**3GPP TSG RAN WG1 Meeting #106-e R1-21xxxxx**

**E-Meeting, August 16th – August 27th, 2021**

**Agenda Item: 8.15**

**Source: Moderator (MediaTek)**

**Title: Summary on - [Post-106-e-Rel17-RRC-15] IoT over NTN**

**Document for: Discussion and Decision**

# Introduction

This documents aims to collect comments in Post email discussion [Post-106-e-Rel17-RRC-15] IoT over NTN for the RRC parameters of Rel-17 Work Item LTE\_NBIOT\_eMTC\_NTN: NB-IoT/eMTC support for Non-Terrestrial Networks.

The draft RRC parameter list has been uploaded in the same folder:

# Comments

## Sub-feature - UL-Synchronization-Common-NR-IoT-NTN

This section is to collect company inputs on RRC parameters for sub-feature synchronization enhancements – NTN. These are based on RAN1 agreements on time and frequency synchronization enhancements common to NR NTN and IoT NTN:

Agreement:

The following agreements from NR NTN are re-used for IoT NTN as working assumption.

1. The Doppler shift over the feeder link and any transponder frequency error for both Downlink and Uplink is compensated by the GW and satellite-payload without any specification impacts in Release 17.
2. The orbital propagator model to be used at UE side can be left to implementation
3. Timing Advance formula can be transposed to IoT-NTN with Ts used instead of Tc

The Timing Advance applied by an NR NTN UE in RRC\_IDLE/INACTIVE and RRC\_CONNECTED is given by:

$$T\_{TA}=\left(N\_{TA}+N\_{TA,UE-specific}+N\_{TA,common}+N\_{TA,offset}\right)×T\_{s}$$

Where:

* $N\_{TA}$  is defined as 0 for PRACH and updated based on TA Command field in msg2/msgB and MAC CE TA command.
	+ FFS: details of NTA update/accumulation.
* $N\_{TA,UE-specific}$  is UE self-estimated TA to pre-compensate for the service link delay.
* $N\_{TA,common}$ is network-controlled common TA, and may include any timing offset considered necessary by the network.
* $N\_{TA,common}$ with value of 0 is supported.
	+ FFS:  details of signaling including granularity.
* $N\_{TA,offset}$ is a fixed offset used to calculate the timing advance.

Note-1: Definition of $N\_{TA}$ is different from that in RAN1#103-e agreement in NR NTN WI.

Note-2: UE might not assume that the RTT between UE and gNB is equal to the calculated TA for Msg1/Msg A.

Note-3: $N\_{TA,common}$ is the common timing offset X as agreed in RAN1 #103-e in NR NTN WI.

1. Support the delivery of ephemeris information using both ephemeris formats, i.e., state vectors and orbital elements
* Set 1: Satellite position and velocity state vectors (position/velocity)
	+ Position X,Y,Z in ECEF (m)
	+ Velocity VX,VY,VZ in ECEF (m/s)
* Set 2: Parameters in orbital parameter ephemeris format
	+ Semi-major axis α [m]
	+ Eccentricity e
	+ Argument of periapsis ω [rad]
	+ Longitude of ascending node Ω [rad]
	+ Inclination i [rad]
	+ Mean anomaly M [rad] at epoch time to
	+ FFS: Whether pre-provisioned ephemeris based on orbital elements can be used as reference. Thereby, only delta corrections can be broadcast in order to reduce the overhead
1. For TA update in RRC\_CONNECTED state, combination of both open (i.e. UE autonomous TA estimation, and common TA estimation) and closed (i.e., received TA commands) control loops shall be supported for IoT-NTN
2. In Rel-17 IoT-NTN, at least support UE which can compute timing advance and frequency adjustment for serving link based on its GNSS position and serving satellite ephemeris signalled by the network and apply corresponding timing advance and frequency adjustment in RRC\_IDLE and RRC\_CONNECTED modes
3. Serving satellite ephemeris Epoch time is implicitly known as a reference time defined by the starting time of a DL slot and/or frame.

FFS: Whether this starting time is given by predefined rule or it is indicated by the Network

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## Sub-feature- UL synchronization-Validity-IoT NTN

This section is to collect company inputs on RRC parameters for sub-feature UL-Synchronization-Validity-IoT based on RAN1 agreements for validity of GNSS position fix and validity timer for UL synchronization:

Validity of GNSS Position fix:

Agreement:

For sporadic short transmission, UE in RRC\_CONNECTED should go back to idle mode and re-acquire a GNSS position fix if GNSS becomes outdated.

Validity timer for UL synchronization:

Agreement:

* Satellite ephemeris read on SIB are valid for the duration of sporadic short transmission in RRC\_CONNECTED.
* Common TA parameters if indicated and read on SIB are valid for the duration of sporadic short transmission in RRC\_CONNECTED.
* Note: The duration of the short transmission is not longer than the “validity timer for UL synchronization” referred to in the WID objective (but which still needs further discussion for specifying further details)

Agreement:

The validity timer of UL synchronization is configured by the network

* FFS: Whether a single validity timer or separate validity timers are used for satellite ephemeris and common TA parameters

Agreement:

UE in RRC\_IDLE reads the satellite ephemeris on SIB and the common TA parameters if indicated on SIB and (re-)start the validity timer(s) for UL synchronization before moving to RRC\_CONNECTED.

* FFS: Details of the precise (re-)start time for the validity timer for UL synchronization to ensure a common understanding between gNB and UE.
* Other signaling details for validity timer are up to RAN2

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## Sub-feature-UL Synchronization-Transmission-IoT NTN

This section is to collect company inputs on RRC parameters for sub-feature UL-Synchronization-Long UL transmission-IoT-NTN based on the following RAN1 agreements for configuration of UL transmission segment, long RACH transmission and long PUSCH transmission:

Configuration of UL transmission segment:

Agreement:

The UL transmission segment duration is configured by the network

* FFS: Details of the configuration signalling.

Agreement:

* The UL transmission segment duration is provided by UE-specific RRC signalling or by signalling in SIB.
* NOTE: the values of UL transmission segment duration for NB-IoT can be different to those for eMTC

Long UL transmission for PRACH:

Agreement:

Duration of UL transmission segment for UE pre-compensation for PRACH transmission is a number of RACH repetition units configured by the network

* For NB-IoT, repetition unit is P symbol groups.
* For eMTC, repetition unit is one preamble including guard period.
* FFS: Configuration details

Agreement:

* For NB-IoT NTN, the network configures one of K values for the UL transmission segment duration of each PRACH preamble format in a k-bit field, where the size of the k-bit field and the number of K candidate values depend on the preamble format.
* Format 0 and format 1: 3-bit field, K=6 candidate values 2.4.(TCP+TSEQ), 4.4.(TCP+TSEQ), 8.4.(TCP+TSEQ), 16.4.(TCP+TSEQ), 32.4.(TCP+TSEQ), 64.4.(TCP+TSEQ)
* Format 2:  2-bit field, K=4 candidate values 2.6.(TCP+TSEQ), 4.6.(TCP+TSEQ), 8.6.(TCP+TSEQ), 16.6.(TCP+TSEQ)
* FFS: Down scoping of K candidate values, size of k-bit field
* FFS: Whether the same segment duration can be used for all preambles within a preamble format

Agreement:

For eMTC, the network configures one of K values for the UL transmission segment duration of PRACH in a k-bit field.

* FFS: K candidate values, size of k-bit field

Long UL transmission for PUSCH:

Agreement:

Duration of UL transmission segment for UE pre-compensation for PUSCH transmission is a number of PUSCH repetition units configured by the network

* For NB-IoT, repetition unit is $M\_{identical}^{NPUSCH}×N\_{slot}^{UL}×T\_{slot}$
* For eMTC, repetition unit is $N\_{slot}^{UL}×T\_{slot}$ for sub-PRB allocation, where Tslot = 0.5 ms. For full-PRB allocation, repetition unit is one subframe.
* NOTE1: $M\_{identical}^{NPUSCH}, N\_{slot}^{UL}, T\_{slot}$ are defined in TS 36.211 10.1.2.3 and 10.1.3.6 for NB-IoT
* NOTE2: $M\_{symb}^{UL}, M\_{slot}^{UL}$M\_^UL\_slot is defined in TS 36.211, 5.2.3A for eMTC
* FFS: RAN1 to further discuss valid and invalid subframes
* FFS: Configuration details

Agreement:

For NB-IoT, if a mapping to Nslots slots or a repetition of the mapping in an UL transmission segment for UE pre-compensation for NPUSCH transmission contains a resource element which overlaps with any configured NPRACH resource, the NPUSCH transmission in overlapped Nslots slots is postponed until the next Nslots slots not overlapping with any configured NPRACH resource.

* NOTE: Nslots is defined in TS 36.211, 10.1.3.6

Agreement:

* For NB-IoT/eMTC NTN, the network configures one of K candidate values for the UL transmission segment duration of NPUSCH/PUSCH in a k-bit field.
	+ For NB-IoT, maximum 3-bit field with a maximum number of K=8 candidate values 2 ms, 4 ms, 8 ms, 16 ms, 32 ms, 64 ms, 128 ms, 256 ms
* FFS: Down scoping of K candidate values, size of k-bit field

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## Sub-feature-Timing relationships-Koffset-IoT NTN

This section is to collect company inputs on RRC parameters for sub-feature Timing relationships-Koffset-IoT NTN based on the following RAN1 agreements and conclusions:

Configuration of Koffset:

Agreement:

For IoT NTN, support cell-specific Koffset configuration for use during initial access.

Agreement:

For IoT NTN, support the use of UE-specific Koffset in CONNECTED mode.

Conclusion:

In IoT NTN the initialisation of generators for scrambling codes for UL channels and DM-RS shall use the subframe number of the UL channel or UL signal that is indicated by the Koffset-modified timing relationship.

NOTE: In the view of RAN1, this does not necessarily involve a specification change.

Conclusion:

For IoT NTN, no modifications are needed for the calculation in NR NTN for estimate of UE-eNB RTT.

Delay of Koffset as compared to transmission as per current specification:

Agreement:

For NB-IoT, on receiving UL grant on DCI format N0 in subframe n, NPUSCH Format 1 is transmitted with a delay of Koffset as compared to transmission as per current specification.

Agreement:

For NB-IoT, on receiving a NPDSCH with a RAR message that ends in subframe n, the corresponding Msg3 is transmitted on NPUSCH format 1, with a delay of Koffset as compared to transmission as per current specification.

Agreement:

For NB-IoT, a UE upon detection of a NPDSCH transmission for which it should provide an ACK/NACK feedback, shall transmit the HARQ ACK/NACK with a delay of Koffset as compared to transmission as per current specification.

Agreement:

For NB-IoT, on receiving a timing advance command ending in DL subframe n, the corresponding adjustment of the uplink transmission timing by the received time advance shall be delayed by Koffset as compared to current specification.

Agreement:

For eMTC, on receiving an UL grant via MPDCCH that ends in DL subframe n, PUSCH is transmitted with a delay of Koffset as compared to transmission as per current specification.

Agreement:

For eMTC, on receiving a RAR in a PDSCH that ends in subframe n, PUSCH for Msg3 is transmitted with a delay of Koffset as compared to transmission as per current specification.

Agreement:

For eMTC, when an MPDCCH ending in subframe n activates UL SPS, the time of the first subframe in which the UE is allowed to transmit SPS-PUSCH is delayed by Koffset as compared to transmission per current specification.

Agreement:

For eMTC, on reception of a PDSCH ending in subframe n, the corresponding HARQ-ACK feedback on PUCCH is transmitted with a delay of Koffset as compared to transmission as per current specification.

Agreement:

For eMTC, for an MPDCCH received in subframe n that triggers aperiodic SRS transmission, SRS is transmitted with a delay of Koffset as compared to transmission as per current specification.

Agreement:

For eMTC, on receiving a timing advance command ending in subframe n, the corresponding adjustment of the uplink transmission timing by the received time advance shall be delayed by Koffset as compared to current specification.

Advance by Koffset as compared to transmission as per current specification:

Agreement:

For eMTC, the ending time for DL physical resources forming a CSI reference resource set is advanced by Koffset as compared to current specification.

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## Sub-feature-Timing relationships-TAreport-IoT NTN

This section is to collect company inputs on RRC parameters for sub-feature Timing relationships-UE specific report-IoT NTN based on the following RAN1 agreements and conclusions:

Agreement:

UE-specific TA reporting is supported in IoT-NTN

* FFS: Detailed contents of report

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## Others

Please input your comments for any other issues related to RRC parameters:

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# Summary