME} as prerequisite. In addition, NAS SMC activates the NAS security mechanisms.
- *K_{eNB} establishment:* The procedure applied is specific for different cases:
  - For a change of state to RRC-CONNECTED, K_{eNB} is derived in the UE and in the MME from K_{ASME} and the eNodeB ID. The MME transmits K_{eNB} to the eNodeB by the S1AP: INITIAL CONTEXT SETUP REQUEST message.
    MME and UE also derive the next hop (NH) parameter from the K_{ASME}.
  - For an intra-LTE intra-frequency handover, the source eNodeB creates K_{eNB}*, a transport security key, which is transferred via X2 interface to the target eNodeB where the K_{eNB} to be used is derived from the K_{eNB}* (for more information, see below).
- *AS Security Mode Command (AS SMC) procedure:*
  The eNodeB selects the security parameters required for deriving the AS security keys. These parameters are transferred to the UE via the SECURITY MODE COMMAND message. Then the UE and eNodeB derive the AS keys K_{UPenc}, K_{RRCint}, and K_{RRCenc} from K_{eNB}. These keys are needed for user plane encryption and RRC integrity protection and encryption. AS SMC needs a valid K_{eNB} as prerequisite. In addition, AS SMC activates the AS security mechanisms.

Key set identifier and key change indicator

At initial context setup AS and NAS security start with a common K_{ASME} key. Later, several K_{ASME} may be known by network and UE. For example, while the RRC-CONNECTED state is still ongoing, NAS may apply a new K_{ASME} (by executing another NAS security mode command). In this case there is the old K_{ASME}, from which NAS and AS keys are still derived, and the new K_{ASME}, from which fresh NAS and AS keys shall be derived. Therefore, a specific parameter identifies a particular K_{ASME}. Subsequently to a NAS change of K_{ASME} (while the AS K_{ASME} is still used), AS follows the NAS change which includes a handover.

The parameter identifying a particular K_{ASME} is KSI (key set identifier). KSI is generated together with K_{ASME} during the Authentication and Key Agreement procedure. All keys derived from a K_{ASME} inherit this KSI (this is why KSI is called a "set" identifier).

The KSI is signalled at NAS level only, i.e. during the Authentication and Key Agreement procedure and NAS security mode command procedure. At AS level the KSI is not signalled. Instead, implicit dependencies between NAS and AS procedures keep the AS keys synchronous in the network and the UE: At beginning of AS procedures for an RRC connection, the AS uses the same K_{ASME} as the NAS, and AS does not change this K_{ASME} during usual AS key changes. Only in combination of an intra-cell handover AS may change the K_{ASME}. In this case the K_{ASME} change is signalled by a flag called KCI (key change indicator).

Key handling in case of handover

The target eNodeB gets its K_{eNB} to be used for generating its U-plane and C-plane keys as follows: The source eNodeB determines a transport security key K_{eNB}* and transmits this key via X2 interface to the target eNodeB. Then the target eNodeB derives K_{eNB} from K_{eNB}*.

One possibility to determine K_{eNB}* is to have it derived directly from the currently active K_{eNB}. This direct derivation of K_{eNB}* uses a cryptographic hash function, so it is not feasible to reconstruct the source K_{eNB} from the new target K_{eNB}. Therefore a target eNodeB does not expose the security of the source eNodeB; in other words: backward security is guaranteed. However, there is no forward security which means that the target eNodeB keys are no secret for the source eNodeB.

The second possibility to determine K_{eNB}* is to have it derived from the NH (next hop) parameter which was calculated from the K_{ASME}. Since the source eNodeB cannot re-calculate K_{eNB}* from K_{eNB}, forward security is achieved. In case of a S1 handover, NH is transported from the MME by the S1AP: HANDOVER REQUEST message and is immediately available for the handover (forward security after one hop). In case of X2 handover, NH is transported by the S1AP: PATH SWITCH ACKNOWLEDGEMENT message and is not availabe for the current handover (because the new keys are already determined at this point in time) but for the next one. Therefore, forward security is reached at next handover (forward security after two hops).

Subsequent handovers with each transport K_{eNB}* derived directly from the previous K_{eNB} form a chain with backward security only. A handover where the transport K_{eNB}* is derived via NH is the starting point for another chain with backward security only. These chains are counted and identified with the NCC (next hop chaining counter) parameter signalled by the MME; NCC has the value 0 at the initial security context setup.

13.3.3 Messages and information elements

The following table shows the messages which include relevant security information and their security related content:

Table 50 Security related messages and information elements

Message	Information element	IE includes
RRC messages		
SECURITY MODE COMMAND	"securityConfigSMC"	"securityAlgorithmConfig" IE ("cipheringAlgorithm" and "integrityProtAlgorithm")
RRC CONNECTION REESTABLISHMENT REQUEST	"ue-Identity"	shortMAC-I
RRC CONNECTION RECONFIGURATION	"securityConfigHO"	"keyChangeIndicator" (not processed by the eNodeB) "nextHopChainingCount" "securityAlgorithmConfig" ("cipheringAlgorithm" and "integrityProtAlgorithm"; only necessary in case of algorithm changes)
RRC MOBILITY FROM EUTRA COMMAND	"nas-SecurityParamFromEUTRA"	
S1AP messages		
INITIAL CONTEXT SETUP REQUEST	"UE Security Capabilities" "Security Key"	"HandoverPreparationinformation" IE such as ciphering and integrity protection information of the serving cell and the "targetCellShortMAC-I" Initial security key K_{eNB}
HANDOVER REQUIRED	"RRC Context"	"HandoverPreparationinformation" IE such as ciphering and integrity protection information of the serving cell and the "targetCellShortMAC-I"
HANDOVER REQUEST	"RRC Context" "UE Security Capabilities" "SecurityContext"	(see above) (see below) NH parameter NCC related to NH.
HANDOVER COMMAND	"NAS Security Parameters from E-UTRAN"	"HandoverPreparationinformation" such as ciphering and integrity protection information of the serving cell and the "targetCellShortMAC-I"
PATH SWITCH REQUEST	"UE Security Capabilities"	Supported encryption and integrity protection algorithms in two 2-bit representations.

Table 50 Security related messages and information elements (Cont.)

Message	Information element	IE includes
PATH SWITCH REQUEST ACKNOWLEDGEMENT	“SecurityContext”	NH parameter NCC related to NH.
X2AP messages		
HANDOVER REQUEST	“UE Context Information”	“RRC Context” “UE Security Capabilities” “AS Security Information” (transition key K_{eNB}* and NCC)

13.4 System impacts

13.4.1 Interdependencies between features

An additional security feature is the optional LTE689 “LTE IPsec support” which allows secure eNodeB control and secure bulk data communication between eNodeBs as well as between eNodeBs and core nodes. IPsec is related to transport and application protocols. Supported IPsec capabilities are data integrity protection, origin authentication and anti-replay protection.

13.4.2 Impacts on network elements

A secure environment is required in the network elements storing security keys. The Flexi Multiradio BTS provides such a secure environment.

13.4.3 Impacts on system performance and capacity

Security mechanisms are associated with processing effort and additional control data according to common laws.

13.5 LTE37 reference data

Requirements

Table 51 LTE37 hardware and software requirements

	FDD	TDD
System release	RL10	RL15

Table 51 LTE37 hardware and software requirements (Cont.)

	FDD	TDD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	RL50FZ	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10 CD2	NS10 CD2
SAE GW	Support not required	Support not required
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE37: Ciphering* feature.

BTS faults and reported alarms

There are no faults related to the *LTE37: Ciphering* feature.

Commands

There are no commands related to the *LTE37: Ciphering* feature.

Measurements and counters

There are no measurements or counters related to the *LTE37: Ciphering* feature.

Key performance indicators

There are no key performance indicators related to the *LTE37: Ciphering* feature.

Parameters

Table 52 New parameters introduced by LTE37

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
`AM RLC poll byte table 1`	`amRlcPBTab1`	LNBTS	-	common
`AM RLC poll byte table 2`	`amRlcPBTab2`	LNBTS	-	common
`AM RLC poll byte table 3`	`amRlcPBTab3`	LNBTS	-	common
`AM RLC poll byte table 4`	`amRlcPBTab4`	LNBTS	-	common

Table 52 New parameters introduced by LTE37 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
AM RLC poll byte table 5	amRlcPBTab5	LNBTS	-	common
Ciphering Algorithm Activation Parameter	actCiphering	LNBTS	-	common
Ciphering Algorithm Parameters	cipherPrefL	LNBTS	-	common
Integrity Protection Algorithm Parameters	integrityPrefL	LNBTS	-	common
Key Refresh Margin	keyRefrMarg	LNBTS	-	common
Null Ciphering Algorithm Fallback	nullFallback	LNBTS	-	common

For parameter descriptions, see the LTE parameters reference document.

Sales information

Table 53 LTE37 sales information

Product structure class	License control	Activated by default
Application software (ASW)	SW Asset Monitoring	No

13.6 LTE38 reference data

Requirements

Table 54 LTE38 hardware and software requirements

	FDD	TDD
System release	RL10	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	RL50FZ	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10 CD2	NS10 CD2
SAE GW	Support not required	Support not required

Table 54 LTE38 hardware and software requirements (Cont.)

	FDD	TDD
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE38: Integrity protection* feature.

BTS faults and reported alarms

There are no faults related to the *LTE38: Integrity protection* feature.

Measurements and counters

There are no measurements or counters related to the *LTE38: Integrity protection* feature.

Key performance indicators

There are no key performance indicators related to the *LTE38: Integrity protection* feature.

Parameters

Table 55 New parameters introduced by LTE38

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
AM RLC poll byte table 1	amRlcPBTab1	LNBTS	-	common
AM RLC poll byte table 2	amRlcPBTab2	LNBTS	-	common
AM RLC poll byte table 3	amRlcPBTab3	LNBTS	-	common
AM RLC poll byte table 4	amRlcPBTab4	LNBTS	-	common
AM RLC poll byte table 5	amRlcPBTab5	LNBTS	-	common
Ciphering Algorithm Activation Parameter	actCiphering	LNBTS	-	common
Ciphering Algorithm Parameters	cipherPrefL	LNBTS	-	common
Integrity Protection Algorithm Parameters	integrityPrefL	LNBTS	-	common
Key Refresh Margin	keyRefrMarg	LNBTS	-	common
Null Ciphering Algorithm Fallback	nullFallback	LNBTS	-	common

For parameter descriptions, see the LTE parameters reference document.

Sales information

Table 56 LTE38 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

13.7 Activating the LTE37: Ciphering feature using the BTS Site Manager

Before you start

The eNB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

Steps

To activate the *LTE37: Ciphering* feature, do the following:

Procedure

1 Start the BTSSM application and establish connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB. For overview select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the *Ciphering algorithm activation parameter* to True.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning on Send parameters** page.

b) Click **Send.**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After a successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

Ciphering is enabled.

Steps

To activate the *LTE37: Ciphering* feature, do the following:

1 Start the BTSSM application and establish connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB. For overview select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the *Ciphering algorithm activation parameter* to True.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning on Send parameters** page.

b) Click **Send.**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After a successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

Ciphering is enabled.

13.8 Deactivating the LTE37: Ciphering Feature Using BTS Site Manager

Purpose

Follow this procedure to deactivate the *LTE37:Ciphering* feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Ciphering algorithm activation parameter* to False.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

Ciphering is disabled, only NULL-Algorithm is running.

14 LTE39: System Information Broadcast

14.1 Introduction to the feature

The system information is structured through SIBs. Each SIB contains a set of parameters. The system information is composed of a master information block (MIB) and a number of SIBs. The types of SIBs described in this document are the SIB1-SIB8 and SIB10-13. Handling of the system information is part of the radio resource control (RRC) protocol.

The system information is structured through SIBs. Each SIB contains a set of parameters. The system information is composed of a master information block (MIB) and a number of SIBs. The types of SIBs described in this document are the SIB1-SIB8 and SIB10-13 . Handling of the system information is part of the radio resource control (RRC) protocol.

14.2 Benefits

The SIB message is necessary for cell access and mobility support. It is broadcast containing information elements from the non-access stratum (NAS) and radio network to all user equipment (UE).

14.3 Functional description

14.3.1 Functional details

The system information (SI) contains data used for making decisions regarding cell selection, reselection, or handover. It is sent from the eNodeB to all UEs in RRC_IDLE or RRC_CONNECTED mode.

The RRC protocol broadcasts the system information containing information elements from the eNodeB to all UEs. The system information is repeated on a regular basis with variable repetition frequency depending on specified parameters. The RRC protocol performs scheduling and repetition of system information messages. This function supports broadcast of core network specific, radio access network specific and cell-specific information.

A system information is consists of the following:

- Master information block (MIB): The MIB includes a limited number of the most essential and most frequently transmitted parameters that are needed to acquire other information from the cell, and is transmitted on BCH with a periodicity of 40 ms.
- System information block Type 1: SIB1 (which contains also scheduling information for the SIs). It is scheduled with a periodicity of 80 ms and transmitted on the DSCH.
- System Information Messages: All other SIBs to be transmitted are mapped onto SIs. The following are mapping restrictions: the SIB2 has to be contained in the first SI in the scheduling information list (contained in SIB1 - according to 3GPP) and each SI message contains just 1 SIB type.

The following information is contained in each of the supported SIB:

- SIB1: SIB1 contains information relevant when evaluating if a UE is allowed to access a cell and defines the scheduling of other system information blocks.
- SIB2: SIB2 contains common and shared channel information.
- SIB3: SIB3 contains cell re-selection information, mainly related to the serving cell.
- SIB4: SIB4 contains information about the serving neighboring frequencies and intra-frequency neighboring cells relevant for cell re-selection.
- SIB5: SIB5 contains information about other E-UTRAN frequencies and inter - frequency neighboring cells relevant for cell reselection.
- SIB6: SIB6 contains information about UTRA frequencies and UTRA neighboring cells relevant for cell reselection.
- SIB7: SIB7 contains information about GERAN frequencies relevant for cell reselection.
- SIB8: SIB8 contains information about CDMA2000 frequencies and CDMA2000 neighboring cells relevant for cell re-selection.
- SIB8: SIB8 contains information about CDMA/eHRPD respective CDMA/1xRTT frequencies and neighboring cells relevant for cell reselection. The time synchronization with CDMA is done by the feature *LTE426: System Time Broadcast for SIB8.*
- SIB10: SIB10 contains Earthquake and Tsunami Warning System (ETWS) primary notification.
- SIB11: SIB11 contains ETWS secondary notification
- SIB12: SIB12 contains Commercial Mobile Alert System (CMAS) notification.
- SIB12: SIB12 contains Commercial Mobile Alert System (CMAS) notification.
- SIB13: SIB13 contains the information required to acquire the MBMS control information.

14.4 System impacts

14.4.1 Interdependencies between features

There are no interdependencies between this and any other feature.

14.5 LTE39 reference data

LTE39: System Information Broadcast requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 57 LTE39 hardware and software requirements

	FDD	TDD
System release	RL09	RL15
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS3.0

Table 57 LTE39 hardware and software requirements (Cont.)

	FDD	TDD
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16S4	TL16S4
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE39: System Information Broadcast* feature.

Measurements and counters

There are no measurements or counters related to the *LTE39: System Information Broadcast* feature.

Key performance indicators

There are no key performance indicators related to the *LTE39: System Information Broadcast* feature.

Parameters

Table 58 New parameters introduced by LTE39 for the FDD solution

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
CDMA2000 frequency idle mode configuration identifier	cdfimId	CDFIM	-	common
CDMA2000 HRPD Band Class List	hrpdBdClList	CDFIM	-	common
CDMA2000 HRPD Band Class	hrpdBdClBcl	CDFIM	hrpdBdClList	common
CDMA2000 HRPD Cell Reselection Priority	hrpdCResPrio	CDFIM	hrpdBdClList	common

Table 58 New parameters introduced by LTE39 for the FDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
CDMA2000 HRPD Reselection High Threshold	hrpdFrqThrH	CDFIM	hrpdBdClList	common
CDMA2000 HRPD Reselection Low Threshold	hrpdFrqThrL	CDFIM	hrpdBdClList	common
CDMA2000 HRPD Neighbour Cell List	hrpdNCList	CDFIM	-	common
CDMA2000 HRPD Carrier Frequency	hrpdArfcn	CDFIM	hrpdNCList	common
CDMA2000 HRPD Band Class	hrpdBdClNcl	CDFIM	hrpdNCList	common
CDMA2000 HRPD Physical Cell Identity	hrpdCellId	CDFIM	hrpdNCList	common
CDMA2000 HRPD NCL extension selector	hrpdExSel	CDFIM	hrpdNCList	common
CDMA2000 1xRTT band class list	rttBdClList	CDFIM	-	common
CDMA2000 1xRTT band class BCL	rttBdClBcl	CDFIM	rttBdClLis	common
CDMA2000 1xRTT cell reselection priority	rttCResPrio	CDFIM	rttBdClLis	common
CDMA2000 1xRTT reselection high threshold	rttFrqThrH	CDFIM	rttBdClLis	common
CDMA2000 1xRTT reselection low threshold	rttFrqThrL	CDFIM	rttBdClLis	common
CDMA2000 1xRTT neighbour cell list	rttNCList	CDFIM	-	common
CDMA2000 1xRTT frequency	rttArfcn	CDFIM	rttNCList	common
CDMA2000 1xRTT band class (NCL)	rttBdClNcl	CDFIM	rttNCList	common
CDMA2000 1xRTT physical cell identity	rttCellId	CDFIM	rttNCList	common

Table 58 New parameters introduced by LTE39 for the FDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
CDMA2000 1xRTT NCL extension selector	rttExSel	CDFIM	rttNCList	common
CDMA Search Window Size	searchWinSize	CDFIM	-	common
CDMA2000 HRPD Cell Reselection Timer	tResHrpd	CDFIM	-	common
Speed Dep Scaling Factors Treselection HRPD	tResHrpdSF	CDFIM	-	common
HRPD Cell Reselection Timer Factor High Mobility	hrpResTiFHM	CDFIM	tResHrpdSF	common
HRPD Cell Reselection Timer Factor Med Mobility	hrpResTiFMM	CDFIM	tResHrpdSF	common
CDMA2000 1xRTT cell reselection timer	tResRtt	CDFIM	-	common
Speed dep scaling factors treselection 1xRTT	tResRttSF	CDFIM	-	common
1xRTT cell reselection timer factor high mobility	rttResTiFHM	CDFIM	tResRttSF	common
1xRTT cell reselection timer factor med mobility	rttResTiFMM	CDFIM	tResRttSF	common
GFIM Identifier	gfimId	GFIM	-	common
GERAN Cell Reselection Timer	tResGer	GFIM	-	common
Speed dependent Scaling Factors Treselection GERAN	tResGerSF	GFIM	-	common
GERAN Cell Reselection Timer Factor High Mobility	gerResTiFHM	GFIM	tResGerSF	common
GERAN Cell Reselection Timer Factor Medium Mobility	gerResTiFMM	GFIM	tResGerSF	common

Table 58 New parameters introduced by LTE39 for the FDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
GERAN Frequency Band Indicator	bandInd	GNFL	-	common
GERAN RAT Carrier Frequency Absolute Priority	gCelResPrio	GNFL	-	common
ARFCN Value List	gerArfcnVal	GNFL	-	common
GERAN Inter Frequency Threshold High	gerFrqThrH	GNFL	-	common
GERAN Inter Frequency Threshold Low	gerFrqThrL	GNFL	-	common
GNFL Identifier	gnflId	GNFL	-	common
NCC Permitted Bit Map	nccperm	GNFL	-	common
GERAN Maximum Allowed Transmit Power	pMaxGer	GNFL	-	common
GERAN Minimum Required Receive Level	qRxLevMinGer	GNFL	-	common
IAFIM Identifier	iafimId	IAFIM	-	common
Intra-Frequency Blacklisted Cell List	intrFrBCList	IAFIM	-	common
Number Of PCI In The Intra Frequency Range	rangeIntraPci	IAFIM	intrFrBCList	common
Lowest PCI In The Intra Frequency Range	startIntraPci	IAFIM	intrFrBCList	common
Intra-Frequency Neighbouring Cell List	intrFrNCList	IAFIM	-	common
Physical Cell Identifier In Neighbouring Cell List	physCellIdNcl	IAFIM	intrFrNCList	common
Cell Reselection Procedure Offset	qOffsetCell	IAFIM	intrFrNCList	common
EUTRA Frequency Value	dlCarFrqEut	IRFIM	-	common

Table 58 New parameters introduced by LTE39 for the FDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
EUTRA Carrier Frequency Absolute Priority	eutCelResPrio	IRFIM	-	common
Inter-Frequency Blacklisted Cell List	intFrBCList	IRFIM	-	common
Number Of PCI In The Inter Frequency Range	rangeInterPci	IRFIM	intFrBCList	common
Lowest PCI In The Inter Frequency Range	startInterPci	IRFIM	intFrBCList	common
Inter-Frequency Neighbouring Cell List	intFrNCList	IRFIM	-	common
Physical Cell Identifier In Neighbouring Cell List	physCellIdNcl	IRFIM	intFrNCList	common
Cell Reselection Procedure Offset	qOffCell	IRFIM	intFrNCList	common
EUTRA Inter Frequency Threshold High	interFrqThrH	IRFIM	-	common
EUTRA Inter Frequency Threshold Low	interFrqThrL	IRFIM	-	common
EUTRA Presence Antenna Port1	interPresAntP	IRFIM	-	common
EUTRA Cell Reselection Timer	interTResEut	IRFIM	-	common
IRFIM Identifier	irfimId	IRFIM	-	common
Allowed Measurement Bandwidth	measBdw	IRFIM	-	common
Pmax Neighbouring EUTRA Cells	pMaxInterF	IRFIM	-	common
EUTRA Frequency Specific Offset	qOffFrq	IRFIM	-	common
Minimum Required Rx RSRP Level	qRxLevMinInterF	IRFIM	-	common

Table 58 New parameters introduced by LTE39 for the FDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Speed dependent Scaling Factors Treselection EUTRAN	tResEutSF	IRFIM	-	common
EUTRA Cell Reselection Timer Factor High Mobility	eutResTiFHM	IRFIM	tResEutSF	common
EUTRA Cell Reselection Timer Factor Medium Mobility	eutResTiFMM	IRFIM	tResEutSF	common
Access class barring for originating calls	acBarOc	SIB	-	common
Access class barring list for mobile originating calls	ocAcBarAC	SIB	acBarOc	common
Access class barring time for originating calls	ocAcBarTime	SIB	acBarOc	common
Access probability factor for originating calls	ocAcProbFac	SIB	acBarOc	common
Access barring for signaling	acBarSig	SIB	-	common
Access class barring list mobile orig signaling	sigAcBarAC	SIB	acBarSig	common
Access class barring time for signaling	sigAcBarTime	SIB	acBarSig	common
Access probability factor for signaling	sigAcProbFac	SIB	acBarSig	common
Additional spectrum emission mask	addSpectrEmi	LNCEL	-	common
Intra Frequency Reselection Timer EUTRA	celResTiF	SIB	-	common
Cell Reselection Timer Factor High Mobility	celResTiFHM	SIB	celResTiF	common
Cell Reselection Timer Factor Medium Mobility	celResTiFMM	SIB	celResTiF	common

Table 58 New parameters introduced by LTE39 for the FDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Cell barred flag	cellBarred	SIB		common
Cell reselection priority	cellReSelPrio	SIB		common
Default Paging Cycle	defPagCyc	LNCEL		common
Access Barred For Emergency Calls	eCallAcBarred	SIB		common
Further PLMN Identity List	furtherPlmnIdL	LNCEL		common
Cell Reserved For Operator Use	cellReserve	LNCEL	furtherPlmnIdL	common
Mobile Country Code	mcc	LNCEL	furtherPlmnIdL	common
Mobile Network Code	mnc	LNCEL	furtherPlmnIdL	common
Mobile Network Code Length	mncLength	LNCEL	furtherPlmnIdL	common
Group assignment for PUSCH	grpAssigPUSCH	LNCEL	-	common
Hopping mode of PUSCH	hopModePusch	LNCEL	-	common
Intra Frequency Cell Reselection Allowed	intrFrqCelRes	SIB	-	common
Presence Antenna Port1	intraPresAntP	SIB	-	common
Modification Period Coefficient	modPeriodCoeff	SIB	-	common
Maximum Number Of Out-Of-Sync Indications	n310	SIB	-	common
Maximum Number Of In-Sync Indications	n311	SIB	-	common
Pmax Intra Frequency Neighbouring E-UTRA	pMaxIntraF	SIB	-	common
Max Uplink Transmission Power Own Cell	pMaxOwnCell	SIB	-	common
Paging nB	pagingNb	LNCEL	-	common

Table 58 New parameters introduced by LTE39 for the FDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
PRACH high speed flag	prachHsFlag	LNCEL_FDD	-	common
Power ramping step	prachPwrRamp	SIB	-	common
Preamble Transmission Maximum	preambTxMax	SIB	-	common
Cell reserved for operator use	primPlmnCellres	SIB	-	common
Cell reselection procedure hysteresis value	qHyst	SIB	-	common
QRX level min. offset	qRxLevMinOffset	SIB	-	common
Minimum Required RX Level in the cell	qrxlevmin	SIB	-	common
Min Required RX level for intra-freq neighbouring cells	qrxlevminintraF	SIB	-	common
Intra Frequency Measurements Threshold	sIntrasearch	SIB	-	common
Inter Frequency And Inter RAT Measurements Threshold	sNonIntrsearch	SIB	-	common
SI Window Length	siWindowLen	SIB	-	common
System Information 2 Scheduling	sib2Scheduling	SIB	-	common
Periodicity	siMessagePeriodicity	SIB	sib2Scheduling	common
Repetition	siMessageRepetition	SIB	sib2Scheduling	common
Message Mapping	siMessageSibType	SIB	sib2Scheduling	common
System Information 3 Scheduling	sib3Scheduling	SIB	-	common

Table 58 New parameters introduced by LTE39 for the FDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Periodicity	siMessagePeriodicity	SIB	sib3Scheduling	common
Repetition	siMessageRepetition	SIB	sib3Scheduling	common
Message Mapping	siMessageSibType	SIB	sib3Scheduling	common
System information scheduling list	sibSchedulingList	SIB	-	common
Periodicity	siMessagePeriodicity	SIB	sibSchedulingList	common
Repetition	siMessageRepetition	SIB	sibSchedulingList	common
SIB type	siMessageSibType	SIB	sibSchedulingList	common
Speed Dependent Reselection Structure	spStResPars	SIB	-	common
Number Cell Changes High Mobility	nCellChgHigh	SIB	spStResPars	common
Number Cell Changes Medium Mobility	nCellChgMed	SIB	spStResPars	common
Cell Reselection Hysteresis High Mobility	qHystSfHigh	SIB	spStResPars	common
Cell Reselection Hysteresis Medium Mobility	qHystSfMed	SIB	spStResPars	common
Timer TCRmax	tEvaluation	SIB	spStResPars	common
Timer TCRmaxHyst	tHystNormal	SIB	spStResPars	common
Timer T300	t300	SIB	-	common
Timer T301	t301	SIB	-	common
Timer T310	t310	SIB	-	common
Timer T311	t311	SIB	-	common

Table 58 New parameters introduced by LTE39 for the FDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Cell reselection timer	tReselEutr	SIB	-	common
Tracking area code	tac	LNCEL	-	common
Threshold Serving Low	threshSrvLow	SIB	-	common
Preamble initial received target power	ulpcIniPrePwr	SIB	-	common
UTRA Cell Reselection Timer	tResUtra	UFFIM	-	common
Speed dependent Scaling Factors Treselection UTRAN	tResUtraSF	UFFIM	-	common
UTRA Cell Reselection Timer Factor High Mobility	utrResTiFHM	UFFIM	tResUtraSF	common
UTRA Cell Reselection Timer Factor Medium Mobility	utrResTiFMM	UFFIM	tResUtraSF	common
UFFIM Identifier	uffimId	UFFIM	-	common
List Of UTRA Carrier Frequencies	utrFddCarFrqL	UFFIM	-	common
UTRA downlink frequency value	dlCarFrqUtra	UFFIM	utrFddCarFrqL	common
UTRA maximum allowed transmit power	pMaxUtra	UFFIM	utrFddCarFrqL	common
UTRA minimum needed quality parameter	qQualMinUtra	UFFIM	utrFddCarFrqL	common
UTRA minimum required receive level	qRxLevMinUtra	UFFIM	utrFddCarFrqL	common
UTRA carrier frequency absolute priority	uCelResPrio	UFFIM	utrFddCarFrqL	common
UTRA inter frequency threshold high	utraFrqThrH	UFFIM	utrFddCarFrqL	common
UTRA inter frequency threshold low	utraFrqThrL	UFFIM	utrFddCarFrqL	common

Note: In the FDD solution, for the SIB1 scheduling list, the parameters for SIB2 (`sib2Scheduling` parameter structure) and SIB3 (`sib3Scheduling` parameter structure) are provided. For all other SIBs (SIB4, SIB5, SIB6, SIB7, SIB8, SIB10, SIB11, and SIB12), the `sibSchedulingList` parameter structure exists with one entry per SIB used.

Table 59 New parameters introduced by LTE39 and LTE762 for the TDD solution

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
GERAN frequency idle mode configuration identifier	gfimId	GFIM	-	common
GERAN cell reselection timer	tResGer	GFIM	-	common
Speed-dependent scaling factors t-reselection GERAN	tResGerSF	GFIM	-	common
GERAN cell reselection timer factor high mobility	gerResTiFHM	GFIM	tResGerSF	common
GERAN cell reselection timer factor medium mobility	gerResTiFMM	GFIM	tResGerSF	common
GERAN frequency band indicator	bandInd	GNFL	-	common
GERAN RAT carrier frequency absolute priority	gCelResPrio	GNFL	-	common
ARFCN value list	gerArfcnVal	GNFL	-	common
GERAN inter-frequency threshold high	gerFrqThrH	GNFL	-	common
GERAN inter-frequency threshold low	gerFrqThrL	GNFL	-	common
GERAN neighbour frequency configuration identifier	gnflId	GNFL	-	common
NCC permitted bitmap	nccperm	GNFL	-	common
GERAN maximum allowed transmit power	pMaxGer	GNFL	-	common
GERAN minimum required receive level	qRxLevMinGer	GNFL	-	common

Table 59 New parameters introduced by LTE39 and LTE762 for the TDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Intra frequency idle mode configuration identifier	iafimid	IAFIM	-	common
Intra-frequency blacklisted cell list	intrFrBCList	IAFIM	-	common
Number of PCI in intra-frequency range	rangeIntraPci	IAFIM	intrFrBCList	common
Lowest PCI in intra-frequency range	startIntraPci	IAFIM	intrFrBCList	common
Intra-frequency neighbouring cell list	intrFrNCList	IAFIM	-	common
Physical Cell Identifier in neighboring cell list	physCellIdNcl	IAFIM	intrFrNCList	common
Cell reselection procedure offset	qOffsetCell	IAFIM	intrFrNCList	common
EUTRA Frequency Value	dlCarFrqEut	IRFIM	-	common
EUTRA Carrier Frequency Absolute Priority	eutCelResPrio	IRFIM	-	common
Inter-frequency blacklisted cell list	intFrBCList	IRFIM	-	common
Number of PCI in inter-frequency range	rangeInterPci	IRFIM	intFrBCList	common
Lowest PCI in inter-frequency range	startInterPci	IRFIM	intFrBCList	common
Inter-Frequency Neighbouring Cell List	intFrNCList	IRFIM	-	common
Physical Cell Identifier In Neighbouring Cell List	physCellIdNcl	IRFIM	intFrNCList	common
Cell Reselection Procedure Offset	qOffCell	IRFIM	intFrNCList	common
EUTRA Inter Frequency Threshold High	interFrqThrH	IRFIM	-	common

Table 59 New parameters introduced by LTE39 and LTE762 for the TDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
EUTRA Inter Frequency Threshold Low	interFrqThrL	IRFIM	-	common
EUTRA Presence Antenna Port1	interPresAntP	IRFIM	-	common
EUTRA Cell Reselection Timer	interTResEut	IRFIM	-	common
IRFIM Identifier	irfimId	IRFIM	-	common
Allowed Measurement Bandwidth	measBdw	IRFIM	-	common
Pmax Neighbouring EUTRA Cells	pMaxInterF	IRFIM	-	common
EUTRA Frequency Specific Offset	qOffFrq	IRFIM	-	common
Minimum Required Rx RSRP Level	qRxLevMinInterF	IRFIM	-	common
Speed-dependent scaling factors t-reselection EUTRAN	tResEutSF	IRFIM	-	common
EUTRA Cell Reselection Timer Factor High Mobility	eutResTiFHM	IRFIM	tResEutSF	common
EUTRA Cell Reselection Timer Factor Medium Mobility	eutResTiFMM	IRFIM	tResEutSF	common
Access class barring for originating calls	acBarOc	SIB	-	common
Access class barring list for mobile originating calls	ocAcBarAC	SIB	acBarOc	common
Access class barring time for originating calls	ocAcBarTime	SIB	acBarOc	common
Access probability factor for originating calls	ocAcProbFac	SIB	acBarOc	common

Table 59 New parameters introduced by LTE39 and LTE762 for the TDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Access barring for signaling	acBarSig	SIB	-	common
Access class barring list mobile orig signaling	sigAcBarAC	SIB	acBarSig	common
Access class barring time for signaling	sigAcBarTime	SIB	acBarSig	common
Access probability factor for signaling	sigAcProbFac	SIB	acBarSig	common
Additional spectrum emission mask	addSpectrEmi	LNCEL	-	common
Intra-frequency reselection timer EUTRA	celResTiF	SIB	-	common
Cell reselection timer factor high mobility	celResTiFHM	SIB	celResTiF	common
Cell reselection timer factor medium mobility	celResTiFMM	SIB	celResTiF	common
Cell barred flag	cellBarred	SIB	-	common
Cell reselection priority	cellReSelPrio	SIB	-	common
Default paging cycle	defPagCyc	LNCEL	-	common
Access barred for emergency calls	eCallAcBarred	SIB	-	common
Further PLMN identity list	furtherPlmnIdL	LNCEL	-	common
Cell reserved for operator use	cellReserve	LNCEL	furtherPlmnIdL	common
Mobile Country Code	mcc	LNCEL	furtherPlmnIdL	common
Mobile Network Code	mnc	LNCEL	furtherPlmnIdL	common
Mobile Network Code length	mncLength	LNCEL	furtherPlmnIdL	common
Group assignment for PUSCH	grpAssigPUSCH	LNCEL	-	common

Table 59 New parameters introduced by LTE39 and LTE762 for the TDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Hopping bandwidth of PUSCH	hopBwPusch	LNCEL_TDD	-	TDD
Hopping mode of PUSCH	hopModePusch	LNCEL	-	common
Intra-frequency cell reselection allowed	intrFrqCelRes	SIB	-	common
Presence antenna Port1	intraPresAntP	SIB	-	common
Modification period coefficient	modPeriodCoeff	SIB	-	common
Maximum number of out-of-sync indications	n310	SIB	-	common
Maximum number of in-sync indications	n311	SIB	-	common
Pmax intra-frequency neighboring E-UTRA	pMaxIntraF	SIB	-	common
Max. uplink transmission power own cell	pMaxOwnCell	SIB	-	common
Paging nB	pagingNb	LNCEL	-	common
Power ramping step	prachPwrRamp	SIB	-	common
Preamble transmission maximum	preambTxMax	SIB	-	common
Cell reserved for operator use	primPlmnCellres	SIB	-	common
Cell reselection procedure hysteresis value	qHyst	SIB	-	common
Q RX level min. offset	qRxLevMinOffset	SIB	-	common
Minimum required RX level in cell	qrxlevmin	SIB	-	common
Min. required RX level for intra-freq neighboring cells	qrxlevminintraF	SIB	-	common

Table 59 New parameters introduced by LTE39 and LTE762 for the TDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Intra-frequency measurements threshold	sIntrasearch	SIB	-	common
Inter-frequency and inter-RAT measurements threshold	sNonIntrsearch	SIB	-	common
SI Window Length	siWindowLen	SIB	-	common
System Information 2 Scheduling	sib2Scheduling	SIB	-	common
Periodicity	siMessagePeriodicity	SIB	sib2Scheduling	common
Repetition	siMessageRepetition	SIB	sib2Scheduling	common
Message Mapping	siMessageSibType	SIB	sib2Scheduling	common
System Information 3 Scheduling	sib3Scheduling	SIB	-	common
Periodicity	siMessagePeriodicity	SIB	sib3Scheduling	common
Repetition	siMessageRepetition	SIB	sib3Scheduling	common
Message Mapping	siMessageSibType	SIB	sib3Scheduling	common
System information scheduling list	sibSchedulingList	SIB	-	common
Periodicity	siMessagePeriodicity	SIB	sibSchedulingList	common
Repetition	siMessageRepetition	SIB	sibSchedulingList	common
SIB type	siMessageSibType	SIB	sibSchedulingList	common
Speed-dependent reselection structure	spStResPars	SIB	-	common

Table 59 New parameters introduced by LTE39 and LTE762 for the TDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Number cell changes high mobility	nCellChgHigh	SIB	spStResPars	common
Number cell changes medium mobility	nCellChgMed	SIB	spStResPars	common
Cell reselection hysteresis high mobility	qHystSfHigh	SIB	spStResPars	common
Cell reselection hysteresis medium mobility	qHystSfMed	SIB	spStResPars	common
Timer TCRmax	tEvaluation	SIB	spStResPars	common
Timer TCRmaxHyst	tHystNormal	SIB	spStResPars	common
Timer T300	t300	SIB	-	common
Timer T301	t301	SIB	-	common
Timer T310	t310	SIB	-	common
Timer T311	t311	SIB	-	common
Cell reselection timer	tReselEutr	SIB	-	common
Tracking area code	tac	LNCEL	-	common
Threshold serving low	threshSrvLow	SIB	-	common
Preamble initial received target power	ulpcIniPrePwr	SIB	-	common
UTRA cell reselection timer	tResUtra	UFFIM	-	common
Speed-dependent scaling factors t-reselection UTRAN	tResUtraSF	UFFIM	-	common
UTRA cell reselection timer factor high mobility	utrResTiFHM	UFFIM	tResUtraSF	common
UTRA cell reselection timer factor medium mobility	utrResTiFMM	UFFIM	tResUtraSF	common

Table 59 New parameters introduced by LTE39 and LTE762 for the TDD solution (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Utran TDD idle mode configuration identifier	uffimId	UFFIM	-	common
UTRA carrier frequencies list	utrFddCarFrqL	UFFIM	-	common
UTRA downlink frequency value	dlCarFrqUtr	UFFIM	utrFddCarFrqL	common
UTRA maximum allowed transmit power	pMaxUtra	UFFIM	utrFddCarFrqL	common
UTRA minimum needed quality parameter	qQualMinUtra	UFFIM	utrFddCarFrqL	common
UTRA minimum required receive level	qRxLevMinUtra	UFFIM	utrFddCarFrqL	common
UTRA carrier frequency absolute priority	uCelResPrio	UFFIM	utrFddCarFrqL	common
UTRA inter frequency threshold high	utraFrqThrH	UFFIM	utrFddCarFrqL	common
UTRA inter frequency threshold low	utraFrqThrL	UFFIM	utrFddCarFrqL	common
List Of UTRA Tdd Carrier Frequencies	utrTddCarFrqL	UFFIM	-	common
UTRA Downlink Frequency Value	dlCarFrqUtra	UFFIM	utrTddCarFrqL	common
UTRA Maximum Allowed Transmit Power	pMaxUtra	UFFIM	utrTddCarFrqL	common
UTRA Minimum Required Receive Level	qRxLevMinUtra	UFFIM	utrTddCarFrqL	common
UTRA Carrier Frequency Absolute Priority	uCelResPrio	UFFIM	utrTddCarFrqL	common
UTRA Inter Frequency Threshold High	utraFrqThrH	UFFIM	utrTddCarFrqL	common
UTRA Inter Frequency Threshold Low	utraFrqThrL	UFFIM	utrTddCarFrqL	common

Note: In the TDD solution, for the SIB1 scheduling list, the parameters for SIB2 (`sib2Scheduling` parameter structure) and SIB3 (`sib3Scheduling` parameter structure) are provided. For all other SIBs (SIB4, SIB5, SIB6, SIB7, SIB8, SIB10, SIB11, and SIB12), the `sibSchedulingList` parameter structure exists with one entry per SIB used.

For parameter descriptions, see *LTE Operating Documentation/ Reference/ Parameters*.

Sales information

Table 60 LTE39 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

15 LTE40: Physical and Transport Channels

15.1 Introduction to the feature

The *LTE40: Physical and Transport Channels* covers the following features:

- definition of the uplink (UL) and downlink (DL) physical and transport channels
- structure of the physical channels, frame format, and physical resource elements
- physical shared channel in the UL and DL
- reference signal in downlink, sounding reference signal and demodulation in uplink
- synchronization signals
- physical layer management
- coding
- radio link failure detection based on the channel quality indicator (CQI) discontinuous transmission (DTX) detection

15.2 Benefits

The physical layer functionality is supported.

15.3 Functional description

15.3.1 Functional details

Transport channels

The evolved node B (eNodeB) supports the following transport channels:

- Broadcast channel (BCH): The BCH is a DL BCH that is used to broadcast the necessary system parameters to enable the UEs to access the system (and to identify the operator). The BCH broadcasts in the entire coverage of a cell.
- Paging channel (PCH): The PCH is used for carrying the paging information for the UE in the DL direction to move the UE from RRC_IDLE to RRC_CONNECTED. The PCH broadcasts in the entire coverage of a cell
- Random access channel (RACH): The RACH is used in the UL to respond the paging message or to initiate the move from/to RRC_CONNECTED state according to UE data transmission needs.
- Downlink shared channel (DSCH): The DSCH carries user data for point-to-point connections in the DL direction. All the information (either user data or higher layer control information) is intended only for one user or UE is transmitted on the DSCH.
- Uplink shared channel (USCH): The USCH carries user data as well as UE originated control information in the UL direction.
- Multicast channel (MCH): The MCH transfers information from one device or point to multiple devices or multiple receiving points.

Physical channels

Downlink physical channels

The eNodeB supports the following DL physical channels:

- Physical broadcast channel (PBCH): The PBCH carries the primary system information (for example: MIB) transport block from the BCH. The eNodeB performs the scrambling, modulation, layer mapping, and precoding on the PBCH. The PBCH is mapped onto the fixed frequency and time resource in a slot.
- Physical control format indicator channel, PCFICH: The PCFICH is transmitted from the eNodeB to the UE and is mapped onto a set of resource element groups in the first orthogonal frequency-division multiplexing (OFDM) symbol in every subframe. The control format indicator (CFI) is mapped onto the PCFICH. The PCFICH carries information of the number of OFDM symbols (1, 2 or 3) used for transmission of physical downlink control channels (PDCCHs) in a subframe.
- Physical hybrid ARQ indicator channel (PHICH): The PHICH is supported and therefore transmitted from the eNodeB to the UE. The PHICH carries the HARQ ACK/NACK for USCH transmission. The hybrid ARQ indicator (HI) is mapped onto the PHICH. The eNodeB supports normal duration of the PHICH.
- Physical downlink control channel (PDCCH): The PDCCH is transmitted from the eNodeB to the UE in every transmission time interval (TTI) via the air interface on an aggregation of one up to eight control channel elements (CCEs).
- Physical downlink shared channel (PDSCH): If data is available, the PDSCH is transmitted from the eNodeB to the UE in every TTI via the air interface. The PDSCH carries transport blocks from the DSCH and paging channel (PCH). The eNodeB performs the scrambling, modulation, layer mapping, and precoding on the PDSCH. The PDSCH is mapped onto the scheduled frequency and time resource.
- Physical multicast channel (PMCH): The PMCH transfers information from a source to one or more devices within the radio coverage area.

Uplink physical channels

The eNodeB supports the following UL physical channels:

- Physical random access channel (PRACH): The PRACH is transmitted from the UE to the eNodeB and carries a preamble sequence selected from a cell specific set of signature sequences. The eNodeB supports the reception of the preamble format 0, 1, 2, and 4.
- Physical uplink control channel (PUCCH): The PUCCH is transmitted from the UE to the eNodeB. The uplink control information (UCI) is mapped onto PUCCH. The PUCCH carries the CQI or precoding matrix indicator (PMI), rank indicator (RI), and ACK/NACK information for DSCH transmission and scheduling request (SR).
- Physical uplink shared channel (PUSCH): The PUSCH is transmitted from the UE to the eNodeB. The PUSCH carries one UL transport block per TTI per UE. It is also time/frequency multiplexed with the UL control signal (CQI and ACK/NACK) if the UE is scheduled in the UL.

In addition to the DL and UL physical channels, the following physical signals are supported:

- primary and secondary synchronization signals, DL
- cell-specific reference signal, DL
- UE-specific reference signal, DL
- channel state information (CSI) reference signal, DL
- positioning reference signal (PRS), DL

- positioning reference signal (PRS), DL
- demodulation reference signal (DMRS), UL
- sounding reference signal, UL
- sounding reference signal, UL
- MBMS reference signal, DL

Mapping

Table 61: Uplink: Mapping of transport channels onto the physical channels. and Table 62: Downlink: Mapping of transport channels onto the physical channels. show the mapping between the transport and physical channels.

Table 61 Uplink: Mapping of transport channels onto the physical channels.

Transport channel	Physical channel
UL-SCH	PUSCH
RACH	PRACH
Control information	
UCI	PUCCH, PUSCH

Table 62 Downlink: Mapping of transport channels onto the physical channels.

Transport channel	Physical channel
DL-SCH	PDSCH
BCH	PBCH
PCH	PDSCH
MCH	PMCH
Control information	
HI	PHICH
DCI	PDCCH
CFI	PCFICH

PBCH is only used for transporting the MIB. The remaining system information is scheduled into PDSCH.

The downlink control information (DCI) carries the DL and UL scheduling information and controls other dedicated physical layer procedures. The UCI includes:

- ACK/NACK
- CQI
- PMI (supported along with closed loop multiple inputs multiple outputs (MIMO))
- RI
- SR
- precoding type indicator (PTI)

LTE applies OFDM in the DL and SC-OFDMA (single carrier orthogonal frequency division multiple access) in the UL. The subcarrier spacing is 15 KHz in a unicast mode. The synchronization and reference signals support 504 unique physical cell identities.

The eNodeB supports the following physical channel processing according to the physical channel type [3GPP TS 36.211]:

- scrambling
- modulation
- precoding
- layer mapping

The PDSCH and PUSCH apply adaptively quadrature phase shift keying (QSPK) and 16-quadrature amplitude modulation (16-QAM) modulations. On PDSCH and PUSCH, a further adaptation to 64-QAM can be enabled through an O&M configuration. The other physical channels and signals mostly apply QPSK with the exception of PUCCH applying QPSK and binary phase shift keying (BPSK) and PHICH applying BPSK. The Flexi Multiradio BTS supports the DCI formats 0, 1, 1A, 1C, 2, and 2A. Resource allocations of type 0 and 2 are supported. The reception of the preamble formats 0 and 1 are supported. The eNodeB supports the following coding functions according to the transport channel type or to control information type [3GBB TS 36.212]:

The PDSCH and PUSCH apply adaptively quadrature phase shift keying (QSPK) and 16-quadrature amplitude modulation (16-QAM) modulations. On PDSCH and PUSCH, a further adaptation to 64-QAM can be enabled through an O&M configuration. The other physical channels and signals mostly apply QPSK with the exception of PUCCH applying QPSK and binary phase shift keying (BPSK) and PHICH applying BPSK. The Flexi Multiradio BTS supports the DCI formats 0, 1, 1A, 1C, 2, and 2A2, 2A, 2B , and 2C. Resource allocations of type 0 and 2 are supported. The reception of the preamble formats 0, 1, 2, and 4 are supported. The eNodeB supports the following coding functions according to the transport channel type or to control information type [3GPP TS 36.212]:

- cyclic redundancy check (CRC)
- code block segmentation
- channel coding
- rate matching
- interleaving

The following coding schemes are applied depending on data type:

- tail biting convolutional codes (CC)
- convolutional turbo codes (TC)
- Reed-Muller block coding
- repetition coding
- simplex coding

15.4 System impacts

15.4.1 Interdependencies between features

There are no interdependencies between this and any other feature.

15.5 LTE40 reference data

Requirements

Table 63 LTE40 hardware and software requirements

	FDD	TDD
System release	RL09	RL05TD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Flexi Zone Controller	FL15A	TL15A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE40:Physical & transport channels* feature.

BTS faults and reported alarms

There are no faults related to the *LTE40:Physical & transport channels* feature.

Commands

There are no commands related to the *LTE40:Physical & transport channels* feature.

Measurements and counters

There are no measurements or counters related to the *LTE40:Physical & transport channels* feature.

Key performance indicators

There are no key performance indicators related to the *LTE40:Physical & transport channels* feature.

Parameters

Table 64 New parameters introduced by LTE40

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Delta cyclic shift for PUCCH	deltaPucchShift	MPUCCH_FDD	-	FDD
Downlink Channel Bandwidth	dlChBw	LNCEL_FDD	-	FDD
EARFCN Downlink	earfcnDL	LNCEL_FDD	-	FDD
EARFCN Uplink	EARFCN Downlink	LNCEL_FDD	-	FDD
Maximum Number of OFDM Symbols for PDCCH	maxNrSymPdcch	LNCEL_FDD	-	FDD
ACK/NACK offset	n1PucchAn	MPUCCH_FDD	-	FDD
PUCCH bandwidth for CQI	nCqiRb	MPUCCH_FDD	-	FDD
Maximum Output Power	pMax	LNCEL	-	common
PHICH Duration	phichDur	MPUCCH_FDD	-	FDD
PHICH Resource	phichRes	MPUCCH_FDD	-	FDD
Physical Layer Cell Identity	phyCellId	LNCEL	-	common
PRACH Cyclic Shift	prachCS	LNCEL_FDD	-	FDD
PRACH Configuration Index	prachConfIndex	LNCEL_FDD	-	FDD
PRACH Frequency Offset	prachFreqOff	LNCEL_FDD	-	FDD
PRACH high speed flag	prachHsFlag	LNCEL_FDD	-	FDD
PUCCH cyclic shift for mixed formats	pucchNAnCs	LNCEL_FDD	-	FDD
Number Of Random Access Preambles	raNondedPreamb	LNCEL	-	common

Table 64 New parameters introduced by LTE40 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
RACH Root Sequence	rootSeqIndex	LNCEL_FDD	-	FDD
Synchronization Signals Transmission Mode	syncSigTxMode	LNCEL_FDD	-	FDD
SRS bandwidth configuration	srsBwConf	LNCEL	-	common
Uplink Channel Bandwidth	ulChBw	LNCEL_FDD	-	FDD
Uplink Reference Signals Cyclic Shift	ulRsCs	LNCEL	-	common
Cqi Periodicity Network Period	cqiPerNp	MPUCCH_TDD	-	TDD
Delta cyclic shift for PUCCH	deltaPucchShift	MPUCCH_TDD	-	TDD
Maximum number of OFDM symbols for PDCCH	maxNrSymPdcch	LNCEL_TDD	-	TDD
ACK/NACK offset	n1PucchAn	MPUCCH_TDD	-	TDD
APUCCH bandwidth for CQI	nCqiRb	LNCEL	-	common
PHICH duration	phichDur	MPUCCH_TDD	-	TDD
PHICH resource	phichRes	MPUCCH_TDD	-	TDD
PRACH Configuration Index	prachConfIndex	LNCEL_TDD	-	TDD
PRACH Frequency Offset	prachFreqOff	LNCEL	-	common
PUCCH cyclic shift for mixed formats	pucchNAnCs	LNCEL	-	common
Number of Random Access preambles	raNondedPreamb	LNCEL	-	common
Synchronization signals transmission mode	syncSigTxMode	LNCEL_TDD	-	TDD
Time Alignment Timer Margin	taTimerMargin	LNCEL	-	common

Table 64 New parameters introduced by LTE40 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
`Uplink reference signals cyclic shift`	ulRsCs	LNCEL	-	common

For parameter descriptions, see *LTE Radio Access Operating Documentation/Reference/Parameters*.

Sales information

Table 65 LTE40 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

16 LTE41: PDCP, RLC and MAC support

16.1 Introduction to the feature

The PDCP, RLC, and MAC are the layer 2 protocols of the radio interface:

- Packet data convergence protocol (PDCP): The main functions of PDCP are encryption and integrity protection (C-plane only).
- Radio link control (RLC): The RLC protocol is responsible for segmenting and concatenation of the packet data convergence protocol-protocol data units (PDCP-PDUs) for radio interface transmission. It also performs error correction with the automatic repeat request (ARQ) method.
- Medium access control (MAC): The MAC layer is responsible for scheduling the data according to priorities, and multiplexing the data to the layer 1 transport blocks. The MAC layer also provides error correction with hybrid ARQ (HARQ).

16.2 Benefits

The feature provides an efficient L2 functionality for data services.

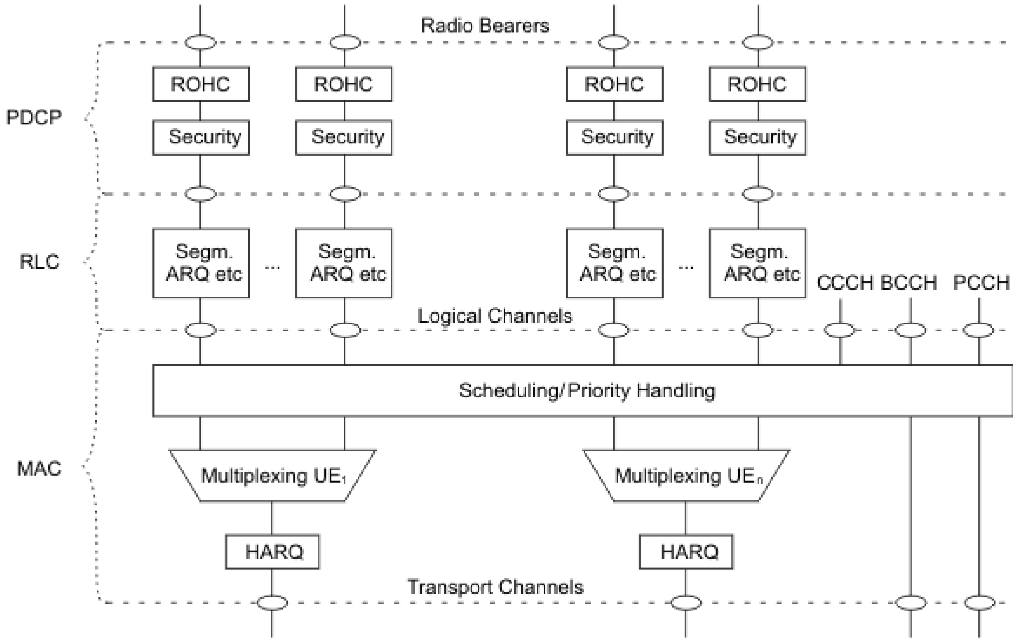
16.3 Functional description

16.3.1 Functional details

Overview

The radio layer 2 is split into the following sublayers: medium access control (MAC), radio link control (RLC) and packet data convergence protocol (PDCP).

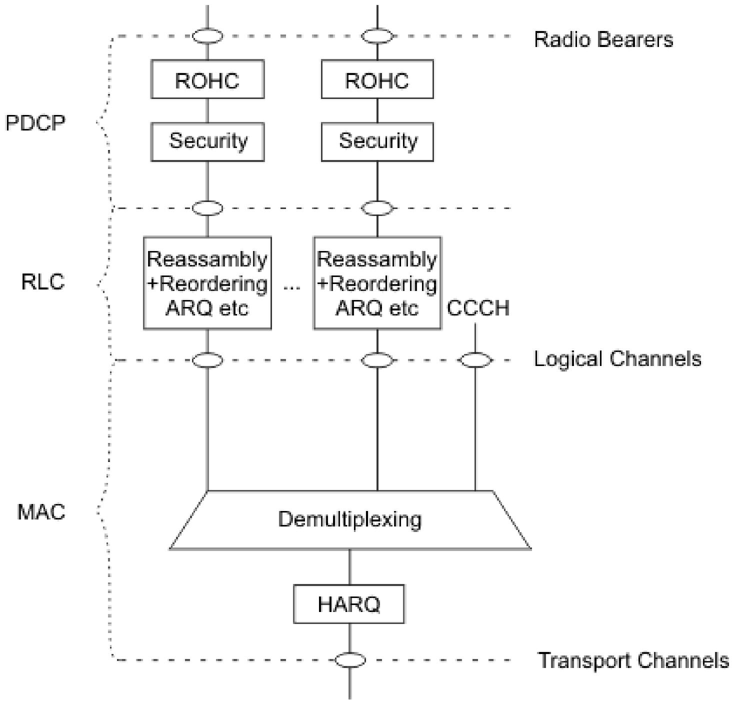
Figure 20 Layer 2 downlink, transmitting side



In the DL direction, the PDCP and RLC sublayers provide the data transfer services from the radio bearers to the logical channels. The MAC sublayer provides the data transfer services on the logical channels which are mapped onto the transport channels.

In the UL direction, the MAC sublayer uses the data transfer services provided by the physical layer on the transport channels. The transport channels are mapped to logical channels. The RLC and PDCP sublayers provide the data transfer to the radio bearers. An overview of the UL direction is given in Figure 21: Layer 2 uplink, receiving side.

Figure 21 Layer 2 uplink, receiving side



MAC sublayer

The following are the main functions of the MAC sublayer:

- mapping between logical channels and transport channels
- scheduling information reporting
- error correction through HARQ
- priority handling between logical channels of one UE
- priority handling between UEs through dynamic scheduling
- transport format selection
- logical channel prioritization (UE)
- time alignment

The eNodeB maps the logical channels to the transport channels in the DL as shown in Table 66: Mapping of logical channels onto transport channels in DL.

Table 66 Mapping of logical channels onto transport channels in DL

Logical channel	Transport channel
MIB of BCCH	BCH
dynamic system information of BCCH	DL-SCH
PCCH	PCH
CCCH	DL-SCH
DCCH	DL-SCH
DTCH	DL-SCH
MTCH	MCCH

The eNodeB maps the transport channels to the logical channels in the UL as shown in Table 67: Mapping of transport channels onto logical channels in UL.

Table 67 Mapping of transport channels onto logical channels in UL

Transport channel	Logical channel
UL-SCH	UL CCCH, UL DCCH, UL DTCH
UL-RACH	no logical channel

HARQ is an error detection and correction procedure. It is located in the MAC sublayer. The Flexi Multiradio BTS applies incremental redundancy in retransmission. The HARQ procedure is applied for common control channel (CCCH), dedicated control channel (DCCH), and dedicated traffic channel (DTCH).

The MAC-sublayer supports control and configuration procedures for DRX functionality with long DRX cycles.

The MAC-sublayer is responsible for the following TDD features:

- ACK/NACK bundling for TDD
- UL-DL configuration 1
- UL-DL configuration 2
- DwPTS, GP, and UpPTS with special subframe 3
- DwPTS, GP, and UpPTS with special subframe 4
- DwPTS, GP, and UpPTS with special subframe 5
- DwPTS, GP, and UpPTS with special subframe 6
- DwPTS, GP, and UpPTS with special subframe 7
- DwPTS, GP, and UpPTS with special subframe 9
- Inter frequency handover for TDD

:

RLC sublayer

The following are the main functions of the RLC sublayer:

- transfer of upper layer protocol data units (PDUs)
- error correction through ARQ (only for AM data transfer)
- concatenation, segmentation and reassembly of RLC service data units (SDUs) (not valid with TM transfer)
- resegmentation and reassembly of RLC data PDUs (only for AM data transfer)
- in-sequence delivery of upper layer PDUs (not valid with TM transfer)
- duplicate detection (not valid with TM transfer)
- SDU discard (not valid with TM transfer)
- RLC re-establishment
- protocol error detection and recovery

The RLC can operate in three modes:

- Transparent Mode (TM): In the TM mode, the RLC only delivers and receives the PDUs on a logical channel but does not add any headers to it and thus, no track of received PDUs is kept between the receiving and the transmitted entity.
- Unacknowledged Mode (UM): In the UM mode of RLC operation, the RLC provides more functionality including in-sequence delivery of data which might be received out of sequence.
- Acknowledged Mode (AM): In addition to UM, with AM, the RLC provides the retransmission if PDUs are lost as a result of operations in the lower layers.

For BCCH, PCCH, and DL CCCH using TM data transfer, the TM RLC transmitting entity in the eNodeB forms the RLC PDU from the whole RLC SDU only when a transmission opportunity has been notified by a lower layer and is then delivered to the lower layer. Neither segmentation nor concatenation is done on RLC SDU to form the RLC PDU. No RLC PDU header is attached to the transparent mode data (TMD) PDU.

For UL CCCH using TM data transfer, the TM RLC receiving entity in the eNodeB delivers the whole TMD PDU (=RLC SDU) to the upper layer. No deconcatenation and reassembling is done on TMD PDU to form the RLC SDU.

For the AM and UM RLC operations, the RLC layer receives data from the PDCP layer, the data are stored in the transmission buffer and then, based on the resources available, segmentation or concatenation is used. For control purposes, in both directions (UL and DL) in UM 5 and 10 bit sequence number (SN) is used. In AM only 10 bit sequence number is used.

When the receiving entity gets a RLC PDU, it checks for possible duplicated parts and then forwards a RLC PDU for reassembly (assuming no SNs are missing in between) and provides data to the next protocol layer (in this case PDCP) for further processing.

In the **AM**, the transmitter polls status report in a continuous manner and the receiver sends the ACKs and NACKs of the RLC PDUs and the RLC PDU segments. This proceeding controls the data transfer in DL and UL. Thus the eNodeB polls the status reports in DL and the eNodeB has to send the status reports to the UE whenever the UE asks for the report.

RLC UM is applied for EPS bearers with QCI 1-4. RLC AM can be applied for EPS bearers with QCI 4-9.

RLC sublayer

The following are the main functions of the RLC sublayer:

- transfer of upper layer protocol data units (PDUs)
- error correction through ARQ (only for AM data transfer)
- concatenation, segmentation and reassembly of RLC service data units (SDUs) (not valid with TM transfer)
- resegmentation and reassembly of RLC data PDUs (only for AM data transfer)
- in-sequence delivery of upper layer PDUs (not valid with TM transfer)
- duplicate detection (not valid with TM transfer)
- SDU discard (not valid with TM transfer)
- RLC re-establishment
- protocol error detection and recovery

The RLC can operate in the following modes:

- Transparent Mode (TM): In the TM mode, the RLC only delivers and receives the PDUs on a logical channel but does not add any headers to it and thus, no track of received PDUs is kept between the receiving and the transmitted entity.
- Unacknowledged Mode (UM): In the UM mode of RLC operation the RLC provides more functionality including in-sequence delivery of data which might be received out of sequence.
- Acknowledged Mode (AM): In the AM mode of RLC operation the RLC provides more functionality including in-sequence delivery of data which might be received out of sequence. In addition, the RLC provides the retransmission if PDUs are lost as a result of operations in the lower layers.

For BCCH, PCCH, and DL CCCH using TM data transfer, the TM RLC transmitting entity in the eNodeB forms the RLC PDU from the whole RLC SDU only when a transmission opportunity has been notified by a lower layer and is then delivered to the lower layer. Neither segmentation nor concatenation is done on RLC SDU to form the RLC PDU. No RLC PDU header is attached to the transparent mode data (TMD) PDU.

For UL CCCH using TM data transfer, the TM RLC receiving entity in the eNodeB delivers the whole TMD PDU (=RLC SDU) to the upper layer. No deconcatenation and reassembling is done on TMD PDU to form the RLC SDU.

For the AM and UM RLC operations, the RLC layer receives data from the PDCP layer, the data are stored in the transmission buffer and then, based on the resources available, segmentation or concatenation is used. For control purposes, in both directions (UL and DL) in UM 5 and 10 bit sequence number (SN) is used. In AM only 10 bit sequence number is used.

When the receiving entity gets a RLC PDU, it checks for possible duplicated parts and then forwards a RLC PDU for reassembly (assuming no SNs are missing in between) and provides data to the next protocol layer (in this case PDCP) for further processing.

In the AM, the transmitter polls status report in a continuous manner and the receiver sends the ACKs and NACKs of the RLC PDUs and the RLC PDU segments. This proceeding controls the data transfer in DL and UL. Thus, the eNodeB polls the status reports in DL and the eNodeB has to send the status reports to the UE whenever the UE asks for the report.

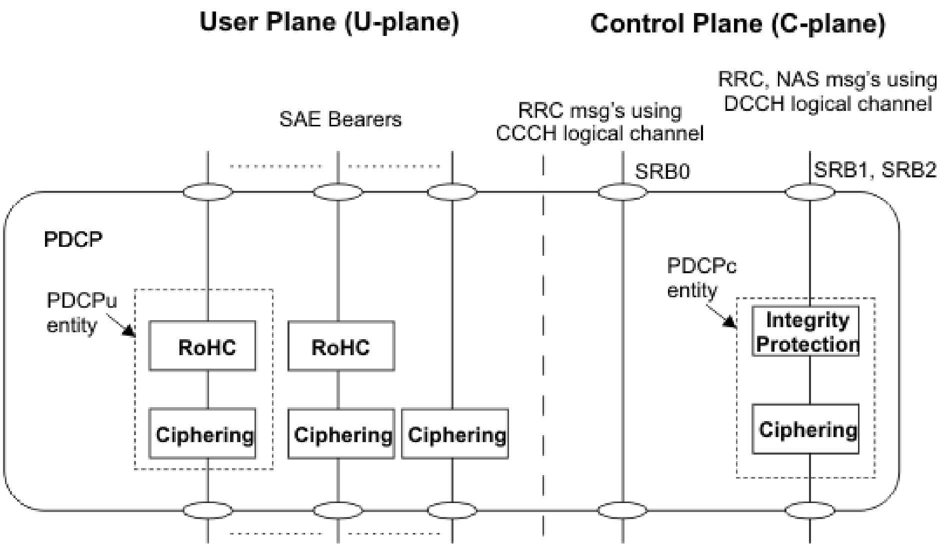
PDCP sublayer

The main functions of the PDCP sublayer include:

- header compression and decompression of IP data flows using the ROHC protocol at the transmitting and receiving entity, respectively (for EPS bearers with QCI 1)
- transfer of data (U-plane or C-plane data): This function is used to convey data between users of PDCP services.
- maintenance of PDCP sequence numbers for radio bearers mapped on RLC AM
- duplicate detection of lower layer SDUs at handover for radio bearers mapped on RLC AM
- in-sequence delivery of upper layer PDUs at handover
- ciphering and deciphering of U-plane data and C-plane data
- integrity protection and integrity verification of control plane data
- timer based discard
- active queue management *(LTE1680: Active Queue Management)*

The PDCP can be split up into U-plane and C-plane usage as shown in Figure 22: PDCP U-plane and C-plane.

Figure 22 PDCP U-plane and C-plane



The SN assignment of NACKed PDCP Sequence Numbers is limited to a maximum number of 2048.

For the U-plane, ciphering per SAE bearer is performed. A separate PDCPu entity must be set up for each SAE bearer. The U-plane traffic is mapped to RLCu SAP.

For the C-plane, integrity and ciphering protection are performed for SRB1 and SRB2 after the security mode command (SMC) procedure. The PDCPc is transparent for SRB0 signaling messages using the CCCH logical channel, that is no integrity and ciphering is performed at all. The C-plane traffic is mapped to RLCc SAP.

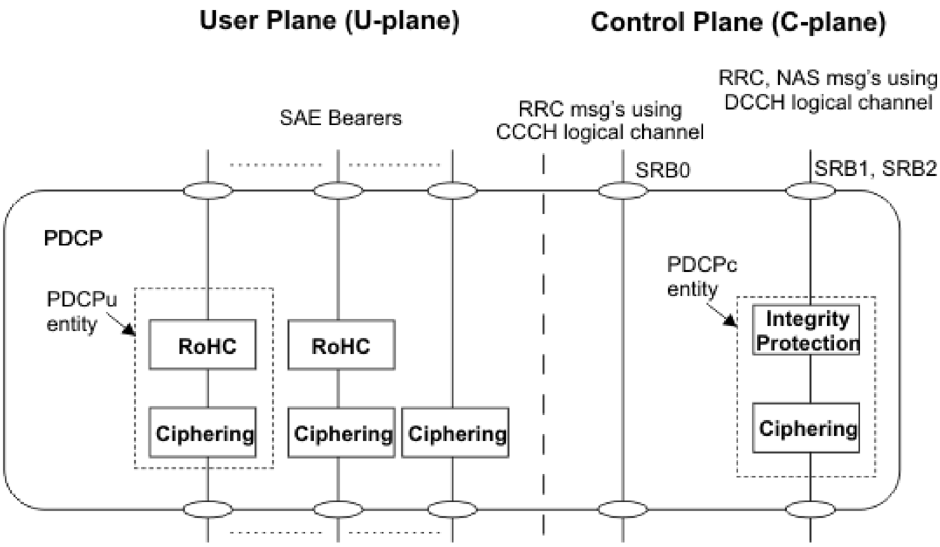
PDCP sublayer

The main functions of the PDCP sublayer include:

- header compression and decompression of IP data flows using the ROHC protocol at the transmitting and receiving entity, respectively
- transfer of data (U-plane or C-plane data): This function is used to convey data between users of PDCP services.
- maintenance of PDCP sequence numbers for radio bearers mapped on RLC AM
- duplicate detection of lower layer SDUs at handover for radio bearers mapped on RLC AM
- in-sequence delivery of upper layer PDUs at handover
- ciphering and deciphering of U-plane data and C-plane data
- integrity protection and integrity verification of control plane data
- timer based discard
- active queue management *(LTE1680: Active Queue Management)*

The PDCP can be split up into U-plane and C-plane usage as shown in Figure 23: PDCP U-plane and C-plane.

Figure 23 PDCP U-plane and C-plane



The SN assignment of NACKed PDCP sequence numbers is limited to a maximum number of 2048.

For the U-plane, ciphering per SAE bearer is performed. A separate PDCPu entity must be set up for each SAE bearer. The U-plane traffic is mapped to RLCu service access point (SAP).

For the C-plane, integrity and ciphering protection are performed for SRB1 and SRB2 after the security mode command (SMC) procedure. The PDCP is transparent for SRB0 signaling messages using the CCCH logical channel, that is no integrity and ciphering is performed at all. The C-plane traffic is mapped to RLCc SAP.

16.4 System impacts

16.4.1 Interdependencies between features

There are no interdependencies between this and any other feature.

16.5 LTE41 reference data

Requirements

Table 68 [Feature ID] hardware and software requirements

	FDD	TDD
System release	RL09	RL05TD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	-	Not supported
Nokia AirScale BTS	FL16S4	TL16S4
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Flexi Zone Controller	FL15A	TL15A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE41:PDCP, RLC & MAC support* feature.

BTS faults and reported alarms

There are no faults related to the *LTE41:PDCP, RLC & MAC support* feature.

Commands

There are no commands related to the *LTE41:PDCP, RLC & MAC support* feature.

Measurements and counters

There are no measurements or counters related to the *LTE41:PDCP, RLC & MAC support* feature.

Key performance indicators

There are no key performance indicators related to the *LTE41:PDCP, RLC & MAC support* feature.

Parameters

Table 69 New parameters introduced by LTE41

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Cell Scheduling Request Periodicity	cellSrPeriod	MPUCCH_FDD_TDD	-	common
Dedicated SR Transmission Maximum	dSrTransMax	LNCEL	-	common
Maximum Number Of Message 3 HARQ Transmissions	harqMaxMsg3	LNCEL	-	common
Maximum Number Of HARQ Transmission In DL	harqMaxTrDl	LNCEL	-	common
Maximum Number Of HARQ Transmission In UL	harqMaxTxUl	LNCEL	-	common
Inactivity Timer	inactivityTimer	LNCEL	-	common
Initial MCS In Downlink	iniMcsDl	LNCEL	-	common
Initial MCS In Uplink	iniMcsUl	LNCEL	-	common
Initial Amount Of PRBs In Uplink	iniPrbsUl	LNCEL	-	common
Maximum Content Resolution Timer	raContResoT	LNCEL	-	common
Large size random access MCS in uplink	raLargeMcsUl	LNCEL	-	common
RA Message Power Offset For Group B Selection	raMsgPoffGrB	LNCEL	-	common
Random Access Preambles Group A Size	raPreGrASize	LNCEL	-	common
Random Access Response Window Size	raRespWinSize	LNCEL	-	common

Table 69 New parameters introduced by LTE41 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Scheduling request indication enable	sriEnable	LNCEL	-	common
Time Alignment Timer	taTimer	LNCEL	-	common

Sales information

Table 70 LTE41 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

17 LTE43: Support of 64 QAM in DL, LTE788: Support of 16 QAM (UL), LTE793: Support of 16 QAM (DL)

17.1 Introduction to the feature

The original bit streams in the eNodeB and in the UE are digital. To send them via radio antenna they must be converted to analogous waveform. This is done by modulation.

The basic modulation method is QPSK for robust transmission on PUSCH and PDSCH. On top there are higher order modulations with QAM (quadrature amplitude modulation) - which are the content of this feature description.

This feature description comprises the following features:

- LTE793:"Support of 16QAM (DL)"
- LTE788:"Support of 16QAM (UL)"
- LTE43:"Support of 64QAM in DL"

17.2 Benefits

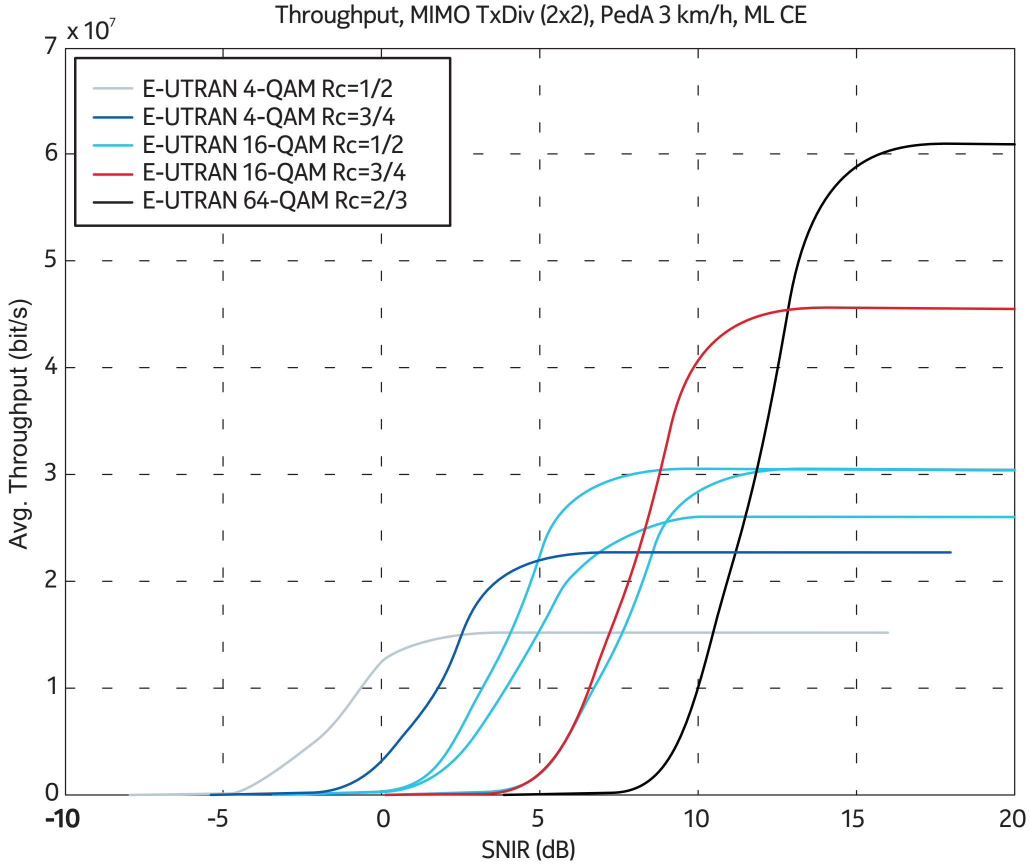
The benefits of the features are:

16QAM: Increase of the peak rate by 100% compared to QSPK, around 70% increased spectral efficiency.

64QAM(DL) : Increase of the DL peak rate by 50% as compared to 16QAM scenario.

Figure 24: Throughput for different modulation schemes gives a short overview of the throughput of different modulation schemes. The figure is valid for a bandwidth of 20Mhz.

Figure 24 Throughput for different modulation schemes



17.3 Functional description

17.3.1 Functional details

Quadrature amplitude modulation (QAM) is one of the widely used modulation schemes, which changes (modulates) the amplitude of two othogonal sinusoidal carrier waves depending on the input bits as follows

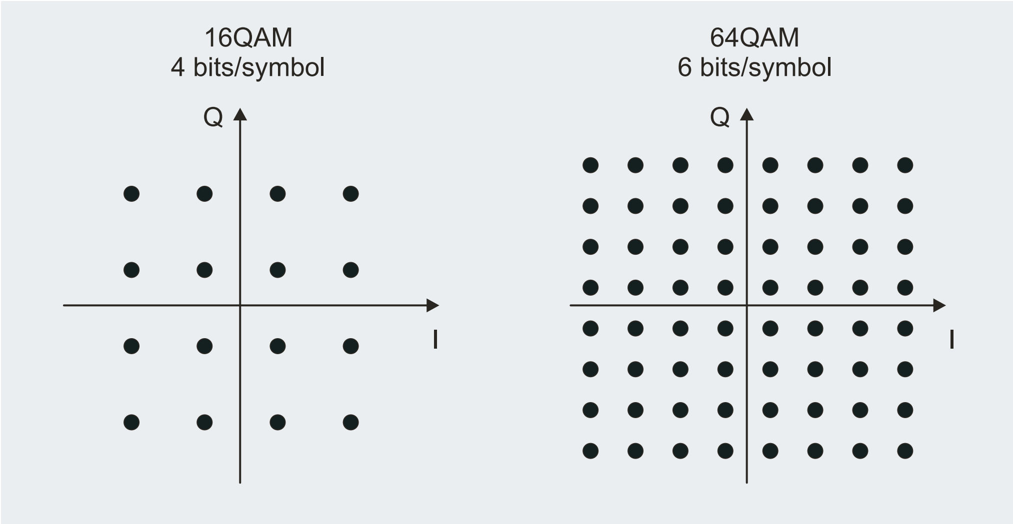
$$s(t) = I(t)\cos(2\pi ft) + Q(t)\sin(2\pi ft)$$

where I(t) and Q(t) are the modulating signal amplitudes, f is the carrier frequency.

In a graphical representation (I-Q-plane) the I- and Q- amplitudes are arranged in a square grid with equal vertical and horizontal spacing.

16QAM consists of a 4 x 4 grid of (I,Q)-points, 64QAM consists of a 8 x 8 grid.

Figure 25 QAM modulation



In case of downlink direction the QAM (both 16QAM and 64QAM) is used by link adaption and coding for PDSCH (physical downlink shared channel), in case of uplink direction the 16QAM is used by adaptive modulation for PUSCH (physical uplink shared channel).

17.4 System impacts

17.4.1 Interdependencies between features

LTE31:” Link adaptation by AMC” describes how QAM is deployed by link adaption.

17.5 LTE43, LTE788, LTE793 reference data

LTE43: Support of 64QAM in DL, LTE788: Support of 16QAM (UL), LTE793: Support of 16QAM (DL) requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 71 LTE43, LTE788, LTE793 hardware and software requirements

	FDD	TDD
System release	RL09	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0

Table 71 LTE43, LTE788, LTE793 hardware and software requirements (Cont.)

	FDD	TDD
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE43: Support of 64QAM in DL, LTE788: Support of 16QAM (UL), LTE793: Support of 16QAM (DL)* features.

Measurements and counters

Table 72 New counters introduced by LTE43

Counter ID	Counter name	Measurement
M8001CRD554	HarqAck16QAM_Dl	LTE Cell Load
M8001CRD555	HarqOkRetr1_16QAM_Dl	LTE Cell Load
M8001CRD556	HarqOkRetr2_16QAM_Dl	LTE Cell Load
M8001CRD557	HarqOkRetr3_16QAM_Dl	LTE Cell Load
M8001CRD558	HarqSizeOrig16QAM_Dl	LTE Cell Load
M8001CRD559	HarqSizeRetr16QAM_Dl	LTE Cell Load
M8001CRD560	HarqSizeOk16QAM_Dl	LTE Cell Load
M8001CRD561	TbSchOrig16QAM_Dl	LTE Cell Load
M8001CRD562	TbSchRetr16QAM_Dl	LTE Cell Load
M8001CRD563	TbSchNoHarq16QAM_Dl	LTE Cell Load
M8001CRD564	HarqAck64QAM_Dl	LTE Cell Load
M8001CRD565	HarqOkRetr1_64QAM_Dl	LTE Cell Load
M8001CRD566	HarqOkRetr2_64QAM_Dl	LTE Cell Load
M8001CRD567	HarqOkRetr3_64QAM_Dl	LTE Cell Load
M8001CRD568	HarqSizeOrig64QAM_Dl	LTE Cell Load
M8001CRD569	HarqSizeRetr64QAM_Dl	LTE Cell Load
M8001CRD570	HarqSizeOk64QAM_Dl	LTE Cell Load
M8001CRD571	TbSchOrig64QAM_Dl	LTE Cell Load
M8001CRD572	TbSchRetr64QAM_Dl	LTE Cell Load
M8001CRD573	TbSchNoHarq64QAM_Dl	LTE Cell Load
M8001CRD574	HarqAckQPSK_Dl	LTE Cell Load

Table 72 New counters introduced by LTE43 (Cont.)

Counter ID	Counter name	Measurement
M8001CRD575	HarqOkRetr1QPSK_Dl	LTE Cell Load
M8001CRD576	HarqOkRetr2QPSK_Dl	LTE Cell Load
M8001CRD577	HarqOkRetr3QPSK_Dl	LTE Cell Load
M8001CRD578	HarqSizeOrigQPSK_Dl	LTE Cell Load
M8001CRD579	HarqSizeRetrQPSK_Dl	LTE Cell Load
M8001CRD580	HarqSizeOkQPSK_Dl	LTE Cell Load
M8001CRD581	TbSchOrigQPSK_Dl	LTE Cell Load
M8001CRD582	TbSchRetrQPSK_Dl	LTE Cell Load
M8001CRD583	TbSchNoHarqQPSK_Dl	LTE Cell Load

For counter descriptions, see *LTE Operating Documentation/ Reference/ Counters and Key Performance Indicators*.

Key performance indicators

There are no key performance indicators related to the *LTE43: Support of 64QAM in DL, LTE788: Support of 16QAM (UL), LTE793: Support of 16QAM (DL)* features.

Parameters

Table 73 New parameter introduced by LTE43

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Enable 64QAM in downlink	dl64QamEnable	LNCEL	-	common

Table 74 New parameter introduced by LTE788

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Activate modulation scheme UL	actModulationSchemeUL	LNCEL	-	common

For parameter descriptions, see *LTE Operating Documentation/ Reference/ Parameters*.

Sales information

Table 75 LTE43, LTE788, LTE793 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

17.6 Activating the LTE43: Support of 64QAM in DL Feature Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE43:Support of 64QAM in DL feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

64 QAM can only be enabled if 16 QAM is already enabled.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Enable 64QAM in downlink* to True.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

64 QAM Modulation is activated for the DL PDSCH.

17.7 Deactivating the LTE43: Support of 64QAM in DL Feature Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE43: Support of 64QAM in DL feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ▶ Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Enable 64QAM in downlink* to False.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

64 QAM Modulation is disabled.

17.8 Activating the LTE788: Support of 16QAM in UL Feature Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE788:Support of 16QAM in UL feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Enable Uplink 16Qam* to True.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

16 QAM Modulation is activated for the UL.

17.9 Deactivating the LTE788: Support of 16QAM in UL Feature Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE788: Support of 16QAM in UL feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View** ► **Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Enable uplink 16QAM* to False.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

16 QAM Modulation in UL is disabled.

17.10 Activating the LTE793: Support of 16QAM (DL) Feature Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE793:Support of 16QAM (DL) feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ▶ Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Enable downlink 16QAM* to True.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

16 QAM Modulation is activated for the DL..

17.11 Deactivating the LTE793: Support of 16QAM (DL) Feature Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE793: Support of 16QAM (DL) feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

The 64QAM Modulation in DL must be disabled, i. e. the parameter *dl64QAM_Enable* must be set false.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter *Enable downlink 16Qam* to False.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

4 Send the commissioning plan file to the eNB.

For details, refer to BTS Site Manager Online Help.

a) Open the **Commissioning - Send parameters** page.
b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

A restart is needed.

Expected outcome

16 QAM Modulation in DL is disabled.

17.12 Abbreviations

17.12.1 0 – Z

3GPP

third generation partnership project

AMC

adaptive modulation and coding

CQI

channel quality indicator

DL

downlink

HARQ

hybrid automatic repeat request

LBTS

land based test side

LTE

long term evolution

MCS

modulation and coding scheme

MIMO

multiple input multiple output

PDSCH

physical downlink shared channel

PUSCH

physical uplink shared channel

QAM

quadrature amplitude modulation

QPSK

quadrature phase shift keying

Rc

Rate code for channel coding

UE

user equipment

UL

uplink

SCH

synchronization channel

SNIR

signal to noise and interference ratio

TB

transport block

TTI

transmission time interval

18 LTE45: Fair Scheduler (UL/DL)

18.1 Introduction to the feature

The *LTE45: Fair Scheduler (UL/DL)* feature introduces fair scheduling strategies in downlink and uplink, using both time and frequency domain multiplexing of multiple users.

18.2 Benefits

Fair scheduling provides efficient usage of hardware and radio resources.

18.3 Functional description

The *LTE45: Fair Scheduler (UL/DL)* feature introduces fair scheduling strategies in downlink and uplink using both time and frequency domain multiplexing of multiple users.

The downlink scheduler in frequency domain is channel aware while in the uplink the scheduler is channel unaware.

In the time domain, appropriate setting the minimum bit rate (`minBitrateUl`, `minBitrateDl`) determines the behavior of the UL and DL scheduler:

- Minimum bit rate at minimum value: channel aware and proportional (rate) fair
- Minimum bit rate at maximum settings: channel unaware and (rate) fair
- Settings in-between: until the minimum rate is reached, the behavior is (rate) fair; the remaining resources are shared in a proportionally fair manner

Note: The *LTE45: Fair Scheduler (UL/DL)* feature is a basic feature which is modified/enhanced by later features.

18.4 System impact

18.4.1 Interdependencies between features

There are no interdependencies between this and any other feature.

18.5 LTE45 reference data

> *LTE45: Fair scheduler (UL/DL) requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information*

Requirements

Table 76 LTE45 hardware and software requirements

	FDD	TDD
System release	RL09	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE45: Fair scheduler (UL/DL)* feature.

Measurements and counters

There are no measurements or counters related to the *LTE45: Fair scheduler (UL/DL)* feature.

Key performance indicators

There are no key performance indicators related to the *LTE45: Fair scheduler (UL/DL)* feature.

Parameters

Table 77 Existing parameters related to LTE45

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
`Maximum amount of users per TTI in DL`	`maxNumUeDl`	LNCEL_FDD_TDD	-	common
`Maximum amount of users per TTI in DL DwPTS`	`maxNumUeDlDwPTS`	LNCEL_TDD	-	TDD
`Maximum amount of users per TTI in UL`	`maxNumUeUl`	LNCEL_FDD_TDD	-	common
`PDCCH aggregation for paging`	`pdcchAggPaging`	LNCEL	-	common

Table 77 Existing parameters related to LTE45 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
PDCCH aggregation for random access response message	pdcchAggRaresp	LNCEL	-	common
PDCCH aggregation for secondary system information	pdcchAggSib	LNCEL	-	common
Small size random access MCS in uplink	raSmallMcsUl	LNCEL	-	common
Small size random access data volume in uplink	raSmallVolUl	LNCEL	-	common
Maximum number of PRBs assigned in downlink	redBwMaxRbDl	LNCEL	-	common

For parameter descriptions, see *LTE Radio Access Operating Documentation > Reference > Parameters*.

Sales information

Table 78 LTE45 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

19 LTE46: Channel Aware Scheduler (UL)

19.1 Introduction To The Feature

The Flexi Multiradio BTS supports channel aware scheduling for the uplink scheduling in the frequency domain. The uplink scheduler uses the Channel State Information (CSI) in order to optimally allocate the PRBs for the individual UEs in the frequency domain. The CSI is derived from the filtered subband sounding reference signals (SRS), PUSCH and from O&M settings.

19.2 Benefits

The channel aware scheduling provides higher throughput and higher cell capacity.

19.3 Functional Description

Channel aware scheduling provides another frequency domain scheduling method related to channel unaware scheduling. The operator configurable parameter `ulsSchedMethod` is provided to choose the UL scheduling mode between channel unaware UL scheduling and channel aware UL scheduling.

The scheduling of the UEs in the frequency domain is based on the average relative signal strength which is equivalent to the Channel Status Information (CSI). Whenever the UL scheduler has to select the next UE in the scheduling sequence, the average relative signal strength provides the required information i.e. the channel aware UL scheduler calculates the average relative signal strength for all UE which are selected for scheduling and which are not yet in the spectrum whenever the decision for the next UE in the sequence has to be taken. The UE which provides the maximum average relative signal strength for the actual starting PRB is selected next.

19.3.1 Feature Scope

The channel aware UL scheduler is located at the eNodeB MAC layer. The scope is mainly between the eNodeB and the UE. There are no other network elements involved such as core network.

The fast Adaptive Transmission Bandwidth (ATB) methods for the UEs including Round Robin and the exhaustive FD scheduling are used for both the channel aware UL scheduler and the channel unaware UL scheduler.

The channel aware UL scheduler is able to deal with the multiple PUSCH sub-areas case. If the frequency position of the PRACH is configured to the middle system bandwidth (it is not recommended, but it is possible) and there are HARQ non-adaptive retransmissions, there are multiple PUSCH sub-areas in the whole system bandwidth. In such case, not only the number of PRBs available to PUSCH but also the interference in the PUSCH sub-areas are considered while initial assignment of the UEs to the PUSCH sub-areas.

19.4 System Impacts

19.4.1 Dependencies Between Features

LTE536: Intra TTI PUSCH hopping type 2 must be disabled while using channel aware UL scheduling.

19.4.2 Impacts on system capacity

Channel aware scheduling improves the average multi-user cell throughput.

19.5 LTE46 reference data

> *LTE46: Channel Aware Scheduler (UL) requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information*

Requirements

Table 79 LTE46 hardware and software requirements

	FDD	TDD
System release	RL40	RL15
Flexi Multiradio 10 BTS	LBTS4.0	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Not supported	TD-LBTS4.0
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	OSS5.4 CD2	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	Support not required	Support not required

This feature requires Flexi System modules which support LTE.

Alarms

There are no alarms related to the *LTE46: Channel Aware Scheduler (UL)* feature.

BTS faults and reported alarms

There are no faults related to the *LTE46: Channel Aware Scheduler (UL)* feature.

Commands

There are no commands related to the *LTE46: Channel Aware Scheduler (UL)* feature.

Measurements and counters

There are no measurements or counters related to the *LTE46: Channel Aware Scheduler (UL)* feature.

Key performance indicators

There are no key performance indicators related to the *LTE46: Channel Aware Scheduler (UL)* feature.

Parameters

Table 80 Existing parameters related to LTE46

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Scheduling Method of the UL Scheduler	ulsSchedMethod	LNCEL	-	Common
Power offset for SRS transmission power calculation	srsPwrOffset	LNCEL_TDD	-	TDD
Power offset for SRS transmission power calculation	srsPwrOffset	LNCEL_TDD	-	FDD

For parameter descriptions, see *FDD-LTE BTS Parameters* and *TD-LTE BTS Parameters*.

Sales information

Table 81 LTE46 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

19.6 Activating LTE46: Channel Aware Scheduler (UL) Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE46: Channel Aware Scheduler feature.

Before you start

The evolved NodeB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Commissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commisioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

The configuration elements related to the **LTE46** feature are found on page: **“Radio network configuration”.** Perform the following configuration settings to activate this feature:

- Click on LNBTS object from the navigation tree located in left upper corner.
- In order to configure the parameters related to this feature, click on LNCEL objectfrom the navigation tree.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_FDD object in case of FDD and LNCEL/LNCEL_TDD object in case of TDD.

- In the LNCEL Properties set the parameter `Scheduling Method of the UL Scheduler` from drop-down list to **channel aware**. This will set `ulsSchedMethod` parameter.
- In the LNCEL Properties set the parameter `Hopping mode of PUSCH status` from drop-down list to **false**. This will set `puschHoppingEnable` parameter.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_FDD object in case of FDD and LNCEL/LNCEL_TDD object in case of TDD.

- In the LNCEL Properties set the parameter `Enable sounding reference signal` from drop-down list to true. This will set `soundRsEnabled` parameter.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_FDD object in case of FDD and LNCEL/LNCEL_TDD object in case of TDD.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

19.7 Deactivating LTE46: Channel Aware Scheduler (UL)

Before you start

The evolved NodeB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Commissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.

- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

---

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commisioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

The configuration elements related to the **LTE46** feature are found on **page "Radio network configuration".** Perform the following configuration settings to deactivate this feature:

- In the LNCEL Properties set the parameter **Scheduling Method of the UL Scheduler** from drop-down list to `channel unaware`.

---

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

c) Click the **Send Parameters** button.

---

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

20 LTE49: Paging

20.1 Introduction to the feature

UE terminated service requests for connection with an UE in LTE_IDLE state.

The paging functionality consists of two components:

- Paging on S1 via S1AP
- Paging on Uu via RRC

The paging messages are scheduled in the time domain. The scheduling is based on UE-specific DRX settings. The eNode B supports cell specifc tracking areas (TA).

20.2 Benefits

The LTE system can contact the UE when the core network gets a request for a connection to it from another device.

20.3 Functional description

Functional overview

Paging is a network-initiated procedure to find and contact a UE. The UE, which is in idle mode and attached to the LTE network, listens regularly to the broadcasted paging messages. When the UE detects a message intended to it, it initiates an access procedure to connect to the network. As a result of a successful connect procedure, a radio bearer is established and the state of the UE changes to RRC_CONNECTED.

The functional description part for paging describes the message flow applied and the paging messages involved. Additionally, the discontinuous reception mechanism is explained by which the UE has to monitor only a small fraction of subframes of a radio frame to detect paging indications.

Paging is initiated by the mobile management entity (MME) as a function of the non-access stratum (NAS). The MME sends paging messages via S1 interface to the relevant eNBs. The eNBs are determined by the tracking areas (maintained in the MME) where the UE is expected to be located. In the eNBs and between the UE and the eNB, paging is included in the radio resource control (RRC) protocol which is a part of the access stratum (AS).

There are several reasons why the network needs to contact a UE. The most common is when downlink data, that are to be delivered to a UE, arrives at the serving gateway (S-GW). Another example is when the indication of a system configuration changes. In order to contact a UE, a paging procedure is initiated. In case of arriving of the downlink data at the S-GW, the S-GW requests the MME to page the UE. The MME then triggers a paging procedure as it is responsible for UE tracking. Its role involves control, execution, and supervision of the procedure. These functions are realized using the S1AP protocol. The MME starts paging by distributing a PAGING message to all eNBs that are related to the cells corresponding to the UE's registered tracking areas. The MME also coordinates paging responses and supervises the process by scheduling retransmissions of PAGING messages.

The eNodeB, having received the paging request from the MME, allocates resources, schedules the paging process related to the air interface, and transmits the PAGING messages in the radio cells involved. The scheduling takes into account DRX (discontinuous reception) of the UE. Once the UE has detected that it is being paged, it initiates a standard random access procedure.

Procedure and message flow

A UE that is attached to the network and is in idle state (ECM-IDLE) is traceable only to its tracking areas (TAs) registered in the serving MME (as part of the mobility information kept in the UE's context). Every time the network needs to contact such a UE, a paging procedure is performed taking into account the TAs.

The following steps are performed during paging:

1. The MME starts the paging procedure by sending a PAGING message via S1 interface to each eNodeB belonging to one of the UE's tracking areas. This message is part of the S1AP protocol.
2. The eNodeBs derive the destination cells for the paging request.
3. For each destination cell, the related eNodeB calculates the radio frames for the paging request and schedules (per cell) the paging request accordingly.
4. The eNodeBs transmit PAGING messages to the indicated cells according to the scheduling. These messages are part of the RRC layer.
5. The addressed UE receives and decodes the PAGING message.
   The UE responds to the successfully decoded PAGING message by initiating a random access procedure in order to establish a connection to the network.

From the eNodeB perspective, multiple paging requests can arrive on S1 before they are actually sent out on the Uu interface. They may need to be scheduled for the same or for different paging occasions. Different paging requests scheduled for the same cell and paging frame have to be transmitted on Uu within the same RRC: PAGING message. Therefore, the eNodeB has to collect and buffer the received paging requests according to their destination cells and their schedule. For each cell and at each paging frame with at least one scheduled paging request, the eNodeB has to setup and send an RRC: PAGING message including all paging requests scheduled for that same paging frame to the UEs.

Discontinuous reception for paging

The UE in idle mode may use discontinuous reception (DRX) in order to reduce power consumption. For this case, a DRX cycling period (which is a number of radio frames) is defined and within this period a number of frames ("paging frames"), which the eNodeB can use for paging. For an individual UE to be paged, a system frame number (SFN) for a paging frame in the current DRX cycling period is calculated depending on the UE's IMSI, and a subframe number within the paging frame is determined, too (the combination of paging frame and subframe number for paging is called "paging occasion"); the eNodeB then begins to page this UE just at this paging occasion in the current DRX cycling period and schedules subsequent paging occasions accordingly in the following DRX cycling periods. Consequently, the UE has to monitor only one subframe of one paging frame within each DRX cycling period. The paging subframe does not contain a complete PAGING message but a L1 PAGING INDICATION message providing information about how the actual paging message can be read and what physical resources have been allocated for it. After having detected a paging indication, the UE listens to the radio frames with the complete PAGING message. The paging indication is repeated until the UE responds or until the number of retries reaches a maximum.

The following parameters are used for calculating the system frame number of the paging frame within a DRX cycling period:

- T:
  The DRX cycling period, which is a number of radio frames, for example 8, 16, 32, ...
  This parameter is broadcasted as `defaultPagingCycle` by a system information message (SystemInformationBlockType2 including the "RadioResourceConfigCommon" IE). The value of T is determined either by the MME which can send an UE-specific value to the eNodeB via the S1AP PAGING message or (if the value from the MME is missing or is too large) by the cell specific DRX cycling period whose value is defined by the O&M parameter `defaultPagingCycle`.
- N:
  A fraction of T, possible values are: T, T/2, T/4, T/8, T/16, T/32
  This parameter defines the number of paging frames within the T radio frames of one DRX cycling period. Its value is determined by T and the parameter nB which is broadcasted via a system information message (SystemInformationBlockType2 including the "RadioResourceConfigCommon" IE).
  N = min(T,nB). Since nB is set by the O&M parameter "**pagingNb**" which has the upper limit of "**oneT**", N = "pagingNb".
- UE_ID:
  The IMSI mod 1024 of the UE.

The SFN (system frame number) of the paging frame satisfies the following formula ("mode T" on the left side of the equation indicates the repetition period):

SFN mod T = (T : N) · (UE_ID mod N)

(T : N) gives the distance between paging frames in units of of radio frames (for example, T = 256, "pagingNb" = quarterT, thus N = 64, T/N = 4, which means that every fourth radio frame can contain a paging occasion). The multiplication with (UE_ID mod N) gives the position of a paging frame relative to the start frame of a DRX cycle. UE_ID allows to distribute different UEs over different positions.

For FDD technology currently the subframe number of the paging frame to be used for a paging indication is always set to 9. Usually, several UEs are addressed with the same paging frame and thus belong to the same paging group. All of them may detect the PAGING INDICATION message and read the PAGING message as well. The UE Identity field in the PAGING message then identifies the desired receiving UE.

S1AP message: PAGING

The S1AP: PAGING message includes the following information elements:

Table 82 Content of the S1AP: PAGING message

IE	Description
Message Type	This fields identifies: PAGING

Table 82 Content of the S1AP: PAGING message (Cont.)

IE	Description
UE Identity Index Value	The IMSI mod 1024 which corresponds with the 10 rightmost bits of the IMSI
UE Paging Identity	The IMSI or the S-TMSI
Paging DRX	This optional field defines the UE specific DRX cycle period. If the value is missing, the cell specific DRX cycle period is used.
CN Domain	Value passed to the UE and used in the paging record
List of TAIs	
TAI (1)	Tracking area identifier
PLMN Identity	One component of the TAI
TAC	Tracking area code, the second component of the TAI
TAI (2)	...
PLMN Identity	...
TAC	...
...	...
Paging Cause	The content of this field is to be passed to the RRC PAGING message

RRC message: PAGING

The RRC: PAGING message includes the following information elements:

Table 83 Content of the RRC: PAGING message

IE	Description
pagingRecordList	This fields is only included if an UE specific paging has been triggered by the MME.
UE Identity	Taken from the S1AP PAGING message from the MME
Choice S-TMSI S-TMSI	
Choise IMSI	

Table 83 Content of the RRC: PAGING message (Cont.)

IE	Description
IMSI	
CN Domain	Taken from the S1AP PAGING message from the MME
systemInfoModification	This IE is present if a system information change is notified.
etws Indication	Not supported This IE is present if a ETWS notification is indicated via S1AP: WRITE-REPLACE WARNING REQUEST message.
cmas Indication	This FDD specific IE is present if a CMAS notification is indicated via S1AP: WRITE-REPLACE WARNING REQUEST message.
Paging Cause	Taken from the S1AP PAGING message

20.4 System impact

The feature has no additional impacts on the system.

20.5 LTE49 reference data

LTE49: Paging requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 84 LTE49 hardware and software requirements

	FDD	TDD
System release	RL09	RL15TD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10	Support not required

Table 84 LTE49 hardware and software requirements (Cont.)

	FDD	TDD
SAE GW	Support not required	Support not required
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE49: Paging* feature.

BTS faults and reported alarms

There are no faults related to the *LTE49: Paging* feature.

Commands

There are no commands related to the *LTE49: Paging* feature.

Measurements and counters

There are no measurements or counters related to the *LTE49: Paging* feature.

Key performance indicators

There are no key performance indicators related to the *LTE49: Paging* feature.

Parameters

Table 85 Parameters introduced by LTE49

Full name	Abbreviated name	Manage d object	Parent structure	FDD/TDD
`Cell barred flag`	`cellBarred`	LNCEL	-	common
`Default paging cycle`	`defPagCyc`	LNCEL	-	common
`Paging nB`	`pagingNb`	LNCEL	-	common
`Tracking area code`	`tac`	LNCEL	-	common

For parameter descriptions, see LTE Operating Documentation/Reference/Parameters.

Sales information

Table 86 LTE49 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

21 LTE50: UE state management

21.1 Introduction to feature

Table 87 Summary of changes

Date	Section	Description
14.11.2017	reference data	`Timer min lifetime of half-open RRC connection` parameter has been added

The LTE50: UE state management feature provides session and RRC connection state management procedures. The feature also introduces the RL failure procedure.

21.2 Benefits

The feature provides a necessary state management functionality for UEs.

21.3 Functional description

Individual UE state models are used to describe the status of a UE for EPS connection management (ECM) and EPS mobility management (EMM):

- **ECM-CONNECTED**
  The RRC connection is established on the air interface and the S1 connection on the S1-MME interface.
- **ECM-IDLE**
  The RRC connection is released on the air interface and the S1 connection on the S1-MME interface.
- **EMM-REGISTERED**
  The registration procedure has been successful for the UE.
- **EMM-DEREGISTERED**
  The UE has been switched off.

The Radio Resource Control (RRC) in E-UTRAN are E-UTRA RRC_IDLE and EUTRA RRC_CONNECTED. In LTE, the states are RRC_IDLE and RRC_CONNECTED.

UE state handling covers those AS procedures that are involved in initiation and support of EPC connection management state transitions such as:

- **Paging**
  triggering the UE to initiate a ECM-IDLE to ECM-CONNECTED transition
- **Initial access**
  transition to ECM-CONNECTED
- **Signaling connection release**
  Transition to ECM-IDLE
- **Error scenarios**
  for example RRC connection re-establishment

21.4 LTE50 reference data

LTE50: UE state management requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 88 LTE50 hardware and software requirements

	FDD	TDD
System release	RL09	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10	NS10
SAE GW	Support not required	Support not required
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE50: UE state management* feature.

Measurements and counters

Table 89 Counters for LTE50: UE state management

PI ID	Counter long name (short name)	Description
M8001CRD833	RL Failures due to CQI DTX (RL_FAIL_CQI_DTX)	Radio Link Failure indications sent to c-plane due to missing CQI
M8001CRD834	Recovery from RL Failures due to CQI DTX (RL_FAIL_CQI_DTX_RECOV)	Radio Link Failure recovery indications sent to c-plane due to re-detected CQI.
M8001CRD835	RL Failures due to PUSCH DTX (RL_FAIL_PUSCH_DTX)	Radio Link Failure indications sent to c-plane due to missing PUSCH
M8001CRD836	Recovery from RL Failures due to PUSCH DTX (RL_FAIL_PUSCH_DTX_RECOV)	Radio Link Failure recovery indications sent to c-plane due to re-detected PUSCH.

For counter descriptions see *LTE Radio Access Operating Documentation/Reference/Counters and Key Performance Indicators*.

Key performance indicators

There are no key performance indicators related to the *LTE50: UE state management* feature.

Parameters

Table 90 New parameters introduced by LTE50

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Number Of Succesful PDSCH Transmissions	rlpDetEndNoDl	LNBTS	-	common
Number Of Failed PDSCH Transmissions	rlpDetMaxNoDl	LNBTS	-	common
Time Frame For Failed PDSCH Transmissions	rlpDetMaxTimeDl	LNBTS	-	common
Timer T302	t302	LNBTS	-	common
Timer min lifetime of half-open RRC connection	tHalfRrcCon	LNBTS	-	common

For parameter descriptions, see *LTE Radio Access Operating Documentation/Reference/Parameters*.

Sales information

Table 91 LTE50 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

22 LTE51: Cell selection and re-selection

22.1 Introduction to the feature

The eNB transmits in each cell physical synchronization signals and broadcast information. This information support initial cell selection and later cell re-selection for an UE in idle state.

The eNB transmits primary and secondary synchronization signals in each cell:

- The UE does initial cell search and synchronization based on synchronization signals.
- In further re-selection, the UE may consider measurement thresholds for optimizing its search effort

The cell selection triggers attachment to EPS. The UE will receive a cell-specific physical configuration from PBCH.

- Synchronization signals and PBCH are bandwidth independently allocated within 72 sub-carriers
- System wide semi-static bandwidth is assumed in RL09RL15TD. Network planning and cell based commissioning is needed for configuring cell identities, cell (re)selection thresholds.

22.2 Benefits

The UE, which may be moving between different tracking areas, can connect to the radio network very quickly.

22.3 Functional description

The functional description part for cell selection and reselection describes the criteria and formulas applied for selection/reselection.

Cell selection means that in idle mode the UE searches for the strongest cell on all supported carrier frequencies until a suitable one is found. The search space includes cells of other supported radio access technologies (for example UMTS, GSM). As a result of successful cell selection, the UE camps on a certain cell. Cell reselection means that when camping on a cell, the UE regularly searches for a better cell, and if one is found, it is selected.

Cell selection and reselection are performed by the UE in RRC_IDLE mode after the UE has been switched on and has selected a PLMN. The information that the idle UE uses for selecting a cell is broadcast within system information messages. Cell selection and reselection functions belong partly to NAS and partly to AS, see the following table (according to 3GPP TS 36.304).

Table 92 NAS and AS parts of cell selection and cell reselection

Process	UE non access stratum	UE access stratum
Cell selection	• Controling cell selection for example by indicating RAT(s) associated with the selected PLMN to be used initially in the search of a cell in the cell selection. • Maintaining a list of forbidden registration areas and providing this list to AS.	• Performing measurements needed to support cell selection. • Detecting and synchronizing to a broadcast channel. Receiving and handling broadcast information. Forwarding NAS system information to NAS. • Searching for a suitable cell. Responding to NAS whether such cell is found or not. • Camping on a suitable cell (if available).
Cell reselection	• Controling cell reselection by for example, maintaining lists of forbidden registration areas. • Maintaining a list of equivalent PLMN identities and providing the list to AS. • Maintaining a list of forbidden registration areas and providing the list to AS.	• Performing measurements needed to support cell reselection. • Detecting and synchronizing to a broadcast channel. Receiving and handling broadcast information. Forwarding NAS system information to NAS. • Changing cell if a more suitable cell is found.

The eNodeB transmits in each cell physical synchronization signals and broadcast information supporting initial cell selection and cell re-selection. The synchronization signals are the basis for the UE to do the initial cell search.

The NAS (non-access stratum) can control the RAT(s) (radio access technologies) in which cell selection is performed, for example, by maintaining a list of forbidden registration areas and a list of equivalent PLMNs.

Cell selection

During the cell selection, the UE searches for a suitable cell on all supported carrier frequencies of each supported RAT. Once a suitable cell is found, this cell is selected. On each carrier frequency the UE only searches for the strongest cell. For speeding up the procedure, the UE can use information stored from a previous access.

The following criterion called S-criterion is used:

A cell is suitable for cell selection if the cell selection RX level S_{rxlev} defined below has a positive value (all values in dB, parameter names are according to 3GPP). In additon in RL50 (*LTE1036: RSRQ Based cell reselection)* a 2nd criterium(for S_{qual}) is introduced:

$S_{rxlev} = Q_{rxlevmeas} – (Q_{rxlevmin} – Q_{rxlevminoffset}) – max(P_{emax} – P_{umax} , 0)$

$S_{qual} = Q_{qualmeas} - (q_{QualMinR9} + q_{QualMinOffsetR9)}$

$Q_{rxlevmeas}$	The measured RX level value, that is, the RSRP
$Q_{rxlevmin}$	The minimum required RX level in the cell
$Q_{rxlevminoffset}$	An offset which may be configured to prevent ping-pong effects between PLMNs which may otherwise occur due to fluctuating radio conditions. The offset is taken into account only when performing a periodic search for a higher priority PLMN while the UE camps on a suitable cell in a visited PLMN
P_{emax}	The maximum transmit power an UE is allowed to use for an uplink transmission in the cell
P_{umax}	The maximum RF output power of the UE according to the UE's power class
$Q_{qualmeas}$	UE measurement (RSRQ)
$q_{QualMinR9}$	Min required RSRQ level incell
$q_{QualMinOffsetR9}$	Offset to the signaled qQualMinR9 taken into account in the Squal evaluation as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN

$max(P_{emax} – P_{umax}, 0)$ is a compensation factor giving a contribution only if the UE has less power capabilities than allowed. In such cases, the compensation factor makes a cell less suitable for cell selection.

In case of FDD technology Th S-criterium is fulfilled if $S_{rxlev} > 0$ and $S_{qual} > 0$.

Assuming that the power class of an UE is high enough and neglecting higher priority PLMNs, a cell is suitable if the measured RX level is higher than a minimum receive level which can be configured.

The cell selection parameters are broadcasted within the `SystemInformationBlockType1`.

Cell reselection

Cell reselection between frequencies and RATs is primarily based on priorities. LTE configures an absolute priority for all applicable frequencies of each RAT. Cell-specific priorities are provided via system information.

Of the frequencies allowed for cell reselection, the UE considers only those for which it has priorities. Equal priorities are not applicable for inter-RAT cell reselection.

The UE can reselect to a cell on a higher-priority frequency only if the S-value (according to the S-criterion above) of the concerned target cell exceeds a high threshold for at least a duration $T_{reselection}$.

The UE can reselect to a cell on a lower-priority frequency only if the S-value of the serving cell is below a low threshold for at least $T_{reselection}$ while the S-value of the target cell exceeds another low threshold. If there is still more than one candidate target cell, the UE compares these cells using the following ranking criterion called R-criterion:

For the serving cell: $R_s = Q_{meas,s} + Q_{hyst,s}$

For the neigbour cells: $R_n = Q_{meas,n} + Q_{offset,s,n}$

Q_{meas}	The measured RX level value, that is, the RSRP
$Q_{hyst,s}$	This parameter controls the degree of hysteresis for the ranking
Q_{offset}	An offset for weighting between serving cell and neigbour cells

The UE selects the highest-ranked candidate cell provided that it is better ranked than the serving cell for at least the time period $T_{reselection}$. Afterwards, the UE checks the accessibility of that cell and performs the cell reselection to that cell if possible.

Broadcasting of cell reselection parameters:

The cell reselection parameters are broadcasted within SystemInformationBlockType3/4/5/6/7/8 in the system information messages. More in detail, the SystemInformationBlockType<N> (SIB<N>) includes the following information:

- SIB3:
  SystemInformationBlockType3 contains cell re-selection information common for intra-frequency, inter-frequency and/or inter-RAT cell reselection (applicable to more than one type of cell reselection but not necessarily all) as well as intra-frequency cell reselection information other than neighboring cell related.
- SIB4:
  SystemInformationBlockType4 contains neighboring cell related information relevant only for intra-frequency cell reselection. The IE includes cells with specific reselection parameters as well as blacklisted cells.
- SIB5:
  SystemInformationBlockType5 contains information relevant only for inter-frequency cell reselection. This is information about other E-UTRA frequencies and inter-frequency neighboring cells relevant for cell reselection. The IE includes cell reselection parameters common for a frequency as well as cell specific reselection parameters.
- SIB6:
  SystemInformationBlockType6 contains information relevant only for inter-RAT cell reselection. This is information about UTRA frequencies and UTRA neighboring cells relevant for cell reselection. The IE includes cell reselection parameters common for a frequency.(depending on support of UMTS)
- SIB7:
  SystemInformationBlockType7 contains information relevant only for inter-RAT cell reselection. This is information about GERAN frequencies relevant for cell reselection. The IE includes cell reselection parameters for each frequency.(depending on support of GSM)
- SIB8:
  SystemInformationBlockType8 contains information relevant only for inter-RAT cell reselection to CDMA/1xRTT or CDMA/eHRPD. The IE includes cell reselection parameters for like frequencies and neighbor cell information. The parameters are described in the following feature descriptions:
  - *LTE807: Idle Mode Mobility from LTE to CDMA/1xRTT*
  - *LTE870: Idle Mode Mobility from LTE to CDMA /eHRPD*

22.4 System impact

The feature has no additional impacts on the system.

22.5 LTE51 reference data

LTE51: Cell selection and re-selection requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 93 LTE51 hardware and software requirements

	FDD	TDD
System release	RL09	RL15TD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE51: Cell selection and re-selection requirements* feature.

BTS faults and reported alarms

There are no faults related to the *LTE51: Cell selection and re-selection requirements* feature.

Commands

There are no commands related to the *LTE51: Cell selection and re-selection requirements* feature.

Measurements and counters

There are no measurements or counters related to the *LTE51: Cell selection and re-selection requirements* feature.

Key performance indicators

There are no key performance indicators related to the *LTE51: Cell selection and re-selection requirements* feature.

Parameters

There are no parameters related to the *LTE51: Cell selection and re-selection requirements* feature.

Sales information

Table 94 LTE51 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

23 LTE53: Intra and inter eNB handover with X2

23.1 Introduction to the feature

The inter-eNodeB handover is the basic type of a handover within LTE. Intra-eNodeB handover is just a specification of the inter-eNodeB handover.

Handovers in LTE are network controlled and UE assisted. Resources are prepared in the target cell before the UE is commanded to move to the target cell. Data packets whose reception could not be acknowledged before the handover procedure are retransmitted.

23.2 Benefits

With this feature, intra- and inter-eNB handover is possible via X2 interface.

23.3 Functional description

Generally, many handover scenarios are supported – at least in future releases –, for example intra-LTE, inter-RAT (for example LTE and UMTS, RAT: radio access technology). The basic handover type is an intra-LTE handover which is mainly controlled between two eNBs connected via X2 interface (inter-eNB handover).

23.3.1 Functional overview

The eNB supports intra-frequency intra-LTE handover via X2.

There are two handover scenarios: intra-eNB (for example inter-sector) handover and inter-eNB (for example inter-site) handover. Both of them are intra-frequency type handovers.

The handover decision is made based on downlink measurements. The serving eNB configures measurements in each RRC-connected UE. Event-triggered reporting is applied. Handover related parameters are operator-configurable on cell basis through O&M settings.

Reference Signal Received Power (RSRP) based measurements are applied. Measurement and reporting mode is dependent on the condition of the serving cell. In the initial intra-LTE and intra-frequency scenario, the measurement control applies s-measure and event A3 or A5. Neighbor cell measurements are initiated by UE when the serving cell level goes below RRC configurable threshold (s-measure). The intra-LTE handover itself is triggered on 'better cell' basis by the event A3 with configured hysteresis. The usage of event A5 can be configured by O&M alternatively. A3 will used as a fallback in case that the event A5 is not supported by the UE.

The serving eNB evaluates handover reports. When the handover decision has been made, the selected target cell is prepared for handover execution, either within the currently serving eNB or over X2AP in the adjacent target eNB.

The eNB supports temporary downlink user data forwarding over X2 during the inter-eNB handover execution phase. Uplink data is transported directly towards the S-GW. The PDCP context is relocated to the target cell in the way that packet loss should be avoided.

In case of an inter-eNB handover the target eNB commands EPC (Evolved Packet Core) for Path Switch with S1-U from the source eNB to the target eNB. Thus the downlink data path becomes optimized again. The direct uplink data path is switched, as well. In opposite, the scenario of intra-eNB handover is invisible for EPC.

Handover scenarios over other cell access cases may be prioritized by Radio Admission Control (RAC) through separate operator configurable thresholds, for example the maximum number of users.

The non-contention based random access process is applied in the handover execution, up to point when dedicated random access preamble can be dynamically allocated. The contention based random access process is used as the fallback solution if dedicated random access preambles are not available.

The handover execution applies the RRC connection reconfiguration procedure in air interface.

The following X2AP procedures will be applied:

- Handover request
- Handover cancel
- SN status transferPath switch procedure will be applied in S1AP.

23.3.2 General procedure

23.3.2.1 Inter-eNodeB handover

The following procedure is performed in case of an inter-eNodeB handover (see Figure 26: Message flow for an inter-eNodeB handover).

1. The source eNodeB makes the decision to handover the UE to the target eNodeB based on the MEASUREMENT REPORT of the UE and RRM information.
2. The source eNodeB issues a HANDOVER REQUEST message via the X2 interface to the target eNodeB which passes necessary information to prepare the handover at the target side. This message includes signalling references, transport layer addresses and tunnel endpoint identifiers to enable the target eNodeB to communicate with the source eNodeB and the EPC nodes, as well as QoS information for the UE's bearers and RRM information.
3. Admission Control is performed by the target eNodeB dependent on the received radio bearer QoS information and S1 connectivity to increase the likelihood of a successful handover. If the resources can be granted by the target eNodeB, it configures the required resources according to the received UE context information, and reserves a C-RNTI (cell radio network temporary identifier) and a dedicated preamble for the UE. One or more U-plane tunnels may also be established between the source and the target eNodeB in order to support data forwarding of downlink PDCP SDUs (PDCP: packet data convergence protocol, SDU: service data unit) that

have not been acknowledged by the UE, and optionally any uplink PDCP SDUs which have been received out of order at the source eNodeB. It should be noted that not all bearers are subject to data forwarding (for example, realtime bearers) and that this is dependent on the bearer's QoS profile.

4. The target eNodeB prepares the handover regarding layer 1 and layer 2 and sends a HANDOVER REQUEST ACKNOWLEDGE message via X2 to the source eNodeB. The HANDOVER REQUEST ACKNOWLEDGE message includes a transparent container to be sent to the UE later as part of the CONNECTION RECONFIGURATION message. The container includes the new C-RNTI and the value of the dedicated preamble to be used by the UE to synchronise with the target cell as well as other parameters required by the UE. The HANDOVER REQUEST ACKNOWLEDGE message also contains transport network layer information for the forwarding tunnels, if necessary, and completes the setup of the X2 signalling connection with the source eNodeB.
5. The source eNodeB sends a CONNECTION RECONFIGURATION message towards the UE, which includes the transparent container (of the previous step) received from the target eNodeB. The source eNodeB performs the necessary integrity protection and ciphering of the message. Once this message has been sent the source eNodeB begins implementing a means to minimize data loss.
6. The SN STATUS TRANSFER message is sent from the source to the target eNodeB. Thereby PDCP layer information is transferred to ensure uplink and downlink PDCP SN continuity for every bearer that requires PDCP status preservation. For each bearer this message contains:

   - The downlink SN the target eNodeB should assign to the first SDU which does not have a SN yet.
   - The SN of the next uplink SDU the target eNB should send to the S-GW.
   - Optionally, a status report created by the source eNodeB for the UE's uplink data which includes a list of the SNs that the UE needs to retransmit in the target cell, if there are any such SDUs.

7. Some time after sending the CONNECTION RECONFIGURATION message to the UE (and possibly before sending the SN STATUS TRANSFER message to the target eNodeB), the source eNodeB begins forwarding user data in the form of PDCP SDUs using the resources set up previously and continues as long as packets are received at the source eNB from the EPC. All SDUs which have already been allocated a SN are forwarded with their SN, otherwise SDUs are forwarded without a SN.
8. When the UE receives the CONNECTION RECONFIGURATION message with the necessary parameters (that is, new C-RNTI, dedicated preamble, target cell ID) it is commanded by the source eNodeB to perform the handover immediately to the target cell. The UE then performs the non-contention based random access procedure. The dedicated preamble which the UE has received is used during the random access procedure.
9. The random access response conveys timing alignment information and initial uplink grant for handover.
10. When the UE has successfully accessed the target cell, it sends the CONNECTION RECONFIGURATION COMPLETE message (containing its new C-RNTI) to the target eNodeB to indicate that the handover procedure is completed for the UE. Once the target eNodeB has verified the C-RNTI it can begin sending downlink data forwarded from the source eNodeB to the UE, and the UE can begin sending uplink data to the target eNodeB.

11. Using the “Source Measurement Configuration” information element given to the target eNodeB by the source eNodeB in the HANDOVER REQUEST message, the target eNodeB decides if a new “Measurement Configuration” needs to be sent to the UE. If a new “Measurement Configuration” is to be sent to the UE, it is sent in a separate CONNECTION RECONFIGURATION message.
12. The target eNodeB sends a PATH SWITCH REQUEST message to the MME to inform it that the UE has been handed over to another eNodeB. Included in this message is information required by the EPC nodes to enable downlink data and C-plane messages to be sent to the target eNodeB (that is, the target eNodeB's signalling reference, transport layer addresses and TEID(s) for each of the UE's bearers).
13. The MME sends a USER PLANE UPDATE REQUEST message to the S-GW, which includes the target eNodeB's TEID(s) received before to enable the user data path to be switched from the source to the target eNodeB.
14. The S-GW switches the downlink data path to the target eNodeB. Before the S-GW can release any U-plane/TNL resources towards the source eNodeB, it sends one or more “end marker” packet(s) to the source eNodeB as an indication that the downlink data path has been switched. It should be noted that the “end marker” packets do not contain user data, and are forwarded transparently by the source eNodeB to the target eNodeB to help it decide when the last forwarded packet was received.
15. The S-GW sends a USER PLANE UPDATE RESPONSE message to the MME to confirm that it has switched the downlink data path.
16. The MME confirms the PATH SWITCH REQUEST message with the PATH SWITCH REQUEST ACK message.
17. By sending a UE CONTEXT RELEASE message, the target eNodeB informs the source eNodeB of the success of the handover and triggers the release of resources. It should be noted that the target eNodeB does not release its data forwarding tunnels from the source eNodeB until it has received an “end marker” packet indicating that all forwarded SDUs have been received.
18. Upon reception of the UE CONTEXT RELEASE message, the source eNodeB may forward any remaining PDCP SDUs before it releases the radio and C-plane related resources associated to the UE context.

Buffering and forwarding data via source eNode during handover

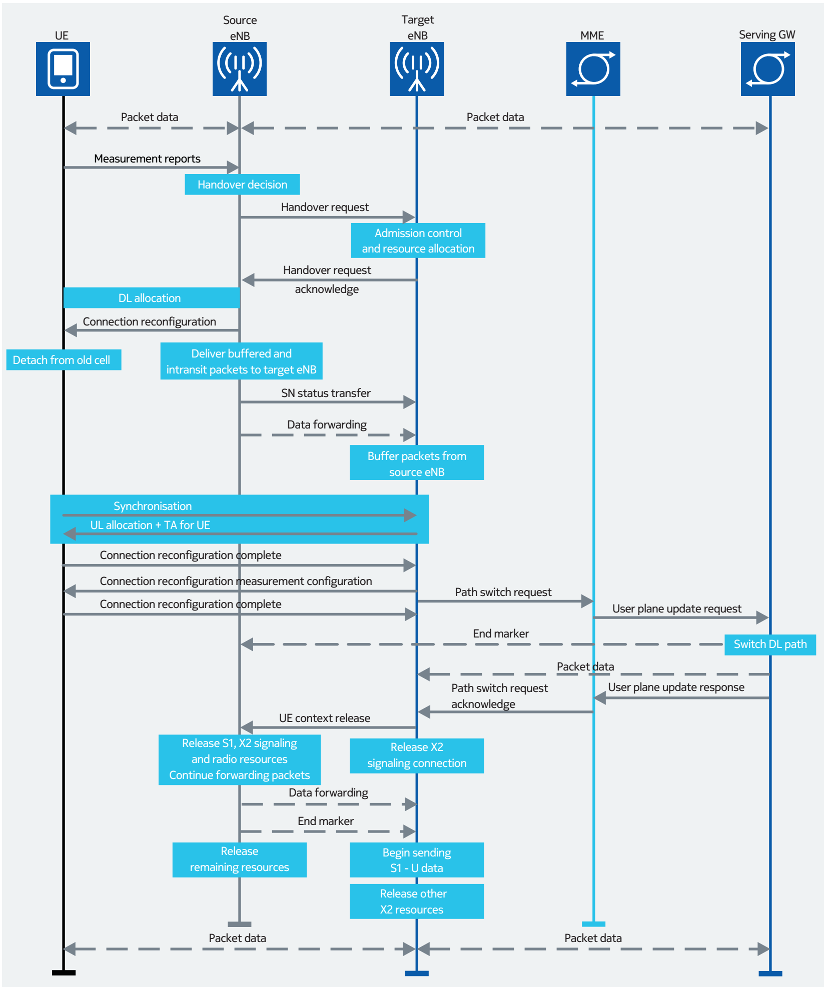
During the handover procedure, the source eNodeB buffers downlink and uplink PDCP SDUs which arrive from the S-GW or from the UE. The PDCP SDUs shall be forwarded as follows:

- PDCP SDUs with a (already assigned) PDCP SN below the value which was reported by the X2AP: SN STATUS TRANSFER message are accompanied by their PDCP SN (these SDUs have already been sent to the RLC layer and may have already been sent to the UE partially). These SDUs are forwarded first and in order of their PDCP SN.
- PDCP SDUs with a (intended) PDCP SN equal or beyond the value which was reported by the internal X2AP: SN STATUS TRANSFER message are not accompanied by a PDCP SN (these SDUs have not been processed by the PDCP layer, so they do not have a SN). These SDUs are forwarded in order of their arrival on the source cell S1 GTP-U interface or from the UE.
- Due to DL RLC retransmission there might exist gaps in downlink PDCP SDUs. For example, if the PDCP SDUs 1 and 3 have not been successfully delivered to the UE, then the PDCP SDUs 1, 2, 3, ... are forwarded to the target eNodeB.

In case of uplink data forwarding, the RLC layer sends to the PDCP layer also the completely received uplink RLC SDUs (PDCP PDUs) which are not delivered to the PDCP layer, because some RLC PDUs, sent earlier, are not yet received and a reordering timer in the RLC layer for that missing PDU is still running. This means that there exists PDCP PDUs in the RLC buffer but they have not been sent to the PDCP layer, because of the RLC reordering function. Therefore the RLC layer provides to the PDCP layer the last correctly received RLC SDU (PDCP PDU) and the list of missing RLC SDUs (PDCP PDUs). All PDCP PDUs which were indicated by the RLC layer are forwarded to the target eNodeB via uplink forwarding tunnel.

The source eNodeB keeps the copies from original user and data of signalling radio bearer SRB2 (and also incoming S1 GTP-U data) in its own data buffers until the handover is accomplished and resources are released or the handover fails.

Figure 26 Message flow for an inter-eNodeB handover



Time control and exception handling

Several timers are used to supervise the duration of the steps of the handover procedure:

- After sending a HANDOVER REQUEST message via the X2 interface to the target eNodeB, the source eNodeB sets the guard timer “TX2 RELOC Prep” to supervise the time period before receiving the HANDOVER REQUEST ACKNOWLEDGE

answer from the target eNodeB. If this timer expires before the answer arrives, the handover procedure is stopped (beginning with the X2AP: HANDOVER CANCEL message to the target eNodeB).
In case of handover cancelling, the source eNodeB starts the “Handover Cancel Latency Timer” when sending the X2AP: HANDOVER CANCEL message.

- The source eNodeB starts the internal “TX2 RELOC Overall” timer after having received the HANDOVER REQUEST ACKNOWLEDGE message from the target eNodeB. This timer supervises the time period until receiption of the the X2AP: RELEASE RESOURCE message from the target eNodeB after a successful handover. “TX2 RELOC Overall” is the sum of T304, T311, T301 and a configurable security offset. If the timer “TX2 RELOC Overall” expires, the handover procedure is cancelled.
- The target eNodeB starts the “TX2 RELOC Exec” timer after sending the HANDOVER REQUEST ACKNOWLEDGE message to the source eNodeB. This timer is used to supervise the duration time until reception of the RRC: RRC CONNECTION RECONFIGURATION COMPLETE message from the UE.
- The timer “TDATA Fwd S1” is started in the source eNodeB when the X2AP: RELEASE RESOURCE message is received from target eNodeB. It is used to define a time period for forwarding all user data and all GTP-U “end marker” packets. When the timer “TDATA Fwd S1” expires, all U-plane user context resources are released including temporary GTP-U data forwarding tunnels between the source eNodeB and the target eNodeB. Also, all C-plane user context resources are released including the eNodeB’s internal connection for X2 message transfer.
- The timer “TX2 RELOC Comp” is started in the target eNodeB when the S1AP: PATH SWITCH REQUEST message is sent to the MME and it is typically stopped when the S1AP: PATH SWITCH REQUEST ACKNOWLEDGE message is received in return. When the timer expires, the eNodeB initiated context release procedure is started.
- The timer “TDATA Fwd X2” is started in the target eNodeB when the S1AP: PATH SWITCH REQUEST ACKNOWLEDGE message is received. If the timer expires, the eNodeB closes its user data tunnels at X2.

23.3.2.2 Intra-eNodeB handover

Handovers between cells of an eNodeB can be seen as a variant of the inter-eNodeB handover without CN node relocation where the handover is performed completely within the eNodeB, and does not involve signalling to EPC nodes at any point during the procedure. The following procedure is performed in case of an inter-eNodeB handover.

1. The eNodeB makes the decision to handover the UE to another cell which belongs to the same eNodeB based on the MEASUREMENT REPORT of the UE and RRM information.
2. Admission Control is performed in the target cell and if the resources can be granted the radio bearers are configured. Additional resources are also configured to allow the UE to access the new cell, which includes allocating the UE a new C-RNTI and a dedicated preamble. At this point, any downlink user data for the UE is buffered until the handover has been completed.
3. The eNodeB sends a CONNECTION RECONFIGURATION message towards the UE with the necessary parameters (i.e. new C-RNTI and dedicated preamble) to allow the UE to connect to the new cell.

4. The UE immediately detaches from the source cell and synchronizes with the target cell using the non-contention based random access procedure.
5. The random access response conveys timing alignment information and initial uplink grant for handover.
6. When the UE has successfully accessed the target cell, it sends the CONNECTION RECONFIGURATION COMPLETE message to the eNodeB to indicate that the handover procedure is completed for the UE. The eNodeB can then begin sending downlink user data towards the UE, and the UE can begin sending uplink user data to the eNodeB.
7. The eNodeB releases the UE's resources in the source cell.

Intra-eNodeB handovers include all cases where the eNodeB-internal system modules (e.g. FSM, flexi system module) or processing units change or do not change. Buffering of data within the eNodeB and forwarding to the target system unit is provided similar to inter-eNodeB handovers.

23.3.3 Target cell list handling

Having decided that a handover is to be executed, the eNodeB selects the most appropriate target cell from the target cell list. Dependent on the output from the RRM handover algorithm, the eNodeB derives the handover mode from the selected target cell.

In special cases, the eNodeB processes the target cell list received by the UE, e.g. excluding inhibited cells and performs a re-sorting of the list if necessary (the sorting of TCL might be obsolete as it is done yet by the UE).

23.4 System impact

The feature has no additional impacts on the system.

23.5 LTE53 reference data

LTE53: Intra and inter eNB handover with X2 requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 95 LTE53 hardware and software requirements

	FDD	TDD
System release	RL09	RL15
Flexi Multiradio 10 BTS	LBTS5.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0

Table 95 LTE53 hardware and software requirements (Cont.)

	FDD	TDD
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	NS10	NS10
SAE GW	NG10 CD2	NG10 CD2
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE53: Intra and inter eNB handover with X2* feature.

Measurements and counters

There are no measurements or counters related to the *LTE53: Intra and inter eNB handover with X2* feature.

Key performance indicators

There are no key performance indicators related to the *LTE53: Intra and inter eNB handover with X2* feature.

Parameters

There are no parameters related to the *LTE53: Intra and inter eNB handover with X2* feature.

Sales information

Table 96 LTE53 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

24 LTE55: Inter-frequency Handover

24.1 Introduction to the Feature

The feature *LTE55: Support of inter-frequency handover* supports several inter-frequency handover scenarios.

eNB supports inter-frequency handover in which handover decision is based on **RSRP** or **RSRQ** (DLmeasurement). Triggers can be "coverage HO" and "Better Cell HO". Typically, the UE requires measurement gaps for performing inter-frequency measurements, depending on the UE capability.

UE performance measurements are done while data transmission between the UE and the source eNB still continues. Therefore, KPIs like U-plane break duration or C-plane break duration do not depend on these UE performance measurements, and the system performance of inter-frequency HO is expected to be the same as for intra-frequency HO.

24.2 Benefits

Inter-frequency handover allows service continuity for LTE deployment in different frequency bands as well as for LTE deployments within one frequency band but with different center frequencies. These center frequencies can also cover cases with different bandwidths, for example 5 MHz and 10 MHz.

24.3 Functional Description

24.3.1 Functional Overview/Details

The following inter-frequency handover scenarios are supported by the Flexi Multiradio BTS:

- intra-eNB, inter-frequency band
- intra-eNB, intra-frequency band with different center frequency
- inter-eNB, inter-frequency band via X2
- inter-eNB, intra-frequency band with different center frequency via X2
- inter-eNB, inter-frequency band via S1 (if enabled)
- inter-eNB, intra-frequency band with different center frequency via S1 (if enabled)

24.3.2 Inter-frequency Handover Variants

As long as RSRP of the serving cell is above s-measure, a UE in RRC_Connected only monitors RSRP of the serving cell. Below s-measure, the UE performs measurements as configured by the eNB. To ensures mobility to neighbor cells in the same frequency , eNB configures intra-frequency RSRP measurement reporting for neighbour cells in the same frequency. When the level of the serving cell becomes worse and there is no neighbour cell in the same frequency that is received by the UE with proper quality, then inter-frequency measurements are configured in the UE in order to find a proper inter-frequency neighbour cell. eNB supports inter-frequency handover in which the handover decision is based on RSRP and/or RSRQ (DL measurement).

Triggers can be "Coverage HO" (A5) and "Better Cell HO" (A3) whereas A3 events are implemented for both, RSRP and RSRQ. Inter-frequency measurements may need Measurement Gaps, depending on the UE capability.

The parameter `measQuantInterFreq` defines which quantity to use for Event A3 measurements towards this frequency set in QuantityConfigEUTRA. The quantities used to evaluate the triggering condition for the Event A3 is configurable (RSRP, RSRQ or both). The values RSRP and RSRQ correspond to Reference Signal Received Power (RSRP) and Reference Signal Received Quality (RSRQ). This parameter refers to event A3. If set to "both", two A3 events will be configured when measuring this carrier, one per specific measurement quantity.

24.3.2.1 RSRP for A3 event (Better Cell HO)

RSRP Definition: portion of energy in a received signal created by the inclusion of a reference pattern. Reference symbol received power can be used to estimate the ability of a receiver to obtain and decode information signals that a carrier signal transports.

The UE measures its neighbor cell environment in a stepwise manner, such that unnecessary measurements are avoided. The measurement is based on the Reference Symbol Received Power (RSRP) and only if the RSRP value of serving cell falls below certain thresholds additional measurements are activated. In best case if RSRP of serving cell is higher than RSRP-Threshold-1, only the serving cell is measured, and if RSRP of serving cell falls below RSRP-Threshold-1 all intra frequency cells are measured as well. This measurement is easy to provide. s-measure is the 3GPP notation for RSRP-Threshold-1. Nevertheless, the measurement of other frequencies is difficult to provide and should be avoided if not necessary. Therefore, inter-frequency measurements are activated when RSRP of the serving cell falls below a still lower threshold than RSRP-Threshold-2.

Table 97 Th1 and Th2 InterFreq are thresholds set by O&M

RSRP of serving cell	Measurement activities in UE
rsrp(s) > RSRP-Threshold-1	no measurement except serving cell
RSRP-Threshold-1 > rsrp(s) > RSRP-Threshold-2	intra-frequency measurement
rsrp(s) < RSRP-Threshold-2	intra-frequency measurement and inter frequency measurements

Transitions: When the UE enters RRC_CONNECTED state, the eNB sends a Measurement Configuration which includes the value RSRP-Threshold-1, such that the UE autonomously starts/stops intra-frequency measurements when rsrp(serv) falls below/ becomes higher than RSRP-Threshold-1. The activation /deactivation of inter-frequency measurement is triggered by a new Measurement Configuration message that the eNodeB sends to the UE. For this reason in the first step when measurement configuration is set up, the MeasConfig contains a trigger that the UE advises when the RSRP(serv) falls below RSRP-Threshold-2. This results in a MeasResult from UE. As a consequence, the eNB sends a new MeasConfig which contains the details about the other frequencies that have to be measured in addition. Additionally, a trigger is added, by which the UE advises when rsrp(serv) becomes better than RSRP-Threshold-2. In this case, when the RSRP becomes better (than RSRP-Threshold-2), then there is no need to continue measuring the inter-frequency and with a new MeasConfig the inter-frequency measurements are deactivated.

For each Measurement Object a separate ReportConfig ‘Better Cell HO RSRP IF’ is used, where the parameter values defined at the same instance as for the related Inter Frequency Measurement Object. The number of ReportConfig's ‘Better Cell HO RSRP IF’ is equal to the number of Inter Frequency Measurement objects. If there exists no Inter Frequency Measurement Object than no ReportConfig "Better Cell HO RSRP IF" is to configure.

24.3.2.2 RSRQ for A3 event (Better Cell HO)

RSRQ Definition: signal strength metric that is calculated as a ratio of the reference symbol received power multiplied by the number of physical resource blocks to the received signal strength indicator. While the reference symbol received power is an indicator of the wanted signal strength, the reference signal received quality takes also the interference into account due to the inclusion of the received signal strength indicator.

For each Measurement Object a separate ReportConfig ‘Better Cell HO RSRQ IF’ is used, where the parameter values defined at the same instance as for the related Inter Frequency Measurement Object. The number of ReportConfig's ‘Better Cell HO RSRQ IF’ is equal to the number of Inter Frequency Measurement objects.

24.3.2.3 RSRP for A5 event (Coverage HO)

For each Measurement Object a separate ReportConfig 'Coverage HO IF' is used, where the parameter values are defined at the same instance as for the related measurement object. The number of ReportConfig's is equal to the number of Inter RAT Measurement objects. If there exists no Inter Frequency Measurement Object or UE does not support Event A5, no ReportConfig 'Coverage HO IF' needs to be configured. Supporting of Event A5 is indicated if Bit14 of parameter `featureGroupIndicators` of 3GPP IE UE-EUTRA-Capability is set to 1.

24.3.2.4 Th2a for deactivation of A3 and A5 events

Th2a is the threshold for RSRP of the serving cell for stopping of Inter-RAT (InterFreq) Measurements. When RSRP of the serving cell becomes better than Th2a, Inter-RAT measurements are deactivated for all A3 and A5 events (RSRP and RSRQ). In order to prevent ping-pong effects it is necessary that the value of Th2a shall be somewhat higher than Th2_InterFreq

Table 98 Th2a InterFreq threshold set by O&M

RSRP of serving cell	Measurement activities in UE
rsrp(s) > RSRP-Threshold-2a	intra-frequency measurement stopped

24.3.3 Handover trigger

The following measurement events are used for the measurement based inter-frequency handover:

- A1 - deactivate inter-frequency measurements
- A2 - activate inter-frequency measurements
- A3 - inter-frequency measurements “Better Cell HO” for RSRP and RSRQ
- A5 - inter-frequency measurements “Coverage HO” for RSRP

The events A1 and A2 are used to control the start and stop of inter-frequency measurements on the target cells.

The target cells for the inter-frequency handover can be configured by the operator.

The events A3 or A5 are used to report suitable inter-frequency neighbors. The UE radio access capabilities are considered for the measurement configuration.

The handover thresholds, hysteresis margins and timer constrains for the inter-frequency handover are O&M parameters that can be configured by the operator.

The evaluation of measurements reports, the handover preparation, execution, completion and data forwarding is identical to the intra-frequency handover via X2 respectively S1.

24.3.4 Performance counters

The following counters are supported per cell in order to track the performance of the inter-frequency handover, for example:

- Number of Inter-Frequency Handover attempts
- Number of Inter-Frequency Handover attempts - measurement gap assisted
- Number of Inter-Frequency Handover completions
- Number of Inter-Frequency Handover completions - measurement gap assisted
- Number of Inter-Frequency Handover failures
- Number of Inter-Frequency Handover failures - measurement gap assisted

The inter-frequency handover functionality can be enabled / disabled per cell via O&M.

24.4 System Impact

The feature has no additional impacts on the system

24.4.1 Dependencies Between Features

There are interdependencies between the following features:

- LTE 54 - Intra-LTE handover via S1 (needs to be enabled in case of inter-frequency handover via S1)

24.4.2 Impact on Interfaces

The feature has no additional impacts on interfaces.

24.4.3 Impact on Network and Network Element Management tools

The feature has additional impacts on O&M parameters:

- Feature Activation Flag for inter-frequency handover

24.4.4 Impact on System Performance and Capacity

The feature has no additional impacts on System Performance and Capacity.

24.5 LTE55 reference data

LTE55: Inter-frequency Handover requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 99 LTE55 hardware and software requirements

	FDD	TDD
System release	RL20	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	L17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	NS20	NS20

Table 99 LTE55 hardware and software requirements (Cont.)

	FDD	TDD
SAE GW	NG20	NG20
UE	3GPP R8 UE capabilities	3GPP R8 UE capabilities

Alarms

There are no alarms related to the *LTE55: Inter-frequency Handover* feature.

Measurements and counters

Table 100 New counters introduced by LTE55

Counter ID	Counter name	Measurement
M8021C0	Number of inter frequency handover attempts	LTE Handover
M8021C1	Number of inter frequency handover attempts (measurement gap assisted)	LTE Handover
M8021C2	Number of successful inter-frequency handover completions	LTE Handover
M8021C3	Number of successful inter-frequency handover completions (measurement gap assisted)	LTE Handover
M8021C4	Number of failed inter-frequency handovers	LTE Handover
M8021C5	Number of failed inter-frequency handovers (measurement gap assisted)	LTE Handover

For counter descriptions, see *LTE Operating Documentation/ Reference/ Counters and Key Performance Indicators*.

Key performance indicators

There are no key performance indicators related to the *LTE55: Inter-frequency Handover* feature.

Parameters

Table 101 New parameters introduced by LTE55

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Enable Inter Frequency Handover	actIfHo	LNBTS	-	-
Eutra Carrier Info	eutraCarrierInfo	LNHOIF	-	common
EUTRA Carrier Frequency	freqEutra	LNCEL	blacklistHoL	common

Table 101 New parameters introduced by LTE55 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Filtering Coefficient Used For RSRP	filterCoefficientRSRP	LNCEL	-	common
Filtering Coefficient Used For RSRQ	filterCoefficientRSRQ	LNCEL	-	common
Threshold Th2 InterFreq For RSRP	threshold2InterFreq	LNCEL	-	common
Related Hysteresis of Threshold Th2 InterFreq for RSRP	hysThreshold2InterFreq	LNCEL	-	common
Threshold Th2a For RSRP	threshold2a	LNCEL	-	common
Related Hysteresis of Threshold Th2a For RSRP	hysThreshold2a	LNCEL	-	common
Time To Trigger For A1 To Deactivate Inter Measurement	a1TimeToTriggerDeactInterMeas	LNCEL	-	common
Time To Trigger For A2 To Activate Inter Measurement	a2TimeToTriggerActInterFreqMeas	LNCEL	-	common
A3 Offset RSRP Inter Frequency	a3OffsetRsrpInterFreq	LNHOIF	-	common
Related Hysteresis of offset a3Offset for RSRP Inter Frequency	hysA3OffsetRsrpInterFreq	LNHOIF	-	common
A3 Offset RSRQ Inter Frequency	a3OffsetRsrqInterFreq	LNHOIF	-	common
Related Hysteresis of offset a3Offset for RSRQ Inter Frequency	hysA3OffsetRsrqInterFreq	LNHOIF	-	common
A3 Report Interval RSRP Inter Frequency	a3ReportIntervalRsrpInterFreq	LNHOIF	-	common
A3 Report Interval RSRQ Inter Frequency	a3ReportIntervalRsrqInterFreq	LNHOIF	-	common

Table 101 New parameters introduced by LTE55 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
A3 Time To Trigger RSRP Inter Frequency	a3TimeToTriggerRsrpInterFreq	LNHOIF	-	common
A3 Time To Trigger RSRQ Inter Frequency	a3TimeToTriggerRsrqInterFreq	LNHOIF	-	common
A5 Report Interval Inter Frequency	a5ReportIntervalInterFreq	LNHOIF	-	common
A5 Time To Trigger Inter Frequency	a5TimeToTriggerInterFreq	LNHOIF	-	common
Presence Antenna Port1	interPresAntP	LNHOIF	-	common
Measurement Quantity Inter Frequency	measQuantInterFreq	LNHOIF	-	common
Measurement Bandwidth	measurementBandwidth	LNHOIF	-	common
Threshold Th3 For RSRP Inter Frequency	threshold3InterFreq	LNHOIF	-	common
Threshold Th3a For RSRP Inter Frequency	threshold3aInterFreq	LNHOIF	-	common
Related Hysteresis of Thresholds Th3 and Th3a for RSRP Inter Frequency	hysThreshold3InterFreq	LNHOIF	-	common
Naming Attribute Of MOC LNHOIF	lnHoIfId	LNHOIF	-	common

Note: The LNHOIF object is used to configure measurement objects in the UE for inter-frequency measurements. Section 6.3.5 of 3GPP TS 36.331 specifies the use of the `carrierFreq` information element (IE) and requires the E-UTRAN to configure only one measurement object for the same physical frequency regardless of the E-ARFCN used in any individual UE. For more information, see section 6.3.5 of 3GPP TS 36.311 (*Measurement information elements - MeasObjectEUTRA*). Using the configuration, the operator has to ensure that the E-UTRAN is in compliance with this requirement. Otherwise, handover measurements and handover triggering might not work as expected. One way to ensure that the E-UTRAN is in compliance with the requirement is to make sure that each physical frequency indicated by the `eutraCarrierInfo` parameter in any LNHOIF object is unique across all LNHOIF instances.

For parameter descriptions, see *LTE Operating Documentation/ Reference/ Parameters*.

Sales information

Table 102 LTE55 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

24.6 Activating the LTE55: Inter-frequency Handover

Purpose

Follow this procedure to activate the LTE55: Inter-frequency Handover feature.

The feature ‘Inter-frequency Handover’ needs to be activated with the parameter *actIFHo*. If activated it applies for all cells of the eNB.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Sub-steps

a) Set the parameter “Enable InterFrequency Handover” - actIfHo to true (1)

b) Set the related parameter:

- threshold 2a shall be 0 ... 97
- a1TimeToTriggerDeactInterMeas shall be 0 (0 ms) ... 15 (5120 ms)
- a2TimeToTriggerActInterFreqMeas shall be 0 (0 ms) ...15 (5120 ms)

- threshold2InterFreq shall be 0 ...97
- hysThreshold2InterFreq shall be 0 ...15dB
- hysThreshold2a shall be 0 ...15dB

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart (if selected).

Sending the command you have to choose whether it should be send with “restart” or without “restart”. Activating this feature a “restart” is not required.

After changing the parameter and sending the comissioning file to the eNB the eNB is resetting.

24.7 Deactivating the LTE55: Inter-frequency Handover

Purpose

Follow this procedure to deactivate the Steps feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eBN, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Sub-steps

a) Set the parameter “Enable InterFrequency Handover” - *actIfHo* to false (0)

b) Switch off the related parameter:

- threshold 2a shall be 98 (not used)
- a1TimeToTriggerDeactInterMeas shall be 16 (not used)
- a2TimeToTriggerActInterFreqMeas shall be 16 (not used)
- threshold2InterFreq shall 98 (not used)
- hysThreshold2InterFreq shall be 255 (not used)
- hysThreshold2a shall be 255 (not used)

The concerned cell must be locked before.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to walk through the pages that contain the full eNB configuration information.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart (if selected).

Sending the command you have to choose whether it should be send with “restart” or without “restart”. For deactivating this feature a “restart” is not required.

After changing the parameter and sending the comissioning file to the eNB the eNB is resetting.

25 LTE69: Transmit Diversity for Two Antennas and LTE70: Downlink Adaptive Open Loop MIMO for Two Antennas

25.1 Introduction to the feature

The following features offer solutions related to multi-path downlink transmissions. As **MIMO** (Multiple Inputs Multiple Outputs) is one of the key features of LTE, techniques for “downlink adaptive open loop MIMO” and “transmission diversity” are presented.

By applying the feature *LTE70: Downlink adaptive open loop MIMO for two antennas*, the eNodeB selects dynamically between “Space Frequency Block Coding (SFBC) transmit diversity” and “Open Loop Spatial Multiplexing” with “Large-delay **Cyclic Delay Diversity**” (“Large-delay CDD”).

When using the feature *LTE69: Transmit diversity for two antennas*, the eNodeB transmits each data stream via 2 TX diversity paths, and the “Space Frequency Block Code” mode is applied. Diversity methods are complementing the basic feature *LTE187: Single TX path mode*, where the TX signal is transmitted via a single TX antenna per cell, either due to HW configuration or in semi-static mode selected by O&M for HW configurations with two TX paths per cell.

25.2 Benefits

In the following section, benefits for operators and end users are summarized with regard to the following features:

- *LTE69: Transmit diversity for two antennas*
- *LTE70: Downlink adaptive open loop MIMO for two antennas*

25.2.1 End user benefits

The mentioned features support radio links, offering high data rates and signal quality.

25.2.2 Operator benefits

By the feature *LTE69: Transmit diversity for two antenna*, cell coverage and capacity are enhanced by the transmit diversity of two antennas.

The feature *LTE70: Downlink adaptive open loop MIMO for two antennas* provides high peak rates (using two code words) and good cell edge performance (using a single code word) by the adaptive algorithm.

Furthermore, “double stream 2x2 MIMO spatial multiplexing (open loop)” can be used for small cells with low load if the UE capabilities are sufficient.

25.3 Functional description

25.3.1 Functional overview

By means of the feature *LTE70: Downlink adaptive open loop MIMO for two antennas*, the eNodeB is able to select dynamically between “Space Frequency Block Coding (SFBC) Transmit Diversity” and “Open Loop Spatial Multiplexing” with “Large-delay Cyclic Delay Diversity” (“Large-delay CDD”). Open loop spatial multiplexing is offered with two code words with “Large-delay CDD” for the **PDSCH** (Physical Downlink Shared Channel) on UE basis.

Using the feature *LTE69: Transmit diversity for two antennas*, the eNodeB transmits single data streams via 2 TX diversity paths. Furthermore, each data stream is transmitted by two diversity antennas per sector, and “Space Frequency Block Coding (SFBC) Transmit Diversity” is applied. Diversity methods complement the basic feature *LTE187: Single TX path mode*.

25.3.2 Downlink adaptive open loop MIMO for two antennas

By means of the feature *LTE70: Downlink adaptive open loop MIMO for two antennas*, the eNodeB is able to select dynamically between “Space Frequency Block Coding (SFBC) Transmit Diversity” and “Open Loop Spatial Multiplexing” with “Large-delay Cyclic Delay Diversity” (“Large-delay CDD”). Open loop spatial multiplexing is offered with two code words with “Large-delay CDD” for the PDSCH on UE basis. The open loop dynamic MIMO switch functionality can be enabled and disabled on cell level by means of O&M. When the dynamic MIMO switch is disabled, either static multiplexing or static transmit diversity can be selected for the whole cell (all UEs). The dynamic switch takes into account the UE’s specific link quality and rank information. Furthermore, the UE radio capabilities are considered and additional offsets for **CQI** reporting compensation are provided with regard to the dynamic MIMO switching functionality.

MIMO is a key technology in achieving the ambitious requirements for throughput and spectral efficiency for the LTE air interface. MIMO refers to the use of multiple antennas at the transmitter and at the receiver. For the LTE downlink, a 2x2 configuration for MIMO is assumed as baseline configuration, i.e. two transmit antennas at the base station and two receive antennas at the terminal side. Configurations with four transmit or receive antennas are also supported by LTE Rel-8. Different gains can be achieved depending on the MIMO mode that is used.

Table 103: Multi antenna options in LTE gives an overview on the typical LTE multi antenna configurations:

Table 103 Multi antenna options in LTE

DL				UL				Configuration type
	BS TX	UE RX	Gain to smaller configuration		UE TX	BS RX	Gain to smaller configuration	
1x2	1	2		1x2	1	2		minimum
2x2	2	2	+ 4 .. 5 dB DL link budget + 100% peak data rate + user experience + 10% spectrum efficiency	1x2	1	2		standard

The “standard” configuration of the LTE base station provides in addition to 2 RX antennas (RX diversity) 2 TX chains, which has the advantage in that no extra antenna and feeder cost is necessary compared to the minimum 1 TX chain. In a “high performance” scenario, 4 RX antennas at the LTE base station substantially enhance the LTE uplink path but require additional antenna and feeder effort and costs. Typically, the LTE UE is equipped with 2 RX antennas and 1 TX chain.

25.3.2.1 Receive diversity

The company supports 2-branch and plans to support 4-branch receive diversity based on **MRC** (Maximum Ratio Combining). MRC aims at combining the 2 (or 4) receive signals in such a way that the wanted signal's power is maximized compared to the interference and the noise power, i.e. the **SINR** (Signal to Interferer and Noise Ratio) is enhanced.

Compared to a single receive branch, 2-branch receive diversity allows for:

- coherence link budget gain of 3 dB
- additional diversity link budget gain of some dB depending on many conditions including velocity, fading channel and carrier bandwidth
- link budget gain from MRC at about 10% Block Error Rate (BLER) may reach up to 6 dB (as shown in simulations)

Correspondingly, 4-branch receive diversity will show a coherence link budget gain of 6 dB plus some dB additional diversity link budget gain.

Receive diversity with two receive branches requires two uncorrelated receive antennas using a single cross-polar antenna or two vertically polarized spatially separated antennas; 4-branch receive diversity requires four uncorrelated receive antennas using e.g. 2 spatially separated cross-polar antennas.

Receive diversity complies with LTE Rel-8 terminals and is supported on all uplink channels.

25.3.2.2 Transmit diversity

The company supports 2-branch and plans to support 4-branch transmit diversity.

If the total eNodeB transmit power keeps the transmit power per transmit branch as high as for the single transmit antenna case, the link budget is increased by 3 dB for two branches and by 6 dB for four branches. This implies coverage and capacity enhancements.

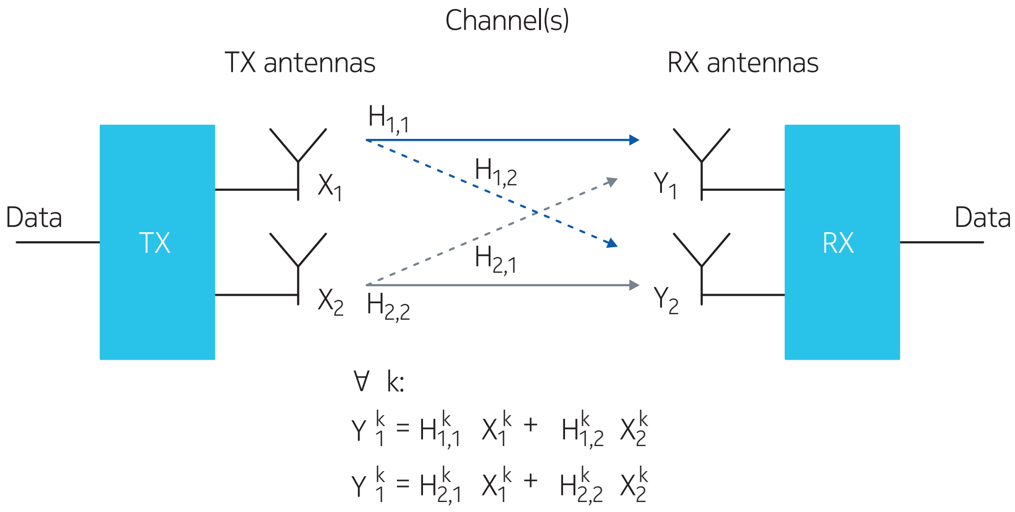
If the total eNodeB transmit power is constant (compared to the single transmit branch case), transmit diversity leads to more robust links at the cell edge while slightly reducing cell capacity. However, for **DRX** (Discontinuous Reception) **VoIP** users, transmit diversity slightly enhances cell capacity by approximately 5% for two transmit branches.

Transmit diversity may be semi-statically configured per cell, while for non-MIMO UEs, `dlMimoMode=1` for PDSCH is automatically selected.

25.3.2.3 Downlink open loop MIMO

The typical MIMO configuration encompassing “dual code word 2x2 DL SU (Single-User) MIMO Spatial Multiplexing” is illustrated in the figure below. This MIMO scheme targets a duplication of the downlink peak user data rate by means of two independent parallel data streams to a single UE. This is also called “Spatial Multiplexing”. The two base station transmit signals, two UE receive signals, and four channels form (for each subcarrier) a system of two equations with two unknown transmit signals. The two unknown transmit signals can be achieved by channel estimation, possible transmit alphabet(s), and the two receive signals.

Figure 27 2x2 MIMO configuration



Y_j($Y_1$and Y_2) - a signal received on the RX antenna port *j* of the UE
$H_{i,j}$($H_{1,1}$; $H_{1,2}$; $H_{2,1}$; $H_{2,2}$) - a channel matrix
X_i (X_1 and X_2)- a signal transmitted on the TX antenna port *i* of the eNodeB

Transmission of 2 independent data streams transmitted at the same time depends on the channels' signal quality and the decorrelation of both channels. Correlation of the channels is determined by the antenna characteristics.

For example antennas are uncorrelated if they:

- are spatially separated by about 10 or more wavelengths, or
- use orthogonal polarization planes (cross-polarity), or
- are located in a diffuse environment.

By uncorrelated antennas diversity and spatial multiplexing gains can be achieved, and coherence gains to some extent.

For example antenna elements are correlated if they:

- are phased by ½ wavelength spacing,
- have a low angular spread, and
- are located in a non-diffuse environment (e.g. on the rooftop).

Correlated antennas easily provide robust coherence gains (the classical beamforming gain), but no spatial multiplexing or diversity gain.

For **Open Loop SU-MIMO Spatial Multiplexing,** UE feedback, like PMI and RI is required. Mapping of data to the transmit antenna ports is fixed and the system cannot be influenced. If the conditions for “Spatial Multiplexing” not good enough, however, the UE may request to lower the transmission rank and ultimately falls back to `dlMimoMode=1`.

For interoperability reasons, the “Open Loop SU-MIMO” scheme has to be based on the “Large-delay Cyclic Delay Diversity” (“Large-delay CDD”) precoding. The optimum unitary precoding matrix is selected by means of a predefined codebook which is known at eNodeB and UE side, and by the UE's radio channel estimate. Operators may (statically) configure whether a cell supports “Transmit Diversity”, or “MIMO Spatial Multiplexing”, or allows for an adaptive mode. In the adaptive mode, the “Open Loop 2x2 SU-MIMO” fallback is “Space Frequency Block Coding (SFBC) Transmit Diversity”.

In ideal situations, 2x2 SU-MIMO duplicates the peak user data rate. For realistic conditions, 2x2 SU-MIMO enhances cell capacity by 10% for macro-cellular and by 40% for micro-cellular deployment scenarios.

The current eNodeB hardware meets the phase noise or the minimum jitter requirements (< 60 ns) between LTE baseband processing and antenna connectors required for MIMO schemes with uncorrelated antennas.

25.3.3 Transmit diversity for two antennas

Using the feature *LTE69: Transmit diversity for two antennas*, the eNodeB transmits each data stream via 2 TX diversity paths. Each data stream is transmitted by two diversity antennas per sector, and “Space Frequency Block Coding (SFBC) Transmit Diversity” is applied. The transmit diversity mode can be used for most physical downlink channels, except for the synchronization signals, which are transmitted only via the first TX antenna, and except when the eNodeB send different cell-specific reference signals per antenna. The operator can enable the semi-static transmit diversity mode on cell basis.

Diversity methods complement the basic feature *LTE187: Single TX path mode*, where the TX signal is transmitted via a single TX antenna per cell. Here, the single TX path mode can be applied for two scenarios dependent on the HW configuration of the eNodeB: Either for HW configurations with only one TX path per cell or for HW configurations with two TX paths per cell where the second TX path is disabled by O&M. The latter scenario is primarily intended for trialing purpose. In this case, the same 2-path HW configuration supports enhanced operational modes of TX diversity or MIMO. The operator can select the TX mode semi-statically on cell basis by the O&M configuration. The single TX path per cell mode is the basic transmit solution without spatial diversity in the eNodeB. A single pattern of symbols for cell-specific reference signals is sent in downlink direction. In uplink direction, 2 RX paths per cell are always supported by the eNodeB.

25.3.4 Open loop spatial multiplexing

For small cells with low load, “double stream 2x2 MIMO spatial multiplexing (open loop)” can be used if the UE capabilities are sufficient. Otherwise, `dlMimoMode=1` has to be selected.

25.4 System impacts

By introduction of the features *LTE70: Downlink adaptive open loop MIMO for two antennas* and *LTE69: Transmit diversity for two antennas*, the following interdependencies and impacts are relevant:

25.4.1 Interdependencies between features

The following features are required for *LTE70: Downlink adaptive open loop MIMO for two antennas*:

- *LTE30: CQI adaptation*
- *LTE899: Antenna line supervision*
- *LTE69: Transmit diversity for two antennas*.

For *LTE69: Transmit diversity for two antennas*, the TX path activation or deactivation can be performed only if MIMO or TX features are enabled.

The features *LTE187: Single TX path mode*, *LTE69: Transmit diversity for two antennas*, *LTE70: Downlink adaptive open loop MIMO for two antennas*, and *LTE703: Downlink adaptive closed loop MIMO for two antennas* are related to each other as they are configured by the same management parameter `dlMimoMode`.

25.4.2 Impacts on interfaces

C-plane, U-plane and other RRM functions have to contain data for the MIMO mode or for the antenna configuration and settings.

25.4.3 Impacts on network and network element management tools

The eNodeB antenna configuration has to comprise at least two antennas if MIMO is applied.

Open loop MIMO has to take into account the UE capabilities. UEs which are not capable to support MIMO shall use `dlMimoMode=1`, i.e. “diversity”, in MIMO configurations.

25.4.4 Impacts on system performance and capacity

By diversity methods, the channel capacity is enhanced, even for more restrictive radio channel constraints with regard to BLER and SINR for instance.

25.5 LTE69 and LTE70 reference data

LTE69: Transmit Diversity for Two Antennas and LTE70: Downlink Adaptive Open Loop MIMO for Two Antennas requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 104 LTE69 and LTE70 hardware and software requirements

	FDD	TDD
System release	RL09	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTS0.5	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	3GPP R8 UE capabilities	3GPP R8 UE capabilities

Alarms

There are no alarms related to the *LTE69: Transmit Diversity for Two Antennas and LTE70: Downlink Adaptive Open Loop MIMO for Two Antennas* features.

BTS faults and reported alarms

There are no faults related to the *LTE69: Transmit Diversity for Two Antennas and LTE70: Downlink Adaptive Open Loop MIMO for Two Antennas* features.

Commands

There are no commands related to the *LTE69: Transmit Diversity for Two Antennas and LTE70: Downlink Adaptive Open Loop MIMO for Two Antennas* features.

Measurements and counters

There are no measurements or counters related to the *LTE69: Transmit Diversity for Two Antennas and LTE70: Downlink Adaptive Open Loop MIMO for Two Antennas* features.

Key performance indicators

There are no key performance indicators related to the *LTE69: Transmit Diversity for Two Antennas and LTE70: Downlink Adaptive Open Loop MIMO for Two Antennas* features.

Parameters

Table 105 New parameters introduced by LTE69 and LTE70

Full Name	Abbreviated Name	Managed Object	Parent Structure	FDD/TDD
Downlink MIMO mode	dlMimoMode	MRBTS/LNBTS/LNCEL/LNCEL_FDD/_TDD	-	Common
CQI threshold for fallback to MIMO diversity	mimoOlCqiThD	LNCEL	-	Common
CQI threshold for activation of OL MIMO SM	mimoOlCqiThU	LNCEL	-	Common
Rank threshold for fallback to MIMO diversity	mimoOlRiThD	LNCEL	-	Common
Rank threshold for activation of OL MIMO SM	mimoOlRiThU	LNCEL	-	Common
MIMO Closed Loop configuration	mimoClConfig	MRBTS/LNBTS/LNCEL/LNCEL_FDD/_TDD	-	Common
MIMO Open Loop configuration	mimoOlConfig	MRBTS/LNBTS/LNCEL/LNCEL_FDD/_TDD	-	Common

For parameter descriptions, see *LTE Operating Documentation/Reference/Parameters*

Sales information

Table 106 LTE69 and LTE70 sales information

Product structure class	License control	Activated by default
Application software (ASW)	SW Asset Monitoring	No

25.6 Activating the Feature

This feature requires activation. For instructions see Activating the LTE69: Transmit diversity for two antennas and LTE70: Downlink adaptive open loop MIMO for two antennas.

This feature requires deactivation. For instructions see Deactivating the LTE69: Transmit diversity for two antennas and LTE70: Downlink adaptive open loop MIMO for two antennas.

25.6.1 Activating the LTE69: Transmit Diversity for Two Antennas and LTE70: Downlink Adaptive open Loop MIMO for Two Antennas Features Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE69: Transmit diversity for two antennas and LTE70: Downlink adaptive open loop MIMO for two antennas features.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

- *LTE69 Transmit Diversity for two antennas*
- *LTE70 Downlink adaptive open loop MIMO for two antennas*

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View** ► **Commissioning** or click **Commissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.

- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to read carefully the pages that contain the full eNB configuration information.

The feature *LTE69 Transmit Diversity for two antennas* is activated by setting the O&M parameter `Downlink MIMO mode` and is located in managed object LNCEL.

Note: In release LTE17 onwards, due to change in MO architecture, the `Downlink MIMO mode` parameter is alocated in **LNCEL_FDD** object for FDD and in **LNCEL_TDD** object for TDD.

Related thresholds can be set by modification of the following parameters:

- `CQI threshold for fallback to Open Loop MIMO diversity (in CQI) - mimoOlCqiThD`
- `CQI threshold for activation of Open Loop MIMO Spatial Multiplexing (in CQI) - mimoOlCqiThU`
- `Rank threshold for fallback to Open Loop MIMO diversity - mimoOlRiThD`
- `Rank threshold for activation of Open Loop MIMO Spatial Multiplexing - mimoOlRiThU`

All parameters are located in managed object LNCEL.

eNB reset is needed in case of changing `Downlink MIMO mode` parameter.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

25.6.2 Deactivating the LTE69: Transmit Diversity for Two Antennas and LTE70: Downlink Adaptive open Loop MIMO for Two Antennas Features Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE69: Transmit diversity for two antennas and LTE70: Downlink adaptive open loop MIMO for two antennas feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

- *LTE69 Transmit Diversity for two antennas*
- *LTE70 Downlink adaptive open loop MIMO for two antennas*

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Commissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to read carefully the pages that contain the full eNB configuration information.

The feature *LTE69 Transmit Diversity for two antennas* is deactivated by setting `Downlink MIMO mode` to any other value than 1 (`TXDiv`).

The feature *LTE70 Downlink adaptive closed loop MIMO for two antennas* is deactivated by setting `Downlink MIMO mode` to any other value than 3 (`Dynamic Open Loop MIMO`).

eNB reset is needed in case of changing `Downlink MIMO mode` parameter.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

26 LTE423: RRC connection release with redirect

26.1 Introduction to the feature

The eNodeB supports RRC Connection Release with redirection to an operator-specifiable RAT & frequency if the UE risks losing coverage and no handover is possible.

Due to RSRP measurements (event A2), the eNodeB then triggers a RRC connection release with redirect.

26.2 Benefits

Faster change over to other frequeny layers is possible with the *LTE423: RRC connection release with redirect* feature.

26.3 Functional description

FDD and TDD common solution

The eNodeB supports RRC Connection Release with redirection to an operator-specifiable RAT & frequency if the UE risks losing coverage and no handover is possible.

Due to RSRP measurements (event A2), the eNodeB then triggers a RRC connection release with redirect.

The thresholds for this event are operator configurable. The target frequency is also operator configurable. It can belong to eUTRAN, WCDMA, GSM, eHRPD, CDMA/1xRTT.

The UE capabilities are considered for the redirect. The redirect functionality can be enabled/disabled via O&M.

FDD solution

In case of FDD, up to six redirection target layers MORED are supported for each profile MOPR.

Note: When configuring the feature, do not configure the RAT `for redirection` (`redir`RAT) parameter value to: **utraTDD** in the following objects:

- **REDRT**
- **MORED**
- **MODRED**

TDD solution

In case of TDD, The eNB evaluates the O&M parameters specifying redirection target according to value of `redirectPrio` parameter, where value “1” means highest priority and value “6” lowest priority. Special value “not used” means that such redirection target defined in O&M database will not be taken for UE Context Release with redirection.

A performance counter for RRC connection release with redirect is supported per cell.

26.4 System impact

The feature has no additional impacts on the system.

26.5 LTE423 reference data

> *LTE423: RRC connection release with redirect requirements, parameters, and sales information*

Requirements

Table 107 LTE423 hardware and software requirements

	FDD	TDD
System release	RL10	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10 CD2	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE423: RRC connection release with redirect* feature.

BTS faults and reported alarms

There are no faults related to the *LTE423: RRC connection release with redirect* feature.

Commands

There are no commands related to the *LTE423: RRC connection release with redirect* feature.

Measurements and counters

There are no measurements or counters related to the *LTE423: RRC connection release with redirect* feature.

Key performance indicators

There are no key performance indicators related to the *LTE423: RRC connection release with redirect* feature.

Parameters

Table 108 New parameters introduced by LTE423

Full name	Abbreviated name	Manage d object	Parent structure	FDD/TDD
Enable UE context release with redirect	actRedirect	LNBTS	-	common
Threshold Th4 For RSRP	threshold4	LNCEL	-	common
Related Hysteresis of Threshold Th4 For RSRP	hysThreshold4	LNCEL	-	common
Redirection target configuration identifier	redrtId	REDRT	-	common
RAT for redirect	redirRat	REDRT	-	common
eUTRA frequency	redirFreqEutra	REDRT	-	common
GERAN band indicator	redirGeranBandIndi cator	REDRT	-	common
UTRA frequency	redirFreqUtra	REDRT	-	common
CDMA band	redirBandCdma	REDRT	-	common
CDMA frequency	redirFreqCdma	REDRT	-	common
Time to trigger for A2 to start redirect procedure	a2TimeToTriggerRe direct	LNCEL	-	TDD
Redirection priority for UE context release	redirectPrio	REDRT	-	TDD
Redirection priority for UE context release	redirectPrio	MODRE D	-	TDD
RAT for redirect	redirRat	MODRE D	-	TDD
Redirection priority for UE context release	redirectPrio	MORED	-	TDD
RAT for redirect	redirRat	MORED	-	TDD

For parameter descriptions, see *LTE Radio Access Operating Documentation > Reference > Parameters*.

Sales information

Table 109 LTE423 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

27 LTE493: TDD beamforming

Introduction to the feature

Beamforming changes the antenna array directionality to provide optimal antenna pattern for the users.

27.1 Benefits

End-user benefits

This feature allows better mobility support.

Operator benefits

Beamforming contributes to TD-LTE system by 50% ~ 65% capacity increase using ideal wideband Sounding Reference Signal (**SRS**). This overall gain results from interference avoidance gain, array gain, diversity gain from radio fading channels at the physical layer.

27.2 Functional description

Functional overview

Beamforming is used in Downlink Shared Data Channel (**DL-SCH**), however the feature has also impact on coverage and capacity gain in uplink thanks to its algorithms. *LTE493: TDD beamforming* introduces non-codebook based beamforming over three sector side, eight antennas and maximum 20MHz per sector. These antennas are halflambda spaced and X-Polarized. In downlink applied single-stream beamforming for Physical Downlink Shared Channel (**PDSCH**) (transmission mode 7 specified by 3GPP RL8 is used).

Beamforming in general means adaptation of antenna beam to UE by applying specific antenna weights. This feature uses Long-term beamforming (LTBF) algorithm in downlink to calculate these weights, while in uplink either Maximal Ratio Combining (**MRC**) or IRC algorithm can be chosen. The most significant advantages of using beamforming are strong coverage and capacity gain both in downlink (**DL**) and uplink (**UL**).

This feature should be treated independently of the scheduler. It can be enabled/disabled by Operation and Maintenance (**O&M**).

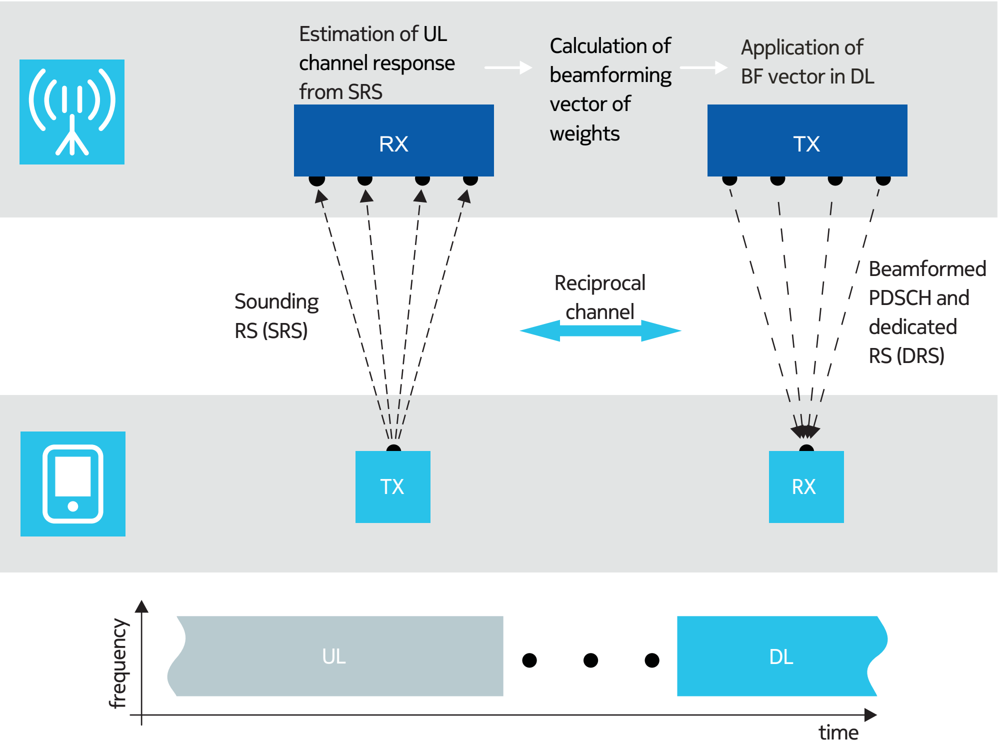
Long-term beamforming

As showed in Figure 28: LTBF algorithm’s steps, the LTBF include the following steps:

1. Channel estimation for each UE and each frequency bin based on the received SRS (advantageous due to the periodicity).
2. Estimate the spatial channel correlation matrix for each UE based on the channel from the previous step, typically, averaging the spatial channel correlation matrix over a long time.

3. Obtain the dominant eigenvector for the spatial channel correlation matrix for each UE.

Figure 28 LTBF algorithm's steps



The weight values are calculated based on phase and amplitude values.

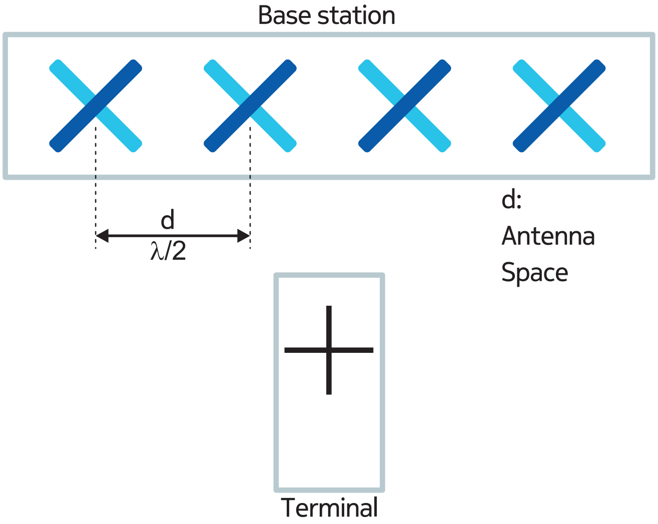
Note: Note that the UE has to meet the following conditions:

- transmit SRS (channel sounding)
- estimate the DL channel based on dedicated RS (DRS), which is combined with beam-formed PDSCH

TDD beamforming antennas

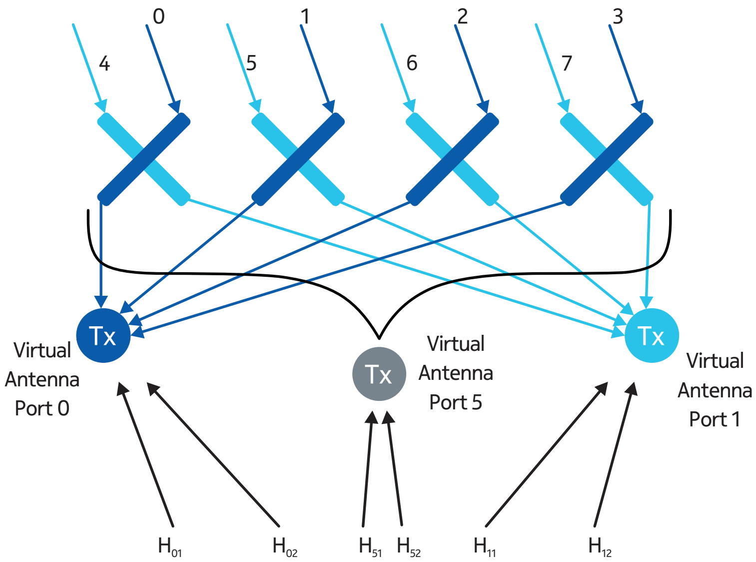
Figure 29: Antenna used in LTE493: TDD beamforming shows the 4 X-Polarized antennas also called "quad-X" which are used in *LTE493: TDD beamforming*. Its spacing is half lambda between the x-pol antennas. The beamforming goes over all eight antennas, however, algorithm does not distinguish polarization groups.

Figure 29 Antenna used in *LTE493: TDD beamforming*



3GPP defines three antenna ports: 0, 1 and 5 as shown in the Figure 30: Antenna ports defined by 3GPP. Port 0 comprises of antennas 0, 1, 2, 3 (polarization 1). Physical antennas 4, 5, 6, 7 are mapped to virtual antenna port 1 (polarization 2), and finally there is port 5 which consists of all antennas. Port 0 and 1 are used for sector beam (distinction of polarizations), while port 5 is used for UE specific beamforming.

Figure 30 Antenna ports defined by 3GPP



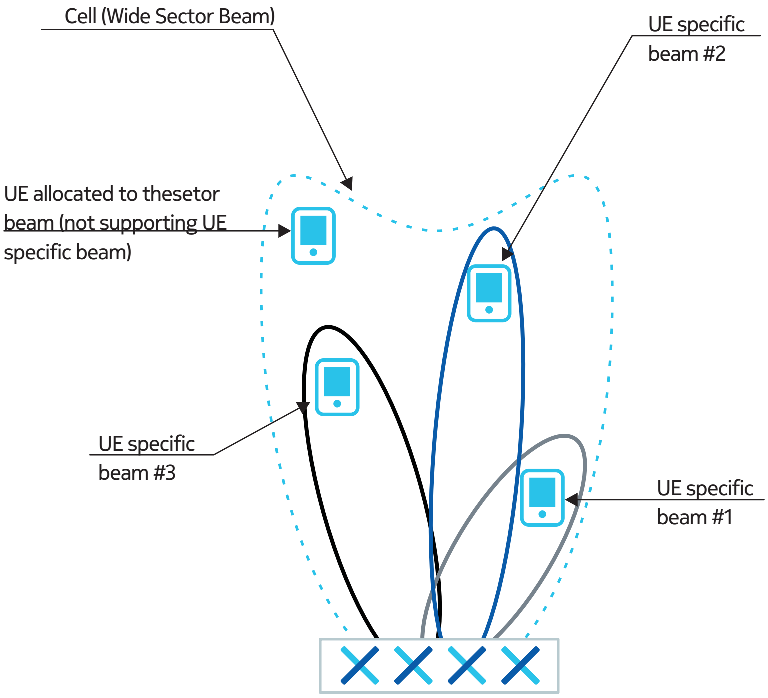
The beamforming approach applies different phase shifts:

- to a group of correlated antennas (4 antennas at the same polarization direction)
- to complex weights to a group of antennas which are not necessarily correlated
- uncorrelated (8 antennas with two different polarization direction) with a single system module and one eight-pipe RF Module (or RRH) accordingly for one sector

Sector beam

Sector beam is used to guarantee coverage for common channels and also for UEs which are not in beamforming mode. It uses ports 0 and 1 of virtual antenna. There are two competitive solutions (selection can be done by O&M parameter, and it should be based on results from the field) which are presented in the Figure 31: UE specific beams

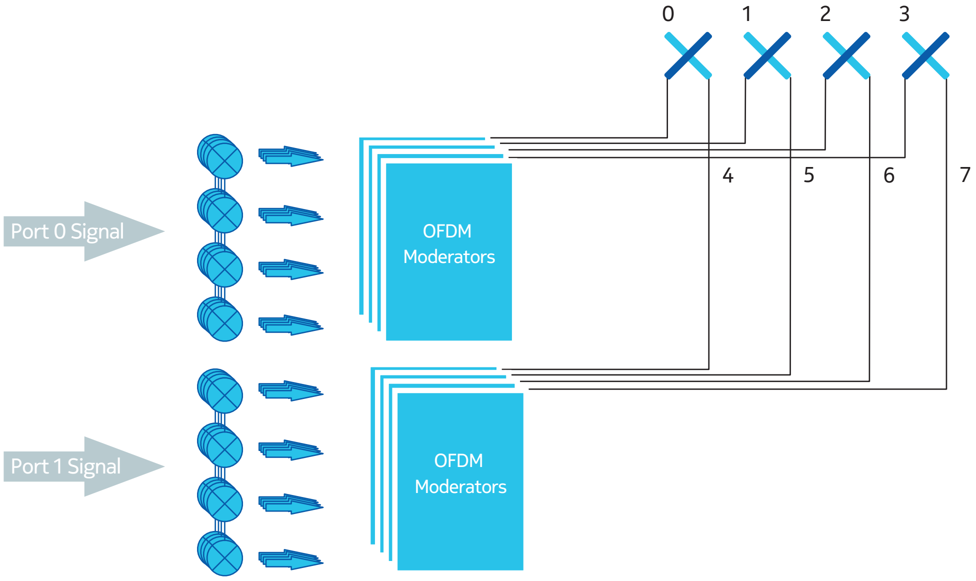
Figure 31 UE specific beams



Wide Sector Beam

In Wide Sector Beam solution (shown in the Figure 32: Wide Sector Beam), the sector beam is formed by appropriate fixed weights. All the antennas work on the same frequency which is the precondition to get beamforming gain. The disadvantage of this solution is power waste due to the fact that sometimes the sum of absolute value of weights is less than 1.

Figure 32 Wide Sector Beam



Beamforming power allocation

Beamforming applies different weights to a group of correlated antennas (four antennas at the same polarization direction) or complex weights to a group of antennas which are not necessarily correlated or uncorrelated (eight antennas with two different polarization directions). These antennas are half lambda-spaced and X-Polarized.

In beamforming there is a sector beam that is the cell basis (that is PDCCH, CRS power setting, the weighting are set statically) and the other type of beam which is on the UE basis and comprises different phase and amplitude corrections.

Different bandwidths are allocated to the UEs from TTI perspective. If a single physical antenna is considered, the application of different weights means that the power density is not flat (within this particular physical antenna). When we take into consideration the aggregation process, where the total power of four physical antennas belong to one polarized antenna array, the power density over the whole spectrum is still flat because the module of each weighting vector equals one. Beamforming vector is generated from Eigen decomposition, that is the characteristic vector.

For more details about beamforming, see also: *LTE541: Dual Stream beamforming*.

27.3 System impact

Interdependencies between features

LTE493: TDD beamforming requires the *LTE513:Support of Sounding reference signal in TDD UpPTS*, which uses SRS in UpPTS for calculate correlation matrix for LTBF. In addition, SRS has to be used in normal frames to calculate correlation matrix for LTBF.

Impact on interfaces

This feature has no impact on interfaces.

Impact on network and network element management tools

This feature has no impact on network management or network element management tools.

Impact on system performance and capacity

The most significant advantages of using beamforming are strong coverage and capacity gain both in DL and UL.

27.4 LTE493 reference data

> *LTE493: TDD beamforming requirements, alarms and faults, parameters, and sales information*

Requirements

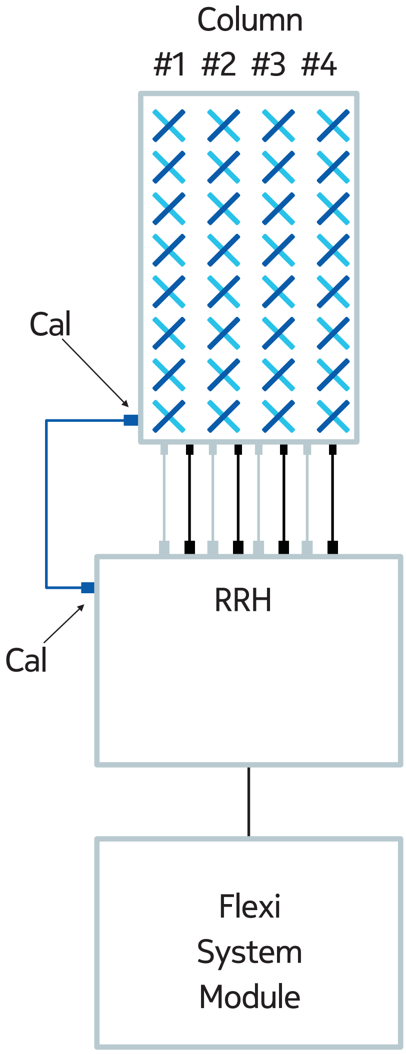
Table 110 LTE493 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15
Flexi Multiradio 10 BTS	Not supported	TD-LBTS2.0
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A
Flexi Zone BTS	Not supported	Not supported
Flexi Zone Access Point	Not supported	Not supported
Cloud Flexi Zone Controller	Not supported	Not supported
OMS	Not supported	Support not required
NetAct	Not supported	Support not required
MME	Not supported	Support not required
SAE GW	Not supported	Support not required
UE	Not supported	Support not required

Additional hardware requirements

This feature concentrates the eight-pipe Remote Radio Head (**RRH**) configuration with antenna constructions where cross-polarized antennas are divided into the four columns. At the moment, each sector is completely separate BTS systems including own Flexi release 2 system module, RRH and transport network interface. Transport network connection can be shared and routing done in one FTLB or external **GE** (Gigabit Ethernet) router can be used instead.

Figure 33 Hardware configuration for 3 sector with FSM.



Alarms

Table 111 New alarms introduced by LTE493

Alarm ID	Alarm name
`4067`	`Calibration initialization failure`

For alarm descriptions, see *LTE Radio Access Operating Documentation > Reference > Alarms and Faults*.

BTS faults and reported alarms

There are no faults related to the *LTE493: TDD beamforming* feature.

Commands

There are no commands related to the *LTE493: TDD beamforming* feature.

Measurements and counters

There are no measurements or counters related to the *LTE493: TDD beamforming* feature.

Key performance indicators

There are no key performance indicators related to the *LTE493: TDD beamforming* feature.

Parameters

Table 112 New parameters introduced by LTE493

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Downlink sector beamforming mode	dlSectorBeamformingMode	LNCEL_TDD	-	TDD
Downlink sector beamforming weight mode	dlSectorBeamformingWeightMode	LNCEL	-	TDD
Uplink combination mode	ulCombinationMode	LNCEL_TDD	-	TDD

Table 113 Parameters modified by LTE493

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Downlink MIMO Mode	dlMimoMode	LNCEL_TDD	-	TDD

Table 114 Existing parameters related to LTE493

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Maximum CQI offset for DL OLQC	dlOlqcDeltaCqiMax	LNBTS_TDD	-	TDD

For parameter descriptions, see *LTE Radio Access Operating Documentation > Reference > Parameters*.

Sales information

Table 115 LTE493 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

Activating the LTE493: TDD beamforming feature using BTS Site Manager

Purpose

Follow this procedure to activate the LTE493: TDD Beamforming feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ▶ Commissioning** or click **Commissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to read carefully the pages that contain the full eNB configuration information.

The configuration elements related to the *LTE493: TDD Beamforming* feature are found on page: ”Cell resources”:

- Set the parameter `MIMO type` from drop-down list to **Single Stream Beamforming**.

Note: Note that in order to set parameter `MIMO type to Single Stream Beamforming,` FZHD radio module has to be available and sector configuration type L has to be selected. `MIMO type` automatically changes the value of `Downlink MIMO Mode` (`dlMimoMode`) to **Single Stream Beamforming**. The parameter `Downlink MIMO Mode` can be found on page: “Radio network configuration”.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_TDD object for the `Downlink MIMO Mode` (`dlMimoMode`) parameter.

- The additional parameters which are used to configure TDD Beamforming are:
  - `Maximum CQI Offset For DL OLQC` (`dlOlqcDeltaCqiMax`) - the parameter defines the maximum CQI offset in DL OLQC.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNBTS/LNBTS_TDD object.

  - `Beamforming antenna bit map` (`beamformingAntennaBitMap`) - This parameter is used to configure which antennae shall be activated. To be activated, the corresponding bit need to be set to '1'.
  - `Downlink beam forming algorithm` (`dlBeamFormingAlgorithm`) - This parameter configures the type of algorithm used to generate the beamforming vector.
  - `Downlink Sector Beamforming Mode` (`dlSectorBeamformingMode`) - Identifies the downlink sector beamfroming mode.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_TDD object for the `Downlink MIMO Mode` (`dlMimoMode`) parameter.

  - `Downlink Sector Beamforming Weight Mode` (`dlSectorBeamformingWeightMode`) - The parameter defines the Downlink Sector Beamforming Weight Mode for sector beamforming solution 1.
  - Uplink Combination Mode (`ulCombinationMode`) - Identifies the uplink combination mode.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_TDD object for the `Downlink MIMO Mode` (`dlMimoMode`) parameter.

They are located on page: “Radio Network Configuration” in LNCEL and LNBTS MOC (*Managed Object Class*). For more details see *Parameters for the LTE493: TDD Beamforming*.

---

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After a successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

Expected outcome

Beamforming changes the antenna array directionality to provide optimal antenna pattern for the users.

Deactivating the LTE493: TDD Beamforming feature using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE493: TDD Beamforming feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

You do not need to restart the eNB after the deactivation of this feature.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ▶ Commissioning** or click **Commissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

Go to the set of pages at the top right of the BTSSM screen to find the feature-related settings. It is recommended to read carefully the pages that contain the full eNB configuration information.

The configuration elements related to the *LTE493: TDD Beamforming* feature are found on page: ”Cell resources”:

- Set the parameter MIMO type from drop-down list to any other value than **Single Stream Beamforming**.

Note: This parameter automatically changes the parameter `Downlink MIMO Mode` (`dlMimoMode`) to the same value as `MIMO type`. The parameter `Downlink MIMO Mode` can be found on page: “Radio network configuration”.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After a successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

28 LTE513: Support of Sounding Reference Signal in TDD UpPTS

28.1 Introduction to the feature

Table 116 LTE513 summary of changes

Date of change	Section	Change description
31.08.2017	System impacts	Section added

The *LTE513: Support of Sounding reference signal in **TDD** Uplink pilot time slot (**UpPTS**)* feature enables the transmission of the Sounding Reference Signal (**SRS**) within the UpPTS. The SRS enables the network to be aware of the wider band channel quality where no UE data or control channel information is transmitted.

28.2 Benefits

The *LTE513: Supporting of Sounding reference signal in TDD UpPTS* feature has the following benefits:

- It helps optimized **UL** scheduling, to facilitate UL timing advance (**TA**) estimation and other advanced transmission schemes, for example, beamforming.
- 5 - 20% UL bandwidth saving can be obtained.
- When using UpPTs, it allows a higher spectral efficiency in UL.

28.3 Functional Description

The Sounding Reference Signal (**SRS**) can be transmitted in one or both symbols of the Uplink pilot time slot (**UpPTS**). Since UpPTS does not carry uplink data traffic, this field is primarily expected to be used by SRS. SRS can be configured as a single transmission or as a periodic transmission, with a period ranging from 2 ms to 320 ms. Frequency hopping can be limited to a certain portion of system bandwidth. The SRS configuration is explicitly signaled via terminal specific higher layer signaling.

SRS from different terminals can be multiplexed in multiple dimensions, which are: time, frequency, cyclic shifts and transmission combs.

In addition to the terminal specific SRS configuration, cell specific SRS defines the subframe that can contain SRS, as well as the bandwidth info. SRS should not extend into the frequency band reserved for **PUCCH**.

28.4 System impacts

Exceeding SRS capacity may result in new calls being rejected.

The number of supported SRS UE per Symbol depends on the configured value of parameter `srsDlMimoModeDepConf` and `srsUePeriodicity`.

Formulas for SRS capacity:

- Max SRS UE= uePeriodicity [2....320ms]/10ms * (Number of SRS opportunities per frame) * (UEs per symbol)
  UEs per symbol = min(srsBwConf/srsBandwidth * comb * cyclic shift, Maximum UEs per symbol)
  Where Maximum UEs per symbol is:
  - For Flexi BTS TDD: 50
  - For Flexi Zone Micro, in one cell case and all SFN configurations: 50
  - For Flexi Zone Micro, in two cell case: 30

  The number of SRS opportunities per frame are depending on TDD frame and parameter `srsSubfrConf` configuration. `srsSubfrConf`maps to the 3GPP table below defines potential subframes for transmission. When these intersect with Uplink subframes for the defined TDD frame configuration, the SRS opportunities will increase. The SRS opportunities increases by 1 for intersections with special subframes and 2 for intersections with normal subframes. PUSCH capacity will be reduced by the normal subframe SRS opportunities.

Table 117 SRS subframe configuration

srsSubframeConfiguration	Binary	Configuration Period (subframe)	Transmission offset (subframe)
0	0	5	{1}
1	1	5	{1, 2}
2	10	5	{1, 3}
3	11	5	{1, 4}
4	100	5	{1, 2, 3}
5	101	5	{1, 2, 4}
6	110	5	{1, 3, 4}
7	111	5	{1, 2, 3, 4}
8	1000	10	{1, 2, 6}
9	1001	10	{1, 3, 6}
10	1010	10	{1, 6, 7}
11	1011	10	{1, 2, 6, 8}
12	1100	10	{1, 3, 6, 9}
13	1101	10	{1, 4, 6, 7}
14	1110	reserved	reserved

Table 117 SRS subframe configuration (Cont.)

15	1111	reserved	reserved

Note: Example calculation for configuration:

- `srsDlMimoModeDepConf/srsUePeriodicity` - 20 ms
- `srsBwConf` - 2bw
- `srsDlMimoModeDepConf/srsBandwidth` - 3hbw
- `tddFrameConf` - 2
- `srsSubfrConf` - sc1

Number of SRS opportunities per frame: `srsSubfrConf` matches subframes 1, 2, 6, 7 in a frame. 1 and 6 are special subframes. 2 and 7 are normal subframes. Therefore, 1+2+1+2=6 opportunities to send SRS per frame.

Example 1: Max SRS Ue = 20 ms/10 ms * 6 * 50 = 600 SRS Ues (FSMr3, 2 cell configuration)

Example 2: Max SRS Ue = 20 ms/10 ms * 6 * 30 = 360 SRS Ues (FZM, 2 cell configuration)

28.5 LTE513 reference data

LTE513: Support of Sounding Reference signal in TDD UpPTS requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 118 LTE513 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15TD
Flexi Multiradio 10 BTS	Not supported	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	Not supported	Not supported

Alarms

There are no alarms related to the *LTE513: Support of Sounding Reference signal in TDD UpPTS* feature.

BTS faults and reported alarms

There are no faults related to the *LTE513: Support of Sounding Reference signal in TDD UpPTS* feature.

Commands

There are no commands related to the *LTE513: Support of Sounding Reference signal in TDD UpPTS* feature.

Measurements and counters

There are no measurements or counters related to the *LTE513: Support of Sounding Reference signal in TDD UpPTS* feature.

Key performance indicators

There are no key performance indicators related to the *LTE513: Support of Sounding Reference signal in TDD UpPTS* feature.

Parameters

Order of parameters inside the tables should reflect the order of managed objects in the Element Manager GUI. Within the managed object, order of the parameters is alphabetical (by parameter's full name).

Table 119 Existing parameters related to LTE513

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Enable Sounding Reference Signal	soundRsEnabled	LNCEL	-	common
Sounding Reference Signal Bandwidth Layer	srsBandwidth	LNCEL	-	common
SRS Bandwidth Configuration	srsBwConf	LNCEL_TDD	-	TDD
SRS Hopping Bandwidth	srsHoppingBw	LNCEL_TDD	-	TDD
SRS Max UpPts	srsMaxUpPts	LNCEL	-	common
Power Offset For SRS Transmission Power Calculation	srsPwrOffset	LNCEL_TDD	-	TDD
SRS To ACK/Nack activation/deactivation	srsSimAckNack	LNCEL_TDD	-	TDD
SRS Subframe Configuration	srsSubfrConf	LNCEL_TDD	-	TDD

Table 119 Existing parameters related to LTE513 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Include SRS Measurements In CL Power Control	ulpcSrsEn	LNCEL	-	common
Consecutive SRS DTX detections number	nSrsDtx	LNCEL_TDD	-	TDD
Consecutive SRS DTX recovery number	nSrsRec	LNCEL_TDD	-	TDD
SRS feature activation/deactivation	srsActivation	LNCEL_TDD	-	TDD
SRS downlink MIMO mode dependant configuration	srsDlMimoModeDepConf	LNCEL_TDD	-	TDD
SRS duration	srsDuration	LNCEL_TDD	-	TDD

For parameter descriptions, see *LTE Radio Access Operating Documentation/Reference/Parameters.*

Sales information

Table 120 LTE513 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

28.6 Activating LTE513: Support of Sounding Reference Signal in TDD UpPTS

Purpose

Follow this procedure to activate the LTE513: Support of Sounding Reference Signal in TDD UpPTS feature.

Before you start

The evolved NodeB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

See Administering Flexi Multiradio BTS LTE for details.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commisioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

Perform the following configuration settings to activate this feature:

- The parameter **SoundRSEnabled**
  must be set to true.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After the changing of the parameter a restart is needed.

Further information

After the successful changing of the parameter **SoundRSEnabled** the parameters srsBandwidth, srsBwConf, srsHoppingBw, srsPwrOffset, srsSimAckNack, srsSubfrConf, srsMaxUpPts, ulpcSrsEn, srsUePeriodicity are free to be changed.

28.7 Deactivating LTE513: Support of Sounding Reference Signal in TDD UpPTS

Purpose

Follow this procedure to deactivate the LTE513: Support of Sounding Reference Signal in TDD UpPTS.

Before you start

The evolved NodeB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

See Administering Flexi Multiradio BTS LTE for details.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

---

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commisioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

Perform the following configuration settings to deactivate this feature:

- To disable this feature the parameter **SoundRSEnabled** must be set to false.

---

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

---

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter SoundRSEnabled a restart of the eNB is needed.

Further information

When the SoundRSEnabled has the value false then the parameters srsBandwidth, srsBwConf, srsHoppingBw, srsPwrOffset, srsSimAckNack, srsSubfrConf, srsMaxUpPts, ulpcSrsEn, srsUePeriodicity can not be modified. Their default values are taken.

29 LTE527: Distributed Resource Allocation Type 2

29.1 Introduction to the feature

The feature *LTE527: Distributed Resource Allocation Type 2* introduces resource allocation type 2 to PDSCH.

Use of type 2 grants yields smaller **DCI** messages and more efficient use of **PDCCH** resources, as well as frequency diversity. This is especially useful for fast fading channels for example where the channel conditions change quickly as to make narrowband **CQI** reporting information outdated.

29.2 Benefits

This feature provides the following benefits:

- it ensures low control overhead via associating small PDCCH payload size
- it is suitable for low rate service
- it is suitable for high variance channel condition
- it yields higher frequency diversity

29.3 Functional description

Resource allocation type 2 introduced allocation of a single resource-block pair and associated with relative small PDCCH payload size compared to type 0 and 1, where the control signaling encodes the resource allocation as a start position and length of the resource blocks.

To provide distributed resource-block allocation in this case, the following approaches are followed:

1. consecutive virtual resource blocks (**VRB)** are not mapped to PRBs that are consecutive in frequency domain
2. single VRB is distributed in the frequency domain

The first step means that the consecutive VRB pairs are not mapped to frequency-consecutive PRB pairs. A block-based “interleaver” is used to perform the frequency spreading.

The second step introduces frequency gap between the two resource blocks of the resource block pair. This provides the frequency diversity inside the pair.

The main function for Distributed Resource Allocation type 2 is the modification in the MAC Downlink Scheduler (DL-S) to assign PRBs not based on channel conditions reported (via narrow band CQI), but based on distributed VRBs (DVRB).

In the frequency domain, PRB allocation is split into two parts: determination of number of VRBs to be allocated to each user via Round Robin Scheduler and allocation of VRBs.

29.4 System impacts

The feature has no additional impacts on the system.

29.4.1 Interdependencies between features

There are interdependencies between the following features:

- *LTE45: Fair scheduler (UL/DL)* The DL channel-aware scheduler supported as part of this feature is DISABLED if DVRB scheduler is **ENABLED**
- *LTE31: Link Adaptation by AMC (UL/DL)* If the DVRB scheduler is **ENABLED**, DL AMC is based only on wideband CQI. Narrow band CQI is not considered in DL AMC.

29.4.2 Impacts on interfaces

The feature has no additional impact on interfaces.

29.4.3 Impacts on network and network element management tools

The feature has no additional impact on network and network element management tools.

29.4.4 Impacts on system performance and capacity

The feature has no additional impact on system performance and capacity.

29.5 LTE527 reference data

LTE527: Distributed Resource Allocation Type 2 requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 121 LTE527 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15
Flexi Multiradio 10 BTS	Not supported	Not supported

Table 121 LTE527 hardware and software requirements (Cont.)

	FDD	TDD
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Not supported	Support not required
NetAct	Not supported	Support not required
MME	Not supported	Support not required
SAE GW	Not supported	Support not required
UE	Not supported	Support not required

Alarms

There are no alarms related to the *LTE527: Distributed Resource Allocation Type 2* feature.

BTS faults and reported alarms

There are no faults related to the *LTE527: Distributed Resource Allocation Type 2* feature.

Commands

There are no commands related to the *LTE527: Distributed Resource Allocation Type 2* feature.

Measurements and counters

There are no measurements or counters related to the *LTE527: Distributed Resource Allocation Type 2* feature.

Key performance indicators

There are no key performance indicators related to the *LTE527: Distributed Resource Allocation Type 2* feature.

Parameters

Table 122 Existing parameters related to LTE527

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Distributed virtual resource block gap value	dlsNgap	LNCEL_TDD	-	TDD
Downlink scheduler type	dlsSchedType	LNCEL_TDD	-	TDD

For parameter descriptions, see *LTE Radio Access Operating Documentation > Reference > Parameters*.

Sales information

Table 123 LTE527 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

29.6 Activating the LTE527: Distributed Resource Allocation Type 2 Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE527: Distributed Resource Allocation Type 2 feature.

Before you start

The evolved NodeB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

You do not need to restart the eNB after the activation of this feature.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ▶ Commissioning** or click **Recommissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commissioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

The configuration elements related to the feature **LTE527** are found on page: **Radio network configuration** Perform the following configuration settings to activate this feature:

- Click on LNBTS object from the navigation tree located in left upper corner.
- In order to configure the parameters related to this feature, click on LNCEL object from the navigation tree.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_TDD object.

- In the LNCEL Properties set the parameter `Downlink scheduler type` from drop-down list to **DVRB**. (This will set `dlsSchedType` parameter.)

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_TDD object.

- In the LNCEL Properties the parameter `Distributed virtual resource block gap value` is set to **NGap1** by default.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_TDD object.

---

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

---

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After a successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

Expected outcome

The feature *`LTE527: Distributed Resource Allocation Type 2`* allows usage of resource allocation type 2.

29.7 Deactivating the LTE527: Distributed Resource Allocation Type 2 Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE527: Distributed Resource Allocation Type 2 feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ▶ Commissioning** or click **Recommissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commissioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

The configuration elements related to the feature **LTE527** are found on page: **Radio network configuration** Perform the following configuration settings to activate this feature:

- In the LNCEL Properties set the parameter `Downlink scheduler type` from drop-down list to other than **DVRB**.

Note: From release LTE17 onwards, due to a change in the MO architecture, you need to select the LNCEL/LNCEL_TDD object.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

30 LTE540: Sounding Reference Signal in Normal Frames

Introduction to the feature

Sounding reference signal (SRS) is a reference signal that the eNB uses to determine the channel state and carrier frequencies to be assigned to the UE for transmission.

SRS provides information about uplink channel quality for wide bandwidths outside the span assigned to a specific UE. This information is needed for UL channel-aware scheduling and UL timing estimation.

This feature makes it possible to transmit the SRS in a normal UL subframe to use a larger capacity of the SRS resource. Without this feature, the SRS is transmitted only in UpPTS.

30.1 Benefits

Operator benefits

The feature provides means for a better estimation of uplink channel quality so that uplink transmissions can be scheduled for good-quality resource blocks.

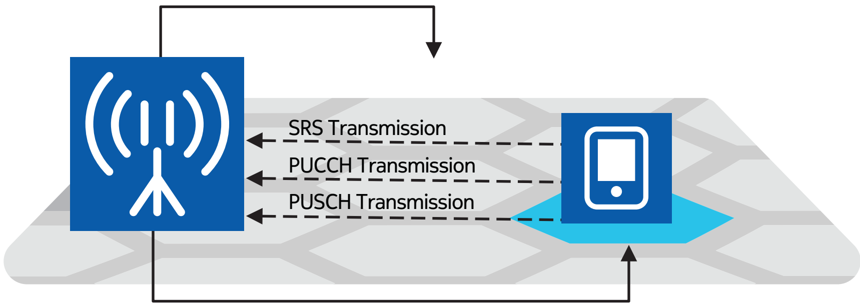
30.2 Functional description

In the scope of feature *LTE513: Sounding Reference Signal in UpPTS*, the sounding reference signal can be transmitted in the uplink pilot time slot, which is used for initial synchronisation, random access, and adjacent cell handover measurements.

Feature *LTE540: Sounding Reference Signal in Normal Frames* makes is possible to transmit the SRS also (or alternatively) in normal uplink subframes. The transmission interval can be configured, the minimum interval being 5ms and the maximum 320ms. On the basis of the received SRS, the eNB makes the measurements required for the channel quality estimation and broadcasts the cell-specific sounding configuration to the UE in SIB2.

The UE-specific sounding configuration is exchanged via the RRC establishment procedure.

Figure 34 Transmission of cell-specific and UE-specific sounding configuration



SRS is transmitted on the last SC-FDMA symbol of the subframe in every second sub-carrier (distributed SC-FDMA transmission). To ensure that the SRS and PUSCH transmissions from different terminals do not overlap, the last symbol is not used for PUSCH by any UE served by the cell.

30.3 LTE540 reference data

LTE540: Sounding Reference Signal in Normal Frames requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 124 LTE540 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15TD
Flexi Multiradio 10 BTS	Not supported	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	Support not required	3GPP release 9 capabilities

Alarms

There are no alarms related to the *LTE540: Sounding Reference Signal in Normal Frames* feature.

BTS faults and reported alarms

There are no faults related to the *LTE540: Sounding Reference Signal in Normal Frames* feature.

Commands

There are no commands related to the *LTE540: Sounding Reference Signal in Normal Frames* feature.

Measurements and counters

There are no measurements or counters related to the *LTE540: Sounding Reference Signal in Normal Frames* feature.

Key performance indicators

There are no key performance indicators related to the *LTE540: Sounding Reference Signal in Normal Frames* feature.

Parameters

Table 125 Parameters related to LTE540

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Consecutive SRS DTX Detections Number	nSrsDtx	LNCEL_TDD	-	TDD
Consecutive SRS DTX Recovery Number	nSrsRec	LNCEL_TDD	-	TDD
SRS feature activation/deactivation	srsActivation	LNCEL_TDD	-	TDD
SRS downlink MIMO mode dependant configuration	srsDlMimoModeDepConf	LNCEL_TDD	-	TDD
Power Offset for SRS Transmission Power Calculation	srsPwrOffset	LNCEL_FDD_TDD	-	TDD
Sounding RS Bandwidth Configuration	srsBwConf	LNCEL_TDD	-	TDD
SRS subframe configuration	srsSubfrConf	LNCEL_TDD	-	TDD
SRS hopping bandwidth	srsHoppingBw	LNCEL_TDD	-	TDD
SRS simultaneous ack/nack	srsSimAckNack	LNCEL_TDD	-	TDD

Table 125 Parameters related to LTE540 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
activation/deactivation				
Sounding RS Subframe Configuration	srsSubfrConf	LNCEL_TDD	-	TDD
SRS beamforming type	beamformingType	LNCEL_TDD	-	TDD
SRS Duration	srsDuration	LNCEL_TDD	-	TDD
SRS act/deact of use of maximum bandwidth on UpPTS	srsMaxUpPTS	LNBTS	-	TDD
SRS Transmission on 2 Symbols of UpPTS Act/Deact	srsOnTwoSymUpPts	LNCEL_TDD	-	TDD

For parameter descriptions, see *LTE Operating Documentation/ Reference/ Parameters*.

The SRS configuration is defined in the following parameters:

- Parameter `Consecutive SRS DTX Detection Number` defines the number of consecutive SRS DTX detections causing a radio link failure indication. The value is an integer in the range of 0 - 8.
- Parameter `Consecutive SRS DTX Recovery Number` defines the number of consecutive SRS non-DTX detections causing radio link failure recovery indication.
- Parameter `Include SRS Measurements in CL Power Control` defines whether RSSI and SINR measurements are included in SRS in the closed-loop PC component.
- Parameter `Periodicity of UE SRS Transmission` defines how often the UE transmits the SRS to the eNB. The number of SRS resources available in the system depends, in addition to the other SRS configuration parameters, on the value of this parameter. The allowed values are: 2 (5ms), 3 (10ms), 4 (20ms), 5 (40ms), 6 (80ms), 7 (160ms), 8 (320ms). Default value is 3.
- Parameter `Power Offset for SRS Transmission Power Calculation` defines the UE-specific power offset used for the SRS transmission power calculation in UE uplink power control equation. The value is an integer in the range of 0 - 15. Default value is 7.
- Parameter `Sounding RS Bandwidth Configuration` defines the allowed set of bandwidths for the SRS. The allowed values are: 2 (2bw), 6 (6bw). Default value is 2.
- Parameter `Sounding RS Bandwidth Layer` defines the layer for sending SRS. The only allowed value is 3 = 4 RB (narrowest possible bandwidth).
- Parameter `Sounding RS Frequency Hopping` determines whether SRS frequency hopping is allowed in a cell. Frequency hopping is automatically enabled when the configured bandwidth for hopping is wider than the UE-dedicated sounding band. The allowed values are: 0 (0hbw), 1 (1hbw), 2 (2hbw), 3 (3hbw). Default value is 3.

- Parameter `Sounding RS Simultaneous to Ack/Nack` determines whether the SRS and ACK/NACK can be transferred simultaneously. The allowed values are: 0 (false), 1 (true). Default value is 0.
- Parameter `Sounding RS Subframe Configuration` defines the cell-specific subframe configuration period and the cell-specific offset, relative to a frame, for the transmission of the SRS. The allowed values are: 0 (sc0), 1 (sc1), 2 (sc2), 4 (sc4). Default value is 0.
- Parameter `SRS Duration` defines the UE transmission duration of the SRS. The only allowed value is 1 (indefinite).
- Parameter `SRS Max UpPTS` defines whether the reconfiguration of the SRS parameter m (max, SRS, 0) applies to UpPts.
- Parameter `SRS Transmission on 2 Symbols of UpPTS Act/Deact` defines whether the SRS transmission on 2 symbols of UpPTS is allowed. The value can be 0 (false) or 1 (true).

Sales information

Table 126 LTE540 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

Note: From release LTE17 onwards, due to a change in the MO architecture, parameter `soundRsEnabled` has been replaced by `srsActivation`, `SRS feature activation/deactivation` parameter, found in **LNCEL/LNCEL_TDD**

30.4 System impact

Interdependencies between features

This feature is dependent on the following features:

- *LTE46: Channel-aware Scheduler (UL)*
- *LTE513: Support of Sounding Reference Signal in TDD UpPTS*

Impact on interfaces

There are parameters in the internal interface that have to be defined to configure the feature. These parameters are described in chapter LTE540: Sounding Reference Signal in Normal Frames reference data

Impact on network and network element management tools

This feature has no impact on network management or network element management tools.

Impact on system performance and capacity

This feature has no impact on system performance or capacity.

31 LTE703: DL adaptive closed loop MIMO for two antennas

31.1 Introduction to the feature

With the feature “LTE703:DL adaptive closed loop MIMO for two antennas” spatial multiplexing mode can be selected dynamically while applying closed loop MIMO for two antennas.

31.2 Benefits

The adaptive algorithm provides the gain of high peak rates (two code words) and good cell edge performance (single code word).

Closed loop MIMO SM transmission mode gives the possibility to use the precoding which offers optimal performance for certain UEs because of UE-specific PMI reporting. This is applicable for both single and dual stream closed loop MIMO SM transmissions.

In case of dual stream transmission, the modulation and coding scheme can be selected separately for both code words thanks to code word specific CQI reporting which should give some throughput gain and better achievement of targeted BLER on PDSCH.

31.3 Functional description

The closed loop adaptive spatial multiplexing for two antennas allows to dynamically switch between a transmission with single code word and a transmission with double code word, both within transmission mode 4 (for more details on the transmission modes see Section 7.1 in [3GPP-36213]). The decision is based on radio conditions and the main criterias for it are CQI (**Channel Quality Indicator**) and Rank Information.

Closed loop MIMO requires the reception of PMI (**Precoding Matrix Indicator**) in UL and selects appropriate precoding in DL. CL (**Closed Loop**) MIMO algorithm is similar to OL (**Open Loop**) algorithm from RL10, however, it is based on separate parameters and thresholds. AMC (**Adaptive Modulation and Coding**) and OLQC (**Outer Loop Quality Control**) consider appropriate MIMO compensation values.

Operator can control algorithm decisions by configuring thresholds via O&M (**Operation and Maintenance**). Closed Loop MIMO can have different thresholds definition from Open Loop MIMO Switch.

Further details on the related layer mapping can be found in TS 36.211.

Spatial multiplexing is applied only for the PDSCH. Pre-coding is done according to the codebook described in TS 36.211. Zero delay CDD is supported.

The feature LTE703: DL adaptive closed loop MIMO for two antennas is optional and it can be switched on/off.

The Flexi Multiradio BTS supports the following performance counters per cell:

- MIMO mode distribution
- Total number of MIMO mode switches

31.4 System impacts

31.4.1 Dependencies between features

- LTE30 CQI adaptation
- LTE899 Antenna Line Supervision
- LTE69 Transmit Diversity for 2 Antennas required and
- LTE70 Downlink adaptive open loop MIMO required

31.5 LTE703 reference data

LTE703: DL adaptive closed loop MIMO for two antennas requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 127 LTE703 hardware and software requirements

	FDD	TDD
System release	RL20	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Support not required	Support not required
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTS2.0	Support not required
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE703: DL adaptive closed loop MIMO for two antennas* feature.

BTS faults and reported alarms

There are no faults related to the *LTE703: DL adaptive closed loop MIMO for two antennas* feature.

Measurements and counters

Table 128 New counters introduced by LTE703

Counter ID	Counter name	Measurement
M8010C 57	MIMO Closed Loop Single Codeword (MIMO_CL_1CW)	-
M8010C 58	MIMO Closed Loop Double Codeword (MIMO_CL_2CW)	-

For counter descriptions, see *LTE Radio Access Operating Documentation/Reference/Counters*.

Key performance indicators

There are no key performance indicators related to the *LTE703: DL adaptive closed loop MIMO for two antennas* feature.

Parameters

Table 129 New parameters introduced by LTE703

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Downlink MIMO Mode	dlMimoMode	LNCEL_FDD/LNCEL_TDD	-	common
CQI threshold for fallback to CL MIMO 1 CW mode	mimoClCqiThD	LNCEL_FDD/LNCEL_TDD	-	common
CQI threshold for activation of CL MIMO 2 CW mode	mimoClCqiThU	LNCEL_FDD/LNCEL_TDD	-	common
Rank threshold for fallback to CL MIMO 1 CW mode	mimoClRiThD	LNCEL_FDD/LNCEL_TDD	-	common
Rank threshold for activation of CL MIMO 2 CW mode	mimoClRiThU	LNCEL_FDD/LNCEL_TDD	-	common

For parameters descriptions, see *LTE Radio Access Operating Documentation/Reference/Parameters*.

Sales information

Table 130 LTE703 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

31.6 Activating the LTE703: DL adaptive closed loop MIMO for two antennas using BTS Site Manager

Purpose

Follow this procedure to activate the LTE703: DL adaptive closed loop MIMO for two antennas feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

You do not need to restart the eNB after the activation of this feature.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View** ▶ **Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

The feature related settings are found in the set of pages which can be selected from the top right of the BTSSM screen. It is recommended to read carefully the pages that contain the full eNB configuration information.

The configuration elements related to the **LTE703** feature are found on page 17: ”Cell resources”:

- Set the parameter `MIMO type` from drop-down list to **Closed Loop Mimo**.

Note: Note that in order to see parameter `MIMO type,` two TX/RX antennas have to be selected for a local cell. This parameter automatically changes the value of `Downlink MIMO Mode` (`dlMimoMode`) to **Closed Loop Mimo**. The parameter `Downlink MIMO Mode` can be found on page 27: “Radio network configuration”.

- The additional parameters which are used to configure tresholds are:
  - `CQI threshold for fallback to CL MIMO 1 CW mode` (`mimoClCqiThD`) - CQI Threshold for fallback to closed loop MIMO single codeword transmission (in CQI).

- `CQI threshold for activation of CL MIMO 2 CW mode` (`mimoClCqiThU`) - CQI Threshold for activation of closed loop MIMO dual codeword transmission (in CQI).
- `Rank threshold for fallback to CL MIMO 1 CW mode` (`mimoClRiThD`) - Rank Threshold for fallback to closed loop MIMO single codeword transmission.
- `Rank threshold for activation of CL MIMO 2 CW mode` (`mimoClRiThU`) - Rank Threshold for activation of closed loop MIMO dual codeword transmission.

They are located on page 27: “Radio Network Configuration” in LNCEL MOC (*Managed Object Class*).

Note: In release LTE17 onwards, due to change in MO architecture, they are alocated in **LNCEL_FDD** for FDD or**LNCEL_TDD** for TDD object .

For more details see *Parameters for the LTE703: DL adaptive closed loop MIMO for two antennas*.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send Parameters**.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After a successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

Note: Please note that the modification of `Downlink MIMO Mode` (`dlMimoMode`) parameter causes the cell delete and setup, and all ongoing connections are dropped.

Expected outcome

Activation of *LTE703 DL adaptive closed loop MIMO for two antennas* allows to dynamically switch between a transmission with single code word and a transmission with double code word, both within transmission mode 4.

31.7 Deactivating the LTE703: DL adaptive closed loop MIMO for two antennas using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE703: DL adaptive closed loop MIMO for two antennas feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or remotely.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View** ▶ **Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Go to the set of pages at the top right of the BTSSM screen to find the feature-related settings. It is recommended to read carefully the pages that contain the full eNB configuration information.

The configuration elements related to the **LTE703** feature are found on page 17: ”Cell resources”:

- Set the parameter `MIMO type` from drop-down list to any other value than **Closed Loop Mimo**.

Note: This parameter automatically changes the parameter `Downlink MIMO Mode` (`dlMimoMode`) to the same value as `MIMO type`. The parameter `Downlink MIMO Mode` can be found on page 27: “Radio network configuration”.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

Note: Please note that the modification of `Downlink MIMO Mode` (`dlMimoMode`) parameter causes the cell delete and setup, and all ongoing connections are dropped.

32 LTE747: Support of UE radio capabilities

32.1 Introduction to feature

LTE747: Support of UE radio capabilities feature introduces the basic function needed to take into account the UE radio capabilities in individual RRM procedures.

32.2 Benefits

The feature make it possible to take into account the UE radio capabilities in individual RRM procedures.

32.3 Functional description

The eNB retrieves the UE radio access capability parameters from one of the following sources:

- the S1AP initial setup request message
- the RRC UE capability transfer procedure if it is not provided via S1AP
- the X2AP in the event of a handover

The UE radio access capability parameters are stored in the eNB and evaluated by individual RRM functions.

The UE radio access capability parameters include:

- Access stratum release
- UE category
- PDCP parameters
- Physical layer parameter
- RF parameter
- Measurement parameter
- Feature group indicator
- Inter RAT-parameters

The eNB sends the UE radio access capability parameters to:

- the MME if the UE radio capabilities have been retrieved via RRC
- the neighbor LBs or eNBs in the event of a handover

32.4 System impact

The feature has no additional impacts on the system.

32.5 LTE747 reference data

Requirements

Table 131 LTE747 hardware and software requirements

	FDD	TDD
System release	RL10	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	RL50FZ	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10 CD2	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE747: Support of UE radio capabilities* feature.

BTS faults and reported alarms

There are no faults related to the *LTE747: Support of UE radio capabilities* feature.

Commands

There are no commands related to the *LTE747: Support of UE radio capabilities* feature.

Measurements and counters

There are no measurements or counters related to the *LTE747: Support of UE radio capabilities* feature.

Key performance indicators

There are no key performance indicators related to the *LTE747: Support of UE radio capabilities* feature.

Parameters

There are no parameters related to the *LTE747: Support of UE radio capabilities* feature.

Sales information

Table 132 LTE747 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

33 LTE749: Link Adaptation for PDCCH

33.1 Introduction to the feature

The code rate and the control channel element (CCE) aggregation level respectively are adapted based on wideband CQI reports.

33.2 Benefits

This feature allows efficient usage of PDCCH resources.

33.3 Functional description

33.3.1 Functional details

FDD solution

Code rates and CCE aggregation

The PDCCH code rate is expressed as net-to-gross ratio where net is the data rate of control data and gross is the overall data rate, that is the rate for control data plus error protection overhead. Alternatively, the code rate can be described in terms of control channel elements (CCEs) since the PDCCH resources are organized in CCE units. A CCE consists of a set of nine resource element groups (REGs) each of which comprises of four QPSK symbols for control data. Thus, one CCE comprises of 36 QPSK symbols (background remark: REGs are the data units used for the interleaving mechanism on PDCCH). The more CCEs are aggregated for a particular PDCCH, the more bits are available for error protection and the lower is the code rate. LTE provides four PDCCH formats related to the number of CCEs used and the code rate respectively, see Table 133: Code rates for PDCCH.

The number of CCEs, in other words the CCE aggregation level, used for transmission of a particular PDCCH is determined by the eNB in a way providing an optimal trade-off between the optimum usage of the available PDCCH space, low hash blocking probability and the reliability of PDCCH transmissions.

Table 133 Code rates for PDCCH

PDCCH format	Code rate	Number of CCEs	Number of bits
0	2/3	1	72
1	1/3	2	144
2	1/6	4	288

Table 133 Code rates for PDCCH (Cont.)

PDCCH format	Code rate	Number of CCEs	Number of bits
3	1/12	8	576

Power adjustment

Link adaptation on PDCCH provides a power control component. If enabled, the following power adjustments are performed:

1. The power on PDCCH is decreased in an appropriate way for all UEs with an assigned CCE aggregation level greater or equal to the calculated one. The power change aims at a target of 1% BLER.
2. The power on PDCCH is increased in an appropriate way for all UEs with an assigned CCE aggregation level lower than the calculated one. The power change aims at a target of 1% BLER.
3. The power on unused CCEs is re-distributed in equal shares onto all scheduled CCEs.

PDCCH scheduling

The mechanisms described above are accompanied by an improved PDCCH scheduling; for example, improved merging of DL and UL messages/users, or a possibility to assign a lower aggregation level than determined via CQI evaluation in order to keep PDCCH blocking very low. The operator can also define how much of the dedicated PDCCH capacity for dynamic uplink and downlink scheduling is really used (for example, setting the related parameter `pdcchAlpha` to 0.8 means 80% of the dedicated PDCCH capacity for users/messages used for dynamic scheduling information; common PDCCH capacity is not concerned), and the operator can define the balance between uplink and downlink PDCCH resource utilization (for example, setting the related parameter `pdcchUlDlBal` to 0.5 means that dynamic uplink and downlink scheduling information get equal PDCCH resource spaces). The PDCCH consists of a common search area and a UE-specific search area, which is defined by a hashing function, and is constant regardless of `pdcchAlpha` or `pdcchUlDlBal`.

TDD solution

Usage based PDCCH adaptation

The eNB automatically adapts the number of OFDM symbols used for PDCCH based on CCE blocking, used CCEs and TDD frame configuration. When the SINR is high, one OFDM PDCCH symbol saving leads to 1/11 = 9% PDSCH capacity gain. Thanks to usage-based PDCCH adaptation in case of low cell load, the user experiences 18% gain for downlink throughput (13 instead of 11 OFDM symbols for PDSCH). For more information, see *LTE939: Usage Based PDCCH Adaptation*.

Code rates and CCE aggregation

The PDCCH code rate is expressed as net-to-gross ratio where net is the data rate of control data and gross is the overall data rate, that is the rate for control data plus error protection overhead. Alternatively, the code rate can be described in terms of CCEs (control channel elements) since the PDCCH resources are organized in CCE units. A CCE consists of a set of 9 resource element groups (REGs) each of which comprises 4

QPSK symbols for control data; thus one CCE comprises 36 QPSK symbols (background remark: REGs are the data units used for the interleaving mechanism on PDCCH). The more CCEs are aggregated for a particular PDCCH, the more bits are available for error protection and the lower is the code rate. LTE provides four PDCCH formats related to the number of CCEs used and the code rate respectively, see Table 134: Code rates for PDCCH.

The number of CCEs, in other words the CCE aggregation level, used for transmission of a particular PDCCH is determined by the eNB in a way providing an optimal trade-off between the optimum usage of the available PDCCH space, low hash blocking probability and the reliability of PDCCH transmissions.

Table 134 Code rates for PDCCH

PDCCH format	Code rate	Number of CCEs	Number of bits
0	2/3	1	72
1	1/3	2	144
2	1/6	4	288
3	1/12	8	576

Power adjustment

Link adaptation on PDCCH provides a power control component. If enabled, the following power adjustments are performed:

1. The power on PDCCH is decreased in an appropriate way for all UEs with an assigned CCE aggregation level greater or equal to the calculated one. The power change aims at a target of 1% BLER.
2. The power on PDCCH is increased in an appropriate way for all UEs with an assigned CCE aggregation level lower than the calculated one. The power change aims at a target of 1% BLER.
3. The power on unused CCEs is re-distributed in equal shares onto all scheduled CCEs.

PDCCH scheduling

The mechanisms described above are accompanied by an improved PDCCH scheduling; for example, improved merging of DL and UL messages/users, or a possibility to assign a lower aggregation level than determined via CQI evaluation in order to keep PDCCH blocking very low. The operator can also define how much of the dedicated PDCCH capacity for dynamic uplink and downlink scheduling is really used (for example, setting the related parameter `pdcchAlpha` to 0.8 means 80% of the dedicated PDCCH capacity for users/messages used for dynamic scheduling information; common PDCCH capacity is not concerned), and the operator can define the balance between uplink and downlink PDCCH resource utilization (for example, setting the related parameter `pdcchUlDlBal` to 0.5 means that dynamic uplink and downlink scheduling information get equal PDCCH resource spaces). The PDCCH consists of a common search area and a UE-specific search area, which is defined by a hashing function, and is constant regardless of `pdcchAlpha` or `pdcchUlDlBal`.

33.4 System impacts

33.4.1 Interdependencies between features

There are no interdependencies between this and any other feature.

33.5 LTE749 reference data

Requirements

Table 135 LTE749 hardware and software requirements

	FDD	TDD
System release	RL10	RL15TD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	3GPP R8 mandatory	3GPP R8 mandatory

Alarms

There are no alarms related to the *LTE749: Link Adaptation for PDCCH* feature.

BTS faults and reported alarms

There are no faults related to the *LTE749: Link Adaptation for PDCCH* feature.

Commands

There are no commands related to the *LTE749: Link Adaptation for PDCCH* feature.

Measurements and counters

There are no measurements or counters related to the *LTE749: Link Adaptation for PDCCH* feature.

Key performance indicators

There are no key performance indicators related to the *LTE749: Link Adaptation for PDCCH* feature.

Parameters

Table 136 New parameters introduced by LTE749

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Enable AMC for PDCCH Link Adaptation	enableAmcPdcch	LNCEL	-	common
Enable lower aggregation selection for PDCCH LA	enableLowAgg	LNCEL	-	common
Enable PDCCH power control	enablePcPdcch	LNCEL	-	common
PDCCH LA UE default aggregation	pdcchAggDefUe	LNCEL	-	common
PDCCH aggregation for RA Msg4	pdcchAggMsg4	LNCEL	-	common
PDCCH allocation limit	pdcchAlpha	LNCEL	-	common
PDCCH LA CQI shift	pdcchCqiShift	LNCEL	-	common
PDCCH LA UL DL allocation balance initial value	pdcchUlDlBal	LNCEL	-	common

For parameter descriptions, see LTE Operating Documentation/ Reference/ Parameters.

Sales information

Table 137 LTE749 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

34 LTE761: Advanced target cell selection and handover retry for intra frequency handover

34.1 Introduction to the feature

The target cell list is a sorted list of potential target cells for the handover. The eNodeB begins with the first entry of the list indicating the highest priority. With “Advanced target cell selection” , the serving eNodeB checks for all handover variants that the highest priority cell is not contained in a blacklist. If the target cell is in a blacklist the eNodeB proceeds to the next target cell of the list.

If an frequency handover attempt fails, a handover retry is performed: The eNodeB retries a handover with the next target cell of the list (including the checks according to “Advanced target cell selection”).

34.2 Benefits

Advanced target cell selection and handover retry increase the handover success rate.

34.3 Functional description

Advanced Target Cell Handling

The eNodeB prepares the target cell list received from the UE by excluding cells which are not suitable and performing a re-sorting of the list if necessary. If a handover attempt with the best suited of the remaining target cells fails, the next best entry of the prepared target cell list is selected and the handover is retried with this new target cell.

For the FDD solution, the list of conditions depends on whether the feature LTE54 is supported. Cells are removed from the target cell list for the following reasons:

- The cell is unknown to the source eNB, for example it was not possible to allocate the ECGI
- Neither the UEs Serving PLMN-ID nor one of the Equivalent PLMNs listed in the Handover Restriction List is supported in the target cell
- The target cell is an inter eNB target cell and is blacklisted by Operatorer.). In the scope of this check the target cell is only considered as blacklisted when child parameter "Blacklisted Topologies" has value "all".
- The target cell is an intra eNodeB target cell and is blacklisted by Operator. In the scope of this check the intra eNodeB target cell is only considered as blacklisted as soon as it is contained in the structure "blacklistHoL" without evaluating child parameter "Blacklisted Topologies".
- The combination of PLMN-Idendity and TAC of the target cell is contained in the Handover Restriction List provided by MME (or during a previous incoming HO)
- The Target Cell is an intra eNodeB target and the target cell is barred. For example, the 'cellBarred' parameter in SIB1 is set to 'barred'

For the FDD solution, if the S1 based handover is not activated, a LTE cell is from the TCL list if at least one of the conditions listed below are met:

- The cell is unknown to Source eNodeB, for example it was not possible to allocate the ECGI
- X2 connection to the Target eNodeB is not available / operable
- Neither the UEs Serving PLMN-ID nor one of the Equivalent PLMNs listed in the Handover Restriction List is supported in the target cell.
- The check of the S1 Connectivity of the Target eNodeB according to has failed
- The target cell is blacklisted by Operator
- The combination of PLMN-Idendity and TAC of the target cell is contained in the Handover Restriction List provided by MME
- The Target Cell is an intra eNodeB target and the target cell is barred. E.g. the 'cellBarred' parameter in SIB1 is set to 'barred'

For the TDD solution, advanced target cell selection and handover retry increase the handover success rate.

For the TDD solution, cells are removed from the target cell list for the following reasons:

- The cell is unknown to the serving eNodeB
- The cell is listed on the operator-configurable blacklist
- Missing X2 connectivity of the target eNodeB: Target cells of an eNodeB without X2 connection to the serving eNodeB are excluded
- Missing S1 connectivity of the target eNodeB: Target cells of an eNodeB without S1 connectivity to the serving MME and serving S-GW are excluded

Re-sorting is done in case intra-eNodeB handovers have been configured to be prioritized over inter-eNodeB handovers and has the result that the target cells of the serving eNodeB are on the top of the target cell list (in other cases the sorting of the target cell list might be obsolete as it is already done by the UE).

34.4 System impact

The feature has no additional impacts on the system.

34.5 LTE761 reference data

> *LTE761: Advanced target cell selection and handover retry for intra frequency handover requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information*

Requirements

Table 138 LTE761 hardware and software requirements

	FDD	TDD
System release	RL10	RL15

Table 138 LTE761 hardware and software requirements (Cont.)

	FDD	TDD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	Not supported	Not supported

Alarms

There are no alarms related to the *LTE761: Advanced target cell selection and handover retry for intra frequency handover* feature.

Measurements and counters

Table 139 New counters introduced by LTE761 for the TDD solution

Counter ID	Counter name	Measurement
`M8006C14`	`PeNB initiated E-RAB releases due to failed Handover Completion phase at target cell`	LTE EPS Bearer
`M8006C15`	`Released E-RABs initiated by the eNB due to RedirectP`	LTE EPS Bearer
`M8007C13`	`Radio Bearer Release requests including redirect information`	LTE EPS Bearer

For counter descriptions, see *LTE Operating Documentation/ Reference/ Counters and Key Performance Indicators*.

There are no measurements or counters related to the *LTE761: Advanced target cell selection and handover retry for intra frequency handover* feature for the FDD solution.

Key performance indicators

There are no key performance indicators related to the *LTE761: Advanced target cell selection and handover retry for intra frequency handover* feature.

Parameters

Table 140 New parameters introduced by LTE761 for the TDD solution

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Enable UE context release with redirect	actRedirect	LNBTS	-	common
Intra ENodeB Priorisation	intraEnbPrio	LNCEL	-	-
Time To Trigger For A2 To Start Redirect Procedure	a2TimeToTriggerRedirect	LNCEL	-	common
Redirection target configuration identifier	redrtId	REDRT	-	common

For parameter descriptions, see *LTE Operating Documentation/ Reference/ Parameters*.

There are no parameters related to the *LTE761: Advanced target cell selection and handover retry for intra frequency handover* feature for the FDD solution.

Sales information

Table 141 LTE761 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

35 LTE762: Idle mode mobility from LTE to WCDMA, GSM or other LTE bands

35.1 Introduction to the feature

This feature enables cell re-selection from LTE to WCDMA, GSM and other LTE networks.

35.2 Benefits

Idle mode mobility for inter frequency and IRAT scenarios is possible.

35.3 Functional description

This feature enables cell re-selection from LTE to WCDMA, GSM and other LTE networks. Information required for the re-selection is broadcasted in system information blocks SIB5, SIB6, and SIB7 as described in the following:

- SIB 5:
  The SIB5 contains information about other E-UTRA frequencies and inter-frequencyneighbouring cells relevant for cell re-selection.
- SIB 6:
  The SIB6 contains information about UTRAN frequencies and UTRAN neighboring cells relevant for cell re-selection.
- SIB 7:
  The SIB7 contains information about GERAN frequencies and GERAN neighboring cells relevant for cell re-selection.

Additionally, the notification of changes in the system information is supported for **RRC idle** and **RRC connected.**

From release LTE16 onwards, it is possible to configure idle mode mobility to WCDMA in a 1,4-MHz and 3-MHz cell. The following rules define how many WCDMA or GERAN neighbor frequencies may be configured in SIB6 and SIB7 for a 1,4-MHz cell:

- if `Maximum code rate for SIB` (`maxCrSibDl`) is equal or higher than 0.40, the max allowed number of UTRAN carrier frequencies is 6, and the allowed number of GNFL instances is limited to 3
- if `Maximum code rate for SIB` (`maxCrSibDl`) is equal or higher than 0.26 but lower than 0.40, the max allowed number of UTRAN carrier frequencies is 3, and the allowed number of GNFL instances is limited to 2
- if `Maximum code rate for SIB` (`maxCrSibDl`) is equal or higher than 0.19 but lower than 0.26, the max allowed number of UTRAN carrier frequencies is 2
- if `Maximum code rate for SIB` (`maxCrSibDl`) is lower than 0.26, the allowed number of GNFL instances is limited to 1

- if `Maximum code rate for SIB` (`maxCrSibDl`) is lower than 0.19, the max allowed number of UTRAN carrier frequencies is 1

The following rules define how many WCDMA neighbor frequencies may be configured in SIB6 for a 3-MHz cell:

- if `Maximum code rate for SIB` (`maxCrSibDl`) is equal or higher than 0.40, the max allowed number of UTRAN carrier frequencies is 15
- if `Maximum code rate for SIB` (`maxCrSibDl`) is equal or higher than 0.26 but lower than 0.40, the max allowed number of UTRAN carrier frequencies is 9
- if `Maximum code rate for SIB` (`maxCrSibDl`) is equal or higher than 0.19 but lower than 0.26, the max allowed number of UTRAN carrier frequencies is 6
- if `Maximum code rate for SIB` (`maxCrSibDl`) is equal or higher than 0.12 but lower than 0.19, the max allowed number of UTRAN carrier frequencies is 3
- if `Maximum code rate for SIB` (`maxCrSibDl`) is lower than 0.12, the max allowed number of UTRAN carrier frequencies is 1

35.4 System impact

The feature has no additional impacts on the system.

35.5 LTE762 reference data

Requirements

Table 142 LTE762 hardware and software requirements

	FDD	TDD
System release	RL10	RL15TD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Flexi Zone Controller	FL15A	TL15A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	NS10	NS10
SAE GW	NG10 CD2	NG10 CD2
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE762: Idle mode mobility from LTE to WCDMA, GSM or other LTE bands* feature.

BTS faults and reported alarms

There are no faults related to the *LTE762: Idle mode mobility from LTE to WCDMA, GSM or other LTE bands* feature.

Commands

There are no commands related to the *LTE762: Idle mode mobility from LTE to WCDMA, GSM or other LTE bands* feature.

Measurements and counters

There are no measurements or counters related to the *LTE762: Idle mode mobility from LTE to WCDMA, GSM or other LTE bands* feature.

Key performance indicators

There are no key performance indicators related to the *LTE762: Idle mode mobility from LTE to WCDMA, GSM or other LTE bands* feature.

Parameters

Table 143 Existing parameters related to LTE762

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
CDMA2000 frequency idle mode configuration identifier	cdfimId	CDFIM	-	common
GERAN frequency idle mode configuration identifier	gfimId	GFIM	-	common
GERAN cell reselection timer	tResGer	GFIM	-	common
Speed-dependent scaling factors t-reselection GERAN	tResGerSF	GFIM	-	common
GERAN cell reselection timer factor high mobility	gerResTiFHM	GFIM	tResGerSF	common
GERAN cell reselection timer factor medium mobility	gerResTiFMM	GFIM	tResGerSF	common
GERAN frequency band indicator	bandInd	GNFL	-	common
GERAN RAT carrier frequency absolute priority	gCelResPrio	GNFL	-	common
ARFCN value list	gerArfcnVal	GNFL	-	common

Table 143 Existing parameters related to LTE762 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
GERAN inter-frequency threshold high	gerFrqThrH	GNFL	-	common
GERAN inter-frequency threshold low	gerFrqThrL	GNFL	-	common
GERAN neighbour frequency configuration identifier	gnflId	GNFL	-	common
NCC permitted bitmap	nccperm	GNFL	-	common
GERAN maximum allowed transmit power	pMaxGer	GNFL	-	common
GERAN minimum required receive level	qRxLevMinGer	GNFL	-	common
EUTRA frequency value	dlCarFrqEut	IRFIM	-	common
EUTRA carrier frequency absolute priority	eutCelResPrio	IRFIM	-	common
Inter-frequency blacklisted cell list	intFrBCList	IRFIM	-	common
Number of PCI in inter-frequency range	rangeInterPci	IRFIM	intFrBCList	common
Lowest PCI in inter-frequency range	startInterPci	IRFIM	intFrBCList	common
Inter-Frequency neighbouring cell list	intFrNCList	IRFIM	-	common
Physical cell identifier in neighbouring cell list	physCellIdNcl	IRFIM	intFrNCList	common
Cell reselection procedure offset	qOffCell	IRFIM	intFrNCList	common
EUTRA inter frequency threshold high	interFrqThrH	IRFIM	-	common
EUTRA inter frequency threshold low	interFrqThrL	IRFIM	-	common

Table 143 Existing parameters related to LTE762 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
EUTRA presence antenna port1	interPresAntP	IRFIM	-	common
EUTRA cell reselection timer	interTResEut	IRFIM	-	common
IRFIM identifier	irfimId	IRFIM	-	common
Allowed measurement bandwidth	measBdw	IRFIM	-	common
Pmax neighbouring EUTRA cells	pMaxInterF	IRFIM	-	common
EUTRA frequency specific offset	qOffFrq	IRFIM	-	common
Minimum required rx RSRP level	qRxLevMinInterF	IRFIM	-	common
Speed-dependent scaling factors t-reselection EUTRAN	tResEutSF	IRFIM	-	common
EUTRA cell reselection timer factor high mobility	eutResTiFHM	IRFIM	tResEutSF	common
EUTRA cell reselection timer factor medium mobility	eutResTiFMM	IRFIM	tResEutSF	common
UTRA cell reselection timer	tResUtra	UFFIM	-	common
Speed-dependent scaling factors t-reselection UTRAN	tResUtraSF	UFFIM	-	common
UTRA cell reselection timer factor high mobility	utrResTiFHM	UFFIM	tResUtraSF	common
UTRA cell reselection timer factor medium mobility	utrResTiFMM	UFFIM	tResUtraSF	common
Utran FDD idle mode configuration identifier	uffimId	UFFIM	-	common
UTRA carrier frequencies list	utrFddCarFrqL	UFFIM	-	common
UTRA downlink frequency value	dlCarFrqUtra	UFFIM	utrFddCarFrqL	common
UTRA maximum allowed transmit power	pMaxUtra	UFFIM	utrFddCarFrqL	common

Table 143 Existing parameters related to LTE762 (Cont.)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
UTRA minumum needed quality parameter	qQualMinUtra	UFFIM	utrFddCarFrqL	common
UTRA minimum required receive level	qRxLevMinUtra	UFFIM	utrFddCarFrqL	common
UTRA carrier frequency absolute priority	uCelResPrio	UFFIM	utrFddCarFrqL	common
UTRA inter frequency threshold high	utraFrqThrH	UFFIM	utrFddCarFrqL	common
UTRA inter frequency threshold low	utraFrqThrL	UFFIM	utrFddCarFrqL	common

For parameter descriptions, see *LTE Radio Access Operating Documentation/Reference/Parameters*.

Sales information

Table 144 LTE762 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	No

35.6 Activating the LTE762: Idle Mode Mobility from LTE to WCDMA, GSM or other LTE bands

Purpose

Follow this procedure to activate the LTE762: Idle Mode Mobility from LTE to WCDMA, GSM or other LTE bands feature.

The activation does not require a license, but for the feature to function, the SIB parameters which define what information is broadcasted to the UE for cell re-selection have to be configured in the eNB.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to *BTS Site Manager Online Help*.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Navigate to **View ► Commissioning**, and under **Commissioning Type** select option **Reconfiguration**, and then click **Next.**

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of pages which can be selected from the **NEXT** button at the bottom of the BTSSM screen.

It is recommended to walk through the pages that contain the full eNB configuration information. Move to page **Radio network configuation**.

a) Right-mouse click on object LNCEL to create an IRFIM object with the following SIB5 parameters for information about E-UTRA frequencies and neighboring cells:

- `dlCarFrqEut`
- `qRxLevMinInterF`
- `interFrqThrH`
- `interFrqTrhL`
- `tResEutSF`
- `measBdw`
- `interPresAntP`
- `qOffFrq`
- `pMaxInterF`
- `interTResEut`
- `eutResTiFMM`
- `eutResTiFHM`
- `eutCelResPrio`
- `intFrNCList`
- `physCellIdNcl`
- `qOffCell`
- `intFrBCList`
- `startInterPci`
- `rangeInterPci`

b) Right-mouse click on object LNCEL to create an UFFIM object with the following SIB6 parameters for information about UTRA frequencies and neighboring cells:

- `utrFddCarFrqL`
- `dlCarFrqUtra`
- `uCelResPrio`
- `utraFrqThrH`
- `utraFrqThrL`
- `qRxLevMinUtra`
- `pMaxUtra`
- `qQualMinUtra`
- `utrTddCarFrqL`
- `tResUtra`
- `tResUtraSF`
- `utrResTiFMM`
- `utrResTiFHM`

c) Right-mouse click on object LNCEL to create a GFIM object with the following SIB7 parameters for information about GERAN frequencies and neighboring cells:

- `tResGer`
- `tResGerSF`
- `gerResTiFMM`
- `gerResTiFHM`
- `gCelResPrio`
- `nccperm`
- `qRxLevMinGer`
- `pMaxGer`
- `gerFrqThrH`
- `gerFrqThrL`
- `bandInd`
- `gerAfrcnVal`

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

Expected outcome

The feature is activated and SIB5, SIB6, and SIB7 information is broadcasted immediately.

35.7 Deactivating the LTE762: Idle Mode Mobility from LTE to WCDMA, GSM or other LTE bands

Purpose

Follow this procedure to deactivate the LTE762: Idle Mode Mobility from LTE to WCDMA, GSM or other LTE bands feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to *BTS Site Manager Online Help*.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View** ► **Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

There is no deactivation parameter for this feature. To take the feature out of use, either remove the parameter settings with which the feature was activated or the related SI messages from the scheduling list in SIB1.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 After successful transmission of the parameters, the new configuration is automatically activated.

BTSSM automatically sends an activation command after finishing the file download.

Expected outcome

SIB5, SIB6, and SIB7 information is not broadcasted to UEs in RRC-IDLE or RRC-CONNECTED mode.

36 LTE767: Support of Aperiodic CQI Reports

CQI reports are the basis for the downlink link adaptation. CQI is an indicator of the current channel conditions which the UE sees. The UE can be ordered to send CQI reports periodically or aperiodically. The periodic CQI report is usually carried on physical uplink control channel (PUCCH). Aperiodic CQI reports always use PUSCH.

36.1 Benefits

This feature allows efficient usage of PUCCH resource as periodic reporting needs to be done less frequently. Aperiodic Reports on PUSCH allows frequent submission of more detailed reports that is including frequency selective parts, MIMO, and so on.

36.2 Functional description

36.2.1 Functional details

The aperiodic CQI reports are transmitted from the UE to the eNB on PUSCH, together with uplink data or alone. A UE can be configured to have both periodic and aperiodic reporting at the same time. In case both periodic and aperiodic reporting occur in the same subframe, only the aperiodic report is transmitted in that subframe. When a CQI report is transmitted together with uplink data on PUSCH, it is multiplexed with the transport block by layer 1 mechanisms. The eNB schedules the aperiodic CQI report through setting a CQI request bit in an uplink resource grant sent on PDCCH.

For more information about aperiodic CQI reports, see 3GPP 36.213 in section 7.2.1.

Table 145 CQI report modes for aperiodic reporting

CQI report group	No PMI	Single PMI	Multiple PMI
Wideband	–	–	mode 1-2 (only with closed loop MIMO SM)
UE selected	mode 2-0	–	mode 2-2 (only with closed loop MIMO SM)
Higher layer configured	mode 3-0	mode 3-1 (only with closed loop MIMO SM)	–

36.3 System impacts

36.3.1 Interdependencies between features

There are no interdependencies between this and any other feature.

36.4 LTE767 reference data

LTE767: Support of Aperiodic CQI Reports requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 146 LTE767 hardware and software requirements

	FDD	TDD
System release	RL10	RL15TD
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	3GPP R8	3GPP R8

Alarms

There are no alarms related to the *LTE767: Support of Aperiodic CQI Reports* feature.

BTS faults and reported alarms

There are no faults related to the *LTE767: Support of Aperiodic CQI Reports* feature.

Commands

There are no commands related to the *LTE767: Support of Aperiodic CQI Reports* feature.

Measurements and counters

There are no measurements or counters related to the *LTE767: Support of Aperiodic CQI Reports* feature.

Key performance indicators

There are no key performance indicators related to the *LTE767: Support of Aperiodic CQI Reports* feature.

Parameters

Table 147 New parameters introduced by LTE767

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
`Rank Indication Reporting Enable`	`riEnable`	MPUCCH_FDD	-	FDD
		MPUCCH_TDD	-	TDD

For parameter descriptions, see *LTE Radio Access Operating Documentation/Reference/Parameters*.

Sales information

Table 148 LTE767 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

37 LTE819: DL Inter-cell Interference Generation

37.1 Introduction To The Feature

With the downlink interference generation feature, it can be ensured that downlink load of neighbor cells is at least on a pre-defined level. By configuring a minimum downlink cell load, the operator is able to test (intra-frequency) interference caused by neighbor cells to the serving cell. The downlink inter-cell interference generator allows running the test without test UEs: the Flexi BTS sends dummy data to non existing UEs in order to generate downlink inter-cell interference.

37.2 Benefits

The operator can perform downlink inter-cell interference related tests in the field without test UEs.

37.3 Functional Description

The Flexi Multiradio BTS transmits PDSCH dummy data (a pseudo random bit sequence) on resource elements not allocated by the downlink scheduler, which are only added if not enough resource elements are allocated to normal users. The dummy data are sent on all configured antennas, e.g. single or two antennas, and their power spectral density is the same as for the PDSCH. The operator configures the modulation scheme for the dummy data and the interference level, i.e. percentage of PDSCH resource elements used by the normal users and dummy data. The downlink scheduler is not limited by this setting and it can allocate data also above the interference level.

37.3.1 Feature Scope

The *LTE819: DL Inter-cell Interference Generation* is configured, activated, modified and deactivated either by the NetAct or locally by Network Element Manager. The eNB has at least one, and up to three LTE cells. The LTE cell a UE is connected to, is serving cell. Other cells are classified as neighbor cells. Because from the downlink inter-cell interference generation point of view the eNB does not see any difference between serving and neighbor cells, the *LTE819: DL Inter-cell Interference Generation* can be configured and activated to any eNB cell.

37.3.2 User Scenarios

Operator can activate and deactivate downlink inter-cell interference generation using a management tool, which is either NetAct or Network Element Manager. The feature can be:

- activated either at the eNB startup, or online in case a cell is already configured

- deactivated by setting the management parameter `dlInterferenceEnable` to **False**

Operator can also modify the *LTE819: DL Inter-cell Interference Generation* online.

37.4 System Impacts

37.4.1 Dependencies Between Features

There are interdepedencies between the following features:

- LTE793 Support of 16 QAM in Downlink. Modulation scheme 16 QAM cannot be used for downlink interference generation unless LTE793 has been enabled and valid license is available.
- LTE43 Support of 64 QAM in Downlink. Modulation scheme 64 QAM cannot be used for downlink interference generation unless both of the features, LTE793 and LTE43 have been enabled and valid license is available.

37.4.2 Impacts on Network and Network Element Management tools

The Downlink inter-cell Interference generation affects only air interface (Uu). Managing (enabling/disabling) the feature does not introduce new functionalities between NetAct/Network Element Manager and the eNB.

37.4.3 Impacts on System Performance and Capacity

37.4.3.1 System Performance

The downlink inter-cell interference generation may affect neighbor cells performance, the feature is actually implemented for that. The exact effect to neighbor cells cannot be described precisely, as it depends, for example, on radio network topology.

37.4.3.2 System Capacity

The downlink inter-cell interference generation does not affect the serving cell capacity, as interference is not added if all PDSCH PRBs are used for data transmission.

37.5 LTE819 reference data

Requirements

Table 149 LTE819 hardware and software requirements

	FDD	TDD
System release	RL20	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	Not supported	Not supported

Note: This feature requires Flexi System modules which support LTE.

Alarms

There are no alarms related to the *LTE819: Downlink Inter-cell Interference Generation* feature.

BTS faults and reported alarms

There are no faults related to the *LTE819: Downlink Inter-cell Interference Generation* feature.

Commands

There are no commands related to the *LTE819: Downlink Inter-cell Interference Generation* feature.

Measurements and counters

There are no measurements or counters related to the *LTE819: Downlink Inter-cell Interference Generation* feature.

Key performance indicators

There are no key performance indicators related to the *LTE819: Downlink Inter-cell Interference Generation* feature.

Parameters

Table 150 New parameters introduced by LTE819

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Enable Downlink Interference Generation	dlInterferenceEnable	LNCEL	-	common
Interference Level for Generated Downlink Interference	dlInterferenceLevel	LNCEL	-	common
Modulation Scheme for Downlink Interference	dlInterferenceModulation	LNCEL	-	common

For parameter descriptions, see LTE Operating Documentation/ Reference/ Parameters.

Sales information

Table 151 LTE819 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

37.6 Activating the LTE819: DL Inter-cell Interference Generation Feature Using BTS Site Manager

Purpose

Follow this procedure to activate the LTE819: DL Inter-cell Interference Generation feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter `dlInterferenceEnable` to **True**.

The related parameter `dlInterferenceLevel` has to be set to a nonzero value.

If the value of the related parameter `dlInterferenceModulation` is changed and the modulation scheme is not supported, an error message will appear on the screen.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

37.7 Deactivating the LTE819: DL Inter-cell Interference Generation Feature Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE819: DL Inter-cell Interference Generation feature.

Before you start

The eNB must be already commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote place.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

For details, refer to BTS Site Manager Online Help.

2 Upload the configuration plan file from the eNB.

When BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.

3 Modify the eNB configuration settings.

Set the parameter `dlInterferenceEnable` to **False**.

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Open the **Commissioning - Send parameters** page.

b) Click **Send**

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

38 LTE861: TDD DL/UL Switching 2DL:2UL

38.1 Introduction to the feature

The DL and UL channels share the same frequency band in TDD. Therefore, it must be switched between the DL and UL.

38.2 Benefits

This feature provides support for symmetric DL/UL dominated traffic.

38.3 Functional description

38.3.1 Functional details

In TDD, the DL and UL channels share the same frequency band. Therefore, it must be switched between the DL and UL. The *LTE861: TDD DL/UL Switching 2DL:2UL* feature supports DL/UL ratio for a 5 ms periodicity 2DL:2UL. This configuration provides support for symmetric DL/UL dominated traffic.

38.4 System impacts

38.4.1 Interdependencies between features

This feature is related to the *LTE892: TDD DwPTS, GP, and UpPTS with SF Configuration 5* feature.

38.5 LTE861 reference data

LTE861: TDD DL/UL Switching 2DL:2UL requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 152 LTE861 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15TD
Flexi Multiradio 10 BTS	Not supported	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A

Table 152 LTE861 hardware and software requirements (Cont.)

	FDD	TDD
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	Not supported	Not supported

Alarms

There are no alarms related to the *LTE861: TDD DL/UL Switching 2DL:2UL* feature.

BTS faults and reported alarms

There are no faults related to the *LTE861: TDD DL/UL Switching 2DL:2UL* feature.

Commands

There are no commands related to the *LTE861: TDD DL/UL Switching 2DL:2UL* feature.

Measurements and counters

There are no measurements or counters related to the *LTE861: TDD DL/UL Switching 2DL:2UL* feature.

Key performance indicators

There are no key performance indicators related to the *LTE861: TDD DL/UL Switching 2DL:2UL* feature.

Parameters

Table 153 New parameters introduced by LTE861

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
`TDD Subframe Configuration`	`tddFrameConf`	LNCEL	-	TDD
`TDD special subframe configuration`	`tddSpecSubfConf`	LNCEL_TDD	-	TDD

For parameter descriptions, see *LTE Radio Access Operating Documentation/Reference/Parameters*.

Sales information

Table 154 LTE861 sales information

Product structure class	License control	Activated by default
BSW	-	-

39 LTE862: TDD DwPTS, GP and UpPTS With SF Configuration 7

39.1 Introduction to the feature

This feature introduces the special subframe configuration 7 which allows reusing a part of the resources in a radio link subframe for the transmission of U-Plane and C-Plane data. This configuration can be used instead of the subframe configuration which is provided by the **LTE892: TDD DwPTS, GP and UpPTS with SF Configuration 5** feature.

39.2 Benefits

This feature offers higher efficiency of the radio link, by introducing a subframe configuration which reuses part of the resources for transmission of U-plane and C-plane data.

39.3 Functional description

The *LTE862: TDD DwPTS, GP and UpPTS with SF Configuration 7* feature provides a means to reuse a part of the radio-link subframe for transmission of uplink and downlink data.

With this configuration:

- the **PDSCH** can be allocated to **DwPTS**
- the short random access channel can be allocated in the UpPTS

Even with this re-allocation of a part of the resources, downlink control signaling is always present in the downlink pilot time-slot (DwPTS) similar to an ordinary downlink subframe, and downlink reference signals are always present in DwPTS.

The feature uses a special frame configuration with (**GP**:DL:UL) of 10:2:2, see Fig. 1.

The minimum duration of the Guard period (GP) is one **OFDM** symbol.

39.4 System impacts

This feature has no additional impacts on the system.

39.5 LTE862 reference data

Requirements

Table 155 LTE862 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15
Flexi Multiradio 10 BTS	Not supported	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Not supported	Support not required
NetAct	Not supported	Support not required
MME	Not supported	Support not required
SAE GW	Not supported	Support not required
UE	Not supported	3GPP release 8

Alarms

There are no alarms related to the *LTE862: TDD DwPTS, GP and UpPTS With SF Configuration 7* feature.

BTS faults and reported alarms

There are no faults related to the *LTE862: TDD DwPTS, GP and UpPTS With SF Configuration 7* feature.

Commands

There are no commands related to the *LTE862: TDD DwPTS, GP and UpPTS With SF Configuration 7* feature.

Measurements and counters

There are no measurements or counters related to the *LTE862: TDD DwPTS, GP and UpPTS With SF Configuration 7* feature.

Key performance indicators

There are no key performance indicators related to the *LTE862: TDD DwPTS, GP and UpPTS With SF Configuration 7* feature.

Parameters

The Parameters (for instance tddSpecSubfConf) of this feature are described in the *FAD: U-plane protocol stacks and SIB*.

Sales information

Table 156 LTE862 sales information

Product structure class	License control	Activated by default
Application software (ASW)	SW Asset Monitoring	No

39.6 Activating LTE862: TDD DwPTS, GP and UpPTS with Configuration 7

Purpose

Follow this procedure to activate the LTE862: TDD DwPTS, GP and UpPTS with configuration 7.

Before you start

The evolved NodeB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

See *Administering Flexi Multiradio BTS LTE* for details.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commisioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

Perform the following configuration settings to activate this feature:

- Change the Parameter **tddSpecSubfConf** to 7.

From the choice of this parameter value (only 5 and 7 are possible) some other parameters depend on. These are maxNumActUe and prachconfindex. (Look at step 5: further information)

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter tddSpecSubfConf a restart of the eNB is needed.

Further information

The parameter **prachconfindex** is restricted to values 3...7 or 51..53 if tddSpecSubfConf is set to '7' (ssp7). For cases where the UpPTS shall include two OFDMA symbols, prachConfIndex shall be set to 51...53.

The parameter **maxNumActUE** value depends on the setting of tddSpecSubfConf and chBw:

1. CHBw = 10 Mhz: maxNumActUE must be less or equal to 94.
2. CHBw = 20 Mhz: maxNumActUe must be less or equal to 112.

39.7 Deactivating LTE862: TDD DwPTS, GP and UpPTS with Configuration 7.

Purpose

Follow this procedure to deactivate the LTE862: TDD DwPTS, GP and UpPTS with Configuration 7 feature.

Before you start

The evolved NodeB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

See *Administering Flexi Multiradio BTS LTE* for details.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commisioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

Perform the following configuration settings to deactivate this feature:

- The parameter **tddSpecSubfConf** is set to 5.

From the choice of this parameter value (only 5 and 7 are possible) some other parameters depend on. These are maxNumActUe, prachconfindex and maxNumUeDlDwPTS. (Look at step 5 :further information)

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter tddSpecSubfConf a restart of the eNB is needed

Further information

The parameter **prachconfindex** is restricted to values 3...7, 23..25, 33..35 or 51..53 if tddSpecSubfConf is set to '5' (ssp5). For cases where the UpPTS shall include two OFDMA symbols, prachConfIndex shall be set to 51...53.

The parameter **maxNumActUE** value depends on the setting of tddSpecSubfConf and chBw:

1. CHBw = 10 Mhz: maxNumActUE must be less or equal to 80.
2. CHBw = 20 Mhz: maxNumActUe must be less or equal to 96.

The parameter **maxNumUeDlDwPTS** must be set to 0.

40 LTE892: TDD DwPTS, GP, and UpPTS with SF Configuration 5

40.1 Introduction to the feature

The *LTE892: TDD DwPTS, GP, and UpPTS with SF Configuration 5* feature introduces subframe configuration and resource reuse between the control plane and the user plane.

40.2 Benefits

This feature offers the customer with high efficiency.

40.3 Functional description

40.3.1 Functional details

DL control signaling are always present in the downlink pilot time-slot (DwPTS) which is similar to an ordinary DL subframe. DL reference signals are always present in the DwPTS.

The supported configuration of DwPTS, guard period (GP), and uplink pilot time-slot (UpPTS) is 3:9:2.

40.4 System impacts

40.4.1 Interdependencies between features

There are no interdependencies between this and any other feature.

40.5 LTE892 reference data

Requirements

Table 157 LTE892 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15
Flexi Multiradio 10 BTS	Not supported	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A

Table 157 LTE892 hardware and software requirements (Cont.)

	FDD	TDD
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Not supported	Support not required
NetAct	Not supported	Support not required
MME	Not supported	Support not required
SAE GW	Not supported	Support not required
UE	Not supported	Support not required

Alarms

There are no alarms related to the *LTE892: TDD DwPTS, GP, and UpPTS with SF Configuration 5* feature.

BTS faults and reported alarms

There are no faults related to the *LTE892: TDD DwPTS, GP, and UpPTS with SF Configuration 5* feature.

Commands

There are no commands related to the *LTE892: TDD DwPTS, GP, and UpPTS with SF Configuration 5* feature.

Measurements and counters

There are no measurements or counters related to the *LTE892: TDD DwPTS, GP, and UpPTS with SF Configuration 5* feature.

Key performance indicators

There are no key performance indicators related to the *LTE892: TDD DwPTS, GP, and UpPTS with SF Configuration 5* feature.

Parameters

There are no parameters related to the *LTE892: TDD DwPTS, GP, and UpPTS with SF Configuration 5* feature.

Sales information

Table 158 LTE892 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

41 LTE893: ACK/NACK Bundling

41.1 Introduction to the feature

One reverse link frame coordinates multiple forward link HARQ processes.

41.2 Benefits

The *LTE893: ACK/NACK Bundling* feature supports the asymmetric traffic character and saves the reverse link resources.

41.3 Functional description

41.3.1 Functional details

The positive acknowledgement (ACK) or negative acknowledgement (NACKs) are transmitted in a single UL subframe to acknowledge multiple DL subframes.

41.4 System impacts

41.4.1 Interdependencies between features

There are no interdependencies between this and any other feature.

41.5 LTE893 reference data

Requirements

Table 159 LTE893 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15
Flexi Multiradio 10 BTS	Not supported	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Not supported	Support not required

Table 159 LTE893 hardware and software requirements (Cont.)

	FDD	TDD
NetAct	Not supported	Support not required
MME	Not supported	Support not required
SAE GW	Not supported	Support not required
UE	Not supported	Support not required

Alarms

There are no alarms related to the *LTE893: ACK/NACK Bundling* feature.

BTS faults and reported alarms

There are no faults related to the *LTE893: ACK/NACK Bundling* feature.

Commands

There are no commands related to the *LTE893: ACK/NACK Bundling* feature.

Measurements and counters

There are no measurements or counters related to the *LTE893: ACK/NACK Bundling* feature.

Key performance indicators

There are no key performance indicators related to the *LTE893: ACK/NACK Bundling* feature.

Parameters

There are no parameters related to the *LTE893: ACK/NACK Bundling* feature.

Sales information

Table 160 LTE893 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

42 LTE895: TDD Support for Random Access Preamble Burst Format 4

This feature introduces the *LTE895: TDD Support for Random Access Preamble Burst Format 4*.

Preamble format 4 is known as short rach (S-RACH) being transmitted on uplink pilot time slot (UpPTS) within the special frame structure type 2. It is only applicable for TDD.

42.1 Benefits

42.1.1 End user benefits

This feature does not affect the end-user experience.

42.1.2 Operator benefits

This feature benefits the operator as follows:

- it ensures high connectivities for terminals in terms of random access, camp, registration, TA, from idle to active,
- it allows the use of UpPTS slot in frame structure 2.

42.2 Functional description

Preamble format 4, known as shotr rach (S-RACH), is a very small preamble which is transmitted in the UpPTS part of the special subframe. It is designed for small cells with a cell radius of less than 1.5 km. It can only be used together with frame structure 2 and UpPTS lengths 4384 Ts and 5120 Ts only.

42.2.1 Functional overview/details

The preamble format 4 is configured and activated in UpPTS using a management tool either by the NetAct, or locally by a Network Element Manager. The preamble format 4 is only configured and activated at the eNB startup and the online modification of preamble configuration is not allowed.

The eNB has at least one, and up to three LTE cells. The LTE cell, to which the UE is connected to, is the serving cell. The other cells of the eNB, and possible neighbor eNBs, are neighbor cells. From the eNB point of view, the preamble format 4 can be configured and activated to any eNB cel,l so it is possible to have different preamble configurations between neighbor cells. For example, format 4 is used for serving cell and format 0-3 is used for neighbor cells. The preamble format 4 is configured by parameters listed in table with parameters for the LTE895: TDD Support for Random Access Preamble Burst Format 4

The random access procedure with preamble format 4 lasts 17 ms on average (without HARQ retransmissions), defined as the time from the start of the PRACH waiting phase until th eNB receives the first RRC message.

The total attach procedure (i.e. from UE ready to send preamble until eNB receives RRC Connection Reconfiguration Complete) lasts at most 143 ms. The included eNB contribution is at most 22 ms.

42.3 System impacts

By the introduction of the feature *LTE895: TDD Support for Random Access Preamble Burst Format 4*, the following interdependencies and impacts are relevant:

42.3.1 Interdependencies between features

The following features are required for *LTE895: TDD Support for Random Access Preamble Burst Format 4*:

- LTE862 TDD DwPTS, GP and UpPTS with SF Configurations 7: Preamble format 4 is only applied when the length of UpPTS is two SC-FDMA symbols
- *LTE892 TDD DwPTS, GP and UpPTS with SF Configurations 5*: Preamble format 4 is only applied when the length of UpPTS is two SC-FDMA symbols

The following features are affected by *LTE895: TDD Support for Random Access Preamble Burst Format 4*:

- LTE513 Suppport of Sounding reference signal in TDD UpPTS: SRS can be sent in parallel with preamble format 4 in UpPTS. Frequency domain collision is avoided by the restrictions on the SRS BW allocation.

42.3.2 Impacts on interfaces

This feature has no impact on interfaces.

42.3.3 Impacts on network and network element management tools

This feature has no impact on network management or network element managementtools.

42.3.4 Impacts on system performance and capacity

The support of preamble format 4 improves UL throughput due to the fact that more resources can be reserved in normal UL subframes for PUSCH.

42.4 LTE895 reference data

LTE895: TDD Support for Random Access Preamble Burst Format 4 requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 161 LTE895 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15TD
Flexi Multiradio 10 BTS	Not supported	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Support not required	Support not required
NetAct	Support not required	Support not required
MME	Support not required	Support not required
SAE GW	Support not required	Support not required
UE	Support not required	3GPP release 8

Alarms

There are no alarms related to the *LTE895: TDD Support for Random Access Preamble Burst Format 4* feature.

BTS faults and reported alarms

There are no faults related to the *LTE895: TDD Support for Random Access Preamble Burst Format 4* feature.

Commands

There are no commands related to the *LTE895: TDD Support for Random Access Preamble Burst Format 4* feature.

Measurements and counters

There are no measurements or counters related to the *LTE895: TDD Support for Random Access Preamble Burst Format 4* feature.

Key performance indicators

There are no key performance indicators related to the *LTE895: TDD Support for Random Access Preamble Burst Format 4* feature.

Parameters

Table 162 New parameters introduced by LTE895

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
PRACH cyclic shift	prachCS	LNCEL_TDD	-	TDD
PRACH configuration index	prachConfIndex	LNCEL_TDD	-	TDD
PRACH high speed flag	prachHsFlag	LNCEL_TDD	-	TDD
Random Access Response Window Size	raRespWinSize	LNCEL	-	TDD
RACH Root Sequence	rootSeqIndex	LNCEL_TDD	-	TDD

For parameter descriptions, see *LTE Radio Access Operating Documentation/ Reference/Parameters*.

Note: For configuration of raRespWinSize parameter preamble format is essential:

- Preamble format 0:
  If the UL/DL configuration is 1 then the raRespWindowSize must be set to a value greater than or equal to 5.
  If the UL/DL configuration is 2 then the raRespWindowSize must be set to a value greater than or equal to 4.
- Preamble format 1:
  If the UL/DL configuration is 1 and the special subframe configuration is 5 then the raRespWindowSize must be set to a value greater than or equal to 4.
- Preamble format 2:
  If the UL/DL configuration is 1 and the special subframe configuration is 5 then the raRespWindowSize must be set to a value greater than or equal to 4.
- Preamble format 4:
  If the UL/DL configuration is 1 and the special subframe configuration is 7 then the raRespWindowSize must be set to a value greater than or equal to 3.
  If the UL/DL configuration is 1 and the special subframe configuration is 5 then the raRespWindowSize must be set to a value greater than or equal to 6.
  If the UL/DL configuration is 2 and the special subframe configuration is 7 then the raRespWindowSize must be set to a value greater than or equal to 3.
  If the UL/DL configuration is 2 and the special subframe configuration is 5 then the raRespWindowSize must be set to a value greater than or equal to 5.

Sales information

Table 163 LTE895 sales information

Product structure class	License control	Activated by default
Basic Software (BSW)	-	Yes

43 LTE905: Non GBR QCI 5, 6,7, 8 and 9

43.1 Introduction to feature

The LTE905: Non GBR QCI 5, 6, 7, 8 and 9 feature introduces the functionality that allows the usages of different QCIs for non GBR bearers.

43.2 Benefits

The feature allows the usage of different QCIs for non GBR bearers.

43.3 Functional description

The eNB supports EPS bearers with the QCIs 5, 6, 7, 8, and 9.

The feature description is valid for RL10/RL15TD and may not be valid in later releases.

43.4 System impacts

The feature has no additional impacts on the system.

43.5 LTE905 reference data

LTE905: Non GBR QCI 5, 6,7, 8 and 9 requirements, alarms and faults, measurements and counters, KPIs, parameters, and sales information

Requirements

Table 164 LTE905 hardware and software requirements

	FDD	TDD
System release	RL10	RL15
Flexi Multiradio 10 BTS	LBTS4.0	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	FL16A	TL16A
Flexi Zone BTS	LBTSFZ5.0	TD-LBTS5.0
Flexi Zone Access Point	FL15A	TL15A
Cloud Flexi Zone Controller	FL17A	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported

Table 164 LTE905 hardware and software requirements (Cont.)

	FDD	TDD
MME	NS10 CD2	NS10 CD2
SAE GW	Not supported	Not supported
UE	Not supported	Not supported

Alarms

There are no alarms related to the *LTE905: Non GBR QCI 5, 6,7, 8 and 9* feature.

Measurements and counters

There are no measurements or counters related to the *LTE905: Non GBR QCI 5, 6,7, 8 and 9* feature.

Key performance indicators

There are no key performance indicators related to the *LTE905: Non GBR QCI 5, 6,7, 8 and 9* feature.

Parameters

Table 165 New parameters introduced by QCI Translation Table (LTE5: Radio bearer and S1 bearer establishment and release)

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
QCI Translation Table	qciTab	LNBTS	-	common
QCI	qci	LNBTS	qciTab	common
Resource Type	resType	LNBTS	qciTab	common
Priority	prio	LNBTS	qciTab	common
Packet Delay Budget	packDelay	LNBTS	qciTab	FDD
Packet Loss Rate	packLoss	LNBTS	qciTab	FDD
QCI Support	qciSupp	LNBTS	qciTab	common
RLC Mode	rlcMode	LNBTS	qciTab	common
RLC Profile Index	rlcProfIdx	LNBTS	qciTab	common
PDCP Profile Index	pdcpProfIdx	LNBTS	qciTab	common
DSCP	dscp	LNBTS	qciTab	common
UL Scheduling - Priority	ulsPrio	LNBTS	qciTab	FDD
UL Scheduling - Bucket Size Duration (BSD)	ulsBSD	LNBTS	qciTab	FDD

For parameter descriptions, see *LTE Operating Documentation/ Reference/ Parameters*.

There are no parameters related to the *LTE905: Non GBR QCI 5, 6,7, 8 and 9* feature.

Sales information

Table 166 LTE905 sales information

Product structure class	License control	Activated by default
BSW	-	Yes

44 LTE906: TDD DL/UL Switching 3DL:1UL

44.1 Introduction to the feature

The feature offers a way to vary the DL/UL capacities with different DL/UL ratios and different Guard Time values. This flexibility is a key feature of the **TDD** LTE system.

44.2 Benefits

This feature offers higher spectrum efficiency by adapting the uplink and downlink capacities to the demands posed by asymmetric uplink/downlink traffic.

44.3 Functional description

This feature supports a DL/UL ratio of 3DL:1UL at 5 ms periodicity, that is, the DL/UL ratio can be modified in each half frame. This DL/UL ratio is available as an alternative to the 2DL:2UL ration provided by the LTE861: TDD DL/UL switching 2DL:2UL feature.

The selected DL/UL pattern is signaled to the **UE** using 3-bits signaling in D-**BCH**.

Special frame will add feature as 3:9:2.

If the 3DL:1UL ratio is configured, the number of simultaneous DL **HARQ** processes is reduced to ten, because DwPTS carries the PDSCH, and therefore the available capacity is reduced.

44.4 System impacts

This feature has no additional impacts on the system.

44.5 LTE906 reference data

> *LTE906: TDD DL/UL Switching 3DL:1UL requirements, alarms and faults, commands, measurements and counters, KPIs, parameters, and sales information*

Requirements

Table 167 LTE906 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15

Table 167 LTE906 hardware and software requirements (Cont.)

	FDD	TDD
Flexi Multiradio 10 BTS	Not supported	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Not supported	Support not required
NetAct	Not supported	Support not required
MME	Not supported	Support not required
SAE GW	Not supported	Support not required
UE	Not supported	Support not required

Alarms

There are no alarms related to the *LTE906: TDD DL/UL Switching 3DL:1UL* feature.

BTS faults and reported alarms

There are no faults related to the *LTE906: TDD DL/UL Switching 3DL:1UL* feature.

Commands

There are no commands related to the *LTE906: TDD DL/UL Switching 3DL:1UL* feature.

Measurements and counters

There are no measurements or counters related to the *LTE906: TDD DL/UL Switching 3DL:1UL* feature.

Key performance indicators

There are no key performance indicators related to the *LTE906: TDD DL/UL Switching 3DL:1UL* feature.

Parameters

Table 168 Existing parameters related to LTE906

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
`TDD Subframe Configuration`	`tddFrameConf`	LNCEL	-	TDD

For parameter descriptions, see *LTE Radio Access Operating Documentation > Reference > Parameters*.

Sales information

Table 169 LTE906 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	No

44.6 Activating LTE906: TDD DL/UL Switching 3DL:1UL

Purpose

Follow this procedure to activate the LTE906: TDD DL/UL Switching 3DL:1UL feature.

Before you start

The evolved NodeB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

See *Administering Flexi Multiradio BTS LTE* for details.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commisioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

Perform the following configuration settings to activate this feature:

- Change the **tddFrameConf** to 2 (sa2).

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the parameter tddFrameConf a restart of the eNB is needed

Further information

cqiPerNp is rectricted to 10ms and 20ms (public) after setting tddFrameConf to 2. prachConfIndex is restricted to values 3,4 and 6 or 51...53 if tddFrameConf is set to '2' (sa2).

srsSubfrConf is restricted to value sc0 or sc1, if tddFrameConf is set different to '1'

44.7 Deactivating LTE906: TDD DL/UL Switching 3DL:1UL Using BTS Site Manager

Purpose

Follow this procedure to deactivate the LTE906: TDD DL/UL Switching 3DL:1UL :feature.

Before you start

The evolved NodeB must already be commissioned. The BTS Site Manager (BTSSM) can be connected to the eNB either locally or from a remote location.

Steps

1 Start the BTSSM application and establish the connection to the eNB.

See *Administering Flexi Multiradio BTS LTE* for details.

2 Upload the configuration plan file from the eNB.

When the BTSSM is connected to the eNB, it automatically uploads the current configuration plan file from the eNB.

- Select **View ► Commissioning** or click **Recommissioning** on the View bar.
- Select the **BTS Site** checkbox in the **Target** session.
- Choose the commissioning type. Use the **Template**, **Manual**, or **Reconfiguration** option depending on the actual state of the eNB.

3 Modify the eNB configuration settings.

The feature-related settings are found in the set of *Commisioning pages*. In the top right-hand corner of the BTSSM window, there is a location bar that tells you at which stage of the *Commissioning process* you are. It is recommended that you carefully read the pages containing the full eNB configuration information.

Perform the following configuration settings to deactivate this feature:

- Set the parameter **tddFrameConf** to 1 (‘sa1’).

4 Send the commissioning plan file to the eNB.

Sub-steps

a) Go to the **Send Parameter** page.

b) In section **Send**, choose whether the BTSSM should send to the eNB only the changed parameters or a whole set of parameters.

Note: after sending a whole set of parameters a restart of the eNB is required.

c) Click the **Send Parameters** button.

5 The new commissioning plan file is automatically activated in the eNB.

Sub-steps

a) After successful transmission of the parameters, the new configuration is automatically activated.

The BTSSM automatically sends an activation command after finishing the file download.

b) Note that the eNB may now perform a restart.

After changing the value of **tddFrameConf** a restart of the eNB is needed.

Further information

prachConfIndex does not have any limitation regarding UL DL configuration if tddFrameConf set to '1' (sa1)

srsSubfrConf can be set to every value (sc0, sc1, sc2 or sc4), if tddFrameConf set to '1'

45 LTE911: TDD Frame Synchronized Operation

45.1 Introduction to the feature

The eNBs of different sites operate in a frame synchronous mode to support synchronization among BSs for at the radio frame level.

45.2 Benefits

With this feature, the eNBs of different sites operate in a frame synchronous mode to support synchronization among BSs for at the radio frame level.

45.3 Functional description

The eNBs of different sites operate in a frame synchronous mode to support:

- synchronization among BSs for at the radio frame level

This provides potential future advanced RRM algorithms exploiting synchronous properties Depending on purpose of synchronous operation, different synchronization precision requirements will apply. Based on 3GPP TS36.133, the cell phase synchronization accuracy measured at BS antenna connectors shall be better than 3us for small cell (<=3km). This requires for each BS, +/-1.5us phase accuracy tolerance with external reference synchronization signal, for example accurate GPS signal.The synchronization accuracy of synchronization sources must be higher than 50 ppb frequency accuracy and +/-1.5 us phase accuracy. Frame synchronous operation is mandatory for:

- LTE TDD to provide synchronous DL/UL switching point
- LTE eMBMS SFN operation for significant coverage enhancement of the eMBMS service in future network deployment

Frame synchronous operation can be used for

- interRAT HO
- UE measurements for location
- potential future advanced RRM algorithms

Note that the last three items are for future. releases)

Holdover Requirement:

When eNB loses the external accurate reference synchronization signal (for example GPS signal), the eNB should maintain the +/- 1.5us normal phase accuracy at least one hour for small size cell (<=3km) or maintain +/- 5us normal phase accuracy at least two hour for larger size cell (>3km) The eNB should maintain +/-10us phase accuracy for more than 24hour (assume oscillator environment temperature variation is 20 degree per day or less). This may lead the performance degradation compared with normal phase accuracy condition. The eNB transceiver should automatically support a switch off when there is a possibilty to overlap the DL (DwPTS) and UL (UpPTS) subframe between neighbor eNBs.

45.4 System impact

The feature has no additional impacts on the system.

45.5 LTE911 reference data

Requirements

Table 170 LTE911 hardware and software requirements

	FDD	TDD
System release	Not supported	RL15TD
Flexi Multiradio 10 BTS	Not supported	Not supported
Flexi Multiradio 10 Indoor BTS	Not supported	Not supported
Nokia AirScale BTS	Not supported	TL16A
Flexi Zone BTS	Not supported	TD-LBTS5.0
Flexi Zone Access Point	Not supported	TL15A
Cloud Flexi Zone Controller	Not supported	TL17A
OMS	Not supported	Not supported
NetAct	Not supported	Not supported
MME	Not supported	Not supported
SAE GW	Not supported	Not supported
UE	Not supported	Not supported

Alarms

There are no alarms related to the *LTE911: TDD Frame Synchronized Operation* feature.

Commands

There are no commands related to the *LTE911: TDD Frame Synchronized Operation* feature.

Measurements and counters

There are no measurements or counters related to the *LTE911: TDD Frame Synchronized Operation* feature.

Key performance indicators

There are no key performance indicators related to the *LTE911: TDD Frame Synchronized Operation* feature.

Parameters

Table 171 New parameters introduced by LTE911

Full name	Abbreviated name	Managed object	Parent structure	FDD/TDD
Holdover mode in temperature control	holdOverModeUsed	BTSSCL	-	TDD

For parameter descriptions, see LTE Radio Access Operating Documentation/ Reference/Parameters.

Sales information

Table 172 LTE911 sales information

Product structure class	License control	Activated by default
ASW	SW Asset Monitoring	Yes