**3GPP TSG-RAN WG2 Meeting #118-e *R2-2204627***

 **eLocation, 9th – 20th May 2022**

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
|  |
|  | **38.300** | **CR** | **xxx** | **rev** | **-** | **Current version:** | **17.0.0** |  |
|  |
| *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 UE location in Non-Terrestrial Networks |
|  |  |
| ***Source to WG:*** | Thales |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_NTN\_solutions-core |  | ***Date:*** | -04-25 |
|  |  |  |  |  |
| ***Category:*** | **F**  |  | ***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 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-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
|  |  |
| ***Reason for change:*** | Corrections of UE location aspect for Non-Terrestrial Networks |
|  |  |
| ***Summary of change:*** | Resolving Editor’s notes |
|  |  |
| ***Consequences if not approved:*** | No support of UE location in NTN |
|  |  |
| ***Clauses affected:*** | 16.14.8 |
|  |  |
|  | **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 CR creation |

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

## 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

BCCH Broadcast Control Channel

BCH Broadcast Channel

BFD Beam Failure Detection

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

CG Configured Grant

CHO Conditional Handover

CIoT Cellular Internet of Things

CLI Cross Link interference

CMAS Commercial Mobile Alert Service

CORESET Control Resource Set

CP Cyclic Prefix

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

FS Feature Set

FSA ID Frequency Selection Area Identity

G-CS-RNTI Group Configured Scheduling RNTI

G-RNTI Group RNTI

GFBR Guaranteed Flow Bit Rate

GIN Group ID for Network selection

GSO Geosynchronous Orbit

H-SFN Hyper System Frame Number

HAPS High Altitude Platform Station

HRNN Human-Readable Network Name

IAB Integrated Access and Backhaul

IFRI Intra Frequency Reselection Indication

I-RNTI Inactive RNTI

INT-RNTI Interruption RNTI

KPAS Korean Public Alarm System

L2 Layer-2

L3 Layer-3

LDPC Low Density Parity Check

LEO Low Earth Orbit

MBS Multicast/Broadcast Services

MCE Measurement Collection Entity

MCCH MBS Control Channel

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

MPE Maximum Permissible Exposure

MRB MBS Radio Bearer

MT Mobile Termination

MTCH MBS Traffic Channel

MTSI Multimedia Telephony Service for IMS

MU-MIMO Multi User MIMO

Multi-RTT Multi-Round Trip Time

MUSIM Multi-Universal Subscriber Identity Module

NB-IoT Narrow Band Internet of Things

NCD-SSB Non Cell Defining SSB

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-MPR Power Management Maximum Power Reduction

P-RNTI Paging RNTI

PCH Paging Channel

PCI Physical Cell Identifier

PDC Propagation Delay Compensation

PDCCH Physical Downlink Control Channel

PDSCH Physical Downlink Shared Channel

PEI Paging Early Indication

PH Paging Hyperframe

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

PRS Positioning Reference Signal

PS-RNTI Power Saving RNTI

PSS Primary Synchronisation Signal

PTM Point to Multipoint

PTP Point to Point

PTW Paging Time Window

PUCCH Physical Uplink Control Channel

PUSCH Physical Uplink Shared Channel

PWS Public Warning System

QAM Quadrature Amplitude Modulation

QFI QoS Flow ID

QMC QoE Measurement Collection

QoE Quality of Experience

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

RLM Radio Link Monitoring

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

SCS SubCarrier Spacing

SD Slice Differentiator

SDAP Service Data Adaptation Protocol

SDT Small Data Transmission

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

SRAP Sidelink Relay Adaptation Protocol

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

TB Transport Block

TCE Trace Collection Entity

TNL Transport Network Layer

TPC Transmit Power Control

TRP Transmit/Receive Point

TRS CSI-RS for Tracking

U2N UE-to-Network

UCI Uplink Control Information

UDC Uplink Data Compression

UE-Slice-MBR UE Slice Maximum Bit Rate

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

VR Virtual Reality

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**.**

**Boundary IAB-node:** as defined in TS 38.401 [4].

**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.

**Direct Path**: a type of UE-to-Network transmission path, where data is transmitted between a UE and the network without sidelink relaying.

**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 [51].

**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.

**IAB topology:** The unison of all IAB-nodes and IAB-donor-DUs that are interconnected via BH links and terminate F1 and/or RRC at the same IAB-donor-CU.

**Indirect Path**: a type of UE-to-Network transmission path, where data is forwarded via a U2N Relay UE between a U2N Remote UE and the network.

**Inter-donor partial migration:** Migration of an IAB-MT to a parent node underneath a different IAB-donor-CU while the collocated IAB-DU and descendant IAB-node(s), if any, are terminated at the initial IAB-donor-CU. The procedure renders the said IAB-node as a boundary IAB-node.

**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

**PC5 Relay RLC channel**: an RLC channel between L2 U2N Remote UE and L2 U2N Relay UE, which is used to transport packets over PC5 for L2 UE-to-Network Relay**.**

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

**RedCap UE:** A UE with reduced capabilities as specified in clause 4.2.21.1. in TS 38.306 [11].

**Relay discovery**: AS functionality enabling 5G ProSe UE-to-Network Relay Discovery as defined in TS 23.304 [48], using NR technology but not traversing any network node.

**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).

**Transmit/Receive Point:** Part of the gNB transmitting and receiving radio signals to/from UE according to physical layer properties and parameters inherent to that element.

**U2N Relay UE:** a UE that provides functionality to support connectivity to the network for U2N Remote UE(s).

**U2N Remote UE:** a UE that communicates with the network via a U2N Relay UE.

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

**Uu Relay RLC channel**: an RLC channel between L2 U2N Relay UE and gNB, which is used to transport packets over Uu for L2 UE-to-Network Relay**.**

**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.

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

## 16.14 Non-Terrestrial Networks

### 16.14.1 Overview

The Figure 16.14.1-1 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 16.14.1-1: Overall illustration of an NTN

NOTE 1: Figure 16.14.1-1 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 2: 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 clause 16.14.5.

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.

### 16.14.2 User Plane aspects

The UE may be configured to report the UE's Timing Advance:

- during Random Access procedure in Idle/Inactive state;

- in connected mode:

- using event-triggered reporting;

- for RRC re-establishment procedure, if an indication is broadcasted by the target cell's SI;

- for handover, the UE should trigger TA report if the target cell indicates this in the handover command.

To accommodate the long propagation delay, 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 A or B per HARQ process;

- Maximum number of HARQ processes is extended to 32;

- The value ranges 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.

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

**Impact on timing aspects**:

To accommodate the long propagation delays, several NR timings involving DL-UL timing interaction are enhanced by the support of two scheduling offsets: $K\_{offset}$and $k\_{mac}$.

The timing relationships that need to be modified for NTN using Koffset are summarized as follows:

- The transmission timing of DCI scheduled PUSCH, including channel state information (CSI) transmission on PUSCH;

- The transmission timing of random access response (RAR) grant or fallbackRAR grant scheduled PUSCH;

- The timing of the first PUSCH transmission opportunity in type-2 configured grant;

- The transmission timing of HARQ-ACK on physical uplink control channel (PUCCH), including HARQ-ACK on PUCCH to message B (MsgB) in 2-step random access;

- The transmission timing of PDCCH ordered physical random access channel (PRACH);

- The timing of the adjustment of uplink transmission timing upon reception of a corresponding timing advance command;

- The transmission timing of aperiodic sounding reference signal (SRS);

- The CSI reference resource timing.

Figure 16.14.2-1 is an illustration of the transmission timing of DCI scheduled PUSCH, the slot allocated for the PUSCH can be modified to be$ n+K\_{2}+K\_{offset}$. Note for this example the subcarrier spacing (SCS) value of the downlink is supposed to be the same as that of the uplink.

For initial access, the information of $K\_{offset}$ is carried in system information. Update of $K\_{offset}$ after initial access is supported. The UE-specific $K\_{offset}$ can be provided and updated by the network with MAC CE.



Figure 16.14.2-1: Timing relationship between UL and DL for PUSCH transmission

$k\_{mac}$ is a scheduling offset supported in NTN for MAC CE timing relationships enhancement. It is provided by the network if downlink and uplink frame timing are not aligned at gNB. It is needed for UE action and assumption on downlink configuration indicated by a MAC-CE command in PDSCH. The $K\_{mac}$ is also used in the beam failure recovery, where after a PRACH transmission in uplink slot n the UE monitors the corresponding PDCCH starting from downlink slot "n + $k\_{mac}$ + 4" within a corresponding RAR window.

If a UE is provided with a $k\_{mac}$ value, when the UE would transmit a PUCCH with HARQ-ACK information in uplink slot n corresponding to a PDSCH carrying a MAC CE command on a downlink configuration, the UE action and assumption on the downlink configuration shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}+k\_{mac}$, where µ is the SCS configuration for the PUCCH. MAC CE timing relationship enhancement with $k\_{mac}$ is illustrated in Figure 16.14.2-2.



Figure 16.14.2-2: MAC CE timing relationship enhancement with $K\_{mac}$

**Timing pre-compensation at the UE:**

To accommodate the long propagation delays experienced in NTN on both service link and feeder link, the UE should be able to perform time pre-compensation for all its uplink transmissions; including PRACH preamble transmissions and uplink transmissions during the RRC\_CONNECTEDstate. To do such pre-compensation, the UE is assisted by its GNSS and by the network which periodically broadcasts assistance information including serving satellite ephemeris as well as higher layer Common-TA-related parameters, where the latter may be used to calculate the common RTD e.g. delay on the feeder link.

Release-17 specified the following formula for TA calculation that shall be applied by NTN UEs for PRACH preamble transmission and in RRC\_CONNECTED state:

$$T\_{TA}=\left(N\_{TA}+N\_{TA,offset}+N\_{TA,adj}^{common}+N\_{TA,adj}^{UE}\right)×T\_{c}$$

Where:

- $N\_{TA}$ and $N\_{TA,offset}$ were already specified in [TS 38.213] [TS 38.211] as part of the existing TA Control;

- $N\_{TA,adj}^{common}$ is network-controlled common TA, and may include any timing offset considered necessary by the network (e.g. feeder link delay). It is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured, otherwise $N\_{TA,adj}^{common}=0$;

- $N\_{TA,adj}^{UE}$ is UE self-estimated TA to pre-compensate for the service link delay. It is computed by the UE based on UE position and serving satellite-ephemeris-related higher-layers parameters if configured, otherwise $N\_{TA,adj}^{UE}=0$;

- $T\_{c}$ is the NR basic time unit [TS 38.211].



Figure 16.14.2-3: Uplink/Downlink Radio Frame Timing at the UE

**Frequency pre-compensation at the UE:**

The UE shall be capable of using its acquired GNSS position and serving satellite ephemeris information (when provided by the network) to calculate frequency pre-compensation to counter shift the instantaneous Doppler shift experienced on the service link.

While the pre-compensation of the instantaneous Doppler shift experienced on the service link is to be performed by the UE, the management of Doppler shift experienced over the feeder link as well as any transponder frequency error whether it is introduced in Downlink or Uplink is left to the network implementation without any specification impacts in Release 17.

### 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 (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.

The UE can determine the network type (Terrestrial or non-terrestrial) implicitly by the existence of scheduling information of SIB19 in SIB1.

Editor's note: Non-NTN capable UE can be prevented from accessing an NTN cell in Rel-17. FFS how.

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 neighbouring 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 neighbour cells.

UE may support mobility between radio access technologies based on different orbit (GSO, NGSO at different altitude).

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

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

Editor's note: FFS details for NTN-TN hand-over impact on RRC procedure.

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

UE may support mobility between radio access technologies based on different orbit (GSO, NGSO at different altitude).

##### 16.14.3.2.2 Conditional Handover

The same principle as described in 9.2.3.4 applies to NTN.

Editor's note: FFS details for NTN-TN CHO impact on RRC procedure.

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

- 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 the measurement-based trigger conditions (CHO events A4). Location is defined by the distance between UE and a reference location. Time is defined by the time between T1 and T2, where T1 is an absolute time value and T2 is a duration started at T1.

#### 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 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.

### 16.14.4 Switch over

#### 16.14.4.1 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.

#### 16.14.4.2 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.

#### 16.14.4.3 Procedures

The NTN Control function (see Annex B.4) 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.

### 16.14.5 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 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 Cell Identities 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 info 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. 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.

### 16.14.6 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 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).

### 16.14.7 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 [51]:

- 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 1: 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 2: 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.

### 16.14.8 UE location aspects

Editor's note: Upon network request, after AS security in connected mode is established, a UE can report coarse UE location information (X most Significant Bits of its GNSS coordinates with accuracy around 2km level) to the NG-RAN without receiving any prior explicit user consent. if "user consent" is available at the UE, the UE will report the coarse UE location information. Else, the UE will respond "no coarse GNSS location available". Periodic location reporting can be configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED. *This proposed text may be updated upon SA3 feedback*.

<<<<<<<<<<<<<<<<<<<< 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#118-e agreements for Rel-17 WI NR-NTN-solutions

A.1 User plane

Agreements via email – from offline 104:

1. The text proposals from corrections 3 and 8 in R2-2206194 are adopted and included in a TS 38.321 Rapporteur CR.

2. T\_TA shall be updated to TTA in “5.4.8 Timing Advance Reporting”.

3. Do not introduce an explicit configuration to support blind Msg3 retransmission in NTN.

4. Upon validity timer expiry in NR NTN, UE shall suspend uplink transmission and acquire SIB-19, flushing HARQ buffers.

5. A new T3XX timer is introduced in RRC specification with duration ntn-UlSyncValidityDuration. Details of timer handling to be addressed in CP discussion

6. RRC indicates to lower layers when T3XX timer has expired or is restarted.

A.2 Control plane - Idle/inactive mode aspects

Agreements:

1. Ephemeris, common TA parameters and epoch time can be updated without invoking the SI modification procedure.

2. Remove the FFS in the field description of t-Service : FFS" This field is excluded when determining changes in system information, i.e. changes of t-Service should neither result in system information change notifications nor in a modification of valueTag in SIB1."

3. The issue of possible ambiguity of cell-specific K\_offset raised by RAN1 can be handled by gNB implementation

4. On-demand SIB19 is not supported for UEs in RRC\_IDLE/RRC\_INACTIVE state.

5. The changes to Stage 2 spec in R2-2205754 are not pursued.

6. [C216] and [C217] are rejected.

A.3 Control plane - RRC aspects

Agreements:

1. RIL V313 is rejected

2. RAN2 to conclude on the operation of triggering event D1

3. report on leave for event D1 is agreed

Agreements:

1. During CHO recovery in NTN the UE checks if the timer T2 has not expired before it can use CHO configuration for recovery. FFS if the same principle applies to location-based CHO triggering event. FFS the stage-3 details (i.e. whether the UE releases the configuration)

2. The following IEs/parameters are broadcast per neighbour cell in NTN:

 Ephemeris,

 DL and UL polarization,

 Epoch time of assistance information

 Validity duration

 FFS how to handle the validity timer for neighbour cell. FFS if epoch time can be same or different. FFS about other parameters

A.4 UE capabilities

Agreements:

1. Whether existing TN capabilities need separate NTN capabilities or IoT bits is focused on per-UE capabilities

2. Add separate IoT bits to convey a subset of UE Radio Access Capability Parameters differently for NR NTN. It also implies that other per-UE UE capabilities not within this list are applicable to both TN and NTN.

3. Proposal 3: at least the following existing TN UE capabilities need separate IoT bits for NTN:

 1) mac-Parameters;

 2) phy-Parameters;

 3) measAndMobParameters;

 4) fdd-Add-UE-NR-Capabilities;

 5) fr1-Add-UE-NR-Capabilities

 6) SON/MDT related capabilities.

 7) at least inactiveState

4. “ntn-ScenarioSupport-r17 is used for both essential and optional NTN capabilities”.

# B Appendix: Who to contact about their comments

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