**3GPP TSG-RAN WG2 Meeting #117-e *R2-2203537***

**eLocation, 21st February – 3rd March 2022 *rev of R2-2202233***

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.300** | **CR** | **NA** | **rev** | **-** | **Current version:** | **16.8.0** |  |
|  | | | | | | | | |
| *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 | **X** |

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|  | | | | | | | | | | |
| ***Title:*** | Support of Non-Terrestrial Networks | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Thales | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_NTN\_solutions-core | | | | |  | ***Date:*** | | | 2022-02-28 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-17 |
|  | *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 can be 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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Introduction of Non-Terrestrial Networks support | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Introduction of specific NTN vocabulary, architecture and protocols aspects | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | NTN is not supported in NR | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 3.1, 3.2, 7.3.1, 4.x and 16.x | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | Rev0: Stage 2 runningCR creation based on email discussion in R2-2010781 (RAN2#112-e), RAN2#113-e outcomes (chairman’s notes) and RAN3#111-e outcomes (R2-2102057).  RAN2#113bis-e & 114-e outcomes (R2-2106539).  RAN2#115-e outcomes (R2-2109586)  RAN2#116-e outcomes (R2-2111613)  RAN2#116-bis-e outcomes (R2-2201894)  RAN2#116-bis-e outcomes (R2-2203537)  This stg2 Running CR incorporates the current endorsed RAN3 stg2 BL CR (R3-221609) | | | | | | | | |

<<<<<<<<<<<<<<<<<<<< First Changes Begin >>>>>>>>>>>>>>>>>>>>

# 2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

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

[2] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2".

[3] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[4] 3GPP TS 38.401: "NG-RAN; Architecture description".

[5] 3GPP TS 33.501: "Security Architecture and Procedures for 5G System".

[6] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[7] 3GPP TS 38.322: "NR; Radio Link Control (RLC) protocol specification".

[8] 3GPP TS 38.323: "NR; Packet Data Convergence Protocol (PDCP) specification".

[9] 3GPP TS 37.324: " E-UTRA and NR; Service Data Protocol (SDAP) specification".

[10] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in Idle mode and RRC Inactive state".

[11] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".

[12] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[13] 3GPP TS 38.133: "NR; Requirements for support of radio resource management".

[14] 3GPP TS 22.168: "Earthquake and Tsunami Warning System (ETWS) requirements; Stage 1".

[15] 3GPP TS 22.268: "Public Warning System (PWS) Requirements".

[16] 3GPP TS 38.410: "NG-RAN; NG general aspects and principles".

[17] 3GPP TS 38.420: "NG-RAN; Xn general aspects and principles".

[18] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[19] 3GPP TS 22.261: "Service requirements for next generation new services and markets".

[20] 3GPP TS 38.202: "NR; Physical layer services provided by the physical layer"

[21] 3GPP TS 37.340: "NR; Multi-connectivity; Overall description; Stage-2".

[22] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[23] IETF RFC 4960 (2007-09): "Stream Control Transmission Protocol".

[24] 3GPP TS 26.114: "Technical Specification Group Services and System Aspects; IP Multimedia Subsystem (IMS); Multimedia Telephony; Media handling and interaction".

[25] Void.

[26] 3GPP TS 38.413: "NG-RAN; NG Application Protocol (NGAP)".

[27] IETF RFC 3168 (09/2001): "The Addition of Explicit Congestion Notification (ECN) to IP".

[28] 3GPP TS 24.501: "NR; Non-Access-Stratum (NAS) protocol for 5G System (5GS)".

[29] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[30] 3GPP TS 38.415: "NG-RAN; PDU Session User Plane Protocol".

[31] 3GPP TS 38.340: "NR; Backhaul Adaptation Protocol (BAP) specification".

[32] 3GPP TS 38.470: "NG-RAN; F1 application protocol (F1AP) ".

[33] 3GPP TS 38.425: "NG-RAN; NR user plane protocol".

[34] 3GPP TS 23.216: "Single Radio Voice Call Continuity (SRVCC); Stage 2".

[35] 3GPP TS 38.101-2: "User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone".

[36] 3GPP TS 38.101-3: "User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios".

[37] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access".

[38] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[39] 3GPP TS 22.104 "Service requirements for cyber-physical control applications in vertical domains".

[40] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[41] 3GPP TS 23.285: "Technical Specification Group Services and System Aspects; Architecture enhancements for V2X services".

[42] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN".

[43] 3GPP TS 37.355: "LTE Positioning Protocol (LPP)".

[44] 3GPP TS 29.002: "Mobile Application Part (MAP) specification".

[x] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[y] NIMA TR 8350.2, Third Edition, Amendment 1, 3 January 2000: “DEPARTMENT OF DEFENSE WORLD GEODETIC SYSTEM 1984”, https://gis-lab.info/docs/nima-tr8350.2-wgs84fin.pdf.

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# 3 Abbreviations and Definitions

## 3.1 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], in TS 36.300 [2] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1] and TS 36.300 [2].

5GC 5G Core Network

5GS 5G System

5QI 5G QoS Identifier

A-CSI Aperiodic CSI

AKA Authentication and Key Agreement

AMBR Aggregate Maximum Bit Rate

AMC Adaptive Modulation and Coding

AMF Access and Mobility Management Function

ARP Allocation and Retention Priority

BA Bandwidth Adaptation

BCH Broadcast Channel

BH Backhaul

BL Bandwidth reduced Low complexity

BPSK Binary Phase Shift Keying

C-RNTI Cell RNTI

CAG Closed Access Group

CAPC Channel Access Priority Class

CBRA Contention Based Random Access

CCE Control Channel Element

CD-SSB Cell Defining SSB

CFRA Contention Free Random Access

CHO Conditional Handover

CIoT Cellular Internet of Things

CLI Cross Link interference

CMAS Commercial Mobile Alert Service

CORESET Control Resource Set

CPC Conditional PSCell Change

DAG Directed Acyclic Graph

DAPS Dual Active Protocol Stack

DFT Discrete Fourier Transform

DCI Downlink Control Information

DCP DCI with CRC scrambled by PS-RNTI

DL-AoD Downlink Angle-of-Departure

DL-SCH Downlink Shared Channel

DL-TDOA Downlink Time Difference Of Arrival

DMRS Demodulation Reference Signal

DRX Discontinuous Reception

E-CID Enhanced Cell-ID (positioning method)

EHC Ethernet Header Compression

ETWS Earthquake and Tsunami Warning System

GFBR Guaranteed Flow Bit Rate

GSO Geosynchronous Orbit

HRNN Human-Readable Network Name

HAPS High Altitude Platform Station

IAB Integrated Access and Backhaul

I-RNTI Inactive RNTI

INT-RNTI Interruption RNTI

KPAS Korean Public Alarm System

LDPC Low Density Parity Check

LEO Low Earth Orbit

MDBV Maximum Data Burst Volume

MEO Medium Earth Orbit

MIB Master Information Block

MICO Mobile Initiated Connection Only

MFBR Maximum Flow Bit Rate

MMTEL Multimedia telephony

MNO Mobile Network Operator

MT Mobile Termination

MU-MIMO Multi User MIMO

Multi-RTT Multi-Round Trip Time

NB-IoT Narrow Band Internet of Things

NCGI NR Cell Global Identifier

NCR Neighbour Cell Relation

NCRT Neighbour Cell Relation Table

NGAP NG Application Protocol

NGSO Non-Geosynchronous Orbit

NID Network Identifier

NPN Non-Public Network

NR NR Radio Access

NTN Non-Terrestrial Network

P-RNTI Paging RNTI

PCH Paging Channel

PCI Physical Cell Identifier

PDCCH Physical Downlink Control Channel

PDSCH Physical Downlink Shared Channel

PLMN Public Land Mobile Network

PNI-NPN Public Network Integrated NPN

PO Paging Occasion

PRACH Physical Random Access Channel

PRB Physical Resource Block

PRG Precoding Resource block Group

PS-RNTI Power Saving RNTI

PSS Primary Synchronisation Signal

PUCCH Physical Uplink Control Channel

PUSCH Physical Uplink Shared Channel

PWS Public Warning System

QAM Quadrature Amplitude Modulation

QFI QoS Flow ID

QPSK Quadrature Phase Shift Keying

RA Random Access

RA-RNTI Random Access RNTI

RACH Random Access Channel

RANAC RAN-based Notification Area Code

REG Resource Element Group

RIM Remote Interference Management

RMSI Remaining Minimum SI

RNA RAN-based Notification Area

RNAU RAN-based Notification Area Update

RNTI Radio Network Temporary Identifier

RQA Reflective QoS Attribute

RQoS Reflective Quality of Service

RS Reference Signal

RSRP Reference Signal Received Power

RSRQ Reference Signal Received Quality

RSSI Received Signal Strength Indicator

RSTD Reference Signal Time Difference

RTT Round Trip Time

SD Slice Differentiator

SDAP Service Data Adaptation Protocol

SFI-RNTI Slot Format Indication RNTI

SIB System Information Block

SI-RNTI System Information RNTI

SLA Service Level Agreement

SMC Security Mode Command

SMF Session Management Function

S-NSSAI Single Network Slice Selection Assistance Information

SNPN Stand-alone Non-Public Network

SNPN ID Stand-alone Non-Public Network Identity

SPS Semi-Persistent Scheduling

SR Scheduling Request

SRS Sounding Reference Signal

SRVCC Single Radio Voice Call Continuity

SS Synchronization Signal

SSB SS/PBCH block

SSS Secondary Synchronisation Signal

SST Slice/Service Type

SU-MIMO Single User MIMO

SUL Supplementary Uplink

TA Timing Advance

TNL Transport Network Layer

TPC Transmit Power Control

UCI Uplink Control Information

UL-AoA Uplink Angles of Arrival

UL-RTOA Uplink Relative Time of Arrival

UL-SCH Uplink Shared Channel

UPF User Plane Function

URLLC Ultra-Reliable and Low Latency Communications

V2X Vehicle-to-Everything

Xn-C Xn-Control plane

Xn-U Xn-User plane

XnAP Xn Application Protocol

## 3.2 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], in TS 36.300 [2] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1] and TS 36.300 [2].

**BH RLC channel**: an RLC channel between two nodes, which is used to transport backhaul packets**.**

**CAG Cell**:a PLMN cell broadcasting at least one Closed Access Group identity.

**CAG Member Cell**:for a UE, a CAG cell broadcasting the identity of the selected PLMN, registered PLMN or equivalent PLMN, and for that PLMN, a CAG identifier belonging to the Allowed CAG list of the UE for that PLMN.

**CAG-only cell**: a CAG cell that is only available for normal service for CAG UEs.

**Cell-Defining SSB**: an SSB with an RMSI associated.

**Child node**: IAB-DU's and IAB-donor-DU's next hop neighbour node; the child node is also an IAB-node.

**Conditional Handover (CHO**): a handover procedure that is executed only when execution condition(s) are met.

**CORESET#0**: the control resource set for at least SIB1 scheduling, can be configured either via MIB or via dedicated RRC signalling.

**DAPS Handover**: a handover procedure that maintains the source gNB connection after reception of RRC message for handover and until releasing the source cell after successful random access to the target gNB.

**Downstream**: Direction toward child node or UE in IAB-topology.

**Early Data Forwarding**: data forwarding that is initiated before the UE executes the handover.

**Earth-centered, earth-fixed**: A global geodetic reference system for the Earth intended for practical applications of mapping, charting, geopositioning and navigation, as specified in NIMA TR 8350.2 [y].

**Feeder link**: Wireless link between the NTN Gateway and the NTN payload.

**Geosynchronous Orbit**: Earth-centered orbit at approximately 35786 kilometres above Earth's surface and synchronised with Earth's rotation. A geostationary orbit is a non-inclined geosynchronous orbit, i.e. in the Earth’s equator plane.

**gNB**: node providing NR user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**High Altitude Platform Station**: airborne vehicle embarking the NTN payload placed at an altitude between 8 and 50 km.

**IAB-donor**:gNB that provides network access to UEs via a network of backhaul and access links.

**IAB-donor-CU**: as defined in TS 38.401 [4].

**IAB-donor-DU**:as defined in TS 38.401 [4].

**IAB-DU**: gNB-DU functionality supported by the IAB-node to terminate the NR access interface to UEs and next-hop IAB-nodes, and to terminate the F1 protocol to the gNB-CU functionality, as defined in TS 38.401 [4], on the IAB-donor.

**IAB-MT**: IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise. IAB-MT function used in 38-series of 3GPP Specifications corresponds to IAB-UE function defined in TS 23.501 [3].

**IAB-node**: RAN node that supports NR access links to UEs and NR backhaul links to parent nodes and child nodes. The IAB-node does not support backhauling via LTE.

**Intra-system Handover**:Handover that does not involve a CN change (EPC or 5GC).

**Inter-system Handover**:Handover that involves a CN change (EPC or 5GC).

**Late Data Forwarding**: data forwarding that is initiated after the source NG-RAN node knows that the UE has successfully accessed a target NG-RAN node.

**Mapped Cell ID**: In NTN, it corresponds to a fixed geographical area.

**MSG1**: preamble transmission of the random access procedure for 4-step random access (RA) type.

**MSG3**: first scheduled transmission of the random access procedure.

**MSGA**:preamble and payload transmissions of the random access procedure for 2-step RA type.

**MSGB**:response to MSGA in the 2-step random access procedure. MSGB may consist of response(s) for contention resolution, fallback indication(s), and backoff indication.

**Multi-hop backhauling**: Using a chain of NR backhaul links between an IAB-node and an IAB-donor.

**ng-eNB**: node providing E-UTRA user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**NG-C**: control plane interface between NG-RAN and 5GC.

**NG-U**: user plane interface between NG-RAN and 5GC.

**NG-RAN node**: either a gNB or an ng-eNB.

**Non-CAG Cell**: a PLMN cell which does not broadcast any Closed Access Group identity.

Non-Geosynchronous orbit: Earth-centered orbit with an orbital period that does not match Earth's rotation on its axis. This includes Low and Medium Earth Orbit (LEO and MEO).

**Non-terrestrial network**: An NG-RAN consisting of gNBs, which provide non-terrestrial NR access to UEs by means of an NTN payload embarked on an airborne or space-borne NTN vehicle and an NTN Gateway.

**NR backhaul link**: NR link used for backhauling between an IAB-node and an IAB-donor, and between IAB-nodes in case of a multi-hop backhauling.

**NR sidelink communication**: AS functionality enabling at least V2X communication as defined in TS 23.287 [40], between two or more nearby UEs, using NR technology but not traversing any network node.

**NTN Gateway**: an earth station located at the surface of the earth, providing connectivity to the NTN payload using the feeder link. An NTN Gateway is a TNL node.

**NTN payload:** a network node, embarked on board a satellite or high altitude platform station, providing connectivity functions, between the service link and the feeder link. In the current version of this specification, the NTN payload is a TNL node.

**Numerology**: corresponds to one subcarrier spacing in the frequency domain. By scaling a reference subcarrier spacing by an integer *N*, different numerologies can be defined.

**Parent node**: IAB-MT's next hop neighbour node; the parent node can be IAB-node or IAB-donor-DU

**PLMN Cell**: a cell of the PLMN.

**Satellite:** a space-borne vehicle orbiting the Earth embarking the NTN payload.

**Service link:** Wireless link between the NTN payload and UE.

**SNPN Access Mode**: mode of operation whereby a UE only accesses SNPNs.

**SNPN-only cell**: a cell that is only available for normal service for SNPN subscribers.

**SNPN Identity:** the identity of Stand-alone NPN defined by the pair (PLMN ID, NID).

**Upstream**: Direction toward parent node in IAB-topology.

**V2X sidelink communication**: AS functionality enabling V2X communication as defined in TS 23.285 [41], between nearby UEs, using E-UTRA technology but not traversing any network node.

**Xn**: network interface between NG-RAN nodes.

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## 7.3 System Information Handling

### 7.3.1 Overview

System Information (SI) consists of a MIB and a number of SIBs, which are divided into Minimum SI and Other SI:

- **Minimum SI** comprises basic information required for initial access and information for acquiring any other SI. Minimum SI consists of:

- *MIB* contains cell barred status information and essential physical layer information of the cell required to receive further system information, e.g. CORESET#0 configuration. *MIB* is periodically broadcast on BCH.

- *SIB1* defines the scheduling of other system information blocks and contains information required for initial access. SIB1 is also referred to as Remaining Minimum SI (RMSI) and is periodically broadcast on DL-SCH or sent in a dedicated manner on DL-SCH to UEs in RRC\_CONNECTED.

- **Other SI** encompasses all SIBs not broadcast in the Minimum SI. Those SIBs can either be periodically broadcast on DL-SCH, broadcast on-demand on DL-SCH (i.e. upon request from UEs in RRC\_IDLE, RRC\_INACTIVE, or RRC\_CONNECTED), or sent in a dedicated manner on DL-SCH to UEs in RRC\_CONNECTED (i.e., upon request, if configured by the network, from UEs in RRC\_CONNECTED or when the UE has an active BWP with no common search space configured). Other SI consists of:

- *SIB2* contains cell re-selection information, mainly related to the serving cell;

- *SIB3* 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);

- *SIB4* contains information about other NR 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), which can also be used for NR idle/inactive measurements;

- *SIB5* contains information about E-UTRA frequencies and E-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);

- *SIB6* contains an ETWS primary notification;

- *SIB7* contains an ETWS secondary notification;

- *SIB8* contains a CMAS warning notification;

- *SIB9* contains information related to GPS time and Coordinated Universal Time (UTC);

- *SIB10* contains the Human-Readable Network Names (HRNN) of the NPNs listed in SIB1;

- *SIB11* contains information related to idle/inactive measurements;

- *SIBpos* contains positioning assistance data as defined in TS 37.355 [43] and TS 38.331 [12].

For sidelink, Other SI also includes:

- *SIB12* contains information related to NR sidelink communication;

- *SIB13* contains information related to *SystemInformationBlockType21* for V2X sidelink communication as specified in TS 36.331 clause 5.2.2.28 [29];

- *SIB14* contains information related to *SystemInformationBlockType26* for V2X sidelink communication as specified in TS 36.331 clause 5.2.2.33 [29].

For non-terrestrial network, other SI also includes:

- *SIBx* contains NTN-specific parameters;

Editor’s note: List of NTN-specific parameters (e.g. satellite ephemeris, K\_mac, common TA, cell-specific Koffset, network enable/disable TA report, …) and scheduling yet to be finalised.

Figure 7.3-1 below summarises System Information provisioning.



Figure 7.3-1: System Information Provisioning

For a cell/frequency that is considered for camping by the UE, the UE is not required to acquire the contents of the minimum SI of that cell/frequency from another cell/frequency layer. This does not preclude the case that the UE applies stored SI from previously visited cell(s).

If the UE cannot determine the full contents of the minimum SI of a cell by receiving from that cell, the UE shall consider that cell as barred.

In case of BA, the UE only acquires SI on the active BWP.

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### 16.3.2 AMF and NW Slice Selection

#### 16.3.2.1 CN-RAN interaction and internal RAN aspects

NG-RAN selects AMF based on a Temp ID or NSSAI provided by the UE over RRC as specified in TS 38.410 [16]. The mechanisms used in the RRC protocol are described in the next clause.

Table 16.3.2.1-1 AMF selection based on Temp ID and NSSAI

|  |  |  |
| --- | --- | --- |
| Temp ID | NSSAI | AMF Selection by NG-RAN |
| not available or invalid | not available | One of the default AMFs is selected (NOTE) |
| not available or invalid | present | Selects AMF which supports UE requested slices |
| valid | not available, or present | Selects AMF per CN identity information in Temp ID |
| NOTE: The set of default AMFs is configured in the NG-RAN nodes via OAM. | | |

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## 16.x Non-Terrestrial Networks

### 16.x.1 Overview

The Figure 16.x-1 below illustrates an example of a Non-Terrestrial Network (NTN) providing non-terrestrial NR access to the UE by means of an NTN payload and an NTN Gateway, depicting a service link between the NTN payload and a UE, and a feeder link between the NTN Gateway and the NTN payload.



**Figure 16.x-1: Overall illustration of an NTN**

NOTE: Figure 16.x-1 illustrates an NTN; RAN4 aspects are out of scope.

The NTN payload transparently forwards the radio protocol received from the UE (via the service link) to the NTN Gateway (via the feeder link) and vice-versa. The following connectivity is supported by the NTN payload:

- A gNB may serve multiple NTN payloads;

- An NTN payload may be served by multiple gNBs.

NOTE: In this release, the NTN-payload may change the carrier frequency, before re-transmitting it on the service link, and vice versa (respectively on the feeder link).

For NTN, the following applies in addition to Network Identities as described in clause 8.2:

- A Tracking Area corresponds to a fixed geographical area. Any respective mapping is configured in the RAN;

- A Mapped Cell ID as specified in subclause 16.x.5.

Non-Geosynchronous orbit (NGSO) includes Low Earth Orbit at altitude approximately between 300 km and 1500 km and Medium Earth Orbit at altitude approximately between 7000 km and 25000 km.

Three types of service links are supported.

* + Earth-fixed: provisioned by beam(s) continuously covering the same geographical areas all the time (e.g., the case of GSO satellites)
  + Quasi-Earth-fixed: provisioned by beam(s) covering one geographic area for a limited period and a different geographic area during another period (e.g., the case of NGSO satellites generating steerable beams)
  + Earth-moving: provisioned by beam(s) whose coverage area slides over the Earth surface (e.g., the case of NGSO satellites generating fixed or non-steerable beams).

With NGSO satellites, the gNB can provide either quasi-Earth-fixed cell coverage or Earth-moving cell coverage, while gNB operating with GSO satellite can provide Earth fixed cell coverage.

In this release, the UE supporting NTN is GNSS-capable.

In the case of NGSO, service link switch refers to a change of serving satellite.

The support for Non-Terrestrial Networks (NTNs) is facilitated by the mechanisms described in the following clauses.

### 16.x.2 User Plane aspects

The UEs may be configured to report the UEs Timing Advance during Random Access procedure in Idle/Inactive states.

The UEs may also be configured to report the UEs Timing Advance in connected mode using event-triggered reporting~~.~~

Editor’s note: if SA3 will confirm that NTN-specific user consent will the available in Rel-17, the network could at least ask the UE to report its UE location for any reason at any time. FFS if we define an event-triggered reporting of UE location for TA reporting purposes

To accommodate the long propagation delays, Use Plane procedures are adapted as follow:

* For downlink, HARQ feedback can be enabled or disabled per HARQ process.
* For uplink, the UE can be configured with a HARQ mode per HARQ process.
* Maximum number of HARQ processes are extended to 32
* The value range of MAC (i.e. sr-ProhibitTimer and configuredGrantTimer), RLC (i.e. t-Reassembly) and PDCP (i.e. discardTimer and t-reordering) layer timers are extended..

NOTE: It is up to network implementation to ensure proper configuration of HARQ feedback (i.e. enabled or disabled) for HARQ processes used by an SPS configuration and of HARQ mode for HARQ processes used by a CG configuration.

Editor’s note: Impact on timing aspects to be added once the RAN1 has drafted a text on Koffset and Kmac principles (a figure illustrating the timing relationship between UL and DL would be beneficial)

Editor’s note: A description of the UE autonomous TA pre-compensation and frequency pre-compensation will be added once RAN1 have drafted a text.

If a logical channel is configured with allowedHARQ-mode, it can only be mapped to a HARQ process with the same HARQ mode.

### 16.x.3 Mobility and State transition

#### 16.x.3.1 Mobility in RRC\_IDLE and RRC\_INACTIVE

The same principles as described in 9.2.1 apply to mobility in RRC\_IDLE for NTN and the same principles as described in 9.2.2 apply to mobility in RRC\_INACTIVE for NTN unless hereunder specified.

The network may broadcast multiple Tracking Area Codes (TAC) per PLMN in a NR NTN cell. A TAC change in the System Information is under network control, i.e. it may not be exactly synchronised with real-time illumination of beams on ground.

Editor’s note: UE is not expected to do Registration procedure triggered by mobility if one of the currently broadcasted TACs belongs to UE’s registration area (only a working assumption and is pending further SA2/CT1 conclusion).

The UE can determine the network type (Terrestrial or non-terrestrial) implicitly by the existence of scheduling information of SIBXX in SIB1.

The NTN ephemeris is divided into serving cell’s satellite ephemeris and neighbouring cell’s satellite ephemeris.

At least in the quasi-earth fixed cell scenario, UE can perform time-based and location-based cell selection /reselection:

* the timing and location information associated to a cell are provided via system information
* Timing information refers to the time when the serving cell is going to stop serving a geographical area
* Location information refers to the reference location of serving or neighboring cells

Location information may be used to assist cell reselection in NTN with for example a condition based on the distance between UE and the reference location of the serving cell and/or neighbor cells.

#### 16.x.3.2 Mobility in RRC\_CONNECTED

##### 16.x.3.2.1 Handover

The same principle as described in 9.2.3.2 applies unless hereunder specified:

During mobility between NTN and Terrestrial Network, a UE is not required to connect to both NTN and Terrestrial Network at the same time.

DAPS handover is not supported for NTN in this release of the specification.

##### 16.x.3.2.2 Conditional Handover

The same principle as described in 9.2.3.4 applies to intra-NTN Conditional Handover (CHO) as well as to NTN-Terrestrial Network CHO unless hereunder specified.

NOTE: NTN-Terrestrial Network CHO refers to mobility in both directions, i.e. from NTN to Terrestrial Network (hand-in) and from Terrestrial Network to NTN (hand-out).

NTN supports the following additional triggering conditions upon which UE may execute CHO to a candidate cell, as defined in TS 38.331 [12]:

- Measurement event A4 for CHO execution triggering.

- A time-based trigger condition.

- A location-based trigger condition.

A time-based or a location-based trigger condition is always configured together with the measurement-based trigger conditions (CHO events A3, A4 or A5). Location is defined by the distance between UE and a reference location. Time is defined by the time between T1 and T2.

#### 16.x.3.3 Measurements

The same principle as described in 9.2.4 applies to measurements in NTN unless hereunder specified.

The network can configure

* multiple SMTCs in parallel per carrier and for a given set of cells depending on UE capabilities using propagation delay difference, feeder link delay as well as serving/neighbour satellite cell ephemeris
* measurement gaps using the same propagation delay difference as computed for SMTC

The adjustment of SMTCs is possible under network control for connected mode and under UE control based on UE location information and ephemeris for idle/inactive modes.

Editor’s note: FFS for assistance information to be used by the UE in IDLE for those shifts of SMTC..

Editor’s note: RAN2 aims to minimize the number of configurable measurement gaps required for monitoring configured SMTCs in NTN. At least gap length and UE capabilities impact the number of required measurement gaps.

Editor’s note: The maximum number of measurements gaps depends on gap length and UE capabilities.

### 16.x.4 Switch over

#### 16.x.4.1 Definitions

A feeder link switch over is the procedure where the feeder link is changed from a source NTN Gateway to a target NTN Gateway for a specific NTN payload. The feeder link switch over is a Transport Network Layer procedure.

Both hard and soft feeder link switch over are applicable to NTN.

#### 16.x.4.2 Assumptions

A feeder link switch over may result in transferring the established connection for the affected UEs between two gNBs.

For soft feeder link switch over, an NTN payload is able to connect to more than one NTN Gateway during a given period i.e. a temporary overlap can be ensured during the transition between the feeder links.

For hard feeder link switch over, an NTN payload only connect to one NTN Gateway at any given time i.e. a radio link interruption may occur during the transition between the feeder links.

#### 16.x.4.3 Procedures

The NTN Control function determines the point in time when the feeder link switch over between two gNBs is performed. The transfer of the affected UE(s)’ context between the two gNBs at feeder link switch over is performed by means of either NG based or Xn based handover, and it depends on the gNBs’ implementation and configuration information provided to the gNBs by the NTN Control function.

### 16.x.5 NG-RAN signalling

The Cell Identity, as defined in TS 38.413 [26] and TS 38.423 [x], used in following cases corresponds to a Mapped Cell ID, irrespective of the orbit of the NTN payload or the types of service links supported.

- The Cell Identity indicated by the gNB to the Core Network as part of the User Location Information;

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

- The Cell Identity used for Area of Interest;

- The Cell Identity used for PWS.

The Cell Identity included within the target identification of the handover messages allows identifying the correct target cell.The Cell Identities used in the RAN Paging Area during Xn RAN paging allow the identification of the correct target cells for RAN paging.

NOTE: The Cell Identity used for RAN Paging is assumed to typically represent a Uu Cell ID.

The mapping between Cell Identities and geographical areas is configured in the RAN and Core Network.

The gNB is responsible for constructing the Mapped Cell ID based on the UE location info received from the UE. The mapping may be pre-configured (e.g., up to operator’s policy) or up to implementation.

NOTE: As described in TS 23.501 [3], the User Location Information may enable the AMF to determine whether the UE is allowed to operate at its present location. Pre-configuration of special mapped cell identifiers may be used to indicate areas outside the serving PLMN’s country.

The gNB reports the broadcasted TAC(s) of the selected PLMN to the AMF as part of ULI. In case the gNB knows the UE’s location information, the gNB may determine the TAI the UE is currently located in and provide that TAI to the AMF as part of ULI.

### 16.x.6 AMF (Re-)Selection by gNB

The gNB implements the NAS Node Selection Function specified in TS 38.410 [16].

For a RRC\_CONNECTED UE, when the gNB is configured to ensure that the UE is connected to an AMF that serves the country in which the UE is located. If the gNB detects that the UE is in a different country to that served by the serving AMF, then it should perform an NG handover to change to an appropriate AMF, or initiate an UE Context Release Request procedure towards the serving AMF (in which case the AMF may decide to de-register the UE).

### 16.x.7 O&M Requirements

The following NTN related parameters shall be provided by O&M to the gNB providing non-terrestrial NR access:

- Ephemeris information describing the orbital trajectory information or coordinates for the NTN vehicles. This information is provided on a regular basis or upon demand to the gNB;

- Two different sets of ephemeris format shall be supported

- Set 1: Satellite position and velocity state vectors:

- Position;

- Velocity;

- Set 2: At least the following parameters in orbital parameter ephemeris format, as specified in NIMA TR 8350.2 [y]:

- Semi-major axis;

- Eccentricity;

- Argument of periapsis;

- Longitude of ascending node;

- Inclination;

- Mean anomaly at epoch time to.

- The explicit epoch time associated to ephemeris data;

- The location of the NTN-Gateways;

NOTE: The ephemeris of the satellites and the location of the NTN-Gateways, are used at least for the Uplink timing and frequency synchronization. It may also be used for the random access and the mobility management purposes.

- Additional information to enable gNB operation for feeder/service link switch overs.

NOTE: The NTN related parameters provided by O&M to the gNB may depend on the type of supported service links e.g. earth fixed beams, quasi earth fixed beams, earth moving beams, etc.

### 16.x.8 UE location aspects

Editor’s note: The network is able to ensure that the CGI constructed by NG-RAN corresponds to a fixed geographical area comparable with a TN cell with a radius of ~2km or more.

Editor’s note: During initial access, the UE can report its location in Msg5. This location information corresponds to a coarse GNSS coordinates of ~2 km accuracy

After AS security is established, gNB can obtain a GNSS-based location information.

Periodic location reporting can be configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED

Editor’s note: RAN2 discuss whether it is part of existing periodic measurement report configuration or a new configuration for periodic reporting of UE location.

<<<<<<<<<<<<<<<<<<<< Next Changes Begin >>>>>>>>>>>>>>>>>>>>

# Annex B.x Example implementation of Non-Terrestrial Networks (informative)

The following figure illustrates an example implementation of an Non-Terrestrial Network for transparent NTN payload:



Figure B-1: NTN based NG-RAN

The gNB depicted in Figure B-1 may be subdivided into non-NTN infrastructure gNB functions and the NTN Service Link provisioning System. The NTN infrastructure may be thought of being subdivided into the NTN Service Link provisioning System and the NTN Control function. The NTN Service Link provisioning System may consist of one or more NTN payloads and NTN Gateways.

The NTN payload is embarked on a spaceborne (or airborne) vehicle, providing a structure, power, commanding, telemetry, attitude control for the satellite (resp. HAPS) and possibly an appropriate thermal environment, radiation shielding.

The NTN Service Link provisioning System maps the NR-Uu radio protocol over radio resources of the NTN infrastructure (e.g. beams, channels, Tx power).

The NTN control function controls the spaceborne (or airborne) vehicles as well as the radio resources of the NTN infrastructure (NTN payload(s) & NTN Gateway(s)). It provides control data, e.g. Ephemeris, to the non-NTN infrastructure gNB functions of the gNB.

Provision of NTN control data to the gNB is out of 3GPP scope.

NOTE: The transport of NR-Uu protocol between the NTN Service Link provisioning system and the non-NTN infrastructure gNB functions is out of 3GPP scope.

At least the following NTN related parameters are expected to be provided by O&M to the gNB for its operation

a) Earth fixed beams: for each beam provided by a given NTN-payload:

- The Cell identifier (NG and Uu) mapped to the beam;

- The Cell’s reference location (e.g. cell’s center and range).

b) Quasi Earth fixed beams: for each beam provided by a given NTN-payload:

- The Cell identifier (NG and Uu) and time window mapped to a beam;

- The Cell’s/beam’s reference location (e.g. cell’s center and range);

- The time window of the successive switch overs (feeder link, service link);

- The identifier and time window of all serving satellites and NTN-Gateways;

c) Earth moving beams: for each beam provided by a given NTN-payload:

- The Uu Cell identifier mapped to a beam and mapping information to fixed geographical areas reported on NG, including information about the beams direction and motion of the beam’s foot print on Earth;

- Its elevation wrt NTN-payload;

- Schedule of successive serving NTN-Gateways/gNBs;

- Schedule of successive switch overs (feeder link, service link).

**<<<<<<<<<<<<<<<<<<<< End of Changes >>>>>>>>>>>>>>>>>>>>**

**The following appendices shall be removed from final CR**

# A Appendix: RAN2 agreements for WI NR-NTN-solutions

## A.1 Scope, requirements, scenarios, architecture

***RAN2#111-e Agreements***

RAN2 to stick to WI scenarios: Any restriction, e.g. on the LEO altitude (if needed) could come from other groups.

From RAN2 perspective, the table 4.2-2 of [TR 38.821] is used as a baseline for the normative work, with the removal of the regenerative payload option

(as the WI is restricted to transparent payload) we assume that the feeder link will use NR (how the satellite is controlled is out of the scope of the WI)

RAN2 confirms the assumptions on the UE ground speed in the handheld and VSAT cases

|  |  |  |
| --- | --- | --- |
| *User equipment characteristics* | *Handheld* | *VSAT (Note 1)* |
| *Motion on the earth* | *Up to 500 km/h (e.g. on board a high speed train)* | *Up to 1200 km/h (e.g. aircraft mounted)* |

In Rel-17, only UEs with GNSS capabilities are supported

Both Earth fixed and earth moving beam scenarios are considered with NGSO constellation.

Both soft and hard feeder link switchover (e.g. for Non GSO) are supported.

Note: This requires satellite to be connected to one NTN GW at a time (hard switch) or at least two NTN GWs simultaneously (soft switch).

RAN2 to start discussing enhancements for soft feeder link switchover and then solutions for hard feeder link switchover.

As part of the NR-NTN WI, the following stepped approach is proposed:

* Step 1: Assessment of the Rel-16 LCS framework/application protocols (3GPP TS 23.273, TS 29.572, TS 38.455, TS 38.305, in particular but not excluding other TS) and its applicability to NTN
* Step 2: Assess whether changes to the existing network-based location methods are needed and define them if needed

The NTN network based positioning of UE should provide an accuracy comparable with the network based UE location accuracy of terrestrial networks.

For TN/NTN mobility, the UE is not required to connect to both TN and NTN at the same time.

RAN2 to discuss about trigger(s) of TN / NTN mobility, once the Intra NTN mobility has sufficiently progressed. Intra NTN mobility refers to idle and connected mode mobility between NTN cells (e.g. intra or inter satellite).

Transparent HAPS is assumed with the IMT BS on the ground and the HAPS is a relay.

The RAN2 work plan described in [R2-2007565](file:///C:\Data\3GPP\Extracts\R2-2007565%20-%20Rel17%20NR-NTN%20workplan.docx) should be considered as a basis for work

The work plan should be based on the following prioritization principles:

* 1st priority: user plane, control plane (idle and connected)
* 2nd priority: NTN-TN service continuity, network based UE location

Comeback to the discussion on capability of UE to support TN / NTN mobility in the future

## A.2 User plane – RACH & MAC aspects

***RAN2#117-e Agreements***

Agreements via email - from offline 103:

1. During RA procedure for RRC re-establishment procedure, the UE should trigger TA report if an indication is broadcasted by the target cell’s SI.

2. During RA procedure for handover, the UE should trigger TA report if the target cell indicates this in the handover command.

3. Other than re-establishment (TA reporting controlled by target cell's SI) and handover procedure (TA reporting controlled by HO command), TA reporting in connected mode is not controlled by enabling/disabling indication in SI.

4. RAN2 confirms ra-ResponseWindow and msgB-ReponseWindow are not extended in NTN.

5. Existing parameter names are updated to: uplinkHARQ-mode, allowedHARQ-mode, and HARQ mode A/B.

6. A NOTE is added to MAC CR clarifying that prior to starting drx-HARQ-RTT-TimerUL/DL, latest UE-gNB RTT is used to set timer length.

7. MAC does not specify how UE detects a cell originates from a non-terrestrial network.

8. Repetition transmission based HARQ retransmission is always allowed and is explicitly indicated via DCI or semi-statically via RRC signalling (as in legacy). This revises the agreement from RAN2#114e (consensus)

9. DL MAC CE execution delay is not captured in MAC specification (consensus)

Agreements online:

1. RAN2 understanding: UE failing to acquire sufficiently accurate UE location to be used in the calculation of the UE’s Timing Advance value (see TS 38.211 [Y] clause 4.3.1) should not perform any UL transmission. No RAN2 specification impact.

2. "UE-specific TA MAC CE" consists of only one field with length 14 bits (+ 2 reserved bits), which contains the UE estimate of full UE-specific TA

3. "Differential UE-Specific K\_Offset MAC CE" consists of only one field with length 6 bits (+2 reserved bits), which contains the Differential UE-Specific K\_Offset

4. uplinkHARQ-mode and allowedHARQ-mode, if configured, also apply for SRB1 to SRB3

5. Upon reception of configuration or reconfiguration of TA reporting trigger event, if connected mode UE has not reported TA to current serving cell before (during this connection), the UE triggers a TA reporting (can further check this during the implementation in the MAC CR)

6. configuredGrantTimer length shall be extended with higher values (FFS on the actual values)

Agreements via email - from offline 103 - second round:

1. The name “UE-Specific TA MAC CE” is revised to “Timing Advance Report MAC CE”

2. Revise the field description of “UE-Specific MAC CE” as follows: Timing Advance: In FR1, the Timing Advance field indicates the least integer number of slots greater than or equal to the Timing Advance value (see TS 38.211 section 4.3.1). The length of the field is 14 bits.

3. The name “Differential UE-Specific K\_Offset MAC CE” is revised to “Differential Koffset MAC CE”.

4. When HARQ process 0 carries PUSCH transmission scheduled by RAR or PUSCH payload of MsgA, configuration of HARQ mode and allowedHARQ-mode is up to NW implementation, and UE always follows it (no specification impact)

5. Rel-17 NTN session will not further discuss clarification on UE DRX behaviour when PDCCH indicates a UL/DL transmission where drx-HARQ-RTT-TimerUL/DL for the corresponding HARQ process has already been running.

6. In NTN, the UE enters Active Time at the first SR transmission + UE-gNB RTT. The Active Time will continue until no pending SR, and the SR retransmission has no impact on the Active Time. Note: This does not impact UE entering Active Time during UE-gNB RTT offset if triggered due to other reasons (e.g. DRX timers).

7. In CFRA case, DRX Active Time follows legacy behaviour (i.e. UE enters DRX Active Time after successful reception of RAR, and remains in DRX Active Time until a PDCCH indicating a new transmission addressed to the C-RNTI of MAC entity has been received).

8. Upon validity timer expiry, UE shall suspend uplink transmission and re-acquire SI (FFS whether or not UE needs to flush HARQ buffer)

***RAN2#116-bis-e Agreements***

*RACH aspects*

1. Do not support allocating dedicated RA preamble for the RACH procedure triggered by TA reporting.

2. UE does not start or restart the timeAlignmentTimer after the UE reports its TA.

3. NTN specific parameters, e.g. ephemeris, K\_mac, common TA, cell-specific Koffset, network enable/disable TA report, etc., are provided in the new NTN-specific SIB.

4. The MAC CE for differential UE-specific K\_offset has a fixed size of a single octet.

5. Use an eLCID for the MAC CE for differential UE-specific K\_offset

1. priority of the TA report MAC CE is lower than LBT failure MAC CE and higher than MAC CE for SL-BSR prioritized.

2. UE triggers a TA reporting upon reception of configuration or reconfiguration of TA reporting trigger event if the UE has not reported TA before.

3. Other than event-triggered TA reporting, no more triggers are introduced for TA reporting in connected mode.

1. For the TA report triggering event which uses the offset threshold between current information about UE specific TA and the last successfully reported information about UE specific TA, no hysteresis or time to trigger is needed.

2. UE reports Full TA (i.e., T\_TA as defined in the UE’s TA formula). The size of the TA report MAC CE is fixed to two octets.

3. if SA3 will confirm that NTN-specific user consent will the available in Rel-17, the network could at least ask the UE to report its UE location for any reason at any time. FFS if we define an event-triggered reporting of UE location for TA reporting purposes.

*Other MAC aspects*

1. uplinkHARQ-DRX-Mode-r17 controls the DRX behaviour of HARQ processes in the same way for configured grants as for dynamic grants.

1. It is up to network implementation to ensure proper configuration of HARQ feedback (i.e. enabled or disabled) for HARQ processes used by an SPS configuration (no Stage 3 specification impact). FFS if a note in Stage 2 is needed

2. It is up to network implementation to ensure proper configuration of HARQ mode for HARQ processes used by a CG configuration (no Stage 3 specification impact). FFS if a note in Stage 2 is needed

3. For HARQ process(es) configured with HARQ Mode B, blind retransmission relies on UE being in DRX Active Time via other means (i.e. drx-RetransmissionTimerUL is not started).

4. For HARQ process(es) configured with disabled HARQ feedback, blind retransmission relies on UE being in DRX Active Time via other means (i.e. drx-RetransmissionTimerDL is not started).

1. RAN2 understanding is that: in general, all HARQ processes used by an SPS configuration are configured with the same HARQ feedback enabled/disabled state. No specification impact.

2. RAN2 understanding is that: in general, all HARQ processes used by a CG configuration are configured with the same HARQ state (e.g. A or B). No specification impact

1. AllowedHARQ-DRX-LCP also applies to CG

Working Assumption:

1. It is up to NW implementation to properly configure allowedHARQ-DRX-LCP or allowedCG-List for a LCH (e.g. to avoid conflicting configuration) (Comeback if we find a problem in the implementation in the spec)

***RAN2#116-e Agreements***

*RACH aspects*

1. Enhancements for RA type selection in NTN will not be pursued in Rel-17. FFS for BSR

1. Do not mandate Msg3/MsgA or Msg5 to include TA report MAC CE, and whether it can be included depends on the TB size of Msg3/MsgA or Msg5. No spec change is needed for this

2. Reserved LCID is used for the TA report MAC CE.

3. Postpone the discussion on the size of the TA report MAC CE until RAN2 concludes on the content of TA report.

4. RAN2 do not pursue any enhancements to allow inclusion of TA information without extending Msg3 size.

5. Logical channel priority of the TA report MAC CE should be lower than that of “C-RNTI MAC CE or data from UL-CCCH” and higher than that of “data from any Logical Channel, except data from UL-CCCH”.

1. Do not introduce additional enhancement on BSR over 2-step RACH in Rel-17.

1. RAN2 further discuss the exact priority of the TA report MAC CE between “C-RNTI MAC CE or data from UL-CCCH” and “MAC CE for BSR, with exception of BSR included for padding

2. If the reported content of information about UE specific TA is TA pre-compensation value in connected mode, MAC CE is used to report

3. In case UE location information can be reported to network, dedicated signaling is used to configure UE to report the UE location and/or the UE specific TA information for the purpose of TA reporting in connected mode. FFS if both mechanisms are needed in parallel

*Other MAC aspects*

1. The extended values for sr-ProhibitTimer in NTN can include values less than UE-gNB RTT (as in legacy). FFS on the actual values and how this is extended

2. RRC parameter “allowedHARQ-DRX-LCP” is included in LogicalChannelConfig (FFS on the actual name of the parameter)

3. configuredGrantTimer can be extended in NTN. FFS details of when extension is applicable and method of extention.

4. The ConfiguredGrantConfiguration shall allow for up to 32 in nrofHARQ-Processes, and up to 31 in harq-ProcID-Offset and harq-ProcID-Offset2.

5. The SPS-Config shall allow up to 32 for nrofHARQ-Processes, and up to 31 in harq-ProcID-Offset.

6. HARQ feedback shall always be sent for SPS deactivation (i.e. regardless of HARQ feedback enabled/disabled).

1. For HARQ process(es) not configured with DL HARQ feedback enabled/disabled, drx-HARQ-RTT-TimerDL behaves as per legacy.

2. Introduce a new sr-ProhibitTimerExt-r17 IE. Values FFS

3. If uplinkHARQ-DRX-LCP-Mode-r17 is configured, a HARQ process may be mapped to either ‘HARQ mode A’ or ‘HARQ mode B’.

4. uplinkHARQ-DRX-Mode shall be included in PUSCH-ServingCellConfig.

1. If uplinkHARQ-DRX-LCP-Mode-r17 is configured, the following LCH to HARQ process mapping rules are supported:

1) LCH is mapped only to a HARQ process configured with HARQ mode A;

2) LCH is mapped only to a HARQ process configured with HARQ mode B;

3) If an LCH is not configured with a mapping rule, it may be mapped to any HARQ process (HARQ mode A or B).

2. downlinkHARQ-FeedbackDisabled shall be included in PDSCH-ServingCellConfig.

***RAN2#115-e Agreements***

1. UE specific TA reporting during RACH procedure is enabled/disabled by SI (FFS for RACH in connected mode)

1. In the MAC specification section 5.1.5, delay the start of ra-ContentionResolutionTimer by the UE-gNB RTT (i.e. sum of UE's TA and K\_mac)

1. The content of UE specific TA pre-compensation reported in RA procedure using MAC CE is UE specific TA (this can be revisited after receiving RAN1 response).

2. Reporting on the information about UE specific TA in connected mode is supported, FFS via RRC signalling or MAC CE

3. Event-triggers for reporting on the information about UE specific TA in connected mode is supported. FFS on the details. Confirmation by RAN1 is also needed

4. If configured, the UE shall report information of the UE specific TA pre-compensation to the target cell during the random access. FFS if a new indication in RRC reconfiguration with sync is needed or not (besides the SIB indication carried in HO command on whether TA report is enabled/disabled in the target cell).

5. Information about UE specific TA pre-compensation is not reported in RA procedures triggered due to “Request for Other SI”

1. The event-triggers for reporting information about UE specific TA are based on TA values (confirmation from RAN1 is needed)

2. A TA offset threshold can be used for event-triggered reporting, at least the offset threshold can be between current information about UE specific TA and the last successfully reported information about UE specific TA

3. The event-triggers for reporting information about UE specific TA based on time threshold is not supported in NTN.

4. No new indication in RRC reconfiguration with sync is needed to configure the UE to report information about UE specific TA in handover procedure (besides the SIB indication carried in HO command on whether TA report is enabled/disabled in the target cell).

1. Under the work assumption "the UE location information cannot be reported in connected mode", the content of UE specific TA reported in connected mode is UE specific TA pre-compensation(for the details of the TA value, confirmation from RAN1 is needed).

2. If the reported content of information about UE specific TA is UE location information in connected mode, RRC signalling is used to report.

1. Under the work assumption "the UE location information can be reported in connected mode", for TA reporting purposes in connected mode, the network can configure the UE to send either the UE specific TA pre-compensation (for the details of the TA value, confirmation from RAN1 is needed) or the UE location information

Working Assumption: If the reported content of information about UE specific TA is TA pre-compensation value in connected mode, MAC CE is used to report

1. Confirm the RAN2 working assumption that offset to drx-HARQ-RTT-TimerUL length is equal to UE-gNB RTT (i.e. sum on UE's TA and K\_mac).

2. Confirm the RAN2 working assumption that for HARQ processes with DL HARQ feedback enabled, the drx-HARQ-RTT-TimerDL length is increased by an offset equal to UE-gNB RTT (i.e. sum on UE's TA and K\_mac).

3. No new LCP restrictions are introduced for exisiting UL MAC CEs (if new MAC CEs will be introduced we can revisit this)

4. For dynamic grants, each LCH can optionally be semi statically configured (by RRC) to be mapped to one or more HARQ processes (FFS if it's possible to map to more than one HARQ process/ process type. FFS on mapping method). If there is no RRC configuration for this, this mapping has no effect (legacy behaviour applies).

1a. For at least dynamic grants, the network may optionally configure an UL HARQ retransmission state per HARQ process. Two UL HARQ retransmission states are defined in NTN: HARQ state A and HARQ state B (FFS whether "HARQ state A" and "HARQ state B" should be renamed)

1b. HARQ state A/B are defined as follows:

- HARQ state A: length of drx-HARQ-RTT-TimerUL is extended by UE-gNB RTT (i.e. UE PDCCH monitoring is optimized to support UL retransmission grant based on UL decoding result).

- HARQ state B: drx-HARQ-RTT-TimerUL is not started.

2. Configuration of UL HARQ retransmission state is semi-static, signalled via RRC, and the decision and criteria to configure UL HARQ retransmission state is under network control.

3. For dynamic grants, each LCH can be optionally mapped to an UL HARQ retransmission state via semi-static RRC configuration. If there is no configuration, the mapping has no effect (legacy behaviour applies).

4. If HARQ process has not been configured with an UL HARQ retransmission state, new LCH mapping rule has no effect (i.e. UE applies legacy behaviour).

5. The following behaviours are supported for drx-HARQ-RTT-TimerUL in NTN per HARQ process: 1) Timer length is extended by offset; 2) Timer disabled (i.e. not started)

6. UE determines drx-HARQ-RTT-TimerUL behaviour per HARQ process based on configured UL HARQ retransmission state.

7. For HARQ process(es) not configured with an UL HARQ retransmission state, drx-HARQ-RTT-TimerUL and drx-RetransmissionTimerUL behave as per legacy.

1. An UL HARQ retransmission state is configured per HARQ process to support new LCH mapping restriction and proper configuration of drx-HARQ-RTT-TimerUL behaviour.

2. The network may consider delay and reliability characteristics of ongoing services when choosing to configure an UL HARQ retransmission state.

3. Alternative naming for HARQ state A/B can be further considered during stage 3, however UE behaviour in each state should be defined in specification.

4. RAN2 understanding is that UE behaviour in HARQ state A (i.e. extending the drx-HARQ-RTT-TimerUL by UE-gNB RTT) best supports reception of UL retransmission grant based on UL decoding result. (No RAN2 specification impact)

5. RAN2 understanding is that UE behaviour in HARQ state B (i.e. not starting drx-HARQ-RTT-TimerUL) best supports no UL retransmission and/or blind UL retransmission. (No RAN2 specification impact)

1. For HARQ state B, FFS to run drx-RetransmissionTimerUL for blind UL retransmission

2. UE configured with an UL HARQ retransmission state (i.e. A or B) will always act as indicated in a grant/assignment provided during a valid occasion (i.e. subject to legacy restrictions in e.g. MAC and RAN1 specifications). (No RAN2 specification impact)

***RAN2#114-e Agreements***

If enabled by the network, the UE reports information about UE specific TA pre-compensation at the random access procedure (MSGA/MSG3 or MSG5) using a MAC CE. Actual content is FFS and also depends on further RAN1 input (we can revise this whole agreement if RAN1 come to a different conclusion in terms of what needs to be conveyed to the NW)

***RAN2#113-bis-e Agreements***

Legacy mechanism for RA type selection based on RSRP threshold is the baseline for NTN. Optimizations can still be suggested, showing the gain (in any case, any method needs to be combined with RSRP based approach)

Reuse legacy RA type switching mechanism

Extend the timer length of sr-ProhibitTimer (FFS on the details).

RAN2 wait for RAN1’s feedback on UE obtaining UE-gNB RTT

RAN2 wait for RAN1’s progress and postpone the discussion on how to broadcast parameters, if any, for TA pre-compensation.

RAN2 send an LS to RAN1, focusing on below aspects:

- Ask RAN1 to prioritize the TA pre-compensation work on whether and/or what parameters to broadcast for TA pre-compensation, and when broadcasted, how often the broadcasted parameters are expected to change over time;

- RAN2 has agreed to use UE-gNB RTT as the offset to start some UP timers (e.g. drx-HARQ-RTT-TimerDL). Ask RAN1 to provide inputs on (i) how UE acquires UE-gNB RTT and (ii) what additional information needs to be broadcasted other than that for TA pre-compensation, if any.

At least for uplink scheduling adaptations, the UE may report information about the UE specific TA pre-compensation. The exact information and frequency of reports depend on RAN1 outcome. FFS on when/how to report.

The UE reports the UE specific TA pre-compensation during RACH procedure using MAC CE (FFS if this needs to be configured). Actual content is FFS and also depends on further RAN1 input.

It is NW scheduling strategy to avoid NTN UE in HARQ stalling state. From RAN2 perspective, the NW can continuously schedule the UE using one or a combination of scheduling strategies, such as without HARQ retransmissions, or with blind retransmissions, or with HARQ retransmissions based on DL HARQ feedback (or UL decoding result).

RAN2 confirms that in NTN if the UE is in DRX Active Time for any reason, the UE should monitor the PDCCH regardless of whether drx-HARQ-RTT-TimerUL or drx-HARQ-RTT-TimerDL is running or not. No specification change is needed.

RAN2 confirms that in NTN using the value= “zero” for drx-HARQ-RTT-TimerUL and drx-RetransmissionTimerUL is possible. No specification change is needed.

In NTN, The drx-HARQ-RTT-TimerUL is configured per UE DRX group and the behaviour can be configured per HARQ process. FFS the different behaviours and how to indicate the behaviour to the UE and the number of behaviours (e.g., two or more behaviours).

LCP restrictions should be further considered for an UL HARQ process in NTN. FFS if no further LCP restrictions are needed, or if (R16) existing LCP restrictions can be re-used or if new LCP restriction shall be defined for this purpose.

***RAN2#113-e Agreements***

Both Type 1 and Type 2 configured grant are feasible in NTN.

From RAN2’s perspective, no need to modify parameter periodicity of IE ConfiguredGrantConfig to support NTN.

No need to modify maxNrofConfiguredGrantConfig-r16 and maxNrofConfiguredGrantConfigMAC-r16 to support NTN.

UE in NTN can have both 2-step RACH and configured grant configurations at the same time.

For HARQ processes with DL HARQ feedback disabled, drx-HARQ-RTT-TimerDL is not started.

FFS: method(s) to support blind retransmission for HARQ processes with HARQ feedback disabled.

From RAN2 perspective, for HARQ processes where gNB can sends UL grant without waiting for decoding result of previous PUSCH transmission, no new network scheduling restrictions are introduced to schedule subsequent grants (i.e. up to network implementation. (Can come back if we don't find an agreement on p8)

For HARQ processes with DL HARQ feedback enabled, drx-HARQ-RTT-TimerDL length is increased by offset (i.e. existing values within value range increased by offset). RAN2 working assumption: offset is equal to UE-gNB RTT (if RAN1 decides something that requires to change this we can revisit it)

***RAN2#112-e Agreements***

RAN2 working assumption (for RRC idle. FFS for Inactive/Connected): Rel-17 UE with pre-compensation capability obtains UE specific UE-gNB RTT based on its GNSS in LEO/GEO. FFS how this is calculated and what/if anything needs to be broadcasted for the different pre-compensation methods (e.g. common TA) to help the UE to obtain the full UE-gNB RTT.

If the UE-gNB RTT is pre-compensated, preamble ambiguity is not an issue in Rel-17 NTN (i.e. no enhancements are necessary). FFS how and by whom the possibly multiple components of UE-gNB RTT are pre-compensated

From RAN2 perspective, for UE with UE-specific pre-compensation as a baseline it is up to gNB implementation to ensure sufficient time on UE side for the Msg3 transmission.

For UE with pre-compensation capability (at least for the HARQ-feedback enabled case. FFS for HARQ-feedback disabled, if supported), drx-HARQ-RTT-TimerDL is offset by UE-specific RTT (UE-gNB delay) in LEO/GEO. FFS if offset is applied to: 1) the start of the timers or 2) the timer value range (i.e. existing values within value range increased by offset)

From RAN2 perspective, for dynamic grant, one possibility for "enabling"/"disabling" HARQ uplink retransmission at UE transmitter is without introducing an additional mechanism (i.e. gNB can send grant with NDI not toggled/toggled without waiting for decoding result of previous PUSCH transmission). FFS on the handling of RTT timers. Other solutions for enabling/disabling HARQ UL reTX are not precluded

If the start of the ra-ResponseWindow and msgB-ResponseWindow is accurately compensated by UE-gNB RTT, ra-ResponseWindow and msgB-ResponseWindow are not extended in LEO/GEO.

At least the following are FFS in Rel-17 NTN:

• Report UE-calculated TA in e.g. msg3/msg5/msgA

• Enhancements to RSRP-based selection mechanism of 2-step vs. 4-step RACH

• LCP impact caused by disabling HARQ UL retransmission

RAN2 decision on starting ra-ContentionResolutionTimer, ra-ResponseWindow and msgB-ResponseWindow is postponed until further progress in RAN1 regarding UE pre-compensation method and TA estimation accuracy.

***RAN2#111-e Agreements***

From RAN2 perspective, an offset is applied to the start of ra-ResponseWindow in NTN for both LEO and GEO scenarios.

An offset to the start of the ra-ContentionResolutionTimer is introduced for both LEO and GEO scenarios.

Modification of drx-LongCycleStartOffset, drx-StartOffset, drx-ShortCycle, drx-ShortCycleTimer, drx-onDurationTimer, drx-SlotOffset and drx-InactivityTimer is not needed in Rel-17 NTN.

From a RAN2 perspective, for DL, HARQ feedback can be enabled/disabled in Rel-17 NTN, but HARQ processes remain configured. The criteria and decision to enable/disable HARQ feedback is under network control and is signalled to the UE via RRC in a semi-static manner. FFS for UL

At least the following methods to enhance UL scheduling are further studied in NTN: configured grant and BSR over 2-step RACH. (other solutions to enhance UL scheduling are not precluded)

Both 2-step and 4-step RACH are supported in Rel-17 NTN. FFS enhancements to RACH to accommodate the NTN environment.

## A.3 User plane – Other aspects (RLC & PDCP)

***RAN2#115-e Agreements***

1. Introduce a new t-ReassemblyExt-r17 IE, which is optional present for NTN network scenario.

2. Introduce a new discardTimerExt-r17 IE with a new value ms2000 and several spare bits for future extension.

3. RAN2 consider not to extend PDCP t-Reordering timer or use several spare bits in legacy IE to add several greater values up to 4400ms.

***RAN2#114-e Agreements***

The following options are supported for drx-HARQ-RTT-TimerUL in NTN per HARQ process: 1) Timer length is extended by offset; 2) Timer set to zero and/or 3) Timer disabled (i.e. not started). FFS if this is based on explicit configuration or not. We can also come back to see whether both 2 and 3 are needed

RAN2 working assumption: Offset for drx-HARQ-RTT-TimerUL is equal to UE-gNB RTT (if RAN1 decides something that requires to change this we can revisit it).

drx-RetransmissionTimerDL timer length is not extended in NTN.

The drx-HARQ-RTT-TimerUL behaviour applied for each HARQ process is up to the network (e.g. to support NW scheduling strategy to avoid HARQ stalling).

RAN2 Working Assumption: No new CG-specific LCP restriction is introduced for NTN. If a new LCP restriction is agreed for dynamic grant, the proposal does not preclude future discussion on whether it may also apply to configured grant

Repetition transmission based HARQ retransmission is always allowed and is explicitly indicated per HARQ process via DCI (as in legacy).

At least the following options for LCP in NTN are further studied: 1) allowedPHY-PriorityIndex is re-used; and 2) A new LCP restriction is introduced to map LCH to one or more HARQ process(es). FFS if HARQ processes can be classified as having retransmission “enabled” or “disabled” in this case.

***RAN2#113-bis-e Agreements***

1. The UE utilizes the t-Reassembly timer value that does not depend on the time-varying UE-gNB delay.

2. The value range of t-Reassembly shall be extended. The following set of values are possibly added for t-Reassembly timer: {ms210, ms220, ms340, ms350, ms550, ms1100, ms1650, ms2200}. Any other values are FFS.

3. The network can configure the values of PDCP discardTimer and PDCP t-Reordering timer greater than the RLC t-Reassembly timer.

4. Extend the range of the PDCP discardTimer and the PDCP t-reordering timer. One option is to enlarge the set of allowed values for the PDCP discardTimer and the PDCP t-reordering timer. The exact values FFS

***RAN2#112-e Agreements***

RLC t-Reassembly timer needs to be extended in NR-NTN.

There is no need to extend t-PollRetransmit Timer in NR-NTN.

There is no need to extend t-statusProhibit Timer in NR-NTN.

There is no need to extend RLC SN length in NR-NTN

There is no need to extend PDCP SN length in NR-NTN

## A.4 Control plane - Earth fixed moving beams related issues

***RAN2#116-bis-e Agreements***

1. A new NTN-specific SIB is introduced (SIBx), scheduled by SIB1

2. Introduce the following serving cell information to the corresponding SIBx (scheduled by SIB1):

- Ephemeris;

- common TA parameters;

- validity duration for UL sync information;

- t-Service;

- cell reference location;

- Epoch time.

Also send a LS to RAN1 asking whether some parameters might be sent more frequently

3. For quasi-earth fixed cell, same as legacy, UE shall perform neighbour cell measurements of “higher priority NR inter-frequency or inter-RAT frequencies” regardless of the remaining serving time

4. RRC\_INACTIVE mode is supported for NTN

1. Regarding UE-based solution for SMTC adjustments, UE autonomously adjust the SMTCs based on location and ephemeris. FFS whether NW assistance information is provided.

2. UE can know the NW type implicitly no later than SIB1 reception, there is no explicit NW type indication in SIB1.

3. No LS is sent to RAN3 on the support of RRC\_INACTIVE.

1. Update of ephemeris and common TA information does not affect the value tag and does not trigger SI modification procedure.

2. The ntnUlSyncValidityDuration applies to the whole SIBX. UE acquires the updated SIBX when the timer expires. FFS whether to also include it in the LS to RAN1.

3. Location information can be used to determine when to start measurement.

4. UE may choose not to perform neighbour cell measurements of “NR intra-freq or inter-freq with equal or lower priority, or inter-RAT freq with lower priority”, if (the distance between UE and serving cell reference location is shorter than a threshold) and (legacy Srxlev/Squal condition is met, i.e., serving cell’s Srxlev/Squal is better than a threshold).

5. Location-based measurement initiation is only applied if the cell broadcasts location-related parameters (e.g. a threshold) and by implementation the UE has location information.

6. Before the stop-time based measurements are triggered, the UE measurements follow Legacy behaviour (i.e., based on Srxlev/Squal) and there is no measurement relaxation.

7. Cell stop time is not applied to cell ranking in determining the target cell for reselection.

***RAN2#116-e Agreements***

1. There will be max 12 TACs per NR NTN cell, including same or different PLMNs.

***RAN2#115-e Agreements***

1. RAN2 confirms AS indicates to NAS layer all received TACs per PLMN.

2. RAN2 responds to CT1 and SA2 with the confirmation that AS indicates to NAS layer all received TACs per PLMN. In addition it is stated that TACs in NTN are fixed to geographical location on Earth and UE’s location information can be used for TAI selection. Final decision on which criteria to apply (e.g. UE location information or other) is anyway up to CT1 and SA2 judgement

***RAN2#114-e Agreements***

Change in TAC in SIB1 triggers SI update notification procedure as legacy behaviour. It is FFS whether broadcasting TAC update time can also be considered

In rel-17, other enhancements like virtual tracking area concept might be considered with low priority at the end of the WI.

***RAN2#113-bis-e Agreements***

When the network stops broadcasting a TAC, the UE needs to know it (FFS on further details)

RAN2 assume UE does not do TAU if one of the currently broadcasted TAC belongs to UE’s registration area.

RAN2 confirm that in NTN when TAC change in SI happens is up to network implementation, i.e. it may not exactly sync up with real-time illumination on ground.

Send a LS to CT1 and SA2, with Cc RAN3. The content is: currently RAN2 has two options on table, and the preference is “AS indicates all received TACs to NAS layer when more than one TAC per PLMN is broadcasted in NTN cell”, compared to “AS still reports only one TAC to NAS layer”, and ask for CT1’s feedback. Also include justification for RAN2 preference

***RAN2#113-e Agreements***

In NTN, the UE determines the TA based on the broadcast information (the use of other information is not excluded). In any case RAN2 will not go in a different direction than other groups

In NTN, the network may broadcast more than one TACs per PLMN in a cell, which is to up to network implementation.

***RAN2#112-e Agreements***

RAN2 to consider the case where gNB is co-located at the GW with higher priority.

RAN2 will continue working with the assumption that service link switch implies L3 mobility (meaning that at least in case the SSBs are on the same sync raster point the PCIs need to be different). Check if an LS to RAN1 asking for feasibility of having same PCI as well can be agreed

Existing cell reselection principles are considered as baseline and that information about when a cell is going to stop serving the area and information about new upcoming cell can be further considered. In which form and how this is exactly implemented in the cell reselection principles is FFS.

## A.5 Control plane – Idle/Inactive mode aspects

***RAN2#117-e Agreements***

Agreements:

1. Satellite ephemeris based cell reselection is represented by time and location based cell reselection. No further enhancement in this release for ephemeris based cell reselection.

2. No further enhancement on cell reselection priority in NTN. Remove the corresponding FFS from 38.304 CR.

3. No need to provide the timing information about the new upcoming cell for either earth fixed scenario or earth moving scenario in Rel-17.

4. No further enhancement on cell reselection procedure to support TN prioritization over NTN in Rel-17.

5. RAN2 assumes that in addition to the ephemeris information, assistance information is needed for UE-based SMTC adjustment in idle and inactive mode. (FFS on the option to enable this)

6. Adopt the text proposal in R2-2203725 to capture the location based cell reselection agreements in 38.304.

Working Assumption:

1. To prevent non-NTN capable UE from accessing an NTN cell in Rel-17, for NR-NTN RAN2 follows a similar solution as in IoT-NTN (FFS on the details and whether this is always needed or not).

Agreements via email - from offline 102 - second round:

1. The introduction of a distance threshold for cell reselection would not impact the cell reselection priority determination in inter-frequency and inter-RAT cell reselection criteria.

***RAN2#116-e Agreements***

1. Location assisted cell reselection, with the distance between UE and the reference location of the cell (serving cell and/or neighbor cell) taken into account, is supported for quasi-earth fixed cell. FFS on how UE performs location acquisition.

1. When UE uses location based cell reselection enhancements, it's up to UE implementation to guarantee that a valid location information is available

2. For quasi-earth fixed cell, same as legacy, UE shall perform neighbour cell measurements of “higher priority NR inter-frequency or inter-RAT frequencies” regardless of the distance between UE and serving cell reference location.

1. For quasi-earth fixed cell, UE should start measurements on neighbour cells before the serving cell stops covering the current area, regardless of (the distance between UE and serving cell reference location) or (if legacy Srxlev/Squal condition is met, i.e., serving cell’s Srxlev/Squal is better than a threshold).

1. Distance based cell reselection criteria for quasi-earth fixed cell is supported

2. For quasi-earth fixed cell, the cell stop time of neighbour cell(s) is NOT broadcast

***RAN2#115-e Agreements***

1. Broadcast of cell stop time in SIB is only applicable to quasi earth fixed cell (not to moving cell). No further work in this release to address any moving cell specific details on using the cell stop time to assist measurements or cell reselection

2. For quasi-earth fixed cell, the reference location of the cell (serving cell or the neighbor cells) is broadcast in system information

1. For quasi-earth fixed cell, UE should start measurements on neighbour cells before the serving cell stops covering the current area.

2. For quasi-earth fixed cell, the broadcast “timing information on when a cell is going to stop serving the area” refers to the time when a cell stops covering the current area.

3. For quasi-earth fixed cell, specify that UE should start measurements on neighbour cells before the broadcast stop time of the serving cell, i.e. the time when the serving cell stops covering the current area, and the exact time to start measurements is up to UE implementation.

Working Assumption: Location assisted cell reselection, with the distance between UE and the reference location of the cell (serving cell and/or neighbor cell) taken into account, is supported for quasi-earth fixed cell, if UE has valid location information, which means location acquisition will not be triggered at UE side only for location assisted cell reselection. FFS on the details.

***RAN2#114-e Agreements***

At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area is needed to assist cell reselection in NTN for earth fixed scenario.

At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area is used to decide when to perform measurement on neighbor cells.

At least in the quasi-earth fixed case (FFS for moving case), the timing information on when a cell is going to stop serving the area for earth fixed scenario is broadcast to UE via system information.

***RAN2#113-e Agreements***

The NTN ephemeris is divided into serving cell’s ephemeris and neighbour’s ephemeris. FFS how would they differ regarding e.g. the required accuracy or signalling impact.

Consider pre-configuration in uSIM, NAS, SIB and RRC signalling for providing the NTN ephemeris. Further discussion depends on the agreed ephemeris contents.

RAN2 thinks that a UE needs to know whether the network is a TN or NTN no later than SIB1 reception

The information on when a cell is going to stop serving the area and/or the timing information (e.g. timer or absolute time) about new upcoming cell is supported at least in Earth-fixed NTN scenario. FFS if both types of information are needed. FFS if this is known from system information and/or the ephemeris.

***RAN2#111-e Agreements***

Cell selection / reselection in NR is the baseline in NTN idle mode procedure.

Satellite/HAPS ephemeris based cell selection and reselection should be defined for NTN (FFS what the term satellite/HAPS ephemeris actually means). FFS when this ephemeris based cell selection / reselection can be used. FFS whether UE location (and/or other information) based cell selection and reselection should be introduced for NTN

The satellite ephemeris should be provided to UE, at least for Satellite/HAPS ephemeris based cell selection and reselection (FFS what the term satellite/HAPS ephemeris actually means).

The network type (i.e. TN or NTN) should be known to UE. FFS whether to achieve this in an implicit or explicit way.

The existing cell reselection priority configuration can be taken as a baseline in NTN. FFS on any further enhancement.

Postpone the discussion on whether to introduce a new SIB until we have more progress on the content of NTN specific system information.

## A.6 Control plane – Connected mode aspects

***RAN2#117-e Agreements***

Agreements:

1. use CommonLocationInfo from 38.331 for NTN location reporting

2. The ellipsoid-Point IE specified in TS 36.331, TS 37.355 (and TS 23.032) is reused for definitions of reference locations in NR NTN. FFS if ellipsoidPointWithAltitude-r10

3. RAN2 to agree for value range for parameter distanceThresFromReferencex-r17 “Option 2 X bits to cover (0, z km) with linear granularity”.

4. RAN2 to adopt for HysteresisLocation-r17 ”INTEGER (0..32768)” with a granularity of 10 meters, i.e. the actual value is the field value \* 10 meters.

5. Configure a parameter OffsetThresholdTA in IE MAC-CellGroupConfig. FFS name of parameter

6. RAN2 to adopt as values for sr-ProhibitTimerExt-r17: {ms192, ms256, ms320, ms384, ms448, ms512, ms576, ms640}. FFS to add 2xRTT, 2x542 ms.

7. RRC processing delay is not impacted

8. The HARQ-feedbackEnablingforSPSactive-r17 is per BWP.

9. RAN2 should wait RAN1 response before progressing on discussing SIB1 NTN specific content.

10. Current SIBxx serving cell content can be adopted as baseline and RAN2 should wait RAN1 response before progressing on discussing further SIBxx NTN specific content.

11. At least neighbour cell Ephemeris information shall be broadcast. FFS on other information about neighbour cells

12. ntnUlSyncValidityDuration applies both to connected mode and idle mode

Agreements via email - from offline 101 - second round:

1. The ellipsoid-Point IE specified in TS 36.331, TS 37.355 (and TS 23.032) is reused for definitions of reference locations in NR NTN.

2. The following for entering and leaving conditions are agreed:

Inequality D1-1 (Entering condition 1)

Ml1-Hys>Thresh1

Inequality D1-2 (Entering condition 2)

Ml2+Hys>Thresh2

1> consider the leaving condition for this event to be satisfied when condition D1-3 or D1-4 is fulfilled;

Inequality D1-3 (Leaving condition 1)

Ml1+Hys<Thresh1

Inequality D1-4 (Leaving condition 2)

Ml2-Hys>Thresh2

3. Largest value for OffsetThresholdTA should not be larger than 16 ms. FFS Include values smaller than 1ms

4. DiscardTimerExt2 has value 2000ms and 2-3 spare values

5. Values for sr-ProhibitTimerExt-r17: {ms192, ms256, ms320, ms384, ms448, ms512, ms576, ms640, ms1082}.

6. Introduce the RLC t-ReassemblyExt field with values {ms210, ms220, ms340, ms350, ms550, ms1100, ms1650, ms2200}.

7. Introduce an OPTIONAL field configuredGrantTimer-r17 with 8 bits representing values 66, 68, …, 574, 576.

8. Add “The network does not configure the configuredGrantTimer-r17 simultaneously with configuredGrantTimer (without suffix).” to the field description of configuredGrantTimer.

9. Capture the following: For SIBxx field description for ephemeris and common TA:

“This field is excluded when determining changes in system information, i.e. changes of XXX should neither result in system information change notifications nor in a modification of valueTag in SIB1.”

Agreements:

1. Joint time-based and location-based CHO execution triggering for the same candidate cell is not supported in Rel-17 NTN.

2. If the CHO is not executed at T2 (timer associated with this candidate CHO cell) the UE continues to operate in the source cell and evaluates other CHO execution conditions (if configured).

Working assumption:

1. T2 timer is defined as an INTEGER (1..6000), where each step represents 100 ms. Its maximum value corresponds to 10 minutes (600 seconds). FFS whether the maximum value needs to be aligned to the cell stop time

Agreements via email - from offline 108:

1. The maximum supported value for timer T2 is 10 minutes (600 seconds).

2. It is up to UE implementation how the UE evaluates the time- or location-based condition jointly with the RRM event Ax, as long as the UE has RRM measurement results within the time window [T1, T2] or when the location condition is met.

3. The maximum number of MeasIDs to be used for CHO execution triggering in NTN is not increased from 2 to 3.

***RAN2#116-e Agreements***

1. We don't introduce new mechanisms (e.g. based on MAC CE) to activate/deactivate SMTCs for NTN neighbour measurements. Which SMTCs the UE will consider is only based on RRC configuration (UE based solutions are not excluded by this)

1. RAN2 will decide which option to choose for NTN assistance information for SMTC/MG once SA3 feedback on user consent is received.

2. If propagation delay based UE assistance information for NTN SMTC is agreed, it is defined in the form of propagation delay difference.

3. RAN2 assumes FL delay is known to and compensated by the network. RAN2 also assumes the UE needs to have neighbour cell ephemeris for the propagation delay estimation.

4. In NW-based SMTC solution the UE is not allowed to apply shifts to configured SMTCs.

5. Measurement gap related aspects for Rel-17 NTN will be addressed in Rel-17 NTN WI. Coordination and avoiding overlap with other WIs and WGs is recommended.

6. RAN2 will reuse at least the SMTC agreements made for UE assistance information reporting also in the area of measurement gaps for NTN

1. UE assistance information for NTN SMTC adjustments is event-triggered. Details of the triggering event are FFS (pending the decision on supported assistance information type).

2. RAN2 aims to minimize the number of configurable measurement gaps required for monitoring configured SMTCs in NTN. At least gap length and UE capabilities impact the number of required measurement gaps.

3. UE-based solution for SMTC adjustments in NTN is supported for IDLE/INACTIVE UEs. FFS how does the UE perform the necessary shifts in SMTC.

1. In NW-based solution, the network can configure up to 2 SMTCs in parallel and the UE uses all of them, i.e. there is no switching between or activation/deactivation of configured SMTCs. FFS whether this (UE support for 2 SMTCs) requires a UE capability. A UE can optionally indicate support for 4 SMTCs (in this case the NW can configure up to 4 SMTCs in parallel)

***RAN2#115-e Agreements***

Working Assumptions: Combination of serving and target cell reference location is supported for location report trigger event and for CHO location trigger

Working Assumptions: Specify that measurement reports can be configured to be piggybacked with location report when location based event triggers it

1. The following event is supported: condEvent L4: Distance between UE and the PCell’s reference location becomes larger than absolute threshold1 AND the distance between UE and the Conditional reconfiguration candidate becomes shorter than absolute threshold2.

FFS other options

2. Specify hysteresis and time to trigger for the location event for RRM and CHO

3. Timing information from RRCReconfiguration message in RRC running CR is removed

4. UE is allowed to perform HO only during T1 to T2

5. Agree to limit to A or B and continue discussion between options A and B

Option A: UTC time + duration/timer, e.g. 00:00:01 + 40s

Option B: Two UTC time to indicate the start (T1) and end time (T2) of the candidate cell, e.g. 00:00:01 + 00:00:41

1. RAN2 adopts Option 1: UTC time + duration/timer, e.g. 00:00:01 + 40s for representing T1 and T2 for CHO time event.

2. RAN2 adopts options C: location and RRM and D: time and RRM to be configuration options for CHO

3. RAN2 down priorities further enhacnements for connected mode for Rel-17 for TN-NTN mobility

4. RAN2 continue discussing the exact solution for TN priorization over NTN for idle mode

1. The specific maximum number of SMTC configuration in one measurement object with the same ssbFrequency can be 4. And a LS will be sent to RAN4 to confirm the conclusion.

2. In NTN, NW-based solution is supported, i.e. the final SMTC/measurement gap configuration is generated and provided by NW in NTN to a given UE (based on the propagation delay difference between at least one target cell and the serving cell of a given UE). FFS whether UE-based solution is supported or not.

3. In NTN, it is necessary of the UE to report assistant information to the NW (which can be configured by NW or upon NW’s request) to assist NW calculating the offset for SMTC/GAP configurations. FFS the detailed information.

1. The UE can be configured with multiple SMTCs per carrier. FFS if the UE can use only a partial set or all of them in parallel, and in case FFS whether based on network configuration or UE implementation

***RAN2#114-e Agreements***

Support CHO location trigger as the distance between UE and a reference location which may be configured as the serving cell reference location or the candidate target cell reference location. FFS if combination can be allowed.

The reference location for the event description is defined as cell center.

For CHO, joint configuration of location and RSRP as well as time and RSRP triggers are supported.

For idle mode reselection, based on configuration NTN UE can prioritise TN over NTN. Configuration details FFS.

CHO time trigger event is defined as time duration [t1, t2] associated for each CHO candidate cell. The UE shall execute CHO to that candidate cell during the time duration, if all other configured CHO execution conditions will apply and there is only one triggered candidate cell.

Same CHO trigger conditions and RRM events can be used within NTN and NTN-TN mobility provided these are supported by the UE. NTN-TN means both “from NTN to TN (hand-in)” and “from NTN to TN (hand-in) and from TN to NTN (hand-out)". FFS for enhancements.

***RAN2#113-bis-e Agreements***

For Rel-17 NTN, Rel-17 NR operation is enhanced (e.g. the SMTC configuration and UE measurement gap configuration) aiming to address the issues associated with the different/larger propagation delays, and the satellites (considering e.g. their deployment, mobility, height, minimum elevation and prioritizing typical NTN scenarios).

Rel-17 NTN will not rely only on network implementation to address the issue explained in agreement 1.

Enhancements of the SMTC configuration is supported for Rel-17 NTN.

Optional new UE assistance is defined in Rel-17 NTN for network to properly (re)configure the SMTC and/or measurement gap

For Rel-17 NTN, one or more SMTC configuration(s) associated to one frequency can be configured. FFS solution details.

- The SMTC configuration can be associated with a set of cells (e.g., per satellite or any other suitable set per gNB determination).

- The multiple SMTC configurations are enabled by introducing different new offsets in addition to the legacy SMTC configuration. FFS how the offsets will be managed/signalled.

FFS the following open questions:

(a) can the UE be configured with multiple SMTCs per carrier and use them all in parallel?

(b) How the NW knows which SMTC (incl. offsets/periodicity, etc.) is relevant for a particular UE?

(c) Is there any validity: in time or for certain location only, foreseen in such multiple SMTC configuration?

(d) What is the potential impact on the signalling, assuming this delay is a dynamic value?

(e) What about the feeder link delay? Is it considered anywhere?

The configuration of one or multiple offsets is left up to the network implementation.

It is up to network to update the SMTC configuration of the UE to accommodate the different propagation delays.

Measurement gaps enhancements should be supported. FFS on the details

Timing information in CHO execution triggering for NTN describes the time after which the UE is allowed to execute CHO to the candidate target cell.

Working assumption: the timing information for CHO execution triggering in NTN is defined in the form of a timer/timers. This can be revised and a solution based on UTC/system frame number can be considered if problems are found (e.g. if the timer lacks accuracy due to RTT in NTN).

The location in location-based CHO execution triggering for NTN describes the distance between the UE and the reference location of the cell (serving cell or the target cell). FFS what the reference location of the cell is (e.g. cell center or other) and how this is provided to the UE

***RAN2#113-e Agreements***

Support A4 event for NTN CHO. FFS whether other triggers needs to be combined with this.

***RAN2#112-e Agreements***Reconfiguration with sync is the baseline for connected mode mobility in NTN (the use of legacy RLF and re-establishment mechanism are not excluded)

The CHO can be used in NTN for both moving cell and fixed cell scenarios, and the CHO procedure and execution condition defined in Rel-16 is the baseline for NTN CHO.

NTN specific CHO execution condition can be further discussed.

The existing measurement framework (e.g. measurement configuration, execution and reporting) is the baseline, and all the existing measurement criteria and event can be used in NTN. Support for new measurement is not excluded.

Legacy SSB periods (as in TN) shall be supported in NTN

Time or timer based CHO triggering event, in combination with the existing R16 CHO measurement based event, should be introduced for both moving cell and fixed cell scenario. FFS on how to configure the time or timer based CHO triggering event. Also FFS how to consider the feeder/service link switch timing.

DAPS HO for NTN is de-prioritized in this release.

Location based CHO triggering event, in combination with the existing R16 CHO measurement based event, should be introduced for both moving cell and fixed cell scenario. FFS on how to configure the location based CHO triggering event. FFS if location based CHO triggering event only (not in combination with other events) can also be considered.

The Location-based measurement event, in combination with the existing measurement event in NR, should be supported in NTN for both moving cell and fixed cell scenarios. FFS on how to configure the location based measurement event.

RAN2 understanding that UE shall not be forced to detect the SSB burst outside the corresponding configured SMTC window in NTN, just like the principle in TN.

SMTC and gap configuration in NTN are configured based on the timing of PCell

RAN2 can first identify the scenarios and discuss how serious the impact is before addressing any enhancement for SMTC configuration in NTN.

RAN2 can’t assume that the network will always have UE accurate location info for SMTC window configuration in NTN

UE along with the network in NTN should also have the same understanding of the timing, including the timing for measurement gap, to avoid any un-synchronized scheduling between UE and the network, just like the way we have in TN

## A.7 Control plane – LCS aspects

***RAN2#115-e Agreements***

1. If SA3 replies with concern on reporting UE location with any granularity during initial access, RAN2 will revisit agreement/solution for reporting UE location during initial access.

2. UE coarse location information refers to coarse GNSS coordinates (FFS on the details, e.g. X MSB bits out of 24 bits of longitude/latitude or GNSS coordinates with ~2km accuracy). FFS if any enhancements to validate the UE’s coarse location information is needed. FFS whether this is only used in initial access or also in connected

1. If SA3 has no concern reporting coarse location during initial access, the coarse location information is reported in Msg5, i.e., via RRCSetupComplete/RRCResumeComplete message.

2. For coarse UE location reporting during initial access, the location granularity is not indicated to UE via SIB

3. Enhancements to validate the UE ’s coarse location information is not needed from RAN2 perspective. Whether this is needed by the network is up to other WGs.

4. After AS security is established, gNB can obtain a GNSS-based location information from the UE using existing signalling method, i.e., by configuring includeCommonLocationInfo in the corresponding reportConfig. It is up to SA3 to decide whether User Consent is required before NW acquires location information from the UE in NTN. RAN2 discuss whether to send LS to SA3

5. Aperiodic location reporting (e.g., via DCI) is not supported.

Working assumption: Event triggered-based UE location reporting are configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED

1. Send new LS to SA3 for the need of NTN specific user consent for obtaining UE location by gNB."

1. If accepted by SA3, if the gNB has user consent to obtain UE location in NTN, reporting of finer location information/full GNSS coordinates in RRC\_CONNECTED can be supported after AS security is enabled

2. Periodic location reporting can also be configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED. RAN2 discuss whether it is part of existing periodic measurement report configuration or a new configuration for periodic reporting of UE location.

***RAN2#114-e Agreements***

RAN2 will work on a solution to ensure that the CGI constructed by NG-RAN corresponds to a fixed geographical area with a size comparable with a cell for TN including connected mode and initial access.

RAN2 Working Assumption: RAN2 doesn’t need to do anything to ensure that final UE location information at the core network is trustable so far (it's other WGs business to define solutions to verify the UE location).

RAN2 will work on a solution to ensure that the CGI constructed by NG-RAN can correspond to a fixed geographical area comparable with a TN cell with a radius of ~2km or more.

Send an LS to RAN3, SA2, SA3 and SA3-LI to inform them of RAN2 decision and check whether it's consistent with their requirements.

## A.8 UE capabilities

***RAN2#117-e Agreements***

Agreements via email - from offline 104:

1. The SMTC enhancements (event-triggered assistance information reporting, 2 SMTC in parallel) are essential for NGSO capable UEs.

2. Incorporate event-triggered TA reporting feature into TA reporting UE capability defined in RAN1 feature list.

3. Specify single UE capability to represent the support of both UL HARQ state B and the new LCP restriction.

4. Postpone the discussion on NTN SMTC UE capabilities, and if the updated RAN1/4 feature lists during this meeting don’t include NTN SMTC related UE capabilities, RAN2 sends an LS to RAN1/4 for triggering this discussion.

Agreements online:

1. RAN2 understands that in NTN, RTT values are assumed to be longer in the calculation of L2 buffer. No spec change

Agreements via email - from offline 104 - second round:

1. the UE capabilities for time based CHO and Event A4 based CHO are optional with capability signalling.

2. RAN2 confirms that, if UE supports both GSO and NGSO, it means UE also supports mobility between GSO and NGSO.

***RAN2#116-bis-e Agreements***

1. define one single NR NTN UE capability to encompass essential features to support NTN, and UE can further indicate other optional capabilities.

2. gnss-Location-r16 is conditionally mandatory when UE indicates the support of NR NTN access, and update the field description to cover NTN case.

3. consider the following differentiation of user plane enhancements as baseline:

Essential sub-features include:

1) the adaptations of RACH;

2) DRX HARQ RTT timer extension;

3) the timer extension to accommodate long RTT for other MAC timers (e.g., extended sr-ProhibitTimer);

4) the timer extension to accommodate long RTT in RLC and PDCP layers (FFS for LEO)

Optional sub-features include:

1) TA reporting (TA reporting during RACH using MAC CE, and Event-triggers for TA reporting in connected mode);

2) disabling HARQ feedback for downlink transmission;

3) new HARQ state for uplink transmission and the corresponding new LCP mapping rule for dynamic grants.

4. consider the following differentiation of control plane enhancements as baseline:

Essential sub-features include (for NGSO, FFS for GEO):

1) soft TAC update;

2) SMTC enhancements (event-triggered assistance information reporting, 2 SMTC in parallel);

Optional sub-features include:

1) cell stop-time based neighbour cell measurements;

2) location based cell reselection criteria;

3) SMTC enhancements (4 SMTC in parallel and UE based solution in idle/inactive);

4) CHO enhancements (location based CHO).

FFS if CHO enhancements (time based and Event A4 based CHO) is essential or optional

5. Postpone the UE capability discussion on location reporting

Working Assumption (further check if anything can be per band):

1. the granularities of all the optional RAN2 determined sub-features with capability signalling are per UE.

1. RAN2 confirms that the RLC timer extension (i.e., t-Reassembly timer) is also essential for NGSO.

2. RAN2 confirms that the PDCP timer extension (i.e., discardTimer and t-Reordering timer) is also essential for NGSO.

3. RAN2 confirms that Multiple TACs feature (i.e., UE should be able derive multiple TACs per PLMN in a cell, and indicate to NAS layer all received TACs per PLMN) is essential for both GSO and NGSO.

4. The support of essential NTN features should be the Prerequisite for optional NR NTN UE capabilities.

1. Define single UE capability to encompass all features essential to support both GSO and NGSO, i.e., when UE indicates it, it means UE supports all the GSO and NGSO essential features (FFS for SMTC enhancements). (this does not automatically mean that interoperability testing between GSO and NGSO is also supported)

2. UE capabilities for optional CHO enhancements (at least location based CHO) for NTN are per band, which is also in line with R16 CHO design

# B Appendix: Who to contact about their comments

|  |  |  |  |
| --- | --- | --- | --- |
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***END***