3GPP TSG-RAN WG2 #124 R2-23xxxxx

Chicago, USA, Nov. 13 – 17, 2023 Revision of R2-2313301

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **36.300** | **CR** | **1387** | **rev** | **2** | **Current version:** | **17.5.0** |  |
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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 enhancements |
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| ***Source to WG:*** | Ericsson |
| ***Source to TSG:*** | R2 |
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| ***Work item code:*** | IoT\_NTN\_enh-Core |  | ***Date:*** | 2023-11-23 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *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-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | Introduction of the Release-18 IoT NTN enhancements in stage 2.  |
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| ***Summary of change:*** | 7.4 Addition of new SIBxx10.1.5.0 Add reporting GNSS validity duration as reason for random access23.21.2.1 Add explanation of disabled HARQ feedback and HARQ mode B. 23.21.2.2 Add GNSS acquisition and suspension of RLM and AS during GNSS acquisition, and uplink transmission extension at out-dated GNSS position. 23.21.3 Add carrier frequency info for discontinuous coverage. Add the eNB behavior to support discontinuous coverage.23.21.4.1 Add that Location and time-based measurements can be used for cell reselection23.21.4.2 Additional triggers for CHO added. Add the description for HO with time-based trigger condition. “23.21.4.X Measurements” new section23.21.6 Specify the type of the cell ID used for X2 and S1 handover. Specify the type of the cell ID used for X2 Setup and eNB Configuration Update procedures. |
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| ***Consequences if not approved:*** | The Relase-18 IoT NTN enhancements are not supported.  |
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| ***Clauses affected:*** | 7.4, 10.1.5.0, 23.21.2.1, 23.21.2.2, 23.21.3, 23.21.4.1, 23.21.4.2, 23.21.4.X (new), 23.21.6  |
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|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 36.321 CRxxxx,TS 36.331 CR4964,TS 36.304 CR0869, |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
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| ***Other comments:*** |  |
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| ***This CR's revision history:*** | R2-2306951: Additions after RAN2#122 included.R2-2308542: Input to RAN2#123: updated to v17.5.0, accepted removal of “Editor’s Note”s that were marked for removal, otherwsie the same as R2-2306951.R2-2309338: Additions after RAN2#123R2-2311244 r0: Input to RAN2#123bis, same as R2-2309338 with updated cover page and document Type CR instead of draftCR, accepted removal of “Editor’s Note” that were marked for removal, and accepted the move of added text about HARQ in 23.21.1 that was moved to 23.21.2.1.R2-2313301 r1: Additions post RAN2#123bis. Compared to post RAN2#123bis email discussion: Uplifted to 17.5.0, removed changes on changes, removed sections witout changes, all changes by only one author, removed appendix with agreements.R2-2313779 r2: Post RAN2#124 Add: reporting GNSS validity duration as a reason for random access, uplink transmission extension after GNSS becomes out-dated, and that UE goes to idle after GNSS measurement failure. Add the RAN3 endorsed stage 2 CR R2-2314003/R3-238164. |

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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;

- *SystemInformationBlockTypeXX* contains assistance information for neighbouring cells in NTN.

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;

- *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;

- *SystemInformationBlockTypeXX-NB* contains assistance information for neighbouring cells in NTN.

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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#### 10.1.5.0 General

The random access procedure is characterized by:

- Common procedure for FDD and TDD;

- One procedure irrespective of cell size and the number of serving cells when CA is configured;

The random access procedure is performed for the following events related to the PCell:

- Initial access from RRC\_IDLE;

- RRC Connection Re-establishment procedure, as defined in TS 24.301 [20];

- Handover, except for NB-IoT or when RACH-less HO is configured;

- DL data arrival during RRC\_CONNECTED requiring random access procedure:

- E.g. when UL synchronisation status is "non-synchronised".

- UL data arrival during RRC\_CONNECTED requiring random access procedure:

- E.g. when UL synchronisation status is "non-synchronised" or there are no PUCCH resources for SR available.

- For positioning purpose during RRC\_CONNECTED requiring random access procedure:

- E.g. when timing advance is needed for UE positioning.

- Reporting GNSS validity duration during RRC\_CONNECTED for BL UEs, UEs in enhanced coverage and NB-IoT UEs.

The random access procedure is also performed on a SCell to establish time alignment for the corresponding sTAG.

For E-UTRA connected to 5GC, the random access procedure is also performed for the transition from RRC\_INACTIVE.

In DC, the random access procedure is also performed on at least PSCell upon SCG addition/modification, if instructed, or upon DL/UL data arrival during RRC\_CONNECTED requiring random access procedure. The UE initiated random access procedure is performed only on PSCell for SCG.

Furthermore, the random access procedure takes two distinct forms:

- Contention based (applicable to all six events, but the sixth event for positioning is applicable for NB-IoT only);

- Non-contention based (applicable to only handover, DL data arrival, positioning and obtaining timing advance alignment for a sTAG).

Normal DL/UL transmission can take place after the random access procedure.

An RN supports both contention-based and non-contention-based random access. When an RN performs the random access procedure, it suspends any current RN subframe configuration, meaning it temporarily disregards the RN subframe configuration. The RN subframe configuration is resumed at successful random access procedure completion.

For NB-IoT, the random access procedure is performed on the anchor carrier or on a non-anchor carrier based on system information.

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#### 23.21.2.1 Scheduling timing

DL and UL are frame aligned at the uplink time synchronization reference point (RP) with an offset given by $N\_{TA,offset} $(see clause 8 of TS 36.211 [4]).

To accommodate the long propagation delays in NTN, several timing relationships are enhanced by a Common Timing Advance (Common TA) and two offsets: $K\_{offset}$ and $K\_{mac}$:

- $Common TA$ is a configured timing offset that is equal to the RTT between the RP and the NTN payload.

- $K\_{offset}$ is a configured scheduling offset that needs to be larger or equal to the sum of the service link RTT and the Common TA.

- $K\_{mac}$ is a configured offset that is approximately equal to the RTT between the RP and the eNB.

The scheduling offset $K\_{offset}$ is used to allow the UE sufficient processing time between a downlink reception and an uplink transmission, see TS 36.213 [6].

The offset $K\_{mac}$ is used to delay the application of a downlink configuration indicated by a MAC CE received on NPDSCH/PDSCH, see TS 36.213 [6], and to determine the UE-eNB RTT, see TS 36.321 [13]. It may be provided by the network when downlink and uplink frame timing are not aligned at eNB. The $K\_{mac}$ is also used in the random access procedure, to determine the start time of random access response window after a random access preamble transmission (see TS 36.213 [6]).

The Service link RTT, Feeder link RTT, the RP, the Common TA, $K\_{mac}$ and TTA (see clause 23.21.2.2) are illustrated in Figure 23.21.2.1-1.



Figure 23.21.2.1-1: Illustration of timing relationship (for collocated eNB and NTN Gateway)

The network may configure the HARQ operation as follows:

- For downlink, HARQ feedback can be enabled or disabled per HARQ process (by dedicated RRC signalling and/or DCI based indication). Disabling HARQ feedback allows scheduling a HARQ process before one HARQ RTT has elapsed since last scheduled;

- For uplink, HARQ mode (i.e. HARQ mode A or HARQ mode B) can be configured per HARQ process (as specified in clause 5.4.3.1 and clause 5.7 of TS 36.321 [13]). HARQ mode B allows scheduling a HARQ process before one HARQ RTT has elapsed since last scheduled. HARQ mode configuration is not applicable for PUR transmissions.

NOTE: For the HARQ processes configured with HARQ feedback enabled/disabled, it is up to network implementation to ensure a proper configuration of HARQ feedback (e.g., either all enabled or all disabled) for HARQ processes used by a downlink SPS configuration. For the HARQ processes configured with HARQ mode, it is up to network implementation to ensure a proper configuration of HARQ mode (e.g., either all HARQ mode A or all HARQ mode B) for HARQ processes used by an uplink SPS configuration.

#### 23.21.2.2 Timing Advance and Frequency Pre-compensation

For the serving cell, the network broadcast ephemeris information and common Timing Advance (common TA) parameters.

The UE shall have valid GNSS position as well as the ephemeris and common TA before connecting to an NTN cell. To achieve synchronisation, before and during connection to a cell, the UE shall pre-compensate the Timing Advance (TTA, see TS 36.211 [4] clause 8.1), see Figure 23.21.2.2-1, by considering the common TA, UE position and the NTN payload position through the ephemeris.

The UE computes the frequency Doppler shift of the service link, and pre-compensates for it in the uplink transmissions, by considering UE position and the ephemeris. If the UE does not have a valid GNSS position and/or valid ephemeris and Common TA, it shall not transmit until they are regained. When ephemeris and Common TA are valid and the GNSS position becomes out-dated, the UE can be configured to allow uplink transmissions extension.

In connected mode, the UE shall continuously update the Timing Advance and frequency pre-compensation. The UE can be triggered to perform, or configured to autonomously perform, GNSS acquisition. In connected mode, upon outdated ephemeris and common Timing Advance, the UE shall acquire the broadcasted parameters. Upon failed GNSS acquisition, the UE shall move to idle mode if the GNSS position is outdated and uplink transmission is not extended. Upon outdated GNSS position the UE shall move to idle mode, unless GNSS measurement is ongoing or uplink transmission extension is active. Upon completing the GNSS acquisition, the UE shall trigger remaining validity duration reporting (see TS 36.321 [13]).

NOTE: The AS operations (e.g. RLM related timers, dataInactivityTimer, CHO execution, neighbour cell measurement, RACH, SR, and BSR) are suspended when UE is performing GNSS acquisition and resumed when the GNSS acquisition is completed.

The UEs may be configured to report Timing Advance at initial access or in connected mode. In connected mode, event-triggered reporting of the Timing Advance is supported.



Figure 23.21.2.2-1: Illustration of Uplink/Downlink Radio Frame Timing at the UE

While the pre-compensation of the instantaneous Doppler shift experienced on the service link is to be performed by the UE, the management of Doppler shift experienced over the feeder link and transponder frequency error, whether introduced in Downlink or Uplink, is left to network implementation.

### 23.21.3 Support of discontinuous coverage

As an NTN payload moves on a specified orbit, for example in case of a NGSO satellite, the NTN payload beam(s) coverage area may move and cover different portions of a geographical area due to the orbital movement of the NTN payload. As a consequence, a UE located in the concerned geographical area may experience a situation of discontinuous coverage, due to e.g. a sparse satellite constellation deployment.

To enable the UE, in RRC\_IDLE, to save power during periods of no coverage, the network provides NTN payload assistance information (e.g. ephemeris parameters, the start-time and/or carrier frequency of upcoming NTN payload coverage) to enable the UE to predict when coverage will be provided by upcoming NTN payloads. Predicting out of coverage and in coverage is up to UE implementation.

If the eNB detects that the UE is out of coverage due to discontinuous coverage, it may initiate a UE Context Release Request procedure towards the serving MME.

### 23.21.4 Mobility Management

#### 23.21.4.1 Mobility Management in ECM-IDLE

The principles described in clause 10.1.1 apply in NTN unless specified otherwise hereafter.

The network may broadcast more than one TAC per PLMN in an NTN cell. The AS layer indicates all received TACs for the selected PLMN to the NAS layer. The network may update the UEs upon TAC removal. UEs may by UE implementation also check whether a TAC has been removed.

For quasi-Earth-fixed cells, timing information on when the cell is going to stop serving the area may be broadcast by the network. This may be used by the UE to start measurements on neighbour cells before the broadcast stop time of the serving cell, while the exact start of the measurements is up to UE implementation.

Location and time-based measurements can be used for cell reselection.

#### 23.21.4.2 Mobility Management in ECM-CONNECTED

Radio link failure and RRC connection re-establishment are supported in NTN. The principles described in clause 10.1.6 apply unless specified otherwise. The principles described in clause 10.1.2 apply to NTN unless specified otherwise.

To enable mobility in NTN, the network provides target cell NTN payload assistance information needed to access the NTN cell in the handover command.

Conditional handover is supported for BL UEs and UEs in enhanced coverage.

When operating in NTNs the following additional trigger conditions upon which UE may execute CHO to a candidate cell is supported, as defined in TS 36.331 [16]:

- The RRM measurement-based event A4;

- A time-based trigger condition;

- A location-based trigger condition.

It is up to UE implementation how the UE evaluates the time-based or location-based trigger condition together with the RRM measurement-based event.

When time-based trigger condition is used, the source eNB should consider the time indicated to the UE to decide when start the early data forwarding to the target eNB.

When a time-based trigger condition is used, the source eNB may signal the corresponding parameters to a single target eNB via the Source eNB to Target eNB Transparent Container in a S1-based handover, see TS 23.401[17]. The source eNB signals the corresponding CHO configuration to the UE in the RRCConnectionReconfiguration message during handover execution.

#### 23.21.4.X Measurements

The principles described in clause 10.1.3.0 apply in NTN unless specified otherwise.

To enable measurements, the network may provide neighbouring cell assistance information via system information.

The following can optionally be used for measurements on neighbour cells in RRC\_IDLE as specified in TS 36.331 [16]:

- The timing and location information associated to the serving cell is provided in SIB3 and SIB31;

- Timing information when the neighbour cell starts serving the current geographical area;

- Location information refering to the reference location of the serving cell and a distance threshold to the reference location.

The following measurement triggers can optionally be used in RRC\_CONNECTED to reduce the time taken for RRC reestablishment or handover as specified in TS 36.331 [16]:

- A time-based trigger condition;

- A location-based trigger condition.

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### 23.21.6 Signalling

The Cell Identity, as defined in TS 36.413 [25] and TS 36.423 [42], corresponds to a Mapped Cell ID, irrespective of the orbit of the NTN payload or the types of service links supported in the following cases:

- The Cell Identity indicated by the eNB to the Core Network as part of the User Location Information, or as E-UTRAN CGI in the related S1AP messages;

- The Cell Identity used for Paging Optimization in S1 interface;

- The Cell Identity used for PWS.

For a BL UE or a UE in enhanced coverage, the Cell Identity included within the target identification of the handover messages allows identifying the correct target cell. The cell identity used in the S1 and X2 handover messages, X2 Setup and X2 eNB Configuration Update procedures is expected to be Uu Cell ID.

The mapping between Mapped Cell ID(s) and geographical area(s) is configured in the RAN and Core Network.

NOTE 1: A specific geographical location may be mapped to multiple Mapped Cell ID(s), and such Mapped Cell IDs may be configured to indicate different geographical areas (e.g. overlapping and/or with different dimensions).

The eNB is responsible for constructing the Mapped Cell ID based on the UE location information received from the UE, if available. The mapping may be pre-configured (e.g., depending on operator's policy) or up to implementation.

NOTE 2: As described in TS 23.401 [17], the User Location Information may enable the MME to determine whether the UE is allowed to operate at its present location. Special Mapped Cell IDs or TACs may be used to indicate areas outside the serving PLMN's country.

The eNB reports the broadcasted TAC(s) of the selected PLMN to the MME. In case the eNB knows the UE's location information, the eNB may determine the TAI the UE is currently located in and provide that TAI to the MME.

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