**3GPP TSG-RAN WG2 Meeting #124 *R2-*** ***2313771***

**Chicago, United States, 13th Nov 2023 - 17th Nov 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.300** | **CR** |  **0734** | **rev** | **1** | **Current version:** | **17.6.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network | **X** | Core Network |  |

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|  |
| ***Title:***  | Introduction of NTN enhancements |
|  |  |
| ***Source to WG:*** | THALES (Rapporteur) |
| ***Source to TSG:*** | RAN2 |
|  |  |
| ***Work item code:*** | NR\_NTN\_enh-core |  | ***Date:*** | 2023-11-20 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | Introduction of Release 18 enhancements for Non-Terrestrial Networks |
|  |  |
| ***Summary of change:*** |  Update of specific NTN architecture and protocols aspects for Release 18 include:* Support for NR NTN coverage enhancements
* Add the Verification of UE location
* Support of mobility enhancements for TN-NTN, RACH-less HO, CHO, satellite switch with re-sync
* Add statements capturing the RAN3 agreement on using Uu Cell ID
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|  |  |
| ***Consequences if not approved:*** | There is no support for enhanced NTN |
|  |  |
| ***Clauses affected:*** | 2, 7.3.1, 16.14.3.1, 16.14.3.2.1, 16.14.3.2.2, 16.14.3.3, 16.14.5, 16.14.6, 16.14.3.2.Y, 16.14.X, 16.14.Z |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 38.304 CR 0357TS 38.305 CR …TS 38.321 CR 1716TS 38.331 CR 4501TS 38.413 CR 1008TS 38.423 CR 0933 TS 38.455 CR 0125TS 37.355 CR 0482 |
| ***affected:*** |  | **x** |  Test specifications |  |
| ***(show related CRs)*** |  | **x** |  O&M Specifications |  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | R2-2306960 endorsed at RAN2#122; R2-2309329 endorsed at RAN2#123; R2-2311255 endorsed at RAN2#123-bis; R2-2312858 endorsed at RAN2#124 |

*First Modified Subclause*

# 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".

[45] 3GPP TS 23.247: "Architectural enhancements for 5G multicast-broadcast services; Stage 2".

[46] 3GPP TS 26.346 "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs".

[47] 3GPP TS 23.122: "Non-Access-Stratum (NAS) functions related to Mobile Station (MS) in idle mode".

[48] 3GPP TS 23.304: "Proximity based Services (ProSe) in the 5G System (5GS)".

[49] 3GPP TS 28.541: "5G Network Resource Model (NRM)".

[50] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[51] NIMA TR 8350.2, Third Edition, Amendment 1, 3 January 2000: "DEPARTMENT OF DEFENSE WORLD GEODETIC SYSTEM 1984".

[52] 3GPP TS 38.211: "NR; Physical channels and modulation".

[53] 3GPP TS 24.587: "Vehicle-to-Everything (V2X) services in 5G System (5GS)".

[54] 3GPP TS 23.041: "Technical realization of Cell Broadcast Service (CBS)".

[55] 3GPP TS 24.554: "Technical Specification Group Core Network and Terminals; Proximity-services (ProSe) in 5G System (5GS) protocol".

[x] 3GPP TS 38.215: "NR; Physical layer measurements".

 *Next Modified Subclause*

### 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 or when the UE configured with inter cell beam management is receiving DL-SCH from a TRP with PCI different from serving cell's PCI). 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;

- *SIB15* contains information related to disaster roaming;

*- SIB16* contains slice-based cell reselection information;

- *SIB17* contains information related to TRS configuration for UEs in RRC\_IDLE/RRC\_INACTIVE;

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

- *SIB18* contains information related to the Group IDs for Network selection (GINs) associated with SNPNs listed in SIB1.

*- SIB19* contains NTN-specific parameters for NTN neighbour cells as defined in 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:

- *SIB19* contains NTN-specific parameters for serving cell and optionally NTN-specific parameters for neighbour cells as defined in TS 38.331 [12].

- SIBxx contains TN coverage are information as defined in TS 38.331 [12].

For MBS broadcast, Other SI also includes:

- *SIB20* contains MCCH configuration;

- *SIB21* contains information related to service continuity for MBS broadcast reception.

Figure 7.3.1-1 below summarises System Information provisioning.



Figure 7.3.1-1: 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.

If the UE is configured with inter cell beam management:

- the UE is not required to acquire the SI from the serving cell while it is receiving DL-SCH from a TRP with PCI different from serving cell's PCI.

*Next Modified Subclause*

### 16.14.X Support for NR NTN coverage enhancements

To improve NR uplink coverage in NTN, the following enhancements are supported:

- PUCCH repetition for Msg4 HARQ-ACK configured in system information or dynamic in DCI for Msg4 when multiple repetition factors are configured in the system information.

- UEs reports the capability of PUCCH repetition for Msg4 HARQ-ACK in Msg3 PUSCH.

- When Msg4 HARQ-ACK is repeated, PUCCH repetition is applied for all PUCCH transmission before dedicated PUCCH resource is provided.

- Improved channel estimation by NTN-specific PUSCH DMRS bundling enhancement that enables DMRS bundling in presence of timing drift, where the UE can maintain phase continuity by considering effects of transmission delay variation between the UE and the uplink time synchronization reference point.

*Next Modified Subclause*

### 16.14.3 Mobility and State transition

#### 16.14.3.1 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 (TACs) per PLMN in an 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.

For the NTN-TN mobility, the network may broadcast cell information on NR TN and EUTRA TN coverage areas in SIBxx. This is supported for Earth-Fixed, Quasi-Earth-fixed and Earth-Moving cells. The coverage information consists in a list of geographical TN areas, with associated frequency information also indicated. UE can skip TN measurement based on the broadcast TN coverage information.

The UE can determine the network type (terrestrial or non-terrestrial) implicitly by the existence of *cellBarredNTN* in SIB1.

The NTN ephemeris is provided in SIB19. It includes serving cell's NTN payload ephemeris and optionally neighbouring cell's NTN payload ephemeris. SIB19 can be broadcasted in TN cells to provide satellite assistance information for NTN neighbour cells.

#### 16.14.3.2 Mobility in RRC\_CONNECTED

##### 16.14.3.2.1 Handover

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

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

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

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

UE may support mobility between gNBs operating with NTN payloads in different orbits (e.g., GSO, NGSO at different altitudes).

RACH-less handover [6] is supported in NTNs.

##### 16.14.3.2.2 Conditional Handover

The same principle as described in 9.2.3.4 applies to NTN unless hereunder specified.

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

- The RRM measurement-based event A4;

- A time-based trigger condition;

- A location-based trigger condition.

Time-based or location-based trigger conditions may be configured independently from the measurement condition for CHO in NTN in at least hard satellite switch case where the service discontinuity gap time length is assumed to be zero or negligible. Otherwise, a time-based or a location-based trigger condition is always configured together with one of the measurement-based trigger conditions (CHO events A3/A4/A5) as defined in TS 38.331 [12].

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

When a time-based trigger condition is used, the source gNB may signal the corresponding parameters to a single target gNB via the Source NG-RAN Node to Target NG-RAN Node Transparent Container in an NG-C based handover, see TS 23.502 [22]. The source gNB signals the corresponding CHO configuration to the UE in the RRC Reconfiguration message during handover execution.

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

Time-based CHO can be performed via RACH-less.

##### 16.14.3.2.Y Satellite switch with re-sync

Upon both hard and soft satellite switch over in the quasi-Earth fixed scenario with the same SSB frequency and the same gNB, the satellite switch with re-sync procedure is supported. The satellite switch with re-sync avoids a L3 mobility for UEs in the cell by maintaining the same PCI on the geographical area covered by quasi-Earth fixed beam. CHO can be configured simultaneously with the satellite switch with re-sync procedure.

For soft satellite switch over, the UE can start synchronizing with the target satellite before the source satellite ends to serve the cell. It is not required for the UE to be connected to source satellite when the UE switches to target satellite.

#### 16.14.3.3 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;

- measurement gaps based on multiple SMTCs;

- assistance information (e.g., ephemeris, Common TA parameters, $k\_{mac}$) provided in SIB19 for UE to perform measurement on neighbour cells in RRC\_IDLE/RRC\_INACTIVE/RRC\_CONNECTED.

NW-controlled adjustment of SMTCs can be based on UE assistance information reported in RRC\_CONNECTED. A UE in RRC\_IDLE/RRC\_INACTIVE can adjust SMTCs based on its location and assistance information in SIB19.

UE assistance information consists of the service link propagation delay difference(s) between serving the cell and neighbour cell(s).

For a UE in Idle/Inactive mode it's up to UE implementation whether to perform NTN neighbour cell measurements on a cell indicated in SIB3/SIB4 but not included in SIB19.

For a UE in Connected mode, it's up to UE implementation whether to perform NTN neighbour cell measurements on a cell included in the measurement configuration but not included in SIB19.

UE can perform time-based and location-based measurements on neighbour cells in RRC\_IDLE/RRC\_INACTIVE:

- The timing and location information associated to the serving cell is provided in SIB19;

- Timing information refers to the UTC time when the serving cell stops serving the current geographical area;

- Location information refers:

- In the quasi-Earth fixed cell scenario, to the reference location of the serving cell and a distance threshold to the reference location.

- In the Earth moving cell scenario, to the reference location of the serving cell at the epoch time and a distance threshold to the reference location.

The time-based measurement initiation may be applicable for the feeder link switchover case for cell (re)selection.

Measurement rules for cell re-selection based on timing information and location information are specified in clause 5.2.4.2 in TS 38.304 [10].

*Next Modified Subclause*

### 16.14.5 NG-RAN signalling

The Cell Identity, as defined in TS 38.413 [26] and TS 38.423 [50], 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 identity used in the NG and Xn handover messages, Xn Setup and Xn NG-RAN Node Configuration Update procedures is expected to be Uu Cell ID.

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

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

NOTE 2: A specific geographical location may be mapped to multiple Mapped Cell ID(s), and such Mapped Cell IDs may be configured to indicate differerent geographical areas (e.g. overlapping and/or with different dimensions).

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

NOTE 3: 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. Special Mapped Cell IDs or TACs 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.

*Next Modified Subclause*

### 16.14.6 AMF (Re-)Selection

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

For an RRC\_CONNECTED UE, when the gNB is configured to ensure that the UE connects 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).

For the purpose of selecting an appropriate AMF, the 5GC may verify the UE location according to TS 23.501 [3] and TS 38.305 [42] after the UE has attached to the network.

NOTE: UE location verification for AMF selection should not be necessary if NTN cell(s) do not extend across countries.

*Next Modified Subclause*

### 16.14.Z Verification of UE location

For UE location verification based on multi-RTT with single satellite in NTN, at least the following UE and gNB measurements specified in [x] are reported: gNB receive-transmit time difference at the uplink time synchronization reference point, UE receive-transmit time difference, UE receive-transmit time difference subframe offset and DL timing drift.

The assistance information provided to the CN may include ephemeris information including accurate satellite position and velocity at the time of multi-RTT measurement, and common TA parameters (ta-Common, ta-CommonDrift, ta-CommonDriftVariant), and Epoch time.

*End of Changes*

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

# A Appendix: RAN2 agreements for WI NR-NTN\_Core

## Coverage enhancements

**RAN2#119-e**

RAN2 understands that, based on the WID, only solutions that address the NTN specific characteristics (e.g. related to propagation delays, coverage loss, satellite movement) should be considered. But the identified solutions could then also be applicable to other cases (TN networks). In any case this will be discussed case by case (this understanding is not meant to change the WID description)

**RAN2#119-bis-e**

RAN2 thinks a UE may use application layer frame aggregation by implementation (no RAN2 spec impacts). (RAN2 can further discuss whether RAN needs to know whether UE is using frame aggregation in the voice packet)

RAN2 understands that it is up to network implementation to decide whether to configure SDAP header and integrity protection for a VoNR DRB to reduce the protocol overhead (no RAN2 spec impacts)

**RAN2#120**

From RAN2 perspective we don’t consider msg3 repetition enhancements in R18 NR NTN (apart from msg3 for CFRA, if decided by RAN1)

RAN2 will consider enhancements to enable initial blind Msg3 retransmission grant reception in Rel-18 NTN

RAN2 doesn’t consider using shorter PDCP SN for VoNR in NTN.

Using RLC TM mode for VoNR in NTN is not supported.

RAN2 doesn’t consider MAC enhancement to reduce MAC header size for VoNR in NTN

RAN2 will not specify signalling whereby the RAN knows the UE’s frame aggregation information in a voice packet

**RAN2#121-bis-e**

Rel-18 NTN coverage enhancements work will focus on addressing the RAN2 impact (if any) from RAN1 agreements on PUCCH enhancements for MSG4 HARQ-ACK and DMRS bundling for PUSCH. No further enhancements are pursued in this release

**RAN2#123**

RAN2 confirms that the request/capability of PUCCH repetition for Msg4 HARQ-ACK via Msg3 higher layer signaling is feasible (can rediscuss if we cannot converge on a specific solution).

**RAN2#123-bis**

RAN2 continues to focus on a solution to address PUCCH repetition for Msg4 HARQ-ACK in Msg3 only for random access procedure triggered by RRC connection establishment, RRC connection re-establishment or RRC connection resume, i.e. to CCCH/CCCH1 (in the future we can consider random access during RRC connected, depending on RAN1)

No explicit NW indication to enable/disable PUCCH repetition for Msg4 HARQ-ACK besides the needed signalling for number of repetition, RSRP configuration in SIB (meaning that if these parameters are signalled, PUCCH repetition for Msg4 HARQ-ACK is enabled)

**RAN2#124**

Use the LCID codepoint within the Rel-18 extension space to indicate the request/capability of PUCCH repetition for Msg4 HARQ-ACK.

Feature combination of NTN, RedCap and eRedCap should be supported for Msg3-based early indication via LCID: 6 LCID codepoints will be specified for this in Rel-18

## Network verified UE location

**RAN2#119-e**

The UE location information is considered verified if the reported GNSS position is consistent with the network based assessment to within 5-10 km (similar to terrestrial network macro cell size) (it is assumed that there is no RAN2 spec impact due to this)

RAN2 should consider, as starting point, the re-use of the LCS framework of the LMF network for the network verification procedure. Send an LS to SA2 indicating RAN2 assumption on this

The network verification of the UE reported location may combine one or several 3GPP defined RAT dependent positioning methods (e.g. Multi RTT, DL/UL-TDOA, DL-AoA, NR E-CID, etc.).

**RAN2#119-bis-e**

RAN2 assumes that the network is able to compute possible UE locations independently from the GNSS location reported by UE

RAN2 assumes that the UE location verification procedure can be triggered by the CN and it is up to the CN to decide when to trigger the procedure

RAN2 should consider in priority the NGSO case with earth moving and earth fixed beams for the definition of the UE location verification procedure

Multi-connectivity involving multiple NTN NG-RAN nodes or NTN NG-RAN node and TN NG-RAN node is not part of the Rel-18 study on UE location verification

RAN2 assumes that the verification of the consistency (within 5-10 km) between the actual reported UE location with the UE location(s) computed by the network is up to the 5GC. (this doesn’t mean that RAN2 has nothing to do for this WI objective)

**RAN2#120**

From RAN2 point of view, assuming the NW may allow the UEs access to services before verifying the UE reported location, the latency of the NW verification can be handled by the NW

RAN2 agrees the re-use of the LCS framework of the LMF for the network verification of UE reported location information in NTN.

RAN2 will work on the details of radio protocol aspects of the verification procedure based on the solution investigated by RAN1

**RAN2#121**

For network verified UE location, the verification procedure can only be triggered by the CN.

Network initiated verification procedure can be triggered by the NW when the UE is in RRC Connected. FFS whether the NTN UE can perform/report measurements also when in Inactive state.

RAN2 will not specify an AS mechanism to prevent UEs not supporting the required RAT dependent positioning methods to access the network

RAN2 assumes that, as a baseline, legacy signalling procedure of location service can be reused for the purpose of network verified UE location in NTN

RAN2 assumes that in general the mirror point issue can be resolved by properly configuring neighbor cell measurement to UE, for example, measurement of two neighbor cells in the opposite side of a satellite beam. FFS if there are any cases that require anything in the specs

**RAN2#121-bis-e**

NTN UE doesn’t support positioning measurement and report in RRC INACTIVE

**RAN2#122**

In order to resolve the mirror point ambiguity issue, the network relies on the legacy signaling and procedure to configure NTN UE to measure and report neighbor cells or reference signals/beams. No spec changes to radio interface are needed from RAN2 perspective. Unclear if changes are needed to other interfaces, NRPPa protocol (RAN2 will no longer discuss this)

**RAN2#123**

A Rel-18 UE capability is needed for indicating whether UE supports the feature of network verified UE location in NR NTN network (FFS whether this is an additional capability on top of FG 44-3)

RAN2 assumption is that how the network handles the access to NR NTN cells for R18 UEs that do not support the new Rel-18 NR NTN “network verified UE location” capability is up to NW implementation, with no need for specs impact (RAN2 can still introduce needed changes to RAN2 specs for this, if requested by other groups)

**RAN2#123-bis**

Add in NR-Multi-RTT-SignalMeasurementInformation the measurements relevant to RAN1 agreed offset (e.g., the actual index difference between subframe j and subframe i and the DL timing drift due to Doppler over the service link associated with the UE RX-TX time difference measurement period) with detailed definition referred to RAN1 agreements.

Ephemeris and corresponding time information (e.g., epochTime) is not provided by the UE. How this is provided to the LMF is up to RAN3 (can come back to see whether the problem that the UE could use a different ephemeris – and then should report it back to the gNB – is a valid case to consider)

RAN2 assumes that FG 44-3 should be an LPP capability to be reported to the LMF (no need for other capabilities)

RAN2 understands that to solve the mirror point issue, the measurements reported by RAN should include the information of the cells on the opposite side

Send LS to RAN3 clarifying the scenarios of satellite switch cases and ask them how to handle it. Ask question whether existing cause value can be used to handle the satellite switch specially in case of RAN node has not changed.

Include in the LS the RAN2 assumption that we expect no LPP impact (in HO/satellite switch). It is up to RAN3 to decide if any NRPPa signaling update is needed.

**RAN2#124**

Legacy procedure can be reused to indicate the LMF about the happening of CHO.

## NTN-TN and NTN-NTN mobility and service continuity enhancements

**RAN2#119-e**

RAN2 to work on a solution so that measurements for TN’s coverage are performed only when relevant (FFS what relevant means).

RAN2 to work on assistance information that can be provided to NTN UEs for the above.

Cell reselection enhancements (for both NTN-NTN and NTN-TN mobility) are considered for both Earth-moving and (quasi-)Earth-fixed scenarios, at least via the use of system information for broadcasting necessary parameters (dedicated signalling is not precluded). FFS whether the same or different solutions are used for Earth-moving and (quasi-)Earth-fixed scenarios

**RAN2#119-bis-e**

For NTN-NTN cell reselection with earth moving cell, RAN2 will consider providing parameters of serving cell to UE, for UE to estimate when the serving cell stops providing coverage at the present UE location (FFS whether this will be an optional UE feature) (this does not exclude any time-based or location-based approach) (other solutions can also be considered)

To enhance NTN-TN cell reselection, means are defined for a UE to differentiate when camping in an area only covered by NTN network (earth-moving or earth-fixed) vs an area where TN network(s) is/are also available.

System information is the basic means for providing necessary parameters to assist UE to estimate when the serving cell stops providing coverage at the present UE location.

UE is not required to perform neighbour cell measurements for TN neighbour cells in an area where there is no TN network coverage.

The method of detecting the transmission energy or SIB presence to determine the NTN coverage when a UE currently camps on a TN cell is not pursued.

In Earth-moving cell, the reference location and distance threshold of serving cell are provided by network for UE to estimate when the serving cell stops providing coverage at the present UE location. FFS how the reference location and/or distance threshold are provided to the UE

RAN2 can further consider whether some information in the handover command that can be common to all UEs, can be delivered to UEs in common signalling and if there is real benefit (in terms of signalling overhead reduction) in this

Send an LS to RAN1 (cc RAN4) listing the scenarios (intra-satellite, inter-satellite with same or different feeder links) and check with RAN1 in which scenarios RACH-less is possible (with no indication of RAN2 preference)

Continue the discussion (in future meeting) on group HO / “UE specific pre-configuration of the target cell + group HO” indication in the next meeting, also on the possible real benefits

RAN2 confirms that at least for the moving cell case the next serving cells can be largely predicted in NTN (at least for UEs not at the cell edge) thanks to the existence of predefined satellite orbits and negligible UE’s mobility in comparison to satellite’s motion (we can further discuss at the next meeting whether this applies to idle mode UEs as well)

New Proposal 2: RAN2 continues the discussion (e.g. at RAN2#120) on the solution with keeping the same PCI after switching of the satellites. Clarify at least the following:

* RAN1 impact
* The need to perform UL beam switching and/or RA
* Applicability to hard or soft satellite switching

**RAN2#120**

RAN2 will first continue the investigation on the details of the TN coverage data (e.g. accuracy requirements for describing where TN network(s) is/are available) and UE storage overhead before deciding how to send the information to the UE.

Continue the discussion on whether to introduce explicit indication to identify TN cells from inter-frequency list and inter-RAT frequency list (FFS on the granularity) or whether we rely on implicit information.

**RAN2#121**

TN coverage area information will be associated to the frequency information.

RAN2 adopts explicit description of geographical TN area, and focuses on the following options for further discussion, taking the signalling overhead into account (FFS on the accuracy of the information):

 Option 1: The corresponding geographical area information is provided by network with location coordinates of area center and radius.

 Option 2: a boundary line is provided by network in the format of a list of location coordinates, additionally an indication can be used to indicate which side is the TN side

 Option 6: for each TN area, a list of locations is provided by network, and the corresponding close shape could be illustrated by a polygon connecting these points within the list.

As a baseline, broadcast signalling is used to provide the information on the TN coverage area for UEs supporting NTN.

Also based on the signalling overhead of the broadcast solution, RAN2 will further consider the option that UE-specific update can be optionally be provided via dedicated signalling, overriding the broadcast configuration (FFS if via RRC or higher layers. FFS on the validity time, if provided by RRC)

We don’t introduce additional cell reselection prioritization rules for NTN vs TN in Rel-18 (e.g. per service type, per mobility state, or per UE type) on top of what specified in Rel-17

In R18, for earth-moving system, satellite with steerable beam is not considered as part of mobility enhancement in NTN.

A serving cell reference location and a distance threshold/radius will be broadcast for earth-moving cell. FFS on whether the R17 IEs are reused or not. FFS on whether additional information needs to be broadcast to inform the UE how the reference location moves over time or if this can be derived from other information (e.g. Epoch time and ephemeris).

For cell selection/reselection, location-based measurement initiation is supported in earth-moving cell

For earth-moving cell, the location-based cell measurement rules of quasi-fixed cell is reused, i.e., for cell reselection in earth-moving cell, UE initiates measurements when its location to serving cell reference location is larger than the configured distance threshold.

Continue in the next meeting, to show the possible signalling gain of the proposal to have some common (C)HO configuration. FFS the number of cells that could be signalled. FFS whether broadcast or groupcast signalling could be used.

For location-based CHO for earth-moving cells we follow the solution being investigated for cell reselection to allow the UE to derive the serving cell’s reference locations as the cells move. FFS whether the same mechanism can also be used for the candidate cell’s reference location

Support RACH-less Handover in Rel-18.

RACH-less Handover in NR NTN is a L3 mobility procedure (FFS if this is combined with the unchanged PCI approach, if supported) and uses the LTE’s RACH-less Handover procedure as a baseline. FFS on TA acquisition

In NTN RACH-less handover, network indicates (implicitly or explicitly) whether NTA in the target cell is identical to the source cell or explicitly provided by the NW.

Support dynamic grant from the target cell for RACH-less PUSCH transmission to reduce random access congestion in the target cell. FFS whether to limit the solution to same feeder link/gateway scenario

**RAN2#121-bis-e**

For signaling the TN coverage, the corresponding geographical area information is provided by broadcast signalling by the network via a list of (possibly overlapping) areas where each area is defined using center location coordinates + radius (where the area is meant to describe a group of cells, not just a single one). FFS on the SIB. FFS on whether additional information in dedicated signalling is needed/useful

Area center location and its radius for TN coverage information is signalled using Ellipsoid-Point and radius separately. FFS if Rel-17 referenceLocation and distanceThresh are directly reused

Decision on the size of TN coverage area list is postponed until more is known on the format of this information and how is it sent.

The discussion on how to indicate the frequency information for each TN coverage area should be combined with the discussion on which SIB will be used to indicate the TN coverage area, possibly based on evaluation of the signalling overhead

The acquired TN area coverage information remains valid until the next system information update of the SIB including TN coverage info

On a frequency band number shared by TN and NTN (e.g., n1), if NTN-specific assistance information is NOT provided for a neighbour cell configured in SIB3/SIB4, UE assumes this is a TN neighbour cell. This understanding is also applicable for Rel-17 and it does not need any spec update

RAN2 understands that for earth-moving cell reselection, the UE can derive the trajectory of serving cell with rough accuracy based on serving satellite ephemeris and epochTime, with the assumption that the serving cell reference location broadcast by the network is the one at Epoch time (FFS whether a new epochTime IE is needed). RAN2 understanding is that both PVT and orbital parameters can be used for this. FFS if additional information is needed to allow more accurate measurements.

For earth-moving cell, new IE is introduced to indicate the reference location of serving cell.

For cell (re)selection in earth-moving system, a distance threshold is introduced for location-based measurement initiation, which reuses distanceThresh in SIB19.

For cell (re)selection in earth-moving system, time-based measurement initiation is used to address feeder-link switch case.

Time-based cell reselection criteria is not pursued in R18.

In Rel-18 we don’t aim at RACH-less HO for NTN-TN mobility

For initial UL transmission in RACH-less HO, support pre-allocated grant in RACH-less HO command

NTN RACH-less HO is supported for Intra-satellite handover with the same feeder link. i.e., with same gateway/gNB;

NTN RACH-less HO can be supported for intra-satellite handover with different feeder links, i.e., with gateway/gNB switch, inter-satellite handover with gateway/gNB switch, and inter-satellite handover with same gateway/gNB.

RAN2 confirms the general UE procedure for NTN RACH-less HO

1. receive a RACH-less HO command which can include pre-allocated grant optionally. FFS N\_TA is optional. (RRC)
2. start timer T304 for the target cell (RRC)
3. perform DL and UL synchronization, and start timer T430. FFS how to perform RACH-less UL synchronization to NTN target cell. (RRC, MAC)
4. start time alignment timer (MAC)
5. monitor target cell PDCCH for dynamic grant if pre-allocated grant is not configured in RACH-less HO command (MAC, PHY)
6. send initial UL transmission including RRCReconfigurationComplete message using the available UL grant (RRC, MAC, PHY)
7. consider RACH-less HO is completed upon receiving NW confirmation. FFS how to confirm RACH-less HO is successfully completed. (RRC, MAC)
8. stop timer T304 for the target cell. (RRC)

The pre-allocated grant is provided as type-1 CG

Send an LS to RAN1 informing RAN2 agreements on NTN RACH-less HO and check RAN1 views on the following aspects:

* whether the pre-allocated grant is provided with association to SSBs; if so, whether a RSRP threshold is configured for SSB selection.
* to monitor target cell PDCCH for dynamic grant for initial UL transmission, whether beam indication can be provided in RACH-less HO command.
* power control for initial UL transmission

At least for pre-allocated grant, for the confirmation of RACH-less HO completion we reuse of LTE approach, i.e., UE Contention Resolution Identity MAC CE is used but UE ignores the content of this field. FFS if anything else is needed for dynamic grant

Consider to support combining RACH-less HO with time-based CHO for NTN, taking into account the 1) validity of pre-allocated grant and potential waste of reserved resource; 2) when/how to provide dynamic grant in PDCCH.

In quasi-earth fixed cell case, for hard satellite switch in the same SSB frequency and same gNB (no key change), satellite switching without PCI changing (not requiring L3 mobility) is supported, unless major technical issues are identified by RAN1 (as usual RAN2 will aim at minimizing the specification impact so that it fits in Rel-18)

Remove the part in brackets “as usual RAN2 will aim at minimizing the specification impact so that it fits in Rel-18” in the LS to RAN1. The action to RAN1 will also ask for feedback for the hard satellite switch (not only the soft satellite switch case), e.g. action to RAN1 is to see if there are any major technical issues (as in the agreement).

**RAN2#122**

An RRC\_IDLE/RRC\_INACTIVE UE is not required to perform neighbour cell measurements for cell reselection for a TN frequency in the area, if configured, where there is no coverage of that frequency, regardless of the frequency priority.

Reuse the same format of Rel-17 referenceLocation and distanceThresh for signaling the TN coverage area centre and radius.

TN coverage info is NOT included in SIB19. FFS if we use an existing SIB or a new one.

We don’t introduce RRC dedicated signalling to provide more accurate TN coverage information.

We no longer consider option 3 from R2-2306643 alone for signaling the frequency information for TN coverage area (in case option 3 should be combined with option 1). Come back in the next meeting to decide between option 2 (plus possible fixes if needed) and option 1+3.

Re-use epochTime-r17 in ntn-Config IE to provide the time reference for an Earth moving cell reference location.

Re-use t-Service-r17 format for the IE used to trigger UE neighbour cell measurements prior to cell replacement due to feeder link switch. FFS whether we reuse exactly the same IE name as in R17 (updating the field description) or a new one.

Location-based cell reselection criteria are not pursued in R18.

Come back to the proposal to broadcast the target cell’s servingCellConfigCommon (as common (C)HO signalling) after feedback from RAN3.

Send al LS to RAN3 asking whether, in case target cell’s servingCellConfigCommon is broadcast in the source cell (as common (C)HO signalling), the target cell’s servingCellConfigCommon can be transferred to the source cell in the inter-gNB HO case in R18.

Group handover related to P1~P4 from R2-2304736 is not supported in Rel-18.

In NTN RACH-less handover, NW either indicates NTA in the target cell is identical to the source cell, or the NTA explicitly provided by the NW is 0. RAN2 will not discuss the case where NTA does not equal to 0.

From RAN2 perspective synchronization among source and target cells is not an issue in NTN RACH-less HO.

Release pre-allocated UL grant after RACH-less HO completion.

LTE approach (of confirming the HO completion) is reused for both pre-allocated grant and dynamic grant. FFS any enhancement to the confirmation of RACH-less HO completion, e.g. the NW does not send the UE Contention Resolution Identity MAC CE, and sends PDCCH/PDSCH addressed to C-RNTI.

Remove “FFS how to perform RACH-less UL synchronization to NTN target cell”, RAN2 assumes the UL sync handling in the target cell is the same in RACH-based HO and RACH-less HO, except how to acquire NTA (FFS on the spec impact , if any).

t-Service in SIB19 can also be interpreted by Rel-18 UE in Connected mode to know that a satellite change or feeder link change happens.

In hard switch unchanged PCI scenario (i.e. no handover), the UE needs to know the time the UE attempts to re-synchronize. (FFS whether a new “t-Start” / a t-gap is needed or whether t-Service can be reused (i.e. no other IE) if the gap is very short/zero).

**RAN2#123**

Define an optional without signalling UE capability to indicate the support of skipping neighbour cell measurements for TN neighbour cells in an area where there is no TN network coverage.

Define an optional without signalling UE capability for location-based measurement initiation in Earth-moving cell for cell selection/reselection.

Define an optional without signalling UE capability for time-based measurement initiation in Earth-moving cell for cell selection/reselection.

RACH-less support is optional with UE capability signalling (RAN2 WA: this is a per band UE capability).

Both of the NR TN coverage and EUTRA TN coverage can be provided.

We introduce a new SIB to provide the TN coverage information

A TN coverage area configuration is associated with a TN coverage Area ID. The frequency information for TN coverage area is indicated by adding TN coverage area IDs in SIB4 and SIB5.

The change of serving cell reference location for earth moving cell should neither result in system information change notifications nor in a modification of valueTag in SIB1.

In the Earth-moving case, it is up to UE implementation to maintain a valid serving cell reference location in RRC\_IDLE and RRC\_Inactive mode. This will be stated in the specification as a Note (or update of an existing Note)

For the IE used to trigger UE neighbor cell measurements prior to feeder link switch, re-use the same field of t-Service-17 as in Rel-17 and update the field description accordingly.

An explicit indication will be introduced to enable the unchanged PCI switch

The unchanged PCI mechanism can be applied to the case where the coverage gap is zero or negligible (where there is no need to introduce t-gap or t-start). FFS whether we need to support scenarios that require the introduction of t-gap or t-start

PCI unchanged procedure can be performed without performing RACH

In the unchanged PCI case, the UE considers UL synchronization timer expired at t-Service (current cell stop time) to stop any UL operation. FFS on timeAlignmentTimer handling.

In the unchanged PCI case, for RACH-based solution, the UE may trigger RACH immediately after DL synchronizing with the new satellite

The UE specific Koffset, if configured, is not used after t-Service and the UE uses the cell specifc Koffset until the UE receives new differential Koffset MAC CE.

Single beam can be indicated in HO command to monitor target cell PDCCH for dynamic grant for initial UL transmission

The pre-allocated grant is provided with association to SSBs

The mapping between type-1 CG and SSBs in CG-SDT can be the baseline of how to configure pre-allocated grant mapped to SSBs (can rediscuss in case of different input from RAN1)

UE selects an SSB associated to the pre-allocated grant with RSRP above a configured threshold, use the selected SSB and the corresponding UL grant occasions for the initial UL transmission

ta-Report can be included in ServingCellConfigCommon in the RACH-less HO command

RAN2 understands that if pre-allocated grant is not configured and dynamic grant is used for first UL transmission, if UL HARQ mode is configured, HARQ mode A is recommended for the HARQ process (this is anyway up to NW implementation and there is no Stage2 and Stage3 spec impact)

The MAC entity applies the N\_TA (value 0 or same as source cell) configured in the RACH-less HO command for the PTAG. FFS on when timerAlignmentTimer associated with this TAG starts

If no SSB mapping to pre-allocated grant has RSRP above the threshold, fallback to RACH HO (with new SSB selection), while T304 is running

**RAN2#123-bis**

The maximum number of TN coverage area information is 32 (5 bits)

RAN2 will not specify restrictions on TN coverage description (i.e., description of TN coverage is left to NW implementation). The signalled TN coverage can describe areas not currently covered by the satellite cell footprint (FFS how to reflect this in the specification)

TN coverage information can be broadcast by both (quasi)earth-fixed and earth-moving cells

The working assumption “We do not introduce new triggers making the UE reacquire the TN coverage information from SI” in Rel-18 is confirmed

The new SIB including the TN coverage information is not an essential SIB for NTN. An NTN-capable UE does not need to consider the cell barred if it is unable to acquire the SIB when scheduled.

Legacy SI update procedure will be used when the network updates the TN coverage information (can further check for moving cell case)

For location-based CHO for earth-moving cells, re-use the procedure from cell reselection as baseline to derive the candidate cell’s reference location as the cell moves (FFS on how to signal the needed parameters, e.g. ephemeris and Epoch time)

Upon T304 expiry, the UE does not fallback to RACH-based HO.

Preallocated UL grant must be configured with an associated RSRP threshold.

UE relies on T304 and RRC Re-establishment procedure to address RACH-less HO failure in Rel-18 NTN (as in LTE). No new NTN-specific enhancements are introduced. If TAT expires, the UE follows the legacy procedures, regardless of the RACH-less HO configuration. RAN2 understands that the NW can ensure a proper configuration for TAT and T304 values (up to NW implementation, no need to capture this in the specs).

As for RACH-less LTM, for RACH-less NTN, the UE determines successful reception of its first UL data based on receiving a PDCCH addressing the UE’s C-RNTI in the target cell scheduling a new transmission as first UL transmission. Can be either DL assignment or UL grant addressed to same HARQ process for the “new transmission”. RAN understands this does not exclude the possibility to use a Contention Resolution MAC CE but this will not be used as a determination of the RACH less HO completion

We follow the LTE baseline for when UE starts the PTAG timeAlignmentTimer in NTN RACH-less HO (option 1 in R2-2311318)

Combination of RACH-less HO with time-based CHO is supported in Rel-18 NTN for both Configured and Dynamic Grant. For the Dynamic Grant case this should be configured by the NW only when the is no risk of confusion about which beam to use (up to NW implementation).

RAN2 confirms satellite switching with unchanged PCI is only applicable on quasi-earth fixed system

Only 1 target satellite information (i.e. NTN-config) of serving cell is provided in SIB19. FFS on exact signalling

SMTC configuration of target satellite needs further discussion: FFS on whether and how to provide the SMTC configuration of target satellite; FFS on how to handle the SMTC adjustment.

We support soft satellite switching in Rel-18

There will be an indication (FFS if explicit or implicit) whether hard switch or soft switch is used.

At least soft satellite switching, network provides SSB information of target satellite to UE. FFS on the details: options include e.g. indicating a time offset/information or indicating a different SSB index for the target satellite (FFS for Hard satellite switch)

In soft satellite switching, UE can start synchronizing with target satellite before T-service of source satellite.

We introduce a T-start which indicates the earliest occasion when the UE can start synchronizing with target satellite (actual signalling is FFS). In soft switch scenario, T-start of target satellite is earlier than T-service of source satellite (FFS if T-start is also used for hard satellite switch)

For soft satellite switching, the exact time when the UE starts synchronizing with target satellite (between T-start and T-service) is up to UE implementation

UE is not required to connect to source satellite when the UE switches to target satellite.

Common signalling (e.g. using servingCellConfigCommon) for the purpose of (C)HO in NTN is not supported in Rel-18

**RAN2#124**

To define a new UE capability, e.g., locationBasedCondHandoverNTN-r18, to indicate whether the UE supports location-based conditional handover for moving cell in NTN bands (which involves the calculation of the present reference location from ephemeris and one reference location at epoch time, as specified in TS 38.331).

This locationBasedCondHandoverNTN-r18 capability is defined per Band, optional with signaling capability, and N/A for FDD/TDD DIFF and FR1/FR2 Diff. This is defined as part of §4.2.7.2 BandNR parameters in TS 38.306.

An editor’s note is added to locationBasedCondHandoverNTN-r18 to capture “FFS whether any change or update is needed considering how locationBasedCondHandover-r17 is defined”, or whether location-based conditional handover for moving cell refers to source cell, target cell or both.

For UE capabilities that indicate the support of satellite switch with re-sync (i.e., unchanged PCI) with hard and soft switch, two UE capabilities are introduced with some dependencies: hardSatelliteSwitch-Resync-NTN-r18 can be supported by itself; but if UE supports softSatelliteSwitch-Resync-NTN-r18, UE is required to also indicate the support of hardSatelliteSwitch-Resync-NTN-r18.

A UE only supporting hardSatelliteSwitch-Resync-NTN-r18 will be able to perform hard satellite switch with re-sync (after T-service) in a NW supporting soft satellite switch with re-sync (and then broadcasting “T-start” and "SSB time offset"). To be reflected in the description of hardSatelliteSwitch-Resync-NTN-r18

SIB19 can be broadcast in TN cells to provide satellite assistance information for NTN neighbour cells (e.g., ntn-NeighCellConfigList-r17).

SIB19 is not an essential SIB when provided in a TN serving cell, i.e. UE does not consider the TN serving cell as barred if it fails to acquire SIB19 (no spec impact)

UE in RRC\_IDLE/INACTIVE is not required to ensure having a valid version of SIB19 in a TN serving cell (no spec impact)

The exact time of reacquiring SIB19 for UE in RRC\_IDLE/INACTIVE in TN serving cell is up to UE implementation (no spec impact)

UE in RRC\_CONNECTED does not start T430 when SIB19 is provided in a TN cell (consider clarifying “Upon receiving SIB19 in a NTN cell …” in 5.2.2.4.21)

The SFN and subframe numbers of epoch time indicated in SIB19 in TN serving cell are based on the timing of the serving cell (no spec impact)

If the epoch time indicated in SIB19 in TN serving cell is absent, UE considers the epoch time as the end of SI window where this SIB19 is scheduled in the TN serving cell (no spec impact).

If the validity duration indicated in SIB19 in TN serving cell is absent, the UE follows R17 behaviour (left to UE implementation) (no spec impact)

Legacy SI update procedure will be used for earth moving cell when the network updates the TN coverage information (no spec change)

The new SIB containing TN coverage area information belongs to Other SI, either periodically broadcast, broadcast on-demand, or sent in a dedicated manner.

When SIB19 is broadcast in a TN cell, SIB19 belongs to Other SI in TN, and is provided by either periodically broadcast, broadcast on-demand, or a dedicated manner.

Separate capability description for location-based measurement initiation for quasi-earth-fixed system and earth moving system is used in 38.304 to align with the capability definition in 38.306.

Adopt the terminology “Skipping TN measurement” in both 38.304 and 38.306

For dynamic grant case, beam information is mandatorily included in the RACH-less HO command.

In NTN RACH-less HO, for dynamic grant case, the beam information included in RACH-less HO command is an SSB index (not tci-stateid).

Similar to LTE, UE shall not trigger RACH for SR when rach-lessHO is configured. LTE text is used as a baseline

UE releases preallocated grant after successful RACH-less HO completion without additional signaling from the network. Nothing is needed to address this issue in MAC.

When CG for initial UL transmission is configured, CG occasions mapping to SSB (i.e. ssb position in burst), is optional. If it is not provided, the RACH-less HO configuration is applicable in all SSBs. Adopt similar wording to CG-SDT in the RRC field description.

If CG for initial UL transmission is configured, UE starts to monitor PDCCH according to existing DRX behaviour on the selected SSB from RACH-less HO configuration after initial UL transmission.

If CG is configured in RACH-less HO, UE uses the earliest available CG occasion associated to the selected SSB for the initial UL transmission. Spec impact is FFS and can use CG-SDT as baseline (if applicable)

It is up to NW to configure HARQ mode A or B. RAN2 understands that HARQ mode A should be used the HARQ process of the initial UL transmission using CG

We don’t introduce a threshold-based mechanism for Dynamic Grant

Check during the final [Post124] review of the joint NTN/mIAB MAC CR for RACH-less HO if the CG-LTM-retransmission timer for the initial UL transmission using CG introduced in LTM can be used for NTN as well (possibly with updates to the value range)

Target cell provides the DG so that the UE can complete the RACH-less CHO within the (t1, t2) time window (no spec impact, up to NW implementation)

For time-based only CHO (no RSRP-based criterion) the UE shall start monitoring for DG from t1

For CHO in EMC a new event (e.g. condEventD2) is introduced.

New event comprises a reference location and distance threshold for source and target cell.

Ephemeris and epochTime information for candidate CHO cell is also provided in RRC Reconfiguration (configuring the CHO) within the configuration prepared by the source cell (outside of the new event).

If ephemeris and epochTime information for candidate CHO cell is not provided in RRC Reconfiguration, the UE may use the corresponding neighbour information from SIB19.

Introduce one new target satellite configuration, e.g. ntn-TargetSatConfig, (but we can keep the current terminology in the running CR) and provide the NTN-config of the target satellite in it for the specific signaling format about the target satellite information in SIB19. The presence of this information indicates that satellite switch without PCI change is supported

At least for soft switch, there needs to be an “SSB time offset” between the source and the target satellite. “SSB time offset” is specified as a new IE, with the same format as “offset” in SSB-MTC4

Target satellite SSB tracking is handled autonomously by the UE based on the provided SSB time offset

The “SSB time offset” between the source and the target satellite should be provided in SIB19

Support implicit indication to inform UE it is hard switch or soft switch case

For soft satellite switch, as a baseline, it is sufficient to provide the “SSB time offset” of the target satellite in SIB19. (Can come back in the next meeting to check whether a different SSB index for the target satellite can optionally be provided)

T-start is explicitly signalled (same format as T-service). If T-start is not signalled, T-start is assumed to be equal to T-service, i.e. hard switch.

For R18 we clarify that signalling a T-start higher than T-service is an unforeseen case and the UE will assume T-start = T-service

During satellite switching procedure, UE should reset the L3 filter for serving cell RRM measurement and RLM, and it’s up to UE implementation (i.e. no RAN2 spec impact).

If UE receive the HO command before UE initiates the satellite switching procedure (i.e. before the time point of satellite switching), UE will initiate the HO procedure immediately.

Both CHO and satellite switching procedure can be configured simultaneously.

When both CHO (for a different cell) and satellite switching procedure are configured, the UE initiates the procedure that triggers earlier; it's up to UE implementation if both procedures are triggered at the same time.

This feature will be called “satellite switch with re-sync”

RACH-less satellite switch procedure as shown in Figure-1 in R2-2313877 is endorsed as the baseline to be further checked in the CR review

Check in the RRC CR review whether the UE may need to acquire SIB19 immediately when UE acquires DL sync of target satellite

A UE supporting TA reporting may trigger TAR and TAR-SR based on network configuration (as in legacy)

It is up to NW implementation to signal T-start, e.g. if it does not want to receive UL TX before T-service (if there is no T-start, UL TX cannot happen before T-service)

We don’t introduce specific changes (e.g. no new indication in SIB19) to a support RACH-based procedure but this does not exclude the possibility for the NW to trigger PDCCH order

# B Appendix: R3-237058 RAN3 BL CR 38.300

**START OF CHANGES**

##### 16.14.3.2.2 Conditional Handover

The same principle as described in 9.2.3.4 applies to NTN unless hereunder specified.

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

- The RRM measurement-based event A4;

- A time-based trigger condition;

- A location-based trigger condition.

A time-based or a location-based trigger condition is always configured together with one of the measurement-based trigger conditions (CHO events A3/A4/A5) as defined in TS 38.331 [12].

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

*When a time-based trigger condition is used, the source gNB may signal the corresponding parameters to a single target gNB via the Source NG-RAN Node to Target NG-RAN Node Transparent Container in a NG-C based handover, see TS 23.502 [22]. The source gNB signals the corresponding CHO configuration to the UE in the RRC Reconfiguration message during handover execution.*

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

**NEXT CHANGE**

### 16.14.5 NG-RAN signalling

The Cell Identity, as defined in TS 38.413 [26] and TS 38.423 [50], 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 identity used in the NG and Xn handover messages, Xn Setup and Xn NG-RAN Node Configuration Update procedures is expected to be Uu Cell ID.*

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

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

NOTE 2: A specific geographical location may be mapped to multiple Mapped Cell ID(s), and such Mapped Cell IDs may be configured to indicate differerent geographical areas (e.g. overlapping and/or with different dimensions).

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

NOTE 3: 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. Special Mapped Cell IDs or TACs 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.

**NEXT CHANGE**

### 16.14.6 AMF (Re-)Selection

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

For an RRC\_CONNECTED UE, when the gNB is configured to ensure that the UE connects 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).

*For the purpose of selecting an appropriate AMF, the 5GC may verify the UE location according to TS 23.501 [3] and TS 38.305 [42] after the UE has attached to the network.*

*NOTE: UE location verification for AMF selection should not be necessary if NTN cell(s) do not extend across countries.*

**END OF CHANGES**

# C Appendix: R1-231669 RAN1 BL CR 38.300

---------------------- TEXT PROPOSAL BEGIN ----------------------

**16.14.X Support for NR NTN coverage enhancements**

To improve NR uplink coverage in NTN, the following enhancements are supported:

* PUCCH repetition for Msg4 HARQ-ACK:
* Supported number of transmissions are 1, 2, 4, 8.
	+ If a single value from {2, 4, 8} is configured via SIB, the configured repetition factor is applied.
	+ If multiple values from {1, 2, 4, 8} are configured via SIB, one of the multiple values is indicated in DAI field of DCI format 1\_0 with CRC scrambled by TC-RNTI.
* The existing mechanism on repetition slot counting (as in section 9.2.6 of TS 38.213) is applied.
* Frequency hopping mechanism in R15/16/17 defined for PUCCH transmission for Msg4 HARQ-ACK, in every slot is applied.
* A RSRP threshold can be configured via SIB when the number of repetitions is configured by SIB. If the RSRP threshold is configured, UE capable of PUCCH repetition for Msg4 HARQ-ACK reports the capability of PUCCH repetition for Msg4 HARQ-ACK via Msg3 PUSCH only if measured RSRP is lower than the configured RSRP threshold. If the RSRP threshold is not configured, UE capable of PUCCH repetition for Msg4 HARQ-ACK reports the capability of PUCCH repetition for Msg4 HARQ-ACK via Msg3 PUSCH.
* The repetition factor applied to Msg4 HARQ-ACK is used also for any PUCCH transmission before dedicated PUCCH resource is provided.
* NTN-specific PUSCH DMRS bundling enhancement that enables DMRS bundling in presence of timing drift, whereby UE maintains phase continuity considering effects of transmission delay variation between UE and uplink time synchronization reference point to enable improved channel estimation.

**16.14.x Verification of UE location**

For UE location verification based on multi-RTT with single satellite in NTN, at least the following UE and gNB measurements specified in [38.215] are reported: gNB receive-transmit time difference at the uplink time synchronization reference point, UE receive-transmit time difference, UE receive-transmit time difference subframe offset and DL timing drift.

The assistance information reported to the CN may include ephemeris information including accurate satellite position and velocity at the time of multi-RTT measurement, and common TA parameters (ta-Common, ta-CommonDrift, ta-CommonDriftVariant, Epoch time).

\*\*\* Unchanged text is omitted \*\*\*

---------- TEXT PROPOSAL END ---------

# D Appendix: R2-2314001\_R3-238157 RAN3 BL CR 38.300

**START OF CHANGES**

##### 16.14.3.2.2 Conditional Handover

The same principle as described in 9.2.3.4 applies to NTN unless hereunder specified.

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

- The RRM measurement-based event A4;

- A time-based trigger condition;

- A location-based trigger condition.

A time-based or a location-based trigger condition is always configured together with one of the measurement-based trigger conditions (CHO events A3/A4/A5) as defined in TS 38.331 [12].

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

***When a time-based trigger condition is used, the source gNB may signal the corresponding parameters to a single target gNB via the Source NG-RAN Node to Target NG-RAN Node Transparent Container in a NG-C based handover, see TS 23.502 [22]. The source gNB signals the corresponding CHO configuration to the UE in the RRC Reconfiguration message during handover execution.***

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

**NEXT CHANGE**

### 16.14.5 NG-RAN signalling

The Cell Identity, as defined in TS 38.413 [26] and TS 38.423 [50], 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:

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- 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 identity used in the NG and Xn handover messages, Xn Setup and Xn NG-RAN Node Configuration Update procedures is expected to be Uu Cell ID.***

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

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

NOTE 2: A specific geographical location may be mapped to multiple Mapped Cell ID(s), and such Mapped Cell IDs may be configured to indicate differerent geographical areas (e.g. overlapping and/or with different dimensions).

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

NOTE 3: 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. Special Mapped Cell IDs or TACs 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.

**NEXT CHANGE**

### 16.14.6 AMF (Re-)Selection

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

For an RRC\_CONNECTED UE, when the gNB is configured to ensure that the UE connects 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).

***For the purpose of selecting an appropriate AMF, the 5GC may verify the UE location according to TS 23.501 [3] and TS 38.305 [42] after the UE has attached to the network.***

***NOTE: UE location verification for AMF selection should not be necessary if NTN cell(s) do not extend across countries.***

**END OF CHANGES**

# E Appendix: Who to contact about their comments

|  |  |  |
| --- | --- | --- |
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