3GPP TSG RAN WG1 Meeting #108-e R1-2111375

e-Meeting, February 21st – March 3rd, 2022

Agenda Item: 8.14.1

Source: Moderator (MediaTek)

Title: Summary #1 of AI 8.14.1 Enhancements to time and frequency

 synchronization

Document for: Discussion and Decision

# Introduction

At the RAN#92 meeting, a new Work Item was approved for IoT Non Terrestrial Network (NTN) [1]. In this meeting, company views on UL synchronization for IoT NTN are summarized and observations/proposals on identified issues are made. Observations and proposals in Company’s TDoc contributions are listed in the Appendix.

# TP to 36.300

## Company views

Thales proposed a TP to 38.300 to describe stage 2 NR NTN concept of K\_offset, K-mac, UE pre-compensation of timing and frequency pre-compensation/adjustment for uplink transmission [18]. The THALES TP is copied in Section 12.5 in FL summary.

## 1st Round FL Proposal

***Moderator View****: A stage-2 description of concept of K\_offset, K-mac, UE pre-compensation of timing and frequency pre-compensation/adjustment for uplink transmission will help understanding of NR NTN and IoT NTN. The Thales TP should first be discussed and agreed in RAN1 AI 8.4.2. The RAN1 agreement of TP o 38.300 can be used as baseline for IoT NTN in TP to 36.300 with minor editorial revisions as needed.*

***First round proposal – Section 2.2:***

* ***For IoT NTN, capture into 36.300 ~~adopt~~ the NR NTN agreement on TP 38.300 for A stage-2 description of concept of K\_offset, K-mac, UE pre-compensation of timing and frequency pre-compensation/adjustment for uplink transmission with modification as needed.***

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| Companies | Comments |
| Ericsson | Agree. Perhaps the proposal can be modified to include 36.300 as well. |
| Qualcomm | Fine. But please keep in mind that *we need to describe frequency pre-compensation in the RAN1 specs* too (especially since we don’t have a RAN4 spec for IoT-NTN in Release 17). It is very odd that timing precompensation has a detailed specification in 36.211—with all the necessary terms specific to satellites—however, analogous description of frequency pre-compensation—something without which the system doesn’t work—is missing. |
| Moderator | ***As mentioned by Ericsson, Clarified to capture into 36.300 the NR NTN agreement on TP 38.300 for A stage-2 description of concept of K\_offset, K-mac, UE pre-compensation of timing and frequency pre-compensation/adjustment for uplink transmission with modification as needed.******On need to describe frequency pre-compensation in the RAN1 specs mentioned by Qualcomm, it is now added in initial proposal Section 3.2-5*** |
| MediaTek2 | Agree |
| Huawei, HiSilicon | Agree |
| ZTE | Fine with the proposal. |
| Xiaomi | Agree |
| Intel | OK |
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# Companies TPs to TS 36.211

## Company views

***Moderator Note****: To make the FL summary concise, the proposed TPs by companies are summarized in this section. The detailed TPs based on companies contributions are referenced and also included in Section 10 in FL summary*

TPs for TTA formula, Common TA and UE-specific TA:

Ericsson proposed TP on Section 8.1 “Uplink-downlink frame timing” on updating Figure 8.1-1: Uplink-downlink timing relationship with the TTA formula agreed in RAN1 for IoT NTN ( also proposed by MediaTek).



( seconds

Figure 8.1-1: Uplink-downlink timing relation

Ericsson TP on Section 8.1 also proposed is is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured, otherwise ; and quantity is computed by the UE to pre-compensate for the two-way delay between the UE and the satellite, based on UE position and serving satellite-ephemeris-related higher-layers parameters if configured, otherwise .

OPPO proposed TP#1 on Section 8.1 “Uplink-downlink frame timing “ on Section 8.1 [3]

* TP#1 on formula for determination of common TA from the configured common TA parameters, and clarify determination of UE-specific TA is computed by the UE based on satellite-ephemeris-related higher-layers parameters if configured

TP for (NTN-specific) frequency pre-compensation/adjustment:

Qualcomm proposed to describe the concept of (NTN-specific) frequency pre-compensation/adjustment for uplink transmission in the physical layer specifications (3GPP TS 36.211), analogous to the current description of NTN-specific timing pre-compensation in Section 8.1 of TS 36.211 on Timing Advance [6].

- Option 1: Create a new section to describe frequency pre-compensation/adjustment for uplink transmission

- Option 2: Describe frequency pre-compensation in the sections on SC-FDMA signal generation (5.6 and 10.1.5)

TP for UL segmented transmission:

In RAN1#107-e, there are a few open issues (highlighted in yellow) related to segmented uplink transmission.

**Agreement**

UE pre-compensation per segment of NPUSCH for NB-IoT and PUSCH/PUCCH for eMTC is applied from one segment to the next segment by using one or more of the following methods if supported by UE implementation

1. UE may drop / Insert samples / Puncture OFDM symbols
2. UE may blank subframes / slots where UE skip a slot or a subframe

The total transmission time is not changed

UE autonomously Drop / insert samples / Puncture OFDM symbols or Blank subframes / slots where UE drops a subframe / slot

The method used for the UE pre-compensation is known to the eNB by a single UE capability

* UE Blank subframes / slots where UE skip a slot or a subframe (slot is based on Sub Carrier Spacing)

FFS Details of method(s) to drop / insert samples, blanking subframes / slots (slot is based on Sub Carrier Spacing)

**Agreement**

For NB-IoT, UE pre-compensation per segment of NPRACH is applied from one segment to the next segment by using one or more of the following methods if supported by UE implementation

* UE may drop / Insert samples
* UE may blank subframe / repetition unit where UE drops a subframe / repetition unit

The total transmission time is not changed

FFS Details of method(s) to drop / insert samples / blank subframe / repetition unit

FFS Specification impact

**Agreement**

For eMTC, UE pre-compensation per segment of PRACH is applied from one segment to the next segment by drop / insert samples in Guard Period of PRACH preamble.

* The total transmission time is not changed
* FFS Details of method(s) to drop / insert samples

Companies views on methods for NPUSCH / NPRACH UE pre-compensation per segment:

* Huawei, MediaTek proposed to leave it to UE implementation for the method utilized for NPUSCH UE pre-compensation per segment and NPRACH UE pre-compensation per segment [1].
* CATT proposed in order to avoid signal overlapping in segment compensation, the gap can be configured via last symbol puncturing of one segment [4].
* Nokia observed that dropping of entire subframe in each segment will cause large performance reduction, especially for the case when segment size is small, e.g. segment size as 2/4/8 subframe. And further observed that for initial access using Random Access the eNB receiver cannot perform UE-specific segment duration configuration. For PUSCH, it is proposed when dropping is not exceeding the CP, samples dropping of partial CP can be considered, otherwise one-symbol to be dropped should be utilized. For PRACH, when dropping is not exceeding the CP, samples dropping of partial CP can be considered, otherwise dropping of CP + one sequence should be utilized [5].
* Qualcomm proposed TP#1 and TP#2 on Section 5.3.4 and Section 10.1.3.6 respectively for specification of capability-based uplink gaps due to segmented pre-compensation during which a UE indicating the need of such gaps is not expected to transmit in the uplink for the requisite number of uplink slots. These may be described in the “Mapping to physical resources” sections for PUSCH (Section 5.3.4) and NPUSCH (Section 10.1.3.6), analogous to the existing 40 ms gap after 256 ms of continuous uplink transmission [6].
* Ericsson proposed to send LS to RAN4 to specify the details of methods to drop/insert samples and blank subframe(s)/repetition unit(s) for segmented uplink transmission for IoT NTN[8].

## 1st Round FL Proposal

TPs for TTA formula, Common TA and UE-specific TA:

***Moderator view****: on proposed TP on TS 36.211 Section 8.1 on updating Figure 8.1-1 [8]*. *This TP is straightforward editorial revision for Figure 8.1-1 Uplink-downlink timing relationship:. The TTA formula was agreed in RAN1 for IoT NTN and the TTA formula is already captured Section 8.1.*

***Moderator view****: on proposed TPs on TS 36.211 Section 8.1 on including calculation of [3], [8]: These TPs can be combined. They clarify the quantity is computed by the UE to pre-compensate for the two-way delay between the UE and the satellite, based on UE position and serving satellite-ephemeris-related higher-layers parameters if configured, otherwise .*

***Moderator view****: on proposed TPs on TS 36.211 Section 8.1* on common TA [3], [8]*: These TPs can be combined for the determination of TA from the configured common TA parameters, and UE-specific TA* computed by the UE based on satellite-ephemeris-related higher-layers parameters.

TP for UL segmented transmission:

*Moderator summary of companies views on methods for NPUSCH / NPRACH UE pre-compensation per segment: To the Moderator understanding, there are three ways for the RAN1 agreement on methods could be further discussed*

1. *No specification in RAN1 core specifications. The eNB has a-priori knowing the UE behavious for “blanking subframes / slots” based on its reported UE capability for PUSCH / NPUSCH transmission and it is up to eNB to optimize receiver algorithms and eNB UL scheduler algorithm accordingly – e.g. “blanked subframes” are not used in the Multi-User Detection process, or eNB avoids scheduling UE with small segment of 2 subframes and 4 subframes where the SNR loss is more significant (i.e. 3 dB and 1.25 dB respectively, for 8 subframes the SNR loss is 0.58 dB). For NPRACH / PRACH transmission, the eNB has no way of knowing whether the UE assumption since UE capability has not been reported as this happens after Message 1 transmission in Random Access procedure.*
2. *Specification in RAN1 TS 36.211. The UE behaviour for subframe blanking is clear based on its capability, but the UE behaviour for other method drop / insert samples / puncture symbols is not clear since the capability agreed in RAN1 is only for “blanking subframes”.*
3. *Send LS to RAN4 to specify the details of methods to drop/insert samples and blank subframe(s)/repetition unit(s) in TS 36.XXX. A TP could potentially be captured in RAN4 to clarify the UE behaviour for blnking subframes (based on UE capability), drop/insert samples / puncture symbols. RAN4 can also discuss impact on demodulation performance for small segments 2/4/8 subframes and specify demodulation requirements accordingly.*

TP for (NTN-specific) frequency pre-compensation/adjustment:

*Moderator view on (NTN-specific) frequency pre-compensation/adjustment: It is needed to have description of (NTN-specific) frequency pre-compensation/adjustment for uplink transmission in the physical layer specifications (3GPP TS 36.211), similarly to the current description of NTN-specific timing pre-compensation in Section 8.1 of TS 36.211 on Timing Advance [6]. Options proposed by Qualcomm cab be discussed in RAN1*

*- Option 1: Create a new section to describe frequency pre-compensation/adjustment for uplink transmission*

*- Option 2: Describe frequency pre-compensation in the sections on SC-FDMA signal generation (5.6 and 10.1.5)*

TPs for TTA formula, Common TA and UE-specific TA:

***First round proposal – Section 3.2-1:***

* ***Adopt TP on TS 36.211 Section 8.1 on updating Figure 8.1-1***

---------------------------------------- Start of TP for 3GPP TS 36.211 ----------------------------------------

8.1 Uplink-downlink frame timing

<Unchanged Text Omitted>

Transmission of the uplink radio frame number  from the UE shall start seconds before the start of the corresponding downlink radio frame at the UE.



Figure 8.1-1: Uplink-downlink timing relation

<Unchanged Text Omitted>

---------------------------------------- End of TP for 3GPP TS 36.211 ----------------------------------------

***First round proposal – Section 3.2-2****:*

* ***Adopt TP on TS 36.211 Section 8.1 on including calculation of***

---------------------------------------- Start of TP for 3GPP TS 36.211 ----------------------------------------

8.1 Uplink-downlink frame timing

<Unchanged Text Omitted>

The quantity is computed by the UE to pre-compensate for the two-way delay between the UE and the satellite, based on UE position and serving satellite-ephemeris-related higher-layers parameters if configured, otherwise .

<Unchanged Text Omitted>

---------------------------------------- End of TP for 3GPP TS 36.211 ----------------------------------------

***First round proposal – Section 3.2-3:***

* ***Adopt TP on TS 36.211 Section 8.1 on including calculation of***

---------------------------------------- Start of TP for 3GPP TS 36.211 ----------------------------------------

8.1 Uplink-downlink frame timing

<Unchanged Text Omitted>

The quantity is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured (see Clause 4.2.3 in [TS 36.213]), otherwise .

<Unchanged Text Omitted>

---------------------------------------- End of TP for 3GPP TS 36.211 ----------------------------------------

TP for UL segmented transmission:

***First round proposal – Section 3.2-4:***

* ***Companies are encouraged to comment on companies views on details of methods for NPUSCH UE pre-compensation per segment on method(s) to drop / insert samples, Puncture OFDM symbols, blanking subframes / slots using one of the following:***
	+ ***Option 1: TP to 36.211 for “blanking subframes / slots” based on its reported UE capability for PUSCH / NPUSCH transmission. For this Option 1, companies can also comment if specify only “blanking subframes / slots”, or whether also specify drop / insert samples, Puncture OFDM symbols need to be specified.***
	+ ***Option 2: Send LS to RAN4 to specify details of methods to drop/insert samples and blank subframe(s)/repetition unit(s) for PUSCH / NPUSCH transmission in TS 36.XXX***
	+ ***Option 3: Leave it to implementation***

***First round proposal – Section 3.2-5:***

* ***Companies are encouraged to comment on companies views on details of methods for NPRACH UE pre-compensation per segment on method(s) to drop / insert samples, blanking subframes / slots using one of the following:***
	+ ***Option 1: TP to 36.211 for “blanking subframes / slots” based on its reported UE capability for NPRACH transmission. For this Option 1, companies can also comment if specify only “blanking subframes / slots”, or whether also specify drop / insert samples need to be specified.***
	+ ***Option 2: Send LS to RAN4 to specify details of methods to drop/insert samples and blank subframe(s)/repetition unit(s) for PRACH / NPRACH transmission in TS 36.XXX***
	+ ***Option 3: Leave it to implementation***

***First round proposal – Section 3.2-5:***

* ***Draft TP to 36.211 for description of (NTN-specific) frequency pre-compensation/adjustment for uplink transmission.***
* ***Companies are encouraged to comment on options***
	+ ***Option 1: Create a new section to describe frequency pre-compensation/adjustment for uplink transmission***
	+ ***Option 2: Describe frequency pre-compensation in the sections on SC-FDMA signal generation (5.6 and 10.1.5)***

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| Companies | Comments |
| Ericsson | 3.2-1: Agree3.2-2: Agree3.2-3: Agree3.2-4: We support Option 2. RAN1 can revisit it after receiving input from RAN4.3.2-5: We support Option 2 (Typo: PUSCH/NPUSCH🡪PRACH/NPRACH). RAN1 can revisit it after receiving input from RAN4. |
| Qualcomm | **3.2-1**: OK**3.2-2**: Potentially, the text “to pre-compensate for the two-way delay between the UE and the satellite” is not needed. But otherwise OK to include the fact that the TA term is also based on the UE’s location, in addition to the serving satellite ephemeris**3.2-3**: OK**3.2-4**: Dropping/inserting samples is already done by UEs, by implementation, for a number of things. However, when there is a “blanking of slots/subframes” involved, this behavior needs to be captured by the specs, since this is related to “mapping to physical resources”. As we have pointed out, *the 40ms gap after 256 ms of consecutive transmissions is captured in 36.211 today*.Based on the capability, the blanking of slots/subframes needs to be captured in the RAN1 specs in 36.211—otherwise, we don’t specify UE behavior in terms of resource mapping.**3.2-5**: We likely can’t have capability-based gaps for NPRACH. However, if gaps are required at the level of a subframe/slot, the resource mapping will be impacted, which needs to be captured in the RAN1 specs (36.211). ***(Additional comment:)*** While the moderator mentioned Qualcomm’s proposal to **describe frequency pre-compensation in the RAN1 specs**, that proposal has not made it to the 3.2-x series for which comments have been sought. As we mentioned in our contribution, and in our comments on Section 2.2 in this summary, it is very odd that timing pre-compensation terms specific to NTN are elaborately described in 36.211, while there is no analogous mention of frequency pre-compensation—something without which the system simply doesn’t work in NTNs! This is more important given that for IoT over NTN (unlike NR-NTN), we will not have a RAN4 specification in Release 17. We kindly request the moderator to take cognizance of this issue and seek company views on this aspect. |
| Moderator | ***Corrected typo in 3.2-5******Added First round proposal – Section 3.2-5:**** ***Draft TP to 36.211 for description of (NTN-specific) frequency pre-compensation/adjustment for uplink transmission.***
* ***Companies are encouraged to comment on options***
	+ ***Option 1: Create a new section to describe frequency pre-compensation/adjustment for uplink transmission***
	+ ***Option 2: Describe frequency pre-compensation in the sections on SC-FDMA signal generation (5.6 and 10.1.5)***
 |
| MediaTek | 3.2-1: Agree3.2-2: Agree3.2-3: Agree3.2-4: We have preference for Option 3, and would also support Option 2. RAN1 can revisit it after receiving input from RAN4.3.2-5: We have preference for Option 3, and would also support Option 2. RAN1 can revisit it after receiving input from RAN4. |
| Huawei, HiSilicon | 3.2-1: Okay3.2-2: Okay3.2-3: Okay3.2-4/3.2-5: we support Option 3 for both PRACH and PUSCH, i.e. up to UE implementation to fultil the UL synchronization requirement.  |
| ZTE | 3.2-1: Fine.3.2-2: we prefer following revision:The quantity is computed by the UE ~~to pre-compensate for the two-way delay between the UE and the satellite~~, based on UE position and serving satellite-ephemeris-related higher-layers parameters if configured, otherwise .There is no need to specify the purpose of calculation, which is not aligned with the style of specification. Moreover, no agreement clearly stated that the UE specific TA is to pre-compensate the two-way delay. Hence, we prefer to remove the description about the purpose and keep a simple specification.3.2-3: We do not think the TP is needed. The only difference between current description in 36.211 and the agreements “ is derived by the UE based on ” is calculation of the intermediate variable . But since how to derive the common TA through intermediate variable is left to UE implementation anyway, we prefer to just keep current simple description and avoid the introduction of additional unneeded intermediate concepts.3.2-4/3.2-5: We agree with Qualcomm that resource mapping may be affected that especially when inserting sample is supported. Hence, the procedure of inserting gap can be specified using similar description as legacy 40ms gap.3.2-6(additional 3.2-5): We don’t think specification on frequency pre-compensation is needed. |
| Xiaomi | 3.2-1: OK3.2-2: OK3.2-3: OK3.2-4 We prefer option 2, we can wait RAN4’s assessment of the impact on the performance, and revise RAN1’s spec if needed. |
| Intel | 3.2-1: Agree3.2-2: Agree3.2-3: Agree3.2-4: Our preference is option 23.2-5: In our understanding the same approach can be used as for NR NTN to describe frequency pre-compensation. |
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# Companies TPs to TS 36.213

## Company views

***Moderator Note****: To make the FL summary concise, the proposed TPs by companies are summarized in this section. The detailed TPs based on companies contributions are referenced and also included in Section 10 in FL summary*

TP for UL segmented transmission:

Huawei proposed TP on TTA adjustment per segment as configured by higher-layer parameters TransmissionDurationNPRACH-NB-r17 and TransmissionDurationNPUSCH-NB-r17 in Section 16.1.2 [1]

Ericsson proposed to send LS to RAN4 to specify the details of methods to drop/insert samples and blank subframe(s)/repetition unit(s) for segmented uplink transmission for IoT NTN.

TP for Epoch time:

OPPO, Apple proposed to adopt the same epoch time derivation as NR-NTN. OPPO proposed TP#2 on Section 8.1 [3]

* TP#2*:* on configured higher layer parameters TACommon, TACommonDrift, TACommonDriftVariation and satellite-ephemeris-related parameters with reference to an epoch time at a reference point. A UE may assume the epoch time as the start of a subframe n of a SFN m, if m and n are provided; otherwise, the UE may assume the epoch time as the end of a SI window in which the parameters are provided. The reference point is where DL and UL are frame aligned with an offset given by NTA,offset.

Xiaomi proposed the epoch time of assistance information (i.e. Serving satellite ephemeris and Common TA parameters) provided through SIB is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number signalled together with the assistance information [9]

TPs for definition of Common TA:

At RAN1#107-e, the following agreement was made:

**Agreement**

Using indicated Higher-layer Common TA parameters, if configured, the UE can determine the one-way propagation time ( used for calculation as follows:

where:­­­­

* ,  and

* TACommon, TACommonDrift and TACommonDriftVariation are Common TA parameter defined in RAN1 Meeting #106-bis-e
* is the distance between the satellite and the uplink time synchronization reference point divided by the speed of light. DL and UL are frame aligned at the reference point with an offset given by **.**

* is derived by the UE based on to pre-compensate the two-way transmission delay between the uplink time reference point and the satellite.

Ericsson proposed TPs on Section 4.2.3 “Transmission timing adjustments” and TP on Section 16.1.2 “Timing synchronization” [8].

* (Section 4.2.3) The detailed procedure to calculate common TA can be left to implementation (subject to RAN4 accuracy requirements). It is necessary that its definition in the specification reflects the timings relative to the DL reference point (A) (according to 36.211 and 36.133) when the common TA is calculated. An unambiguous definition of common TA time of determination, that does not constrain implementations, is needed.
* (Section 16.1.2) The UE shall determine the that corresponds to the two-way transmission delay expressed in T\_s time units according to Clause 4.2.3.

Qualcomm proposed that for GEO NTNs, a UE applies common TA only in accordance with the common TA term, TACommon, and is not required to process the drift/variation parameters TACommonDrift and TACommonDriftVariation.

## 1st Round FL Proposal

Common Delay:

Moderator view (aligned with NR NTN): The formula of 〖Delay〗\_common (t) agreed in previous RAN1 meeting is essential because it provides how the UE interpret/use the Common TA related parameters indicated by the Network. It is also used by the UE to compute/derive the N\_"TA,adj" ^"common" . From this perspective, the agreement on 〖Delay〗\_common (t) made at previous RAN1 meeting should be captured in the specs. TS 38.213 is the right place for that. Nevertheless, how the UE derive the N\_"TA,adj" ^"common" from 〖Delay〗\_common (t) might be left the UE implementation and thereby, it is not needed to be captured in the specifications.

To the moderator understanding the procedure captured in the proposed TP by Ericsson and the definition of tref allows the UE implementation to determine the common delay using higher-layer parameters TACommon, TACommonDrift, and TACommonDriftVariation, if configured. As mentioned earlier, This (last paragraph in TP by Ericsson) may not be needed to be given by the spec.

How to capture RAN1 agreements was discussed offline discussion with specs editors during RAN1#107e meeting for NR NTN, and similar understanding with IoT NTN spec editors.

* For 38.211, the assumption has been to cover any additional details/requirements needed in 38.133, e.g. in section 7.3 (but I have not checked this with the 133 editor). This would allow the UE to, based on the RRC parameters and whatever measurements that is implemented, compute N\_TA,common (for N\_TA,UE-specific, the agreements already says it is up to the implementation). Any algorithm would be allowed as long as it fulfills the requirements in 38.133. If the intention is to mandate a specific way of calculating N\_TA,common I think we need more decisions nailing down the details.
* For 38.213, assumption is TACommon, TACommonDrift and TACommonDriftVariation to be in 211. Then, what does “N\_(TA, common) is derived by the UE based on 〖Delay〗\_common (t)” mean from a specification perspective? How is the derivation done?

There is same understanding for the above w.r.t TS 36.211 and TS 36.213 for IoT NTN.

TP for Epoch time:

***Moderator view****: on proposed TPs on Section 8.1 for same epoch time derivation as NR-NTN, common delay formula agreed in RAN1#107-e for NR NTN and IoT NTN, and determination of UE-specific TA [3], [8]. These TPs can be combined and aligned with NR NTN. How to determine further the common delay from common TA parameters relative to the DL reference point proposed by Ericsson can be discussed in NR NTN 8.4.2  ~~Section~~* ~~3~~*.*

In NR-NTN, the following agreements on epoch time were made and copied directly to the list of RRC parameters for IoT NTN, which was endorsed in RAN1#107-e in [17]

**NR NTN Agreement**

* When explicitly provided through SIB, Epoch time of assistance information (i.e. Serving satellite ephemeris and Common TA parameters) is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number signaled together with the assistance information.
* Otherwise, when indicated in SIB (other than SIB1), epoch time of assistance information (i.e. Serving satellite ephemeris and Common TA parameters) is implicitly known as the end of the SI window during which the SI message is transmitted.
* When provided through dedicated signaling, epoch time of assistance information (i.e. Serving satellite ephemeris and Common TA parameters) is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number.

NR NTN Agreement

* The reference point for epoch time of the serving satellite ephemeris and Common TA parameters is the uplink time synchronization reference point.

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| *EpochTime-NB-r17 / EpochTime-r17* | *new* | *EpochTime-NB-r17 / EpochTime-r17* | *Indicate the epoch time for assistance information (i.e. Serving satellite ephemeris and Common TA parameters).* *When explicitly provided through SIB, or through dedicated signaling, EpochTime is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number signaled together with the assistance information.**The reference point for epoch time of the serving satellite ephemeris and Common TA parameters is the uplink time synchronization reference point.* | *0 to 1023 to indicate SFN and 0 to 9 to indicate the sub-frame number.* |

Common Delay:

***First round proposal – Section 4.2-1:***

* ***Adopt TP on TS 36.213 Section 4.2.3 on common delay formula***

---------------------------------------- Start of TP for 3GPP TS 36.213 ----------------------------------------

4.2.3 Transmission timing adjustments

<Unchanged Text Omitted>

UE can be provided satellite position by higher layer ephemeris parameters indicated in NTN SIB in Keplerian or PV state vector format. Using satellite position and its own position the UE can calculate which is used to compensate the two-way transmission delay on the service link.

Using indicated Higher-layer Common TA parameters, if configured, the UE can determine the one-way propagation time ( used for  calculation as follows:

Where is the epoch time of the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation*. And , and .

This one-way transmission delay function gives the distance at time between the satellite and the uplink time synchronization reference point divided by the speed of light.

DL and UL are frame aligned at the reference point with an offset given by .

is derived by the UE based on to pre-compensate the two-way transmission delay between the uplink time reference point and the satellite.

 <Unchanged Text Omitted>

---------------------------------------- End of TP for 3GPP TS 36.213 ----------------------------------------

***First round proposal – Section 4.2-2: Confirm agreement on Epoch time in NR NTN is re-used for IoT NTN***

* ***When explicitly provided through SIB, Epoch time of assistance information (i.e. Serving satellite ephemeris and Common TA parameters) is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number signaled together with the assistance information.***
* ***Otherwise, when indicated in SIB (other than SIB1), epoch time of assistance information (i.e. Serving satellite ephemeris and Common TA parameters) is implicitly known as the end of the SI window during which the SI message is transmitted.***
* ***When provided through dedicated signaling, epoch time of assistance information (i.e. Serving satellite ephemeris and Common TA parameters) is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number.***
* ***The reference point for epoch time of the serving satellite ephemeris and Common TA parameters is the uplink time synchronization reference point.***

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| Companies | Comments |
| Ericsson | 4.2-1: We support this TP and suggest following editorial changes for improved readability:-------------------------------------------------------------------------------------------------------------------UE can be provided satellite position by higher-layer ephemeris parameters indicated in NTN SIB. Using satellite position and its own position, the UE can calculate which is used to compensate the two-way transmission delay on the service link.Using indicated higher-layer Common TA parameters, if configured, the UE can determine the one-way propagation delay ( used for  calculation as follows:where is the epoch time of the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation*, and , and .This one-way transmission delay function gives the distance at time between the satellite and the uplink time synchronization reference point divided by the speed of light.DL and UL are frame-aligned at the uplink time synchronization reference point with an offset given by .is derived by the UE based on to pre-compensate the two-way transmission delay between the uplink time synchronization reference point and the satellite.-------------------------------------------------------------------------------------------------------------------Moreover, we propose a TP for NB-IoT in Clause 16.1.2, TS 36.213 NB-IoT (as captured in Section 10.4, Proposal 5 of this summary): -------------------------------------------------------------------------------------------------------------------“The UE shall determine the that corresponds to the two-way transmission delay expressed in time units according to Clause 4.2.3.”-------------------------------------------------------------------------------------------------------------------4.2-2: Agree that agreement on Epoch time in NR NTN is re-used for IoT NTN. Note that Epoch time definition for NR NTN is revisited in RAN1#108-e. Further alignment may be needed. |
| Qualcomm | **4.2-1**: Seems OK to include this (exact wording can be checked finally, if there is “in principle” consensus).**4.2-2**: In eMTC/NB-IoT, the SIB can have multiple repetitions. Where does counting start from in that case? It makes sense (to ensure that the ephemeris validity is optimally tracked) to designate the “first repetition” of such a SIB as the epoch time. |
| Moderator | *How to determine further the common delay from common TA parameters relative to the DL reference point proposed by Ericsson can be discussed in NR NTN 8.4.2  ~~Section~~* ~~3~~For 4.2-2, the TP only capture the RAN1 agreements. We added Initial proposal – Section 6.2-4 “Duration of valid ephemeris (and common TA, if applicable) is counted starting from the first repetition of the SIB carrying satellite ephemeris”.  |
| MediaTek | 4.2-1: Support4.2-2: Support |
| Huawei, HiSilicon | 4.2-1/4.2-2: Both aspects are being discussed/patially revisted in NR NTN, it is better to wait for NR NTN’s conclusion. |
| ZTE | 4.2-1: We do not support to adopt this TP. For common TA, as replied by 38.211 spec editor in RAN1#107e email discussion, the only difference between current description and the agreements “ is derived by the UE based on ” is calculation of the intermediate variable . But since how to derive the common TA through intermediate variable is left to UE implementation anyway, we prefer not to introduce additional unneeded intermediate concepts. Similarly, how to derive UE specific TA through ephemeris and UE position is also left to UE implementation so that the description on UE specific TA calculation is not needed. 4.2-2: Fine with the proposal. |
| Xiaomi | 4.2-2We share Huawei’s view that revision on the epoch time is possible in ongoing NTN email discussion. We can waiyt for NTN’s conclusion.Meawhile, it is questional to us ion associate the the epoch time to the SI window, UE may have different understanding on the common epoch time. |
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# GEO configuration values for Validity timer

## Company views

RAN1#107-e made the following agreements

 **Agreement**

Validity timer duration is configured per cell and indicated to the UE in X bits with:

·       Value range {5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 120, 180, 240}

·       Unit is second

·       FFS Additional values for GEO

Several companies contributed their views on additional values for GEO

* Nokia commented to re-use NR NTN solution for IoT NTN.
* Apple, CMCC, Xiaomi proposed that larger configuration values are used for GEO
* MediaTek propose reasonable target is 900 seconds for GEO, with up to 1800 seconds if needed.
* Thales proposed in NR NTN additional value of 900s (instead of infinity) for GEO with a 4-bit indication.
* Ericsson proposed additional values {900 s, 1800 s, 3600 s, 7200 s} and remove values {25 s, 35 s, 45 s, 55 s}, with a 4-bit indication
* Marvenir proposed up to 2 hours
* ZTE proposed no additional values
* Qualcomm proposed for GEO NTNs, a UE applies common TA only in accordance with the common TA term, TACommon, and is not required to process the drift/variation parameters TACommonDrift and TACommonDriftVariation.

## 1st Round FL proposal

***Moderator view****: There is reasonable consensus on additional values for GEO, but views are not aligned on what the additional values could be and how many will be needed. Generally, it is not well discussed why additional values are needed for GEO since already up to 240 seconds (5 minutes) is supported in GEO. Since contributing companies have simarly made proposals on additional GEO values in NR NTN, to avoid duplicating discussions it can be discussed first in is proposed to discuss AI 8.4.2.*

***Moderator recommendation – Section 5.2:***

* ***First discuss for additional values of validity timer for GEO in NR NTN AI 8.4.2. For IoT NTN, adopt the NR NTN agreement without modification for additional values of validity timer for GEO.***

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| --- | --- |
| Companies | Comments |
| Ericsson | We support the moderator’s recommendation. |
| Qualcomm | Agree; however, a value of infinity should be considered for certain GEO deployments, since it may be supportable by the satellite vendors, as well as simplify UE operations.**Additional Comment**: We request the moderator to open a discussion to ***consider the relevance of Common TA Drift Rate and Common TA Drift Rate variation for GEO networks***. We don’t see any need for these in GEO systems, and a simplified setup (relieving the UE from processing these two components for GEO NTNs) will lead to faster deployments of IoT-NTN over GEO networks. |
| MediaTek2 | Support 5.2**Addition comments:** We think based on simulations of GEO satellite parameters using ephemeris and common TA parameters that a reasonable target is 900 seconds for GEO. Up to 1800 seconds could be considered if needed. As proposed by Thales in 8.4.2, to keep the size of indication to 4 bits, one value of 900 seconds could be added Value range {5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 120, 180, 240, 900}. With reference point at eNB, we observed with simulations that it is needed to use the Common TA Drift Rate and Common TA Drift Rate variation for GEO networks for longer validity timer value of 900 seconds (or 1800 s). The Doppler shift in GEO necessicate accurate UE prediction over long time using the common TA parameters.Note that there is a factor ~25 = 24 ppm/0.93 ppm between LEO and GEO. With 30 seconds considered to be a reasonable target for LEO using common TA, common TA drift, and common TA drift variation , then 900 seconds ~25\*30 is consistent for GEO. Note that the common TA parameters are not configured if reference point is at the satellite.  |
| Huawei, HiSilicon | Agree |
| ZTE | Fine with the proposal. |
| Xiaomi | Agree to adopt NR-NTN agreement |
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# MISC

## Company views

DL synchronization:

Qualcomm proposed to add an RRC parameter to the RRC parameter list, corresponding to the 2 LSBs of the ARFCN in the MIB for NB-IoT, in accordance with the RAN1#107-e agreement

Start of validity timer:

Qualcomm proposed the duration of valid ephemeris (and common TA, if applicable) is counted starting from the first repetition of the SIB carrying satellite ephemeris (and, if applicable, common TA-related) information [6]

Single value X / multiple values Xi for segmented transmission of NPRACH for NB-IoT:

Apple, Xiaomi, ZTE, proposed a single value X is indicated in SIB for the uplink transmission segment duration for NPRACH for NB-IoT and PRACH for eMTC. Nokia observed for initial access using Random Access the eNB receiver cannot perform UE-specific segment duration configuration and will require the UE indicates the selected segment duration before it has received all repetitions of the preamble. A simple solution is to define one segment duration for the Random Access preamble formats

Re-acquisition of NTN-specific SIB

Nokia proposed UL scheduling for reading NTN SIB and keep effectiveness of IoT NTN system should be considered.

GNSS measurements:

CMCC proposed to support conclusion on acquisition of GNSS position fix during paging procedure is up to UE implementation and network configuration of paging timers considering GNSS measurement duration (e.g. GNSS Time To First Fix with cold start of typically 10 seconds) impact in NTN scenario. These paging timers are not specified in 3GPP in legacy paging procedure (i.e. T3413 / T3415).

CMCC proposed UE reports GNSS position fix validity duration to be used by network to move UE to RRC\_IDLE can be considered as an enhancement functionality.

- The rest GNSS position fix validity duration after the reporting may be reported.

- The report may be triggered by the network before UL transmission is scheduled.

Nokia proposed a GNSS measurement gap, corresponding to the time the UE requires to validate GNSS, shall be configured in the paging procedure. UE shall report GNSS measurement capability such that network can allocate sufficient time between sending a paging message and when to expect random access procedure initialization from UE.

UE-specific TA report:

ZTE proposed to determine the reported TA value based on the time instant of real UL transmission/the last segment [11].



Configuration of UL transmission segment:

CATT proposed UL transmission segment duration can be provided to UE by SIB message, and dedicated RRC signaling is not necessary [4].

## 1st Round FL proposal

Based on contributing companies, the following proposals are made

***Moderator recommendation****: Adding 2 LSBs of the ARFCN in the MIB in RRC parameter can be done in accordance with* RAN1#107-e agreement. This can be discussed in separate email discussion [108-e-R17-RRC-IoT-NTN]

**Moderator view on GNSS measurements**: *RAN2 still discussing aspects related to GNSS position validity specification work following RAN1 LS to RAN2. RAN1 can wait for RAN2 to conclude discussions.*

RAN1#107-e endorsed LS to RAN2 on GNSS validity [15]:

*RAN1 has discussed the following aspects and leaves it up to RAN2 to take the following RAN1 agreements into consideration to specify the aspects related to GNSS position validity:*

* *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*
* *The UE autonomously determines its GNSS validity duration X and reports information associated with this valid duration to the network via RRC signalling.*
	+ *X = {10s, 20s, 30s, 40s, 50s, 60s, 5 min, 10 min, 15 min, 20 min, 25 min, 30 min, 60 min, 90 min, 120 min, infinity}*
* *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)*

*RAN1 respectfully requests RAN2 to prioritize the aspects related to GNSS position validity specification work.*

*RAN2#116bis-e made the following agreements:*

* ***UE need to have a valid GNSS fix before going to connected. RAN2 assumes that the UE may need to re-aquire the GNSS fix right before establishing the connection (regardless if previously valid or not), if needed to avoid interruption during the connection.***
* ***When the GNSS fix becomes outdated in RRC\_CONNECTED mode, the UE goes to IDLE mode.***

*Ericsson, Nokia, Nokia Shanghai Bell, Turkcell, NEC, Qualcomm, ZTE discussed in RAN2 that without any knowledge of how long the UE can be expected to stay in connected mode there would make IoT NTN challenging for network operations, and proposed in RAN2 that UE reports remaining GNSS validity duration to the network [19].*

**Moderator view on NTN-specific re-acquisition***: RAN2 still discussing aspects related to validity timer / re-acquisition on NTN-specific SIB following RAN1 LS to RAN2. RAN1 can wait for RAN2 to conclude discussions.*

RAN1#106bis-e endorsed LS to RAN2 on Validity Timer for UL Synchronization [15]:

*RAN1 has discussed the following aspects and leaves it up to RAN2 to specify UE behaviour related to expiry of UL synchronization validity timer and determine which of the following aspects are to be specified:*

* *Mechanisms for UE to declare loss of UL synchronization including mechanisms for UL synchronization recovery procedure when UL synchronization is lost if UL synchronization validity timer expires in RRC\_CONNECTED*
	+ *It is up to RAN2 to specify this new behaviour for connected UE within RLF set of procedures or a new procedure for re-acquiring satellite ephemeris*
	+ *Mechanism for UL synchronization includes re-acquiring the satellite ephemeris and common TA parameters if indicated on SIB*
	+ *A new clause of RLF for loss of UL synchronization if validity timer for UL synchronization expires assuming a new re-interpretation of RLF set of procedures is specified for recovery of UL synchronization with re-acquisition of satellite ephemeris and common TA parameters if indicated*
	+ *Potential additional RACH after re-acquisition of satellite ephemeris and common TA parameters if indicated for the UL synchronization recovery procedure in case of potential residual TA error.*
* *If validity timer for UL synchronization expires and no UL synchronization recovery mechanisms specified as above, UE behaviour shall declare RLF and go into idle mode autonomously to re-acquire ephemeris SIB. UE will then need to re-access the cell via Random Access procedure.*
* *UE signalling to indicate the validity timer for UL synchronization is about to expire*

*RAN1 respectfully requests RAN2 to prioritize the validity timer for UL synchronization specification work.*

RAN2#116bis-e made the following agreements on validity timer for UL synchronization:

* *When SI used for UL synch (pre-compensation) is no longer valid, the UE autonomously tunes away and re-aquires the required SI, and then comes back. FFS whether anything additional is needed.*
* *UE acquires the NTN specific SIB before accessing the cell.*

UE-specific TA report:

**Moderator view on UE-specific TA report**: *RAN2 still discussing UE-specific TA report.*

*RAN2#116bis made agreements*

* *Reuse NR NTN’s TA reporting trigger event in IoT NTN, i.e., a TA offset threshold between current TA and the last successfully reported TA is used for event-triggered TA reporting. FFS for location used for TA reporting purpose.*
* *(Following NR NTN) Neither of the following options are supported “TA information requested by network”, “Periodical reporting of TA information”*
* *(Following NR NTN) Upon reception of configuration or reconfiguration of TA reporting trigger event, if UE has not reported TA before, the UE triggers a TA reporting. FFS whether we need different behaviour for different re-configurations e.g. Handover.*

***Moderator view on Configuration of UL transmission segment****: It was agreed in RAN1#107-e Support network re-configuration of UL transmission segment by dedicated RRC Signalling. There was no consensus on the need for the network re-configure UL transmission segment, and it was only proposed to be discussed again by one company. Proponent of ways to re-configure UL segment are encouraged to discuss offline.*

Agreement

Support network re-configuration of UL transmission segment by dedicated RRC Signalling.

***Moderator view on*** ***start of ephemeris and common TA:*** *It is needed to clarify the start of ephemeris and common TA if configured, because the SIB is repeated within the SI window. Duration of valid ephemeris (and common TA, if applicable) is counted starting from the first repetition of the SIB carrying satellite ephemeris.*

***Initial proposal – Section 6.2-1:***

* *RAN1 can wait for RAN2 to conclude discussions on GNSS Measurements.*

***Initial proposal – Section 6.2-2:***

* *RAN1 can wait for RAN2 to conclude discussions on validity timer / re-acquisition on NTN-specific SIB.*

***Initial proposal – Section 6.2-3:***

* *RAN2 can further discuss when the UE-specific TA report is reported.*

***Initial proposal – Section 6.2-4:***

* *Duration of valid ephemeris and common TA if configured is counted starting from the first repetition of the SIB carrying satellite ephemeris.*

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| Companies | Comments |
| Ericsson | 6.2-1: Agree6.2-2: Agree.6.2-3: Agree. |
| Qualcomm | Agree |
| Moderator  | Added Initial proposal – Section 6.2-4 “Duration of valid ephemeris (and common TA, if applicable) is counted starting from the first repetition of the SIB carrying satellite ephemeris” |
| MediaTek | 6.2-1: Agree6.2-2: Agree.6.2-3: Agree. |
| Huawei, HiSilicon | ***Initial proposal – Section 6.2-1:*** Agree***Initial proposal – Section 6.2-2:*** Agree***Initial proposal – Section 6.2-3:*** Agree |
| ZTE | 6.2-1: Agree.6.2-2: Agree.6.2-3: Agree to let RAN2 further discuss when TA is reported. However, we think how to determine the reported TA value should be discussed in RAN1. In IoT-NTN, when repetition number is very large, the applied TA values for different segments of same transmission may cross the boundary. In this case, the TA of last segment should be reported instead of the initial segment to avoid incorrect configuration of Koffset. Since segment pre-compensation for long transmission was discussed in RAN1, RAN1 should also discuss how to determine the reported TA value. |
| Xiaomi | 6.2-1: Agree6.2-2: Agree.6.2-3: Agree.6.2-4: seems it is associate to the epoch time, we can hold the discussion until concrete design is completed. |
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# Synchronization aspects common to IoT NTN and NR NTN

## Company views

Huawei discussed in NR NTN 8.4.2 and IoT NTN NTN 8.14.1 each satellite velocity vector component needs 18 bits to quantize given a total 54-bits field size for velocity [vx, vy, vz]. The velocity range is calculated as , with the quantization step being 0.06m/s and 1 bit indicating the sign of vx. The velocity range cannot support up to +/- 8000 m/s and need to be updated to [-7864, 7863] m/s accordingly.

## 1st Round for Issue

***Moderator view on satellite velocity vector****: it can be discussed in NR NTN 8.4.2.*

***1st Round Proposal - 7.2-2:*** *satellite velocity vector range can be discussed in NR NTN 8.4.2 first. IoT NTN can use conclusion / agreement from NR NTN without any modification.*

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| --- | --- |
| Companies | Comments |
| Ericsson | 7.2-2: Agree. |
| Qualcomm | Agree |
| MediaTek | 7.2-2: Agree. |
| Huawei, HiSilicon | Agree with the proposal. |
| ZTE | Agree |
| Xiaomi | Agree |
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# Conclusions

TBA

# References

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2. R1-2201217, MediaTek, Enhancements to time and frequency synchronization for IoT NTN, RAN1#107-e, February 2022
3. R1-2201275, OPPO, Discussion on enhancements to time and frequency synchronization, RAN1#107-e, February 2022
4. R1-2201342, CATT, Remaining issues on time and frequency synchronization enhancement for IoT over NTN, RAN1#107-e, February 2022
5. R1-2201587, Nokia, Nokia Shanghai Bell, Remaining issues of time and frequency synchronization for NB-IoT/eMTC over NTN, RAN1#107-e, February 2022
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14. R1-2110673, Moderator (MediaTek), LS on Validity Timer for UL Synchronization, RAN1#106bis-e, October 2021
15. R1-2112848, Moderator (MediaTek), LS on GNSS Validity duration for IoT NTN, RAN1#107-e, November 2021
16. R1-2111377, Moderator (MediaTek), List of IoT over NTN Rel-17 RRC parameters, RAN1#107-e, November 2021
17. R1-2112975, Moderator (Ericsson), Consolidated higher layers parameter list for Rel-17 LTE, RAN1#107-e, November 2021
18. R1-2201184, Thales, TP for RAN1 additions to the stg2 CR for TS 38.300, , RAN1#108-e, February 2021

# Proposed Companies TPs

## Huawei TP#1 to 36.213 (R1-2200941)

Proposal 1: Capture TP#1 in clause 16.1.2 in TS 36.213.

=========================== Start of TP #1 for TS 36.213 ===============================

16.1.2 Timing synchronization

---------------------------------------------------- Unchanged Text Omitted -------------------------------------------------------

If a segment duration is configured by higher layer parameter *TransmissionDurationNPRACH-NB-r17*, the UE is expected to adjust the per segment during the transmission of narrowband physical random access preamble.

If a segment duration is configured by higher layer parameter *TransmissionDurationNPUSCH-NB-r17*, the UE is expected to adjust the per segment during the transmission of narrowband physical uplink shared channel.

============================== End of TP #1 for TS 36.213 ===============================

## OPPO TP#1 and TP#2 to TS 36.211 (R1-2201275)

Proposal 1: Adopt TP#1.

Proposal 2: Adopt the same epoch time derivation as NR-NTN and adopt TP#2.

------------------------------------ TP#1 TS 36.211 (in bleu)-----------------------------------------------

**8. Timing**

8.1 Uplink-downlink frame timing

The quantity is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured, otherwise ; a UE may determine the one-way propagation time , used for calculation as follows:

 , where, , , and , are provided by *TACommon*, *TACommonDrift*, and *TACommonDriftVariation,* respectively; andis the distance between the satellite and the uplink time synchronization reference point divided by the speed of light. The reference point is where DL and UL are frame aligned with an offset given by **;**

The quantity is computed by the UE based on satellite-ephemeris-related higher-layers parameters if configured, otherwise .

-------------------------------- end of TP#1-------------------------------------------------------------------

------------------------------------ TP#2 TS 36.211 (in bleu)-----------------------------------------------

**8 Timing**

8.1 Uplink-downlink frame timing

The quantity is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured, otherwise ;

The quantity is computed by the UE based on satellite-ephemeris-related higher-layers parameters if configured, otherwise .

The provided highe layer parameters *TACommon*, *TACommonDrift*,*TACommonDriftVariation* andsatellite-ephemeris-related parameters are with reference to an epoch time at a reference point. A UE may assume the epoch time as the start of a subframe *n* of a SFN *m*, if *m* and *n* are provided; otherwise, the UE may assume the epoch time as the end of a SI window in which the parameters are provided. The reference point is where DL and UL are frame aligned with an offset given by **.**

-------------------------------- end of TP#2-------------------------------------------------------------------

## Qualcomm TP#1 and TP#2 to TS 36.211 (R1-2201652)

Proposal 3: Specify capability-based uplink gaps due to segmented pre-compensation in TS 36.211, during which a UE indicating the need of such gaps is not expected to transmit in the uplink for the requisite number of uplink slots.

- These may be described in the “Mapping to physical resources” sections for PUSCH (Section 5.3.4) and NPUSCH (Section 10.1.3.6), analogous to the existing 40 ms gap after 256 ms of continuous uplink transmission.

- Candidate TPs capturing this—TP1 and TP2 in this contribution—may be endorsed.

**<TP1, Section 5.3.4, TS 36.211>**

For BL/CE UEs communicating over NTN, for PUSCH transmission, for frame structure type 1, after a transmission duration of time units (which may include subframes that are not BL/CE UL subframes), a gap of time units shall be inserted, according to the UE capability *ue-CE-NeedSegmentedPrecompensationGaps*, as specified in 3GPP TS 36.331. BL/CE UL subframes within the gap of time units shall be counted for the PUSCH resource mapping but not used for transmission of the PUSCH. The quantity is provided by higher layers, and the quantity is one subframe.

For BL/CE UEs in CEModeB, for PUSCH transmission not associated with Temporary C-RNTI, for frame structure type 1, after a transmission duration of  time units (which may include subframes that are not BL/CE UL subframes), a gap of  time units shall be inserted, according to the UE capability *ue-CE-NeedULGaps*, as specified in 3GPP TS 36.331 [9]. BL/CE UL subframes within the gap of  time units shall be counted for the PUSCH resource mapping but not used for transmission of the PUSCH.

**</TP1>**

**<TP2, Section 10.1.3.6, TS 36.211>**

For a UE communicating over NTN, after transmissions and/or postponements due to NPRACH of time units, for frame structure type 1, a gap of time units shall be inserted according to the UE capability *ue-NBIOT-NeedSegmentedPrecompensationGaps* , as specified in 3GPP TS 36.331. UL slots within the gap of time units shall be counted for the NPUSCH resource mapping but not used for transmission of the NPUSCH. The quantity is provided by higher layers, and the quantity is one slot. The portion of a postponement due to NPRACH which coincides with a gap is counted as part of the gap.

NPRACH gaps as defined in clause 10.1.6.1 are not part of the NPRACH resource. For frame structure type 2, the valid uplink subframes which are not used for NPRACH transmission when it is not possible to map G symbol groups back-to-back are not part of the NPRACH resource. The mapping of  is then repeated until  slots have been transmitted. After transmissions and/or postponements due to NPRACH of  time units, for frame structure type 1, a gap of  time units shall be inserted where the NPUSCH transmission is postponed. The portion of a postponement due to NPRACH which coincides with a gap is counted as part of the gap.

**</TP2>**

## Ericsson TPs to TS 36.213 (R1-2201808)

Proposal 3: Adopt the following text proposal for 3GPP TS 36.211:

( seconds

---------------------------------------- Start of TP for 3GPP TS 36.211 ----------------------------------------

8.1 Uplink-downlink frame timing

<Unchanged Text Omitted>

Transmission of the uplink radio frame number  from the UE shall start seconds before the start of the corresponding downlink radio frame at the UE.

****

Figure 8.1-1: Uplink-downlink timing relation

Except for the cases mentioned in Table 8.1-1, Table 8.1-2 and Table 8.1-3, the range of  is: .

For frame structure type 1  and for frame structure type 2  unless stated otherwise in [4]. Note that not all slots in a radio frame may be transmitted. One example hereof is TDD, where only a subset of the slots in a radio frame is transmitted.

 is defined in different ranges depending on the UE configuration according to Table 8.1-1, Table 8.1-2 and Table 8.1-3. In case of subslot based transmission (Table 8.1-2 and Table 8.1-3), the UE is configured by higher layer signalling a processing timeline and an associated range of timing advance.

The quantity is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured (see Clause 4.2.3 in [4]), otherwise .

The quantity is computed by the UE to pre-compensate for the two-way delay between the UE and the satellite, based on UE position and serving satellite-ephemeris-related higher-layers parameters if configured, otherwise .

---------------------------------------- End of TP for 3GPP TS 36.211 ----------------------------------------

Proposal 4: Adopt the following text proposal for TS 36.213:

---------------------------------------- Start of TP for 3GPP TS 36.213 ----------------------------------------

4.2.3 Transmission timing adjustments

<Unchanged Text Omitted>

Using higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation*, if configured, the UE shall determine to pre-compensate the two-way transmission delay between the satellite and the uplink time synchronization reference point as follows.

The one-way transmission delay function gives the distance at time between the satellite and the uplink time synchronization reference point divided by the speed of light and is defined as

where is the epoch time of the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* and , and .

For transmission of UL slot , the UE shall determine the that corresponds to the two-way transmission delay , where

* is the transmission time of the corresponding DL slot from the uplink time synchronization reference point.

---------------------------------------- End of TP for 3GPP TS 36.213 ----------------------------------------

Proposal 5: Adopt the following text proposal for TS 36.213:

---------------------------------------- Start of TP for 3GPP TS 36.213 ----------------------------------------

16.1.2 Timing synchronization

<Unchanged Text Omitted>

The UE shall determine the that corresponds to the two-way transmission delay expressed in time units according to Clause 4.2.3.

---------------------------------------- End of TP for 3GPP TS 36.213 ----------------------------------------

## THALES TP to 38.300

Text proposal for RAN1 additions to the stg2 CR for TS 38.300

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

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

### 16.x.2 User Plane aspects

* **Impact on timing aspects:**

To accommodate the long propagation delays, several NR timing involving DL-UL timing interaction are enhanced by the support of two scheduling offsets: Koffset and K\_mac.

The list of timing relationships that need to be modified for NTN using Koffset is 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 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 1 is an illustration of the transmission timing of DCI scheduled PUSCH, the slot allocated for the PUSCH can be modified to be. Note for this example the subcarrier spacing (SCS) value of the downlink is supposed to be the same as that of the uplink.

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 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. And it is needed for UE action and assumption on downlink configuration indicated by a MAC-CE command in PDSCH.

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 , where µ is the SCS configuration for the PUCCH. MAC CE timing relationship enhancement with K\_mac is illustrated in Figure 2.



Figure 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 compensation for all its uplink transmissions; including PRACH preamble transmissions and uplink transmissions during the RRC Connected state. 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 and higher layer Common-TA-related parameters 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\_CONNECED state:

Where:

- and were already specified in [TS 38.213] [TS 38.211] as part of the existing TA Control;

- is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured, otherwise ;

- is computed by the UE based on satellite-ephemeris-related higher-layers parameters if configured, otherwise ;

- is the NR basic time unit [TS 38.211].



Figure 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 satellite ephemeris information (when configured by the network) to calculate frequency pre-compensation to counter shift the Doppler shifts experienced on the service links.

While the pre-compensation of the Doppler shifts experienced on the service links is to be performed by the UE, the management of Doppler shifts experienced over the feeder links 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.

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

# Appendix

|  |  |
| --- | --- |
| Contribution | Observation/Proposals |
| Huawei (R1-2200941) | ***Observation 1****: The velocity range (+/- 8000 m/s) is not correct for the current agreement.****Proposal 1****: Capture TP#1 in clause 16.1.2 in TS 36.213.****Proposal 2****: The velocity range of +/- 8000 m/s should change to [-7864,7863] according to the bit allocation and granularity.*  |
| MediaTek (R1-2201217) | ***Observation 1****: For UL segments length is shorter than 8 ms, the max delay drift is much smaller than the required transmit timing error in NB-IoT.****Observation 2****: For UL segments length is 8 ms or longer, the SNR loss for 1 ms blanked Subframe/ total subframes in eNB receiver is not significant.****Proposal 1:*** *Leave it to UE implementation for the method utilized for NPUSCH UE pre-compensation per segment.****Proposal 2:*** *Leave it to UE implementation for the method utilized for NPRACH UE pre-compensation per segment.****Proposal 3:*** *Add the GEO candidate values for UL validity timer: {300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800}.**Validity timer duration is configured per cell and indicated to the UE in X=5 bits with:** *Value range {5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 120, 180, 240, 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800}*
* *Unit is second*

***Proposal 4****: Update TS 36.211 Figure 8.1-1: Uplink-downlink timing relation with .* |
| OPPO (R1-2201275) | ***Proposal 1:*** *Adopt TP#1.****Proposal 2:*** *Adopt the same epoch time derivation as NR-NTN and adopt TP#2.* |
| CATT (R1-2201342) | ***Proposal 1****: UL transmission segment duration can be provided to UE by SIB message, and dedicated RRC signaling is not necessary.****Proposal 2****: In order to avoid signal overlapping in segment compensation, the gap can be configured via last symbol puncturing of one segment.*  |
| Nokia, Nokia Shanghai Bell (R1-2201587) | ***Observation 1****: If the network is not aware that a UE requires time to obtain valid GNSS information the network may trigger additional paging before the UE has a chance to initiate the pre-compensated random access procedure.****Observation 2****: Basing paging repetition/escalation on GNSS cold start time value significantly delays the paging procedure.****Observation 3****: If UE validates GNSS before every paging occasion it will waste energy due to low paging probability.****Observation 4****: The more dropping, the more performance loss for the dropped symbol/subframe.****Observation 5****: Dropping of entire subframe in each segment will cause large performance reduction, especially for the case when segment size is small, e.g. segment size as 2/4/8 subframe.****Observation 6****: considering the longer CP of first symbol, it will be good to dropping starting from first symbol of the segment.****Observation 7****: If always dropping the same symbol, then the receiving error rate of that symbol will be larger than other symbols, finally impact the BLER of the packet.****Observation 8****: A UE with a high elevation angle will benefit from using a longer segment duration than a minimum value applicable to all angles.****Observation 9****: The eNB receiver needs to know which segment duration a UE is applying in order to determine when samples will be modified.****Observation 10****: For initial access using Random Access the eNB receiver cannot perform UE-specific segment duration configuration.****Observation 11****: UE needs to notify which segment duration it is applying in the preamble transmission if network has configured more than one segment duration.****Observation 12****: A simple solution is to define one segment duration for the Random Access preamble formats, but it may cause additional UE complexity for processing too many short segments.****Observation 13****: Over a long uplink transmission the elevation angle change will cause large variation of TA drift rate.****Observation 14****: Different segment sizes may be needed depending on the TA drift rate.* ***Observation 15****: IoT UE with long UL repetition may miss the NTN SIB.* ***Proposal 1****: UE shall report GNSS measurement capability such that network can allocate sufficient time between sending a paging message and when to expect random access procedure initialization from UE.* ***Proposal 2****: Network shall not repeat the paging message for a UE during the UE’s GNSS measurement gap.****Proposal 3****: A GNSS measurement gap, corresponding to the time the UE requires to validate GNSS, shall be configured in the paging procedure. The position and duration of the gap can be decided and supported in Rel 17.****Proposal 4****: For PUSCH, when dropping is not exceeding the CP, samples dropping of partial CP can be considered, otherwise one-symbol to be dropped should be utilized.****Proposal 5****: How to mitigate the performance loss because of dropping in segments should be considered.****Proposal 6****: For PRACH, when dropping is not exceeding the CP, samples dropping of parital CP can be considered, otherwise dropping of CP + one sequence should be utilized.****Proposal 7****: How to reduce the TA error for repetitions in the segment for good performance should be considered and discussed.****Proposal 8****: RAN1 to discuss configuration of more than one segment duration X for PRACH and how the UE can indicate the selected segment duration.****Proposal 9****: RAN1 to discuss how to configure multiple segment size for an uplink transmission.* ***Proposal 10****: Regarding validity timer for GEO scenario reuse the NR NTN solution.****Proposal 11****: How to remove limitation of UL scheduling for reading NTN SIB and keep effectiveness of IoT NTN system should be considered.* |
| Qualcomm (R1-2201652) | ***Proposal 1****: Describe the concept of (NTN-specific) frequency pre-compensation/adjustment for uplink transmission in the physical layer specifications (3GPP TS 36.211), analogous to the current description of NTN-specific timing pre-compensation in Section 8.1 of TS 36.211 on Timing Advance.**- Option 1: Create a new section to describe frequency pre-compensation/adjustment for uplink transmission**- Option 2: Describe frequency pre-compensation in the sections on SC-FDMA signal generation (5.6 and 10.1.5)* ***Proposal 2****: For GEO NTNs, a UE applies common TA only in accordance with the common TA term, TACommon, and is not required to process the drift/variation parameters TACommonDrift and TACommonDriftVariation.****Proposal 3****: Specify capability-based uplink gaps due to segmented pre-compensation in TS 36.211, during which a UE indicating the need of such gaps is not expected to transmit in the uplink for the requisite number of uplink slots.**- These may be described in the “Mapping to physical resources” sections for PUSCH (Section 5.3.4) and NPUSCH (Section 10.1.3.6), analogous to the existing 40 ms gap after 256 ms of continuous uplink transmission.**- Candidate TPs capturing this—TP1 and TP2 in this contribution—may be endorsed.****Proposal 4****: The duration of valid ephemeris (and common TA, if applicable) is counted starting from the first repetition of the SIB carrying satellite ephemeris (and, if applicable, common TA-related) information.****Proposal 5****: Add an RRC parameter to the RRC parameter list, corresponding to the 2 LSBs of the ARFCN in the MIB for NB-IoT, in accordance with the RAN1#107-e agreement.* |
| Apple (R1-2201789) | ***Proposal 1:*** *An additional NTN validity duration value longer than 240 seconds is supported for GEO scenario.* ***Proposal 2:*** *In IoT NTN, the reference point for epoch time of the serving satellite ephemeris and Common TA parameters is the uplink time synchronization reference point.****Proposal 3:*** *In IoT NTN,* * *when explicitly provided through SIB, epoch time of assistance information is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number signaled together with the assistance information.*
* *otherwise, when indicated in SIB (other than SIB1), epoch time of assistance information is implicitly known as the end of the SI window during which the SI message is transmitted.*
* *when provided through dedicated signaling, epoch time of assistance information is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number.*

***Proposal 4:*** *A single value X is indicated in SIB for the uplink transmission segment duration for NPRACH for NB-IoT and PRACH for eMTC.* ***Proposal 5:*** *In uplink transmissions,* * *if UE is to drop samples between two successive segments, it drops the tail samples of the earlier segment.*
* *if UE is to insert samples between two successive segments, it repeats the last sample of the earlier segment.*
* *if UE is to blank subframe/slot/repetition unit between two successive segments, it blanks the last subframe/slot/repetition unit of the earlier segment.*
 |
| Ericsson (R1-2201808) | ***Proposal 1****: Add NTN validity duration values suitable for GEO, e.g., {900 s, 1800 s, 3600 s, 7200 s}. To limit the field size to 4 bits, other values could be removed, e.g., {25 s, 35 s, 45 s, 55 s}.****Proposal 2****: Send LS to RAN4 to specify the details of methods to drop/insert samples and blank subframe(s)/repetition unit(s) for segmented uplink transmission for IoT NTN.****Proposal 3****: Adopt the following text proposal for 3GPP TS 36.211:****Proposal 4:*** *Adopt the following text proposal for TS 36.213:* |
| CMCC (R1-2201880) | ***Observation 1:*** *For sporadic DL traffic, UE may perform GNSS measurements after a paging occasion and only if it has been paged to reduce battery consumption. The existing timers (e.g., T3413/T3415) can be configured large enough to ensure a sufficient gap to accommodate GNSS acquisition after decoding the paging message and before initiating UL transmission.****Proposal 1:*** *Support the following conclusion.** *Acquisition of GNSS position fix during paging procedure is up to UE implementation and network configuration of paging timers considering GNSS measurement duration (e.g. GNSS Time To First Fix with cold start of typically 10 seconds) impact in NTN scenario. These paging timers are not specified in 3GPP in legacy paging procedure (i.e. T3413 / T3415).*

***Proposal 2:*** *UE reports GNSS position fix validity duration to be used by network to move UE to RRC\_IDLE can be considered as an enhancement functionality.** *The rest GNSS position fix validity duration after the reporting may be reported.*
* *The report may be triggered by the network before UL transmission is scheduled.*

***Proposal 3:*** *Update of assistance information in SIB will not trigger system information modification procedure.** *It is up to RAN2 to determine detailed solutions for updating the assistance information. (e.g., changes of the assistance information should neither result in system information change notifications nor in a modification of systemInfoValueTag in SIB1, just like “timeInfoUTC” field acts in SIB16.)*

***Proposal 4:*** *For**NTN validity duration configuration, larger values than 240 seconds are needed for GEO scenario.****Proposal 5:*** *“Infinity” is not needed in the NTN validity duration value range for the case of GEO.****Proposal 6:*** *Confirm the above working assumption. Higher-layer parameters TACommon, TACommonDrift, TACommonDriftVariation are indicated with the following range, granularity and bits allocation:*

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter name** | **Value range** | **Granularity** | **Bits allocation** |
| **TACommon** | **0 ...8316827****(i.e: 0… 270.73 ms)** | **32.55208 ×10-3μs** | **23 bits** |
| **TACommonDrift** | **- 261935… + 261935****(i.e: -53.33   μs/s… +53.33 μs/s)** | **0.2×10-3μs/s** | **19 bits** |
| **TACommonDriftVariation** | **0…29470****(0…0.60 μs/s2)** | **0.2×10-4μs/s2** | **15 bits** |
| -        **Value ranges are given in unit of corresponding granularity** |   |   |   |

 |
| Xiaomi (R1-2201950) | ***Proposal 1****: The epoch time of assistance information (i.e. Serving satellite ephemeris and Common TA parameters) provided through SIB is the starting time of a DL sub-frame, indicated by a SFN and a sub-frame number signalled together with the assistance information.****Proposal 2****: An additional NTN validity duration value longer than 240 seconds is supported for GEO scenario.****Proposal 3****: UL transmission segment duration with one single value X for NPRACH for NB-IoT and PRACH for eMTC is indicated on SIB.* |
| ZTE (R1-2202210) | ***Proposal 1:*** *UL transmission segment duration with one value X for NPRACH for NB-IoT and PRACH for eMTC may be indicated on SIB.** *For NB-IoT/eMTC, X is one of K candidate values for the UL transmission segment duration of NPRACH/PRACH*
* *Only one X is indicated for all UEs within the cell*

***Proposal 2:*** *UE should determine the reported TA value based on the time instant of real UL transmission instead of the time instant of triggering.****Proposal 3:*** *In case of segment pre-compensation, the TA value applied for the last segment should be used for reporting.****Proposal 4:*** *Additional validity duration values for GEO is not supported.*  |
| SONY (R1-2202408) | ***Proposal:*** *The agreed equation of and epoch time definition in RAN1 107-e should be captured in specification. If this issue is agreed in NR NTN, IoT NTN should also capture the agreement in the TS36.211 specification.* |
| Marvenir (R1-2202479) | ***Proposal 1:*** *Additional value of 2 hours shall be supported for the validity timer duration of GEO.* |