3GPP TSG RAN WG2 Meeting #113bis-e R2- 2104648

April 12th - 20th, 2021

**Source:** Eutelsat, MediaTek

**Title:** TP for TR 36.763 capturing RAN2 #113bis-e agreements

**Agenda Item:** 9.2.1

**Document for:** Discussion and decision

# 1 Introduction

This document contains Text Proposals for TR 36.763 based on agreements in A.I. 9.2.1 and 9.2.3 at RAN2#113bis-e further to RAN2 email and meeting discussions for the Study on Narrow-Band Internet of Things (NB-IoT) / enhanced Machine Type Communication (eMTC) support for Non-Terrestrial Networks (NTN) [R2], [R1].

TPs are based on agreements as captured in the RAN2#113bis-eChairman notes [R3] on:

- Control plane enhancements

- IoT NTN essential functionalities

# 2 Contact information

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# 3 Text Proposal for TR 36.763

Note: The revision marks used in this document are comparing to the draft TR in [R2]

--- Start of text proposal (Sections 2-3) ---

# 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 TR 38.811 v15.2.0: "Study on New Radio (NR) to support non-terrestrial networks (Release 15)"

[3] 3GPP TR38.821 v16.0.0: " Solutions for NR to support non-terrestrial networks (NTN) (Release 16)"

[4] 3GPP TR 45.820 v13.1.0: "Cellular system support for ultra-low complexity and low throughput Internet of Things (CIoT) (Release 13)"

[5] 3GPP TS 22.261: "Service requirements for the 5G system; Stage 1 (Release 16)"

[6] R2-1901404: "IoT Device Density Models for Various Environments", Vodafone, RAN2 #105

[7] 3GPP TS 36.331: "E-UTRA Radio Resource Control (RRC) protocol specification (Release 16)"

[8] 3GPP TS 36.322: "E-UTRA Radio Link Control (RLC) protocol specification (Release 16)"

[9] 3GPP TS 36.323: "E-UTRA Packet Data Convergence Protocol (PDCP) specification (Release 16)"

[10] R2-2011275: "[IoT-NTN] Applicability of TR 38.821 (MediaTek)"

[11] 3GPP TS 36.304: "Evolved Universal Terrestrial Radio Access (E-UTRA); UE Procedures in Idle Mode (Release 16)"

[12] 3GPP TS 36.321: "Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification (Release 16)"

# 3 Definitions of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] 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].

**Availability:** % of time during which the RAN is available for the targeted communication. Unavailable communication for shorter period than [Y] ms shall not be counted. The RAN may contain several access network components among which an NTN to achieve multi-connectivity or link aggregation.

**Feeder link:** Wireless link between NTN Gateway and satellite

**Geostationary Earth orbit:** Circular orbit at 35,786 km above the Earth's equator and following the direction of the Earth's rotation. An object in such an orbit has an orbital period equal to the Earth's rotational period and thus appears motionless, at a fixed position in the sky, to ground observers.

**Low Earth Orbit:** Orbit around the Earth with an altitude between 300 km, and 1500 km.

**Medium Earth Orbit:** region of space around the Earth above low Earth orbit and below geostationary Earth Orbit.

**Minimum Elevation angle**: minimum angle under which the satellite or UAS platform can be seen by a terminal.

**Mobile Services:** a radio-communication service between mobile and land stations, or between mobile stations

**Mobile Satellite Services:** A radio-communication service between mobile earth stations and one or more space stations, or between space stations used by this service; or between mobile earth stations by means of one or more space stations

**Non-Geostationary Satellites:** Satellites (LEO and MEO) orbiting around the Earth with a period that varies approximately between 1.5 hour and 10 hours. It is necessary to have a constellation of several Non-Geostationary satellites associated with handover mechanisms to ensure a service continuity.

**Non-terrestrial networks:** Networks, or segments of networks, using an airborne or space-borne vehicle to embark a transmission equipment relay node or base station.

**NTN-gateway:** an earth station or gateway is located at the surface of Earth, and providing sufficient RF power and RF sensitivity for accessing to the satellite. NTN Gateway is a transport network layer (TNL) node.

**On Board processing:** digital processing carried out on uplink RF signals aboard a satellite or an aerial.

**On board NTN eNB**: eNB implemented in the regenerative payload on board a satellite.

**On ground NTN eNB**: eNB of a transparent satellite payload implemented on ground.

**One-way latency:** time required to propagate through a telecommunication system from a terminal to the public data network or from the public data network to the terminal. This is especially used for voice and video conference applications.

**Regenerative payload:** payload that transforms and amplifies an uplink RF signal before transmitting it on the downlink. The transformation of the signal refers to digital processing that may include demodulation, decoding, re-encoding, re-modulation and/or filtering.

**Round Trip Delay:** time required for a signal to travel from a terminal to the sat-gateway or from the sat-gateway to the terminal and back. This is especially used for web-based applications.

**Satellite:** a space-borne vehicle embarking a bent pipe payload or a regenerative payload telecommunication transmitter, placed into Low-Earth Orbit (LEO), Medium-Earth Orbit (MEO), or Geostationary Earth Orbit (GEO).

**Satellite beam:** A beam generated by an antenna on-board a satellite

**Service link:** Radio link between satellite and UE

**Transparent payload:** payload that changes the frequency carrier of the uplink RF signal, filters and amplifies it before transmitting it on the downlink

**User Connectivity:** capability to establish and maintain data / voice / video transfer between networks and Terminals

**User Throughput:** data rate provided to a terminal

## 3.2 Symbols

Void

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] 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].

CHO Conditional Handover

DRX Discontinuous Reception

ECEF Earth-Centered, Earth-Fixed

eDRX Extended DRX

EIRP Equivalent Isotropic Radiated Power

GEO Geostationary Earth Orbiting

eNB E-UTRAN Node B

GW Gateway

LEO Low Earth Orbiting

Mbps Mega bit per second

MEO Medium Earth Orbiting

MS Mobile Services

MSS Mobile Satellite Services

NGEO Non-Geostationary Earth Orbiting

NTN Non-Terrestrial Network

PSM Power Saving Mode

PUR Preconfigured Uplink Resource

RAN Radio Access Network

RTD Round Trip Delay

Rx Receiver

SNR Signal-to-Noise Ratio

TA Tracking Area

TAC Tracking Area Code

TAU Tracking Area Update

TLE Two-Line Element

UAS Unmanned Aircraft System

UE User Equipment

WUS Wake Up Signal

--- End of text proposal (Sections 2-3) ---

--- Start of text proposal (Section 7.3) ---

## 7.3 Control plane enhancements

Editor's Note: RAN2 should wait for RAN1's input on supporting multiple beams per cell for IoT NTN.

### 7.3.1 Idle mode mobility enhancements

#### 7.3.1.1 Tracking area

*Problem Statement*

As outlined in 38.821 [3], satellites may provide very large cells, covering hundreds of kilometres, and consequently would lead to large tracking areas. In this scenario the tracking area updates (TAUs) are minimal, however the paging load could be high because it then relates to the number of devices in the tracking area.

Moving cells and consequently moving tracking areas would be difficult to manage in the network as the contrast between the TAU and the paging signalling load would be too extreme to find a practical compromise.

On one hand, small tracking areas would lead to massive TAU signalling for UE at the boundary between 2 TAs as illustrated in figure 7.3.1.1-1.



Figure 7.3.1.1-1: Moving Cells and Small tracking areas leading to massive TAU signalling

On the other hand, wide tracking areas would lead to high paging load in the satellite beams as illustrated in figure 7.3.1.1-2.



Figure 7.3.1.1-2: Moving Cells and wide tracking areas leading to higher Paging load

However, tracking areas must be dimensioned to minimise the TAUs as this is more signalling-intensive than paging on the network.

In practical tracking area design, one of the criteria affecting the performance and capacity is the limiting capabilities of MME/AMF platforms and the radio channel capacity.

Ping-pong effect generating excessive TAU, and it can be minimised by ensuring 10-20% overlaps between the adjacent cells and appropriate allocation of TAI List to UEs especially at the edge of cells/TAs.

*Solution Overview*

In order not to have TAU performed frequently by the UE triggered by the satellite motion, the tracking area should be designed to be fixed on ground (i.e. earth-fixed TA similar to NR NTN). For NTN LEO, this implies that while the cells sweep on the ground, the tracking area code (i.e. TAC) broadcasted is changed, when the cell arrives to the area of next planned earth fixed tracking area location. The TAC broadcasted by the eNB needs to be updated as the eNB enters to the area of next planned tracking area. When the UE detects entering a tracking area that is not in the list of tracking areas that the UE previously registered in the network, a mobility registration update procedure will be triggered.



Figure 7.3.1.1-3: An example of updating TAC and PLMN ID in real-time for LEO with moving beams

As shown in Figure 7.3.1.1-3, network updates the broadcast TAC in real time according to the ephemeris and confirms that the broadcast TAC is associated with the geographical area covered by the satellite beam. UE listens to TAI = PLMN ID + TAC and determines to trigger registration area update procedure based on the broadcast TAC and PLMN ID when it moves out of the registration area.

The two signalling options to update the broadcast TAC for IoT NTN are described as follows:

**(1) "Hard switch" option:**

One cell broadcast only one TAC per PLMN. The new TAC replaces the old TAC and there may be some fluctuation at the border area. As shown in Figure 7.3.1.1-4, the UE will see its TAC changing like TAC-2 -> TAC-1 -> TAC-2 from T1 to T3.



Figure 7.3.1.1-4: TAC fluctuation at the border area

**(2) "Soft switch" option:**

One cell can broadcast more than one TAC per PLMN. The cell adds the new TAC in its system information in addition to the old TAC, and subsequently removes the old TAC. If there is a chain of Tracking Areas, the TA list adds one TAC more and removes one old TAC while the cell sweeps the ground. This also reduces the amount of TAUs for UEs that happen to be located at the border area. However, for the "soft switch" option, the more TACs a cell broadcast, the heavier paging load it experiences, which usually leads to a significant imbalance distribution of paging load among cells. Thus, there is a trade-off between paging load and balancing the fluctuation of actual TA area enabled by the soft switch to be considered in network planning and implementation.

Editor’s Note: The NR-NTN agreements, whereby the network may broadcast more than one TAC per PLMN in a cell, are considered for IoT NTN, if applicable. Other options are not excluded.

Editor's Note: RAN2 will wait for progress in NR NTN for possible updates, if applicable to IoT NTN.

#### 7.3.1.2 Using satellite assistance information and UE location information

Satellite assistance (e.g. Ephemeris information) and UE location information can be used to help UEs in IoT NTN perform measurement and cell selection/reselection, in addition to PCI and frequency information included in the broadcast system information [3] [10].

Satellite assistance information (e.g. ephemeris information), can be used for the handling of coverage holes or discontinuous satellite coverage in a power efficient way.

Editor's Note: Provisioning of satellite assistance information using System Information (SI) message(s) for IoT NTN is FFS.

Editor's Note: RAN2 will wait for RAN1 progress about the details of satellite ephemeris information.

#### 7.3.1.3 Enhancements to UE Idle mode mobility

Cell selection/reselection mechanisms specified for NB-IoT/eMTC [11] will be reused as a baseline. Enhancements introduced for cell selection/re-selection procedures in NR NTN [3] [10] will be considered if applicable to IoT NTN.

### 7.3.2 Connected mode mobility enhancements

#### 7.3.2.1 General

Similar to NR NTN [3], for LEO NTN, mobility management procedures should take satellite movement into account, while for GEO NTN, the large propagation delay needs to be accommodated.

#### 7.3.2.2 Connected mode mobility for NB-IoT NTN

There are no connected mode mobility procedures defined for NB-IoT. When an NB-IoT UE goes out of service coverage of the source cell, it experiences a Radio Link Failure (RLF). This triggers the UE to perform RRC connection re-establishment.

RLF and RRC connection re-establishment procedures, as specified up to Release 16, are used as a baseline in NB-IoT NTN. Release-17 enhancements to reduce the time taken for RRC re-establishment can be considered in NB-IoT NTN, if applicable. Further minor enhancements can be considered, e.g. by using satellite assistance (ephemeris) information.

#### 7.3.2.3 Connected mode mobility for eMTC NTN

Challenges in connected mode mobility for eMTC NTN are similar to the connected mode mobility issues in NR NTN. These include (1) high latency associated with handover signalling, (2) measurement validity, (3) frequent handovers, (4) dynamic neighbour cell list, (4) handover of a large number of UEs and (5) impact of propagation delay difference in measurements [3] [10].

RLF and RRC connection re-establishment procedures, as specified up to Release 16, are used as a baseline in eMTC NTN. Further minor enhancements can be considered.

Conditional Handover (CHO) can be used for both the moving cell and the fixed cell scenarios. The CHO procedure and execution conditions as defined in Release-16 are taken as the baseline, with the following considerations:

- The existing measurement framework for CHO (e.g. measurement configuration, execution) is the baseline.

- The existing measurement criteria and events applicable to eMTC can be used for IoT NTN. Support for new measurement types would need justification, but is not precluded, e.g. for enhanced coverage.

- Time or timer based and location based CHO triggering event, in combination with the existing Release-16 CHO measurement based event, can be introduced for both moving cell and fixed cell scenarios. Support for new triggering events is not precluded.

- Enhancements to CHO, e.g., location-based and time-based triggering events related to CHO in eMTC NTN, should be based on enhancements to CHO in NR NTN.

NOTE 1: CHO for IoT NTN does not apply for E-UTRA connected to 5GC (a similar limitation applies in Release-16).

### 7.3.3 Paging capacity

The paging capacity and the impact on the size of the Tracking Area are evaluated considering the target IoT NTN device density captured in Annex B.2.

Editor's Note: Paging capacity is evaluated using the methodology captured in TR 38.821 as the baseline.

--- End of text proposal (Section 7.3) ---

--- Start of text proposal (Annex C - New) ---

# Annex C: IoT NTN essential parts

C.1 Introduction

This annex captures the agreements related to the evaluation of solutions addressing essential functionality of IoT NTN scenarios further to RAN plenary meeting #91e (March 2021).

C.2 RAN2 Agreements

C.2.1 Agreements at RAN2 #113bis-e (April 2021)

* The following points are endorsed

Enhancements to ra-ResponseWindow and mac-ContentionResolutionTimer are essential. R2 assume that design can follow NR NTN agreements as baseline.

Enhancements to HARQ-RTT-Timer and UL-HARQ-RTT-Timer are essential. R2 assume that design can follow NR NTN agreements as baseline.

Enhancements to sr-ProhibitTimer are essential. R2 assume that design can follow NR NTN agreements as baseline.

Enhancements to RLC SN and PDCP SN are not essential.

Enhancements to tracking area management are essential.

Provisioning of ephemeris is essential. NR NTN agreements can be used as the baseline.

* There is significant interest for Power saving in idle mode for NTN IOT devices, e.g. there is significant interest for enhancements to eDRX/PSM (discontinuous coverage) and to relaxed monitoring, SI acquisition and WUS.
* The following points are endorsed

Enhancements to UL scheduling for latency reduction are not essential.

Enhancements to PUR are not essential. Enhancement to pur-ResponseTimer is needed and feasibility of PUR in GEO and LEO scenarios needs to be checked by RAN1.

Enhancements to RLC t-Reordering timer are essential. There is no need for further study as design can follow NR NTN agreements.

--- End of text proposal (Annex C - New) ---

# 4 Conclusion

In this contribution, we provided Text Proposals for inclusion in TR 36.763 "Study on Narrow-Band Internet of Things (NB-IoT) / enhanced Machine Type Communication (eMTC) support for Non-Terrestrial Networks (NTN)" (Release 17) as captured in the RAN2#113bis-e Chairman notes.

# 5 References

[R1] RP-210869: SID "Study on NB-IoT/eMTC support for Non-Terrestrial Networks", RAN#91e, March 2021

[R2] 3GPP TR 36.673 v0.1.0: "Study on Narrow-Band Internet of Things (NB-IoT) / enhanced Machine Type Communication (eMTC) support for Non-Terrestrial Networks (NTN)", Release 17

[R3] Meeting notes, RAN2 Chairman (MediaTek), RAN2#113bis-e, April 21, 2021