**3GPP TSG-RAN WG2 Meeting # 131 *R2-25xxxx***

**Bangalore, India, 25 - 29 August 2025**

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| *CR-Form-v12.3* |
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|  | **36.300** | **CR** | **DRAFT** | **rev** | **-** | **Current version:** | **18.4.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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|  |
| ***Title:***  | Introduction of IoT NTN phase 3 |
|  |  |
| ***Source to WG:*** | Ericsson  |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** |  |  | ***Date:*** | 2025-08-15 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-19 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
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| ***Reason for change:*** | Specifies the support for IoT NTN phase 3 functionality.  |
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| ***Summary of change:*** | The store and forward functionality is captured in the latest RAN3 endorsed baseline CR R3-253973 and therefore not included here.The contention based Msg3 EDT procedure is added in section 7.3b and with small additions in 7.3c.The public warning system for NB-IoT is added in 4.10 and 23.3. |
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| ***Consequences if not approved:*** | IoT NTN phase 3 has no stage 2 description.  |
|  |  |
| ***Clauses affected:*** | 3.2, 4.10, 7.3b, 7.3c, 7.4, 8.1, 23.3.1, 23.3.2 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 36.331 CRxxxx, TS 36.321 CRyyyy, TS 36.304 CRzzzz, TS 36.306 CR1912 |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | This document is based on R2-2504646 endorsed at RAN2#130. The non affected clauses have been removed as well as all Editor’s Note.The proposed new section 7.3x was removed and instead incorporated into 7.b2.This revision is the outcome of the [Post130][305][R19 IoT NTN] Stage2 CR (Ericsson) email discussion. |

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| START OF CHANGE |

## 3.2 Abbreviations

1xCSFB Circuit Switched Fallback to 1xRTT

5GC 5G Core Network

A2X Aircraft-to-Everything

ABS Almost Blank Subframe

AC Access Category

ACK Acknowledgement

ACLR Adjacent Channel Leakage Ratio

AM Acknowledged Mode

AMBR Aggregate Maximum Bit Rate

ANDSF Access Network Discovery and Selection Function

ANR Automatic Neighbour Relation

ARP Allocation and Retention Priority

ARQ Automatic Repeat Request

AS Access Stratum

AUL Autonomous Uplink

BCCH Broadcast Control Channel

BCH Broadcast Channel

BL Bandwidth reduced Low complexity

BR-BCCH Bandwidth Reduced Broadcast Control Channel

BRID Broadcast Remote Identification

BSR Buffer Status Report

C/I Carrier-to-Interference Power Ratio

CA Carrier Aggregation

CAZAC Constant Amplitude Zero Auto-Correlation

CBC Cell Broadcast Center

CB-Msg3-EDT Contention Based Msg3 EDT

CB-Msg4 Contention Based Msg4

CB-RNTI Contention Based Msg4 RNTI

CC Component Carrier

CG Cell Group

CHO Conditional Handover

CIF Carrier Indicator Field

CIoT Cellular Internet of Things

CMAS Commercial Mobile Alert Service

CMC Connection Mobility Control

C-plane Control Plane

C-RNTI Cell RNTI

CoMP Coordinated Multi Point

CP Cyclic Prefix

CQI Channel Quality Indicator

CRC Cyclic Redundancy Check

CRE Cell Range Extension

CRS Cell-specific Reference Signal

CSA Common Subframe Allocation

CSG Closed Subscriber Group

CSI Channel State Information

CSI-IM CSI interference measurement

CSI-RS CSI reference signal

DAA Detect and Avoid

DAPS Dual Active Protocol Stack

DC Dual Connectivity

DCCH Dedicated Control Channel

DCN Dedicated Core Network

DeNB Donor eNB

DFTS DFT Spread OFDM

DL Downlink

DMTC Discovery Signal Measurement Timing Configuration

DRB Data Radio Bearer

DRS Discovery Reference Signal

DRX Discontinuous Reception

DTCH Dedicated Traffic Channel

DTX Discontinuous Transmission

DwPTS Downlink Pilot Time Slot

E-CID Enhanced Cell-ID (positioning method)

E-RAB E-UTRAN Radio Access Bearer

E-UTRA Evolved UTRA

E-UTRAN Evolved UTRAN

EAB Extended Access Barring

ECGI E-UTRAN Cell Global Identifier

ECM EPS Connection Management

EDT Early Data Transmission

EHC Ethernet Header Compression

eHRPD enhanced High Rate Packet Data

eIMTA Enhanced Interference Management and Traffic Adaptation

EMM EPS Mobility Management

eNB E-UTRAN NodeB

EPC Evolved Packet Core

EPDCCH Enhanced Physical Downlink Control Channel

EPS Evolved Packet System

ETWS Earthquake and Tsunami Warning System

FDD Frequency Division Duplex

FDM Frequency Division Multiplexing

G-RNTI Group RNTI

GBR Guaranteed Bit Rate

GERAN GSM EDGE Radio Access Network

GNSS Global Navigation Satellite System

GP Guard Period

GRE Generic Routing Encapsulation

GSM Global System for Mobile communication

GSO Geosynchronous Orbit

GUMMEI Globally Unique MME Identifier

GUTI Globally Unique Temporary Identifier

GWCN GateWay Core Network

GWUS Group Wake Up Signal

H-SFN Hyper System Frame Number

HARQ Hybrid ARQ

(H)eNB eNB or HeNB

HO Handover

HPLMN Home Public Land Mobile Network

HRPD High Rate Packet Data

HSDPA High Speed Downlink Packet Access

ICIC Inter-Cell Interference Coordination

IDC In-Device Coexistence

IP Internet Protocol

ISM Industrial, Scientific and Medical

KPAS Korean Public Alert System

L-GW Local Gateway

LAA Licensed-Assisted Access

LB Load Balancing

LBT Listen Before Talk

LCG Logical Channel Group

LCR Low Chip Rate

LCS LoCation Service

LEO Low Earth Orbit

LHN Local Home Network

LHN ID Local Home Network ID

LIPA Local IP Access

LMU Location Measurement Unit

LPPa LTE Positioning Protocol Annex

LTE Long Term Evolution

LWA LTE-WLAN Aggregation

LWAAP LTE-WLAN Aggregation Adaptation Protocol

LWIP LTE WLAN Radio Level Integration with IPsec Tunnel

LWIP-SeGW LWIP Security Gateway

MAC Medium Access Control

MBMS Multimedia Broadcast Multicast Service

MBR Maximum Bit Rate

MBSFN Multimedia Broadcast multicast service Single Frequency Network

MCCH Multicast Control Channel

MCE Multi-cell/multicast Coordination Entity

MCG Master Cell Group

MCH Multicast Channel

MCS Modulation and Coding Scheme

MDT Minimization of Drive Tests

MeNB Master eNB

MEO Medium Earth Orbit

MGW Media Gateway

MIB Master Information Block

MIMO Multiple Input Multiple Output

MME Mobility Management Entity

MMTEL Multimedia telephony

MO-EDT Mobile Originated Early Data Transmission

MPDCCH MTC Physical Downlink Control Channel

MSA MCH Subframe Allocation

Msg3 The third message sent during random access

Msg4 The fourth message sent during random access

MSI MCH Scheduling Information

MSP MCH Scheduling Period

MT-EDT Mobile Terminated Early Data Transmission

MTC Machine-Type Communications

MTCH Multicast Traffic Channel

MTSI Multimedia Telephony Service for IMS

MUSIM Multi-Universal Subscriber Identity Module

N2 Reference point between the NG-RAN and the AMF

NACK Negative Acknowledgement

NAS Non-Access Stratum

NB-IoT Narrow Band Internet of Things

NCC Next Hop Chaining Counter

NCGI NR Cell Global Identifier

NCR Neighbour Cell Relation

NG-RAN NG Radio Access Network

NGSO Non-Geosynchronous Orbit

NH Next Hop key

NNSF NAS Node Selection Function

NPBCH Narrowband Physical Broadcast channel

NPDCCH Narrowband Physical Downlink Control channel

NPDSCH Narrowband Physical Downlink Shared channel

NPRACH Narrowband Physical Random Access channel

NPUSCH Narrowband Physical Uplink Shared channel

NPRS Narrowband Positioning Reference Signal

NPSS Narrowband Primary Synchronization Signal

NR NR Radio Access

NRT Neighbour Relation Table

NSSS Narrowband Secondary Synchronization Signal

NTN Non-Terrestrial Network

OFDM Orthogonal Frequency Division Multiplexing

OFDMA Orthogonal Frequency Division Multiple Access

OPI Offload Preference Indicator

OTDOA Observed Time Difference Of Arrival (positioning method)

P-GW PDN Gateway

P-RNTI Paging RNTI

PA Power Amplifier

PAPR Peak-to-Average Power Ratio

PBCH Physical Broadcast CHannel

PBR Prioritised Bit Rate

PCC Primary Component Carrier

PCCH Paging Control Channel

PCell Primary Cell

PCFICH Physical Control Format Indicator CHannel

PCH Paging Channel

PCI Physical Cell Identifier

PDCCH Physical Downlink Control CHannel

PDCP Packet Data Convergence Protocol

PDN Packet Data Network

PDSCH Physical Downlink Shared CHannel

PDU Protocol Data Unit

PHICH Physical Hybrid ARQ Indicator CHannel

PHY Physical layer

PLMN Public Land Mobile Network

PMCH Physical Multicast CHannel

PMK Pairwise Master Key

PPPP ProSe Per-Packet Priority

PPPR ProSe Per-Packet Reliability

PRACH Physical Random Access CHannel

PRB Physical Resource Block

ProSe Proximity based Services

PSBCH Physical Sidelink Broadcast CHannel

PSC Packet Scheduling

PSCCH Physical Sidelink Control CHannel

PSCell Primary SCell

PSDCH Physical Sidelink Discovery CHannel

PSK Pre-Shared Key

PSM Power Saving Mode

PSSCH Physical Sidelink Shared CHannel

pTAG Primary Timing Advance Group

PTW Paging Time Window

PUCCH Physical Uplink Control CHannel

PUR Preconfigured Uplink Resource

PUR-RNTI Preconfigured Uplink Resource RNTI

PUSCH Physical Uplink Shared CHannel

PWS Public Warning System

QAM Quadrature Amplitude Modulation

QCI QoS Class Identifier

QoE Quality of Experience

QoS Quality of Service

R-PDCCH Relay Physical Downlink Control CHannel

RA-RNTI Random Access RNTI

RAC Radio Admission Control

RACH Random Access Channel

RANAC RAN-based Notification Area code

RAT Radio Access Technology

RB Radio Bearer

RBC Radio Bearer Control

RCLWI RAN Controlled LTE-WLAN Interworking

RF Radio Frequency

RIBS Radio-interface based synchronization

RIM RAN Information Management

RLC Radio Link Control

RLM Radio Link Monitoring

RMTC RSSI Measurement Timing Configuration

RN Relay Node

RNA RAN-based Notification Area

RNAU RAN-based Notification Area Update

RNC Radio Network Controller

RNL Radio Network Layer

RNTI Radio Network Temporary Identifier

ROHC Robust Header Compression

ROM Receive Only Mode

RRC Radio Resource Control

RRM Radio Resource Management

RTT Round Trip Time

RU Resource Unit

S-GW Serving Gateway

S-RSRP Sidelink Reference Signal Received Power

S1-MME S1 for the control plane

SAE System Architecture Evolution

SAP Service Access Point

SBCCH Sidelink Broadcast Control Channel

SC-FDMA Single Carrier – Frequency Division Multiple Access

SC-MCCH Single Cell Multicast Control Channel

SC-MTCH Single Cell Multicast Transport Channel

SC-N-RNTI Single Cell Notification RNTI

SC-PTM Single Cell Point To Multiploint

SC-RNTI Single Cell RNTI

SCC Secondary Component Carrier

SCell Secondary Cell

SCG Secondary Cell Group

SCH Synchronization Channel

SCTP Stream Control Transmission Protocol

SD-RSRP Sidelink Discovery Reference Signal Received Power

SDAP Service Data Adaptation Protocol

SDF Service Data Flow

SDMA Spatial Division Multiple Access

SDU Service Data Unit

SeGW Security Gateway

SeNB Secondary eNB

SFN System Frame Number

SI System Information

SI-RNTI System Information RNTI

S1-U S1 for the user plane

SIB System Information Block

SIPTO Selected IP Traffic Offload

SIPTO@LN Selected IP Traffic Offload at the Local Network

SL-BCH Sidelink Broadcast Channel

SL-DCH Sidelink Discovery Channel

SL-RNTI Sidelink RNTI

SL-SCH Sidelink Shared Channel

SPDCCH Short PDCCH

SPID Subscriber Profile ID for RAT/Frequency Priority

SPT Short Processing Time

SPUCCH Short PUCCH

SR Scheduling Request

SRB Signalling Radio Bearer

sTAG Secondary Timing Advance Group

STCH Sidelink Traffic Channel

SU Scheduling Unit

TA Tracking Area

TAC Tracking Area Code

TAG Timing Advance Group

TB Transport Block

TCP Transmission Control Protocol

TDD Time Division Duplex

TDM Time Division Multiplexing

TEID Tunnel Endpoint Identifier

TFT Traffic Flow Template

TM Transparent Mode

TMGI Temporary Mobile Group Identity

TNL Transport Network Layer

TTI Transmission Time Interval

U-plane User plane

UAC Unified Access Control

UDC Uplink Data Compression

UE User Equipment

UL Uplink

UM Unacknowledged Mode

UMTS Universal Mobile Telecommunication System

UpPTS Uplink Pilot Time Slot

UTRA Universal Terrestrial Radio Access

UTRAN Universal Terrestrial Radio Access Network

V2I Vehicle-to-Infrastructure

V2N Vehicle-to-Network

V2P Vehicle-to-Pedestrian

V2V Vehicle-to-Vehicle

V2X Vehicle-to-Everything

VRB Virtual Resource Block

WLAN Wireless Local Area Network

WT WLAN Termination

WUS Wake Up Signal

X2-C X2-Control plane

X2 GW X2 GateWay

X2-U X2-User plane

Xw-C Xw-Control plane

Xw-U Xw-User plane

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## 4.10 NB-IoT

NB-IoT provides access to network services using physical layer optimized for very low power consumption (e.g. full carrier bandwidth is 180 kHz, subcarrier spacing can be 3.75 kHz or 15 kHz).

As indicated in the relevant clauses in this specification, a number of E-UTRA protocol functions supported by all Rel-8 UEs are not used for NB-IoT and need not be supported by eNBs and UEs only using NB-IoT.

In this version of the specification, a number of functions including inter-RAT mobility, handover, measurement reports, GBR, CSG, support of HeNBs, relaying, carrier aggregation, dual connectivity, NAICS, real-time services, interference avoidance for in-device coexistence, RAN assisted WLAN interworking, sidelink communication/discovery, V2X sidelink communication, MDT, emergency call, CS fallback, ACB, EAB, ACDC, SSAC, aerial UE Communication, EN-DC and RRC\_INACTIVE are not supported for NB-IoT. This is not further stated in the corresponding procedures. In NTN, public warning system requirements may not be supported for some scenarios.

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## 7.3b MO-EDT

### 7.3b.1 General

MO-EDT allows one uplink data transmission optionally followed by one downlink data transmission either during the random access procedure or during the CB-Msg3-EDT procedure.

MO-EDT is triggered when the upper layers have requested the establishment or resumption of the RRC Connection for Mobile Originated data (i.e., not signalling or SMS) and the uplink data size is less than or equal to a TB size indicated in the system information. MO-EDT is not used for data over the control plane when using the User Plane CIoT EPS/5GS optimisations.

MO-EDT is only applicable to BL UEs, UEs in enhanced coverage and NB-IoT UEs.

MO-EDT using CB-Msg3-EDT procedure is only applicable in NTNs to Control Plane CIoT EPS optimisation and User Plane CIoT EPS optimisation for BL UEs, UEs in enhanced coverage mode A and NB-IoT UEs.

Contention based Msg3 EDT procedure (CB-Msg3-EDT procedure) allows EDT from RRC\_IDLE using contention based uplink resources without random access preamble transmission and without random access response reception. The CB-Msg3-EDT uplink transmission utilize a diversity slotted aloha (DSA) method where the uplink transmission is replicated k number of times at randomly selected occasions within a configurable window and the value of k is configured by the network. Following a CB-Msg3-EDT uplink transmission, the UE monitors PDCCH for a response, the network may respond to multiple UEs in one contention based Msg4 (CB-Msg4). A UE shall at most have one ongoing CB-Msg3-EDT procedure at any time.

### 7.3b.2 MO-EDT for Control Plane CIoT EPS/5GS optimisations

MO-EDT for Control Plane CIoT EPS optimisation, as defined in TS 24.301 [20], and Control Plane CIoT 5GS Optimisation, as defined in TS 24.501 [91], are characterized as below:

- Uplink user data are transmitted in a NAS message concatenated in UL RRCEarlyDataRequest message on CCCH;

- Downlink user data are optionally transmitted in a NAS message concatenated in DL RRCEarlyDataComplete message on CCCH;

- There is no transition to RRC CONNECTED.

The MO-EDT procedure for Control Plane CIoT EPS optimisation and Control Plane CIoT 5GS Optimisation are illustrated in Figure 7.3b-1 and Figure 7.3b-1a respectively.



Figure 7.3b-1: MO-EDT for Control Plane CIoT EPS Optimisation



Figure 7.3b-1a: MO-EDT for Control Plane CIoT 5GS Optimisation

0. Upon connection establishment request for Mobile Originated data from the upper layers, the UE either initiates the MO-EDT procedure and selects a random access preamble configured for EDT or the UE initiates CB-Msg3-EDT procedure.

1. UE sends *RRCEarlyDataRequest* message concatenating the user data on CCCH. For EPS if enabled in the cell, or for 5GS, the UE may indicate AS Release Assistance Information.

2. For EPS, the eNB initiates the S1-AP Initial UE message procedure to forward the NAS message and establish the S1 connection. For 5GS, the ng-eNB initiates the NG-AP Initial UE message procedure to forward the NAS message. The (ng-)eNB may indicate in this procedure that this connection is triggered for EDT.

3. For EPS, the MME requests the S-GW to re-activate the EPS bearers for the UE. For 5GS, the AMF determines the PDU session contained in the NAS message.

4. For EPS, the MME sends the uplink data to the S-GW. For 5GS, the AMF sends the PDU Session ID and the uplink data to the SMF and the SMF forwards the uplink data to the UPF.

5. For EPS, if downlink data are available, the S-GW sends the downlink data to the MME. For 5GS, if downlink data are available, the UPF forwards the downlink data to SMF and the SFM forwards the downlink data to AMF.

6. If downlink data are received from the S-GW or SMF, the MME or AMF forwards the data to the eNB or ng-eNB via DL NAS Transport procedure and may also indicate whether further data are expected. Otherwise, the MME or AMF may trigger Connection Establishment Indication procedure and also indicate whether further data are expected.

7. If no further data are expected, the (ng-)eNB can send the *RRCEarlyDataComplete* message on CCCH to keep the UE in RRC\_IDLE. If downlink data were received in step 6, they are concatenated in *RRCEarlyDataComplete* message.

8. For EPS, the S1 connection is released and the EPS bearers are deactivated. For 5GS, the AN release procedure is started.

NOTE 1: If the MME/AMF or the (ng-)eNB decides to move the UE in RRC\_CONNECTED mode, *RRCConnectionSetup* message is sent in step 7 to fall back to the legacy RRC Connection establishment procedure; the (ng-)eNB will discard the zero-length NAS PDU received in *RRCConnectionSetupComplete* message.

NOTE 1a: The CB-Msg3-EDT procedure is successful if the UE receives a matching UE contention resolution identity in CB-Msg4 of step 7. If the eNB decides it needs to schedule the UE further, the eNB may include a CB-RNTI with the mathing UE contention resolution identity of CB-Msg4 in step 7.

NOTE 2: If neither a matching UE contention resolution identity in a CB-Msg4, nor *RRCEarlyDataComplete* nor, in case of fallback, *RRCConnectionSetup* is received in response to *RRCEarlyDataRequest*, the UE considers the UL data transmission not successful.

### 7.3b.3 MO-EDT for User Plane CIoT EPS/5GS optimisations

MO-EDT for User Plane CIoT EPS optimisation, as defined in TS 24.301 [20], and for User Plane CIoT 5GS Optimisation, as defined in TS 24.501 [91], are characterized as below:

- The UE has been provided with a *NextHopChainingCount* in the *RRCConnectionRelease* message with suspend indication;

- Uplink user data are transmitted on DTCH multiplexed with UL *RRCConnectionResumeRequest* message on CCCH;

- Downlink user data are optionally transmitted on DTCH multiplexed with DL *RRCConnectionRelease* message on DCCH;

- The short resume MAC-I is reused as the authentication token for *RRCConnectionResumeRequest* message and is calculated using the integrity key from the previous connection;

- The user data in uplink and downlink are ciphered. The keys are derived using the *NextHopChainingCount* provided in the *RRCConnectionRelease* message of the previous RRC connection;

- The *RRCConnectionRelease* message is integrity protected and ciphered using the newly derived keys;

- There is no transition to RRC CONNECTED.

The MO-EDT procedure for User Plane CIoT EPS optimisation is illustrated in Figure 7.3b-2.



Figure 7.3b-2: MO-EDT for User Plane CIoT EPS Optimisation

0. Upon connection resumption request for Mobile Originated data from the upper layers, the UE either initiates the MO-EDT procedure and selects a random access preamble configured for EDT or the UE initiates the CB-Msg3-EDT procedure.

1. The UE sends an *RRCConnectionResumeRequest* to the eNB, including its Resume ID, the establishment cause, and an authentication token. The UE resumes all SRBs and DRBs, derives new security keys using the *NextHopChainingCount* provided in the *RRCConnectionRelease* message of the previous RRC connection and re-establishes the AS security. The user data are ciphered and transmitted on DTCH multiplexed with the *RRCConnectionResumeRequest* message on CCCH. If enabled in the cell, the UE may indicate AS Release Assistance Information.

2. The eNB initiates the S1-AP Context Resume procedure to resume the S1 connection and re-activate the S1-U bearers.

3. The MME requests the S-GW to re-activate the S1-U bearers for the UE.

4. The MME confirms the UE context resumption to the eNB.

5. The uplink data are delivered to the S-GW.

6. If downlink data are available, the S-GW sends the downlink data to the eNB.

7. If no further data are expected, the eNB can initiate the suspension of the S1 connection and the deactivation of the S1-U bearers.

8. The eNB sends the *RRCConnectionRelease* message to keep the UE in RRC\_IDLE. The message includes the *releaseCause* set to *rrc-Suspend*, the *resumeID,* the *NextHopChainingCount* and *drb-ContinueROHC* which are stored by the UE. If downlink data were received in step 6, they are sent ciphered on DTCH multiplexed with the *RRCConnectionRelease* message on DCCH. The procedure ends with the reception of the HARQ feedback (ARQ) acknowledging the successful DL transmission.

The MO-EDT procedure for User Plane CIoT 5GS Optimisation is illustrated in Figure 7.3b-2a.



Figure 7.3b-2a: MO-EDT for User Plane CIoT 5GS Optimisation

0. Upon connection resumption request for Mobile Originated data from the upper layers, the UE initiates the MO-EDT procedure and selects a random access preamble configured for EDT.

1. The UE sends an *RRCConnectionResumeRequest* to the ng-eNB, including its I-RNTI, the resume cause, and an authentication token. The UE resumes all SRBs and DRBs, derives new security keys using the *NextHopChainingCount* provided in the *RRCConnectionRelease* message of the previous connection and re-establishes the AS security. The user data are ciphered and transmitted on DTCH multiplexed with the *RRCConnectionResumeRequest* message on CCCH. The UE may indicate AS Release Assistance Information.

2. The uplink data are delivered to the UPF.

3. The ng-eNB sends a NG-AP Context Resume Request message to the AMF to resume the connection. If the UE included AS Release Assistance information indicating No further UL/DL higher layer PDU in step 1, ng-eNB may request for immediate transition to RRC IDLE with Suspend.

4. If the AMF does not receive a request for immediate transition to RRC IDLE with Suspend in step 3 or the AMF is aware of downlink data or signalling pending, the AMF requests the SMF to resume the PDU session.

5. The AMF sends a NG-AP Context Resume Response to the ng-eNB. If the AMF receives a request for immediate transition to RRC IDLE with Suspend in step 3 and there is no downlink data or signalling pending, the AMF includes a Suspend indication, and keeps the UE in CM-IDLE with Suspend.

6. If the AMF includes Suspend indication in step 5, the ng-eNB proceeds to step 8. If the AMF does not include Suspend indication and the UE included AS Release Assistance information indicating Only a single Downlink Data transmission subsequent to the Uplink transmission in step 1, the ng-eNB may wait for the DL data to arrive, and proceeds to step 7.

7 The ng-eNB initiates the NG-AP UE Context Suspend procedure to inform the AMF that the RRC connection is being suspended. The AMF requests the SMF to suspend the PDU session and the SMF requests the UPF to release the tunnel information for the UE.

8. The eNB sends the *RRCConnectionRelease* message to keep the UE in RRC\_IDLE. The message includes the *releaseCause* set to *rrc-Suspend*, the *I-RNTI,* the *NextHopChainingCount* and *drb-ContinueROHC* which are stored by the UE. If downlink data were received in step 6, they are sent ciphered on DTCH multiplexed with the *RRCConnectionRelease* message on DCCH. The procedure ends with the reception of the HARQ feedback (ARQ) acknowledging the successful DL transmission.

NOTE 1: If the MME/AMF or (ng-)eNB decides to move the UE to RRC\_CONNECTED mode, *RRCConnectionResume* message is sent in step 8 to fall back to the RRC Connection resume procedure. In that case, the *RRCConnectionResume* message is integrity protected and ciphered with the keys derived in step 1 and the UE ignores the *NextHopChainingCount* included in the *RRCConnectionResume* message. Downlink data can be transmitted on DTCH multiplexed with the *RRCConnectionResume* message. In addition, an *RRCConnectionSetup* can also be sent in step 8 to fall back to the RRC Connection establishment procedure.

NOTE 1a: The CB-Msg3-EDT procedure is successful if the UE receives a matching UE contention resolution identity in CB-Msg4 of step 8. If the eNB decides it needs to schedule the UE further, the eNB may include a CB-RNTI with the mathing UE contention resolution identity of CB-Msg4 in step 8.

NOTE 2: If neither *RRCConnectionRelease* nor, in case of fallback, *RRCConnectionResume* is received in response to *RRCConnectionResumeRequest* for MO-EDT,the UE considers the UL data transmission not successful.

For MO-EDT for User Plane CIoT EPS Optimisation and User Plane CIoT 5GS Optimisation, an RRC connection can also be resumed in an (ng-)eNB (the new (ng-)eNB) different from the one where the connection was suspended (the old (ng-)eNB). Inter (ng-)eNB connection resumption is handled using context fetching, whereby the new (ng-)eNB retrieves the UE context from the old (ng-)eNB over the X2 (Xn) interface. The new (ng-)eNB provides the Resume ID for EPS or I-RNTI for 5GS which is used by the old (ng-)eNB to identify the UE context. This is illustrated in Figure 7.3b-3 and Figure 7.3b-3a for the case of User Plane CIoT EPS Optimisation and for the case of User Plane CIoT 5GS Optimisation respectively.



Figure: 7.3b-3: MO-EDT for User Plane CIoT EPS Optimisations in different eNB



Figure: 7.3b-3a: MO-EDT for User Plane CIoT 5GS Optimisation in different ng-eNB

1. Same as step 1 in the intra (ng-)eNB connection resumption.

2. The new (ng-)eNB locates the old (ng-)eNB using the Resume ID (for EPS) or I-RNTI (for 5GS) and retrieves the UE context by means of the X2-AP (for EPS) or Xn-AP (for 5GS) Retrieve UE Context procedure.

3. The old (ng-)eNB responds with the UE context associated with the Resume ID (for EPS) or I-RNTI (for 5GS).

4. For EPS, the new eNB initiates the S1-AP Path Switch procedure to establish a S1 UE associated signalling connection to the serving MME and to request the MME to resume the UE context. For 5GS, the new ng-eNB initiates the NG-AP Path Switch procedure to establish a NG UE associated signalling connection to the serving AMF and to request the AMF to resume the UE context.

5. For EPS, the MME requests the S-GW to activate the S1-U bearers for the UE and updates the downlink path. For 5GS, the AMF requests requests the SMF to resume the PDU session and the SMF requests the UPF to create the tunnel information for the UE and update the downlink path.

6. MME/AMF Acks step 5.

7. For EPS, after the S1-AP Path Switch procedure the new eNB triggers release of the UE context at the old eNB by means of the X2-AP UE Context Release procedure. For 5GS, after the NG-AP Path Switch procedure the new ng-eNB triggers release of the UE context at the old ng-eNB by means of the Xn-AP UE Context Release procedure.

8. For EPS, same as step 5 in the intra eNB connection resumption. For 5GS, the uplink data are delivered to the UPF.

9. Same as step 6 in the intra (ng-)eNB connection resumption.

10. Same as step 7 in the intra (ng-)eNB connection resumption.

11. Same as step 8 in the intra (ng-)eNB connection resumption.

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## 7.3c MT-EDT

### 7.3c.1 General

MT-EDT is intended for a single downlink data transmission either during the random access procedure or during the CB-Msg3-EDT procedure.

MT-EDT is initiated by the MME if the UE and the network support MT-EDT and there is a single DL data transmission for the UE.

MT-EDT for Control Plane CIoT EPS Optimisation and for User Plane CIoT EPS Optimisation, as defined in TS 23.401 [17], is characterised as below:

- Support for MT-EDT for the Control Plane CIoT EPS Optimisation and/or for the User Plane CIoT EPS Optimisation is reported by UE at NAS level;

- DL data size is included in the S1-AP Paging message for the UE;

- MT-EDT indication is included in the *Paging* message for the UE over the Uu interface;

- For User Plane CIoT EPS Optimisation, the UE has been provided with a *NextHopChainingCount* in the *RRCConnectionRelease* message with suspend indication;

- In response to the *Paging* message including MT-EDT indication, the UE triggers the MO-EDT procedure for Control Plane CIoT EPS Optimisation or for User Plane CIoT EPS Optimisation if the upper layers request the establishment or resumption of the RRC Connection for Mobile Terminated Call;

- There is no transition to RRC CONNECTED.

MT-EDT is only applicable to BL UEs, UEs in enhanced coverage and NB-IoT UEs.

MT-EDT using CB-Msg3-EDT procedure is only applicable in NTNs for BL UEs, UEs in enhanced coverage mode A and NB-IoT UEs.

### 7.3c.2 MT-EDT for Control Plane CIoT EPS Optimisation

The MT-EDT procedure for Control Plane CIoT EPS Optimisation is illustrated in Figure 7.3c-1.



Figure 7.3c-1: MT-EDT for Control Plane CIoT EPS Optimisation

1. Upon arrival of downlink data, the SGW may send the DL data size information to the MME for MT-EDT consideration by the MME.

2. The MME includes the DL data size information in the S1-AP PAGING message to assist eNodeB in triggering MT-EDT.

3. If the data can fit in one single downlink transmission according to the UE category included in the UE Radio Capability for Paging provided in the S1-AP Paging message, the eNB includes *mt-EDT* indication in the *Paging* message for the UE.

4. The UE initiates the MO-EDT procedure for the Control Plane CIoT EPS Optimisation as described in clause 7.3b.2 with the following differences:

- In step 1, the UE sends *RRCEarlyDataRequest* message with the establishment cause *mt-Access* andwithout user data.

- In step 7, in case of fallback to the RRC Connection establishment procedure, the downlink data may optionally be included in *RRCConnectionSetup* message.

### 7.3c.3 MT-EDT for User Plane CIoT EPS Optimisation

The MT-EDT procedure for User Plane CIoT EPS Optimisation is illustrated in Figure 7.3c-2.



Figure 7.3c-2: MT-EDT for User Plane CIoT EPS Optimisation

1. Upon arrival of downlink data, the SGW may send the DL data size to the MME for MT-EDT consideration by the MME.

2. The MME includes the DL data size in the S1-AP PAGING message to assist eNodeB in triggering MT- EDT.

3. If the data can fit in one single downlink transmission according to the UE category included in the UE Radio Capability for Paging provided in the S1-AP Paging message, the eNB includes *mt-EDT* indication in the *Paging* message for the UE.

4. The UE initiates the MO-EDT procedure for the User Plane CIoT EPS Optimisation as described in clause 7.3b.3/ figure 7.3b-2 with the following differences:

- In step 0, the UE either initiates MO-EDT procedure and selects a random access preamble not configured for EDT or the UE initiates the CB-Msg3-EDT procedure;

- In step 1, the UE sends *RRCConnectionResumeRequest* message with the resume cause *mt-EDT* and without user data.

- In step 4, the MME may include the Pending Data Indication in the S1AP UE Context Resume Response message to notify the eNB of further data traffic in excess of that initially signalled in step 2. The eNB may use this indication to decide whether to release the UE.

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## 7.4 System Information

System information is divided into the *MasterInformationBlock* (MIB) and a number of *SystemInformationBlocks* (SIBs):

*- MasterInformationBlock* defines the most essential physical layer information of the cell required to receive further system information;

- *SystemInformationBlockPos* contains positioning assistance data;

- *SystemInformationBlockType1* and *SystemInformationBlockType1-BR* (for a BL UE or UE in enhanced coverage) contain information relevant when evaluating if a UE is allowed to access a cell and defines the scheduling of other system information blocks;

- *SystemInformationBlockType2* contains common and shared channel information;

- *SystemInformationBlockType3* contains cell re-selection information, mainly related to the serving cell;

- *SystemInformationBlockType4* contains information about the serving frequency and intra-frequency neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters);

- *SystemInformationBlockType5* contains information about other E‑UTRA frequencies and inter-frequency neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters). It can also contain information about E-UTRA and NR idle/inactive measurements;

- *SystemInformationBlockType6* contains information about UTRA frequencies and UTRA neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters);

- *SystemInformationBlockType7* contains information about GERAN frequencies relevant for cell re-selection (including cell re-selection parameters for each frequency);

- *SystemInformationBlockType8* contains information about CDMA2000 frequencies and CDMA2000 neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters);

- *SystemInformationBlockType9* contains a home eNB name (HNB name);

- *SystemInformationBlockType10* contains an ETWS primary notification;

- *SystemInformationBlockType11* contains an ETWS secondary notification;

- *SystemInformationBlockType12* contains a CMAS warning notification;

- *SystemInformationBlockType13* contains MBMS-related information;

- *SystemInformationBlockType14* contains information about Extended Access Barring for access control;

- *SystemInformationBlockType15* contains information related to mobility procedures for MBMS reception;

- *SystemInformationBlockType16* contains information related to GPS time and Coordinated Universal Time (UTC);

- *SystemInformationBlockType17* contains information relevant for traffic steering between E-UTRAN and WLAN;

- *SystemInformationBlockType18* contains information related to sidelink communication;

- *SystemInformationBlockType19* contains information related to sidelink discovery;

- *SystemInformationBlockType20* contains information related to SC-PTM;

- *SystemInformationBlockType21* contains information related to V2X sidelink communication;

- *SystemInformationBlockType24* contains information about NR frequencies and NR neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency), which can also be used for NR idle/inactive measurements;

- *SystemInformationBlockType25* contains information about UAC parameters;

- *SystemInformationBlockType26* contains additional information related to V2X sidelink communication;

- *SystemInformationBlockType26a* contains information related to NR bands list which can be used for EN-DC operation with the serving cell;

- *SystemInformationBlockType27* contains assistance information for inter-RAT cell selection to NB-IoT;

- *SystemInformationBlockType28* contains information related to NR sidelink communication;

- *SystemInformationBlockType29* contains information related to common resource reservation;

- *SystemInformationBlockType30* contains information related to disaster roaming;

- *SystemInformationBlockType31* contains information required for accessing an NTN cell;

- *SystemInformationBlockType32* contains assistance information for discontinuous coverage in NTN;

- *SystemInformationBlockType33* contains assistance information related to neighbouring NTN cells for measurements.

System information for NB-IoT is divided into the *MasterInformationBlock-NB* (MIB-NB) and a number of *SystemInformationBlocks-NB* (SIBs-NB):

- *MasterInformationBlock-NB* defines the most essential information of the cell required to receive further system information;

- *SystemInformationBlockType1-NB* contains information relevant when evaluating if a UE is allowed to access a cell and defines the scheduling of other system information blocks;

- *SystemInformationBlockType2-NB* contains common radio resource configuration information;

- *SystemInformationBlockType3-NB* contains cell re-selection information for intra-frequency, inter-frequency;

- *SystemInformationBlockType4-NB* contains neighboring cell related information relevant for intra-frequency cell re-selection;

- *SystemInformationBlockType5-NB* contains neighboring cell related information relevant for inter-frequency cell re-selection;

- *SystemInformationBlockType10-NB* contains an ETWS primary notification;

- *SystemInformationBlockType11-NB* contains an ETWS secondary notification;

- *SystemInformationBlockType12-NB* contains a CMAS warning notification;

- *SystemInformationBlockType14-NB* contains information about access barring;

- *SystemInformationBlockType15-NB* contains information related to mobility procedures for MBMS reception;

- *SystemInformationBlockType16-NB* contains information related to GPS time and Coordinated Universal Time (UTC);

- *SystemInformationBlockType20-NB* contains information related to SC-PTM;

- *SystemInformationBlockType22-NB* contains common radio resource configuration information for paging and random access procedure on non-anchor carriers;

- *SystemInformationBlockType23-NB* contains common additional radio resource configuration information for random access procedure on anchor and non-anchor carriers;

- *SystemInformationBlockType27-NB* contains assistance information for inter-RAT cell selection to E-UTRAN and/or GERAN;

- *SystemInformationBlockType31-NB* contains information required for accessing an NTN cell;

- *SystemInformationBlockType32-NB* contains assistance information for discontinuous coverage in NTN;

- *SystemInformationBlockType33-NB* contains assistance information related to neighbouring NTN cells for measurements.

On MBMS-dedicated cell, only system information relevant for receiving MBMS service is broadcasted. *MasterInformationBlock-MBMS* (MIB-MBMS) and *SystemInformationBlockType1-MBMS* (SIB1-MBMS) are used instead of MIB and SIB1 respectively:

*- MasterInformationBlock-MBMS* defines the most essential physical layer information of the cell required to receive further system information on MBMS-dedicated cell;

*- SystemInformationBlockType1-MBMS* contains information relevant for receiving MBMS service and defines the scheduling of other system information blocks on MBMS-dedicated cell;

The MIB is mapped on the BCCH and carried on BCH while all other SI messages are mapped on the BCCH and BR-BCCH, and carried on DL-SCH. Except for BL UEs, UEs in enhanced coverage and NB-IoT UEs, all other SI messages than the MIB which are dynamically carried on DL-SCH, can be identified through the SI-RNTI (System Information RNTI). Both the MIB and *SystemInformationBlockType1* (*SystemInformationBlockType1-BR* for BL UEs and UEs in enhanced coverage) use a fixed schedule with a periodicity of 40 and 80 ms respectively. The scheduling of other SI messages is flexible and indicated by *SystemInformationBlockType1* (*SystemInformationBlockType1-BR* for BL UEs and UEs in enhanced coverage, and *SystemInformationBlockType1-NB* for NB-IoT). For NB-IoT, the MIB-NB is mapped on the BCCH and carried on BCH while all other SI messages are mapped on the BCCH and carried on DL-SCH. Both the MIB-NB and *SystemInformationBlockType1-NB* use a fixed schedule with a periodicity of 640 and 2560 ms respectively. The MIB-NB contains all information required to acquire SIB1-NB and SIB1-NB contains all information required to acquire other SI messages.

On MBMS-dedicated cell, the MIB-MBMS and SIB1-MBMSuse a fixed schedule with a periodicity of 160 ms. Additionally, SIB1-MBMS may be scheduled in additional non-MBSFN subframes indicated in MIB-MBMS.

For NB-IoT, in TDD mode, the MIB-TDD-NB is transmitted on the same NB-IoT carrier as NPSS/NSSS, *SystemInformationBlockType1-NB* can be transmitted on NB-IoT carrier other than the MIB-NB, and the SI messages can be transmitted on a NB-IoT carrier other than the MIB-NB. At most two NB-IoT carriers are used to transmit the MIB-NB, *SystemInformationBlockType1-NB* and the SI messages.

Except for NB-IoT, the eNB may schedule DL-SCH transmissions concerning logical channels other than BCCH or BR-BCCH in the same subframe as used for BCCH or BR-BCCH. The minimum UE capability restricts the BCCH or BR-BCCH mapped to DL-SCH e.g. regarding the maximum rate.

The Paging message is used to inform UEs in RRC\_IDLE and UEs in RRC\_CONNECTED about a system information change. For NB-IoT UEs, BL UEs, and UEs in CE, the UE is not required to detect SIB changes when in RRC\_CONNECTED, and the network may release the NB-IoT UE, BL UE or UE in CE to RRC\_IDLE if it wants the NB-IoT UE, BL UE or UE in CE to acquire changed SIB(s).

Except for NB-IoT, system information may also be provided to the UE by means of dedicated signalling e.g. upon handover.

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## 8.1 E-UTRA related UE identities

The following E-UTRA related UE identities are used at cell level:

- C-RNTI: unique identification used for identifying RRC Connection and scheduling;

- Semi-Persistent Scheduling C-RNTI: unique identification used for semi-persistent scheduling;

- Temporary C-RNTI: identification used for the random access procedure;

- TPC-PUSCH-RNTI: identification used for the power control of PUSCH;

- TPC-PUCCH-RNTI: identification used for the power control of PUCCH;

- SL-RNTI: identification used for sidelink communication scheduling;

- SL-V-RNTI: identification used for V2X sidelink communication scheduling;

- Random value for contention resolution: during some transient states, the UE is temporarily identified with a random value used for contention resolution purposes;

- SRS-TPC-RNTI: identification used for triggering group SRS and power control of SRS for SRS-only SCells;

- SL Semi-Persistent Scheduling V-RNTI: identification used for semi-persistent scheduling for V2X sidelink communication;

- UL Semi-Persistent Scheduling V-RNTI: identification used for multiple semi-persistent scheduling for UE capable of V2X communication;

- AUL C-RNTI: unique identification used for autonomous uplink scheduling;

- PUR-RNTI: identification used for transmission using PUR;

- CB-RNTI: identification used for the CB-Msg3-EDT procedure.

In DC, two C-RNTIs are independently allocated to the UE: one for MCG, and one for SCG.

The following UE identity is only used for E-UTRA connected to EPC:

- Resume ID: unique identification used for the RRC connection resume procedure;

The following UE identity is only used for E-UTRA connected to 5GC:

- I-RNTI: unique identification used for the RRC connection resume procedure in RRC\_INACTIVE or for the User Plane CIoT 5GS Optimisation as specified for NR connected to 5GC in TS 38.300 [79];

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## 23.3 E-UTRAN Support for Warning Systems

### 23.3.0 General

The E-UTRAN provides support for warning systems through means of system information broadcast capability. The E-UTRAN performs scheduling and broadcasting of the "warning message content" received from the CBC, which is forwarded to the E-UTRAN by the MME. The schedule information for the broadcast is received along with the "warning message content" from the CBC. The E-UTRAN is also responsible for paging the UE to provide indication that the warning notification is being broadcast. The "warning message content" received by the E-UTRAN contains an instance of the warning notification. Depending on the size, E-UTRAN may segment the secondary notification before sending it over the radio interface.

### 23.3.1 Earthquake and Tsunami Warning System

ETWS is a public warning system developed to meet the regulatory requirements for warning notifications related to earthquake and/or tsunami events. ETWS warning notifications can either be a primary notification (short notifications delivered within 4 seconds, see TS 22.168 [37]) or secondary notification (providing detailed information). The ETWS primary notification is broadcast in *SystemInformationBlockType10* (*SystemInformationBlockType10-NB* for NB-IoT) while the secondary notification is broadcast in *SystemInformationBlockType11* (*SystemInformationBlockType11-NB* for NB-IoT). For BL UEs and UEs in enhanced coverage in NTNs, ETWS geofencing issupported.

### 23.3.2 Commercial Mobile Alert System

CMAS is a public warning system developed for the delivery of multiple, concurrent warning notifications (see TS 22.268 [34]). The CMAS warning notifications are short text messages (CMAS alerts). The CMAS warning notifications are broadcast in *SystemInformationBlockType12* (*SystemInformationBlockType12-NB* for NB-IoT). The E-UTRAN manages the delivery of multiple, concurrent CMAS warning notifications to the UE and is also responsible for handling any updates of CMAS warning notifications.

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