3GPP TSG RAN WG1 #110bis-e R1-22xxxxx

e-Meeting, October 10th – 19th, 2022

**Agenda item:** 8.4

**Source:** Moderator (Thales)

**Title:** Summary of [110bis-e-R17-NR-NTN-02] Email discussion for maintenance on timing relationship enhancements and UL time and frequency synchronization for NR NTN for issues 1-6, 1-1 and 1-4.

**Document for:** Discussion and Decision

## Introduction

This document is the summary of [110bis-e-R17-NR-NTN-02] Email discussion for maintenance on timing relationship enhancements and UL time and frequency synchronization for NR NTN for issues 1-6, 1-4 (as recommendation for editor’s alignment CR) and 1-1 in R1-2210436.

Please note the following checkpoint for agreements:

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| * Check points: October 14, October 19
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## Issue#1-4 Correction on timing relationship parameter for NR NTN

## Background

It is agreed to discuss issue#1-4 as per the conclusion of the summary of [110bis-e-R17-NR-NTN-01] in R1-2210436:

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| **Issue#** | Issue | **Recommendation from the moderator in R1-2210436.** |
| 1-4 | 38.213- Correction on timing relationship parameter for NR NTN:**Reason for change:** The name of the scheduling offset provided by network if downlink and uplink frame timing are not aligned at gNB is called K-Mac in TS 38.213. While in TS 38.331, the name of the scheduling offset is called kmac. It is better to align the name in TS 38.213 and TS 38.331. **Summary of change:** Align the name of scheduling offset provided by network if downlink and uplink frame timing are not aligned at gNB in TS 38.213 with the parameter name used in TS 38.331. **Consequences if not approved**: Misaligned parameter name between TS 38.213 and TS 38.331. | **Discuss over email in RAN1#110bis-e.**11 companies expressed views on this topic.11 companies agree with the FL assessment: This is an editorial issue that will be handled as editorial CRs/ alignment CR.**Moderator recommendation:** Discuss this issue over email in RAN1#110bis-e. This is an editorial issue that will be handled as editorial CRs (to be communicated to the editors/chairs). |

## Initial Proposal (Round-1)

A draft CR for 38.213 providing correction on timing relationship parameter for NR NTN is proposed in [1]. This CR is about the alignment of kmac in TS 38.213 and TS 38.331. The TP, reason/summary of change are provided within **Initial Proposal 1-4-**1.

The following proposal is made:

**Initial Proposal 1-4-1:**

**Adopt the following TP.**

**The TP is to be provided to the TS 38.213 editor for aligning the name of kmac in TS 38.213 and TS 38.331**

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| ***Reason for change:*** | The name of the scheduling offset provided by network if downlink and uplink frame timing are not aligned at gNB is called K-Mac in TS 38.213. While in TS 38.331, the name of the scheduling offset is called kmac. It is better to align the name in TS 38.213 and TS 38.331. |
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| ***Summary of change:*** | Align the name of scheduling offset provided by network if downlink and uplink frame timing are not aligned at gNB in TS 38.213 with the parameter name used in TS 38.331. |
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| ***Consequences if not approved:*** | Mislignmed parameter name between TS 38.213 and TS 38.331. |

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| 6 Link recovery procedures*====Unchanged parts ====*For the PCell or the PSCell, the UE can be provided, by *PRACH-ResourceDedicatedBFR*, a configuration for PRACH transmission as described in clause 8.1. For PRACH transmission in slot $n$ and according to antenna port quasi co-location parameters associated with periodic CSI-RS resource configuration or with SS/PBCH block associated with index $q\_{new}$ provided by higher layers [11, TS 38.321], the UE monitors PDCCH in a search space set provided by *recoverySearchSpaceId* for detection of a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI starting from slot $n+4+2^{μ}∙k\_{mac}$, where $μ$ is the SCS configuration for the PRACH transmission and $k\_{mac}$ is a number of slots provided by *kmac* [12, TS 38.331] or $k\_{mac}=0$ if *kmac* is not provided, within a window configured by *BeamFailureRecoveryConfig*. For PDCCH monitoring in a search space set provided by *recoverySearchSpaceId* and for corresponding PDSCH reception, the UE assumes the same antenna port quasi-collocation parameters as the ones associated with index $q\_{new}$ until the UE receives by higher layers an activation for a TCI state or any of the parameters *tci-StatesPDCCH-ToAddList* and/or *tci-StatesPDCCH-ToReleaseList*. After the UE detects a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI in the search space set provided by *recoverySearchSpaceId*, the UE continues to monitor PDCCH candidates in the search space set provided by *recoverySearchSpaceId* until the UE receives a MAC CE activation command for a TCI state or *tci-StatesPDCCH-ToAddList* and/or *tci-StatesPDCCH-ToReleaseList.**====Unchanged parts ====*7 Uplink Power controlUplink power control determines a power for PUSCH, PUCCH, SRS, and PRACH transmissions. A UE does not expect to simultaneously maintain more than four pathloss estimates per serving cell for all PUSCH/PUCCH/SRS transmissions as described in clauses 7.1.1, 7.2.1, and 7.3.1, except for SRS transmissions configured by *SRS-PosResourceSet* as described in clause 7.3.1. If the UE is provided a number of RS resources for pathloss estimation for PUSCH/PUCCH/SRS transmissions that is larger than 4, the UE maintains for pathloss estimation RS resources corresponding to RS resource indexes $q\_{d}$ as described in clauses 7.1.1, 7.2.1, and 7.3.1. If an RS resource updated by MAC CE, as described in clauses 7.1.1, 7.2.1 and 7.3.1, is one from the RS resources the UE maintains for pathloss estimation for PUSCH/PUCCH/SRS transmissions, the UE applies the pathloss estimation based on the RS resources starting from the first slot that is after slot $k+3∙N\_{slot}^{subframe, μ}+2^{μ}∙k\_{mac}$ where $k$ is the slot where the UE would transmit a PUCCH or PUSCH with HARQ-ACK information for the PDSCH providing the MAC CE, $μ $is the SCS configuration for the PUCCH or PUSCH, respectively, that is determined in the slot when the MAC CE command is applied and $k\_{mac}$ is a number of slots for SCS configuration $μ=0$ provided by *kmac* or $k\_{mac}=0$ if *kmac* is not provided*.**====Unchanged parts ====*8.2 Random access response - Type-1 random access procedureIn response to a PRACH transmission, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding RA-RNTI during a window controlled by higher layers [11, TS 38.321]. The window starts at the first symbol of the earliest CORESET the UE is configured to receive PDCCH for Type1-PDCCH CSS set, as defined in clause 10.1, that is at least one symbol, after the last symbol of the PRACH occasion corresponding to the PRACH transmission, where the symbol duration corresponds to the SCS for Type1-PDCCH CSS set as defined in clause 10.1. If$N\_{TA,adj}^{UE}$or$N\_{TA,adj}^{common}$, as defined in [4, TS 38.211], is not zero, the window starts after an additional $T\_{TA}+k\_{mac}$ msec where $T\_{TA}$ is defined in [4, TS 38.211] and $k\_{mac}$ is provided by *kmac* or $k\_{mac}=0$ if *kmac* is not provided.The length of the window in number of slots, based on the SCS for Type1-PDCCH CSS set, is provided by *ra-ResponseWindow*.*====Unchanged parts ====*8.2A Random access response - Type-2 random access procedureIn response to a transmission of a PRACH and a PUSCH, or to a transmission of only a PRACH if the PRACH preamble is mapped to a valid PUSCH occasion, a UE attempts to detect a DCI format 1\_0 with CRC scrambled by a corresponding MsgB-RNTI during a window controlled by higher layers [11, TS 38.321]. The window starts at the first symbol of the earliest CORESET the UE is configured to receive PDCCH for Type1-PDCCH CSS set, as defined in clause 10.1, that is at least one symbol, after the last symbol of the PUSCH occasion corresponding to the PRACH transmission, where the symbol duration corresponds to the SCS for Type1-PDCCH CSS set. If$N\_{TA,adj}^{UE}$or$N\_{TA,adj}^{common}$, as defined in [4, TS 38.211], is not zero, the window starts after an additional $T\_{TA}+k\_{mac}$ msec where $T\_{TA}$ is defined in [4, TS 38.211] and $k\_{mac}$ is provided by *kmac* or $k\_{mac}=0$ if *kmac* is not provided. The length of the window in number of slots, based on the SCS for Type1-PDCCH CSS set, is provided by *msgB-ResponseWindow*.*====Unchanged parts ====*10.1 UE procedure for determining physical downlink control channel assignment *====Unchanged parts ====*For a CORESET other than a CORESET with index 0, if a UE is provided a single TCI state for a CORESET, or if the UE receives a MAC CE activation command for one or two of the provided TCI states for a CORESET, the UE assumes that the DM-RS antenna port associated with PDCCH receptions in the CORESET is quasi co-located with the one or more DL RS configured by the TCI states. For a CORESET with index 0, the UE expects that a CSI-RS configured with *qcl-Type* set to 'typeD' in a TCI state indicated by a MAC CE activation command for the CORESET is provided by a SS/PBCH block- if the UE receives a MAC CE activation command for one of the TCI states, the UE applies the activation command in the first slot that is after slot $k+3N\_{slot}^{subframe,μ}+2^{μ}∙k\_{mac}$ where $k$ is the slot where the UE would transmit a PUCCH with HARQ-ACK information for the PDSCH providing the activation command, $μ$ is the SCS configuration for the PUCCH in the slot when the activation command is applied, and $k\_{mac}$ is a number of slots for SCS configuration $μ=0$ provided by *kmac* or $k\_{mac}=0$ if *kmac* is not provided.*====Unchanged parts ====* |

Companies are encouraged to comment on the Draft CR within the following table:

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| **Companies** | **Comments and Views** |
| LG | Support |
| MediaTek | Support  |
| ZTE | Support. It’s an editorial issue and the TP can be included in alignment CR. |
| Lenovo | Support. |
| Nokia, Nokia Shanghai Bell | Support – agree with ZTE that this is an editorial issue and may be implemented via alignment CR. |
| Samsung | Support for inclusion in the Rel-17 alignment CR. |
| Ericsson | Support |

## Updated Proposal (Round-2)

The proposal is posted on the reflector for mail Approval

## Issue 1-6 Draft CR for 38.213 to clarify calculation and application of timing advance values for common TA and UE specific TA

## Background

In [2], Nokia, Nokia Shanghai Bell made the following observations and proposals:

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| **Observation 1:** The application time of downlink timing reference, *N*TA-offset and*N*TA is well defined in the timing advance requirements as outlined by 38.113. |
| **Observation 2:** The application of *N*TA,common lacks the definition of the expected point of application. |
| **Proposal 8:** Both $N\_{TA,adj}^{UE}$ and $N\_{TA,adj}^{common}$ shall be updated at the beginning of every UL frame.  |
| **Proposal 9:** The timing advance must be fully corrected considering any DL and UL offsets, and satellite mobility, at the moment the UL signal is received by the satellite.  |

It is agreed to discuss issue#1-6 as per the conclusion of the summary of [110bis-e-R17-NR-NTN-01] in R1-2210436:

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| **Issue#** | Issue | **Recommendation from the moderator in R1-2210436:** |
| 1-6 | Draft CR for 38.213 to clarify calculation and application of timing advance values for common TA and UE specific TA:**Reason for change:** Promote unique expected timing advance correction by the UE in NTN **Summary of change:** Introduce the points of application for the common delay and UE specific delay components in the timing advance. Clarify calculation aspects on the common delay and UE specific delay components in the timing advance. **Consequences if not approved:** UEs may implement different solutions in compliance with the text, but yielding to different behaviour, making the conformance testing and gNB development more difficult. | **Discuss over email in RAN1#110bis-e**8 companies (**LG, MediaTek, Qualcomm, Samsung, Apple, ZTE, DCM, Lenovo**) think this is Non-essential issue3 companies (**Ericsson, Nokia, NSB, Panasonic)** prefer or fine to discuss this issue in this meeting.Moderator’s view: The proposed solution could be left to UE implementation. However, further discussions may be needed.Moderator recommendation: The issue can be discussed in this meeting. |

## Initial Proposal (Round-1)

A draft CR for 38.213 to clarify calculation and application of timing advance values for common TA and UE specific TA is proposed in [3]. The TP, reason/summary of change are provided within **Initial Proposal 1-6-1**.

The following proposal is made:

**Initial Proposal 1-6-1:**

**Adopt the following TP.**

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| ***Reason for change:*** | Promote unique expected timing advance correction by the UE in NTN |
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| ***Summary of change:*** | Introduce the points of application for the common delay and UE specific delay components in the timing advance. Clarify calculation aspects on the common delay and UE specific delay components in the timing advance. |
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| ***Consequences if not approved:*** | UEs may implement different solutions in compliance with the text, but yielding to different behaviour, making the conformance testing and gNB development more difficult. |

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| \*\*\* Unchanged text skipped \*\*\*4.2 Transmission timing adjustmentsA UE can be provided a value $N\_{TA,offset}$ of a timing advance offset for a serving cell by *n-TimingAdvanceOffset* for the serving cell. If the UE is not provided *n-TimingAdvanceOffset* for a serving cell, the UE determines a default value $N\_{TA,offset}$ of the timing advance offset for the serving cell as described in [10, TS 38.133]. If a UE is configured with two UL carriers for a serving cell, a same timing advance offset value $N\_{TA,offset}$ applies to both carriers. Upon reception of a timing advance command for a TAG, the UE adjusts uplink timing for PUSCH/SRS/PUCCH transmission on all the serving cells in the TAG based on a value $N\_{TA,offset}$ that the UE expects to be same for all the serving cells in the TAG and based on the received timing advance command where the uplink timing for PUSCH/SRS/PUCCH transmissions is the same for all the serving cells in the TAG. For a band with synchronous contiguous intra-band EN-DC in a band combination with non-applicable maximum transmit timing difference requirements as described in Note 1 of Table 7.5.3-1 of [10, TS 38.133], if the UE indicates *ul-TimingAlignmentEUTRA-NR* as 'required' and uplink transmission timing based on timing adjustment indication for a TAG from MCG and a TAG from SCG are determined to be different by the UE, the UE adjusts the transmission timing for PUSCH/SRS/PUCCH transmission on all serving cells part of the band with the synchronous contiguous intra-band EN-DC based on timing adjustment indication for a TAG from a serving cell in MCG in the band. The UE is not expected to transmit a PUSCH/SRS/PUCCH in one CG when the PUSCH/SRS/PUCCH is overlapping in time, even partially, with random access preamble transmitted in another CG.For a SCS of $2^{μ}∙15$ kHz, the timing advance command for a TAG indicates the change of the uplink timing relative to the current uplink timing for the TAG in multiples of $16∙{64∙T\_{c}}/{2^{μ}}$. The start timing of the random access preamble is described in [4, TS 38.211].A timing advance command [11, TS 38.321] in case of random access response or in an absolute timing advance command MAC CE, $T\_{A}$, for a TAG indicates $N\_{TA}$values by index values of $T\_{A}$ = 0, 1, 2, ..., 3846, where an amount of the time alignment for the TAG with SCS of $2^{μ}∙15$ kHz is $N\_{TA}=T\_{A}∙16∙{64}/{2^{μ}}$. $N\_{TA}$is defined in [4, TS 38.211] and is relative to the SCS of the first uplink transmission from the UE after the reception of the random access response or absolute timing advance command MAC CE.In other cases, a timing advance command [11, TS 38.321], $T\_{A}$, for a TAG indicates adjustment of a current $N\_{TA}$value, $N\_{TA\\_old}$, to the new $N\_{TA}$value, $N\_{TA\\_new}$, by index values of $T\_{A}$ = 0, 1, 2,..., 63, where for a SCS of $2^{μ}∙15$ kHz, $N\_{TA\\_new}=N\_{TA\\_old}+\left(T\_{A}-31\right)∙16∙{64}/{2^{μ}}$. If a UE has multiple active UL BWPs, as described in clause 12, in a same TAG, including UL BWPs in two UL carriers of a serving cell, the timing advance command value is relative to the largest SCS of the multiple active UL BWPs. The applicable $N\_{TA\\_new}$ value for an UL BWP with lower SCS may be rounded to align with the timing advance granularity for the UL BWP with the lower SCS while satisfying the timing advance accuracy requirements in [10, TS 38.133]. Adjustment of an $N\_{TA}$ value by a positive or a negative amount indicates advancing or delaying the uplink transmission timing for the TAG by a corresponding amount, respectively.For a timing advance command received on uplink slot $n$ and for a transmission other than a PUSCH scheduled by a RAR UL grant or a fallbackRAR UL grant as described in clause 8.2A or 8.3, or a PUCCH with HARQ-ACK information in response to a successRAR as described in clause 8.2A, the corresponding adjustment of the uplink transmission timing applies from the beginning of uplink slot $n+k+1+2^{μ}∙K\_{offset}$ where $k=\left⌈N\_{slot}^{subframe, μ}∙{\left(N\_{T,1}+N\_{T,2}+N\_{TA,max}+0.5\right)}/{T\_{sf}}\right⌉$, $N\_{T,1}$ is a time duration in msec of $N\_{1}$ symbols corresponding to a PDSCH processing time for UE processing capability 1 when additional PDSCH DM-RS is configured, $N\_{T,2}$ is a time duration in msec of $N\_{2}$ symbols corresponding to a PUSCH preparation time for UE processing capability 1 [6, TS 38.214], $N\_{TA,max}$ is the maximum timing advance value in msec that can be provided by a TA command field of 12 bits, $N\_{slot}^{subframe, μ}$ is the number of slots per subframe, $T\_{sf}$ is the subframe duration of 1 msec, and $K\_{offset}=K\_{cell,offset}-K\_{UE,offset}$, where $K\_{cell,offset}$ is provided by *CellSpecific\_Koffset* and $K\_{UE,offset}$ is provided by a Differential Koffset MAC CE command [11, TS 38.321]; otherwise, if not respectively provided, $K\_{cell,offset}=0$ or $K\_{UE,offset}=0$. $N\_{1}$ and $N\_{2}$ are determined with respect to the minimum SCS among the SCSs of all configured UL BWPs for all uplink carriers in the TAG and of all configured DL BWPs for the corresponding downlink carriers. For $μ=0$, the UE assumes $N\_{1,0}=14$ [6, TS 38.214]. Slot $n$ and $N\_{slot}^{subframe, μ}$ are determined with respect to the minimum SCS among the SCSs of all configured UL BWPs for all uplink carriers in the TAG. $N\_{TA,max}$ is determined with respect to the minimum SCS among the SCSs of all configured UL BWPs for all uplink carriers in the TAG and for all configured initial UL BWPs provided by *initialUplinkBWP*. The uplink slot $n$ is the last slot among uplink slot(s) overlapping with the slot(s) of PDSCH reception assuming $T\_{TA}=0$, where the PDSCH provides the timing advance command and $T\_{TA}$ is defined in [4, TS 38.211].If a UE changes an active UL BWP between a time of a timing advance command reception and a time of applying a corresponding adjustment for the uplink transmission timing, the UE determines the timing advance command value based on the SCS of the new active UL BWP. If the UE changes an active UL BWP after applying an adjustment for the uplink transmission timing, the UE assumes a same absolute timing advance command value before and after the active UL BWP change.If the received downlink timing changes and is not compensated or is only partly compensated by the uplink timing adjustment without timing advance command as described in [10, TS 38.133], the UE changes $N\_{TA}$ accordingly. If two adjacent slots overlap due to a TA command, the latter slot is reduced in duration relative to the former slot. The UE does not change $N\_{TA}$ during an actual transmission time window for a PUSCH or a PUCCH transmission [6, TS 38.214].Using higher-layer ephemeris parameters for a serving satellite, if provided, a UE pre-compensates the two-way transmission delay on the service link based on $N\_{TA,adj}^{UE}$ that the UE determines using the serving satellite position and its own position, provided that the UE has a running validity timer for this parameter [12, TS 38.331]. The UE shall adjust the $N\_{TA,adj}^{UE}$ component at the beginning of every uplink slot. The adustment in slot n must compensate for the summation of the service link distance travelled by the downlink reference signal to reach the UE, D1, and the distance travelled by the transmitted uplink slot n to reach the satellite, D2. Where $N\_{TA,adj}^{UE}=\left[\frac{D1+D2}{speed\_{light}.T\_{c}}\right]$, D1 and D2 are measured in meters and $speed\_{light}$ is the speed of light, [299 792 458 m/s], and $T\_{C}$ is the basic timing defined in [4, TS 38.211]. To pre-compensate the two-way transmission delay between the uplink time synchronization reference point and the serving satellite, the UE determines $N\_{TA,adj}^{common} $[4, TS 38.211] based on one-way propagation delay $Delay\_{common}\left(t\right)$ that the UE determines as:$$Delay\_{common}\left(t\right)= \frac{TA\_{Common}}{2}+ \frac{TA\_{CommonDrift}}{2}×\left(t-t\_{epoch}\right)+\frac{TA\_{CommonDriftVariant}}{2}×\left(t-t\_{epoch}\right)^{2} $$where $TA\_{Common}$, $TA\_{CommonDrift}$, and $TA\_{CommonDriftVariant}$ are respectively provided by *ta-Common*, *ta-CommonDrift*, and *ta-CommonDriftVariant* and $t\_{epoch}$ is the epoch time of $TA\_{Common}$, $TA\_{CommonDrift}$, and $TA\_{CommonDriftVariant}$ [12, TS 38.331]. $Delay\_{common}(t)$ provides a distance at time $t$ between the serving satellite and the uplink time synchronization reference point divided by the speed of light. The uplink time synchronization reference point is the point where DL and UL are frame aligned with an offset given by $N\_{TA,offset}$. The UE shall adjust the common delay component, $N\_{TA,adj}^{common}$ at the beginning of every uplink slot. The value of $N\_{TA,common}$ after the adjustment is given by $N\_{TA,adj}^{common} =\left[\frac{Delay\_{common}\left(t\_{0}\right)+Delay\_{common}\left(t\_{1}\right)}{T\_{c}}\right]$, where Tc is the basic timing defined in [4, TS 38.211] and $ t\_{o}$ is the time where the downlink reference signal was transmitted and t1 is the time where the uplink signal transmitted reaches the satellite.\*\*\* Unchanged text skipped \*\*\* |

Companies are encouraged to comment on the Draft CR within the following table:

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| **Companies** | **Comments and Views** |
| LG | Regarding the UE specific TA, following conclusion was already made in RAN1#107-e. Therefore, we cannot support **Initial Proposal 1-6-1**.**Conclusion**$N\_{TA,UE-specific} $is UE self-estimated TA to pre-compensate for the service link delay, which is calculated using the UE position and the serving satellite ephemeris. * How the UE calculates/updates NTA, UE-specific is left to UE implementation.
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| MediaTek  | We see no need for this draft CR. The current specification of common delay formula is sufficient. How the formula is applied in the UE can be left to the UE implementation  |
| ZTE | Not support. In previous meetings, how to derived TA has been discussed a lot and companies cannot achieve consensus on the detailed solution. Finally, it is compromised that the detailed calculation procedures are left to UE implementation. Therefore, we do not think additional specifications, which need a lot of discussions and agreements instead of simple maintenance, should be considered in maintenance phase. |
| Lenovo | We don’t support the CR and think this issue can be up to UE implementation. |
| Nokia, Nokia Shanghai Bell | We are not really sure whether or not the companies that are not supporting this proposal has read the “consequences if not approved”? The consequence of a UE applying its autonomous TA adjustments at random time instants would be that the actual application time of any adjustments would be random as well, and the RAN4 task of performing conformance tests will be impossible – how would you test for behavior when behavior is not well-defined? |
| Samsung | We would be OK to defer discussion on this topic to ~1 month from now to properly consider the arguments by Nokia. |
| Ericsosn | We support the proposed changes except the addition "provided that the UE has a running validity timer for this parameter [12, TS 38.331] ". It is implicitly understood that the provided parameters need to be valid but the details of this (handling of the validity timer T430, etc) are better described in 38.331. |

## Updated Proposal (Round-2)

7 companies provided views during 1st round.

It seems the majority is not supportive of the Initial Proposal 1-6-1.

Companies are encouraged to read each other view and further comment on the Initial Proposal 1-6-1 during the second round:

Companies are encouraged to comment on the Draft CR within the following table:

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| **Companies** | **Comments and Views** |
| QC | We don’t support the CR. The physical meaning of signaled common TA parameter is already clearly defined. Implementation of open-loop TA is up to UE implementation and subject to RAN4 timing requirement. The proposed text imposes unnecessary limitation on UE implementation. |
| Lenovo | We still don’t support the CR and think this can be up to UE implementation without the proposed CR. |
| LG | We think that this draft CR is not necessary. According to previous conclusion, how to update/calculate the UE specific TA is up to UE implementation. Also, the common delay formula in current specification seems to be sufficient.  |

## Issue 1-1 UE backward propagation of the orbit and common TA

## Background

Issue 1-1 is discussed in contributions [4], [5], [6] and [7].

The following proposal about backward propagation of the orbit and Common TA was discussed in last RAN1 meeting but no consensus could be achieved: **Network may expect that assistance information given by the SIB19 can be applied by the UE upon SIB19 acquisition.**

Within the contributions submitted to current RAN1 meeting: There are 4 contributions with conflicting views on support of backward propagation :

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| **Oppo** | Proposal: RAN1 to inform RAN2 that no backward propagation is supported for SIB19 acquisition. |
| **Ericsson**  | Proposal 1 The UE should consider assistance information valid as soon as it is received.Proposal 2 Send an LS to RAN2 asking them to clarify in relevant RAN2 specifications that the UE should consider assistance information valid as soon as it is received. Due to parallel RAN1/RAN2 meetings, the LS should be sent as soon as possible during the RAN1 meeting. |
| **Lenovo** | Proposal 2: The assistance information given by the SIB19 is applied by the UE at the epoch time. |
| **Nokia, Nokia Shanghai Bell** | Proposal 1: The information provided in SIB19 is considered symmetrical around the Epoch time.Proposal 2: The UE may apply the information obtained from SIB19 prior to the Epoch time.Proposal 3: UE may assume that total Validity time for provided serving satellite ephemeris information is larger than explicitly indicated Epoch time.Proposal 4: The gNB may assume that the UE supports backwards propagation of the serving satellite ephemrsis information. |

During the preparation phase of current meeting. FL initial assessment was to handle/discuss the issue in this meeting.

The following view were expressed by companies:

**Oppo:** First off, it is not reasonable to mandate the UE implementation in particular when many UE vendors expressed concerns in last meeting. Secondly, as discussed in RAN1#110 meeting, gNB does not have a precise knowledge on the exact time for acquiring SIB19 for each of the UEs in a cell. Thus, it surely will end up having the case where some UE use backward propagation and some others use forward propagation. As the error directions are opposite, the relative error is doubled, which eventually would lead the gNB to reduce the validity duration in order to compensate for this error. As a result, the claimed benefit by forcing UE to implement backward propagation vanishes. Last but not least, to mandate the UE to implement backward propagation would also require RAN1 to have much of spec impact, such as to define new UE behavior during the period between the end of the validity expiry and the next epoch time. Further, more RAN2 change would also needed. Given we are already at the end of the maintenance phase, this optimization is not needed at all.

LG: Considers this is non-essential issue.

**Ericsson**: We agree with the FL initial assessment.

 The specification currently does not mention or restrict determination of the satellite orbit (or common TA) to before or after the epoch time. On the contrary, 38.331 implies that assistance info is valid when received. We do not support introducing such restriction, considering e.g. the drawbacks of increased initial access latency and increased SIB19 acquisition rate (or UL transmission gaps). The support for indicating an epoch time in the future was agreed at RAN1#107-e and RAN1#110 (for implicit and explicit epoch time, respectively).

 Regarding OPPO's reasoning that the error will be doubled due to opposite error directions when some UEs are using forward propagation and some backward propagation, we disagree. The error direction can be positive or negative regardless of propagation direction, and opposite error directions are equally possible for two UEs both performing forward propagation, both performing backward propagation, or one in each direction.

[Nokia, NSB] Agree with FL that this should be a high priority topic to discuss.

MediaTek: We do not see a need for additional specification:.

* UE can calculate TA and Doppler shift to apply for pre-compensation from epoch time in future to time it reads ephemeris on SIB19. UE can subsequently apply pre-compensation forwards immediately after reading ephemeris on SIB19 even if Epoch time is in the future.
* UE and gNB can have same understanding for start of validity duration at Epoch time based on RAN1 agreement “*NTN ephemeris validity timer should be started/restarted with configured timer validity duration at the epoch time of the assistance information (i.e. serving satellite ephemeris data)*”

QC: We fully agree with MediaTek’s comments.

Samsung: Agree with MediaTek.

Apple: Considers this is non-essential issue.

ZTE: We fully agree with MediaTek’s comments.

DCM: Agree with MediaTek’s comments.

Panasonic: We are not supportive to introduce backward propagation of satellite ephemeris. It was agreed in RAN1#106bis-e that “NTN ephemeris validity timer should be started/restarted with configured timer validity duration at the epoch time of the assistance information (i.e. serving satellite ephemeris data)”

Lenovo: We think current agreement is enough. No optimization is necessary.

## Initial Proposal (Round-1)

Based on the above discussion, the following is proposed for further discussions during this meeting:

**Initial Proposal 1-1:**

Network may expect that assistance information given by the SIB19 can be applied by the UE upon SIB19 acquisition.

**If this proposal is agreed:**

* **[Ericsson] Send an LS to RAN2 asking them to clarify in relevant RAN2 specifications that the UE should consider assistance information valid as soon as it is received.**

**If not:**

* **[OPPO]: RAN1 to inform RAN2 that no backward propagation is supported for SIB19 acquisition.**

Companies are encouraged to provide views within the following table:

|  |  |
| --- | --- |
| **Companies** | **Comments and Views** |
| ZTE | We think the assistance information should be applied at epoch time, i.e., no backward propagation is supported.In current RAN2 spec, the validity duration is clearly defined as the time period start from epoch time, which was agreed by both RAN1 and RAN2. Hence, UE should apply the assistance information during the validity duration, i.e., start from epoch time. The initial access latency can be reduced by setting the epoch time close to the receiving time of assistance information.If UE will apply assistance information upon receiving, how to define the validity duration with consideration that different UE may receive assistance information at different time? If every UE regards its receiving time as the start of validity duration, the indicated validity duration length should be reduced to ensure the latest UE will not lose UL sync during the validity duration and more frequent updates on assistance information is needed. If the epoch time is still regarded as the start of validity duration, there will be misalignment between the validity duration and the time when UE can perform UL transmission. More complicated specification will be needed illustrate the problem. Hence, keeping current definition of validity duration should be the best choice. RAN2 may modify other parts to accommodate the validity duration definition. |
| Nokia, Nokia Shanghai Bell | The consequence of not allowing backwards propagation may be severe. Consider the case where a gNB provides the SIB19 with Epoch time that is 5 seconds into the future and a validity time of 10 seconds. For this case a UE with data for initial access would have to either (a) delay any initial access attempts with an average delay of 2.5 seconds, or (b) continuously read the SIB19 to be able to be “prepared for UL data”. No matter which solution the UE choses, the device owner would be suffering from either excessive delays or extreme battery drain.**Hence, we support Ericsson’s proposal of informing RAN2 that UE should consider assistance information valid as soon as it is received.** |
| Lenovo | We don’t agree with this proposal and think the assistance information should be applied at the epoch time as previous agreement. |
| LG | Agree with ZTE and Lenovo. We think the assistance information should be applied at epoch time. |
| Ericsson | RAN1 has agreed that explicit epoch time can be used for assistance information broadcast in SIB19 and must be used for assistance information in dedicated signaling, e.g., HO command. For the serving cell, RAN1 has agreed that explicit epoch time can only be indicated in the future (up to 10.24 s into the future) and implicit epoch time at the end of SI window which will be in the future (up to 1.28 s).If RAN1 decides to prohibit backward propagation, this has strong implications:1. Initial access delay will increase while the UE waits to reach the epoch time before accessing the serving cell
2. Handover delay will increase while the UE waits to reach the epoch time before accessing the target cell
3. RRC reestablishment delay will increase while the UE waits to reach the epoch time before accessing the target cell
4. UE power consumption in RRC\_CONNECTED state is higher as the UEs cannot utilize the time before the epoch time which means a higher reacquisition rate. The UE must reacquire SIB19 10.24 seconds before the validity timer expires to ensure that the new assistance info is valid before the old expires. E.g., with a validity duration of 20 seconds, SIB19 has to be re-acquired every <10 seconds.

To prevent these adverse effects, the network must always provide epoch times in the current frame or in a very near future. This has the following implications:1. Explicit epoch time is useless. Most of the 14 bits indicating epoch time in SIB19 and in dedicated signaling are wasted.
2. The SI window length must be limited to force the implicit epoch time to be in a near future.
	1. This may limit the coverage, especially for narrow bandwidths, because long SI windows are needed to support high number of repetitions.
	2. This may limit the TBS of other important SI, for example public warning systems (PWS), resulting in increased latency
3. Handover delay will increase since the probability increases that the validity timer for assistance info in the HO command expires, which forces the UE to acquire SIB19 in the target cell before accessing. This is a problem at least for CHO (conditional handover).
4. RRC reestablishment delay will increase if UE do not have valid SIB19 for the selected target cell
5. In GEO networks, where the need for frequently updated assistance info is small, the network still must update its broadcast assistance info frequently, since only a small fraction of the epoch time range can be utilized. This will cause unnecessary signaling load in the network.
6. Unless this restriction of the used epoch time is mandated in the specs, the UE still cannot rely on that the epoch time will not be in the future, and still has to reacquire SIB19 >10 seconds prior to the validity timer expiry.

This will affect the following KPIs, see 28.554:1. Registration success rate
2. PDU session establishment success rate
3. PDU session establishment time
4. NG-RAN handover success rate
5. Mean time of inter-gNB handover execution
6. Success rate of mobility registration update
7. NG-RAN handover success rate for all handover types
8. DRB Retainability

These aspects may be more important to RAN2 but should not be ignored by RAN1. Therefore, we strongly suggest that **RAN1 does not prohibit backward propagation but instead sends an** **LS to RAN2 indicating that backward propagation is possible from RAN1 point of view and that RAN2 should decide based on what is best from their point of view.**Note that there is nothing in RAN1 spec today that prohibits backward propagation. Further, backward propagation has been shown to work with the same accuracy as forward propagation in R1-2209654. Therefore, no other RAN1 action is expected than informing RAN2 of RAN1's view. |

## Updated Proposal (Round-2)

Only 5 companies provided views during 1st round.

To give us better chance to share common understanding of the issue. Companies are encouraged to read each other view and further comment on the Initial Proposal 1-1: during the second round:

Companies are encouraged to provide views within the following table:

|  |  |
| --- | --- |
| **Companies** | **Comments and Views** |
| QC | We don’t support the proposal. The issues mentioned by the proponents of backward propagation (BP) don’t exist as long as the new epoch time is a few hundred ms before the expiration of the current assistance information. Due to SFN ambiguity issue, the epoch time has to be updated at least once every 10s regardless if BP is supported or not. If the validity duration is longer than 10s, we don’t see any issue. If the validity duration is shorter, the network has to update the assistance information frequently, and we don’t see any issue either. |
| Lenovo | We still don’t support the proposal and prefer previous agreement. |
| LG | Agree with QC, and we think the assistance information should be applied at epoch time. |
| ZTE | We don’t support the proposal. Letting UE apply the assistance information immediately will not reduce the frequency of assistance information update. As we commented in first round, different UE may receive the assistance information at different time. If UE is ensured able to apply it upon reacquision, it means that the start of validity duration should be at least set at the receiving time of earliest UE, i.e., t\_epoch – 10.24s. In such case, the indicated validity duration should be the total duration minus 10.24s. As a result, the assistance information should be updated more frequently. |

## Conclusion

TBC

## References

1. R1-2209823 Correction on timing relationship parameter for NR NTN Huawei, HiSilicon
2. R1-2210045 Additional aspects of Rel-17 maintenance for NR over NTN Nokia, Nokia Shanghai Bell
3. R1-2210048 Draft CR for 38.213 to clarify calculation and application of timing advance values for common TA and UE specific TA Nokia, Nokia Shanghai Bell
4. R1-2208829 Discussion on remaining issue for NTN-NR OPPO
5. R1-2209654 On the validity of assistance information for R17 NR NTN Ericsson
6. R1-2210019 Remaining issues on solutions for NR to support NTN Lenovo
7. R1-2210045 Additional aspects of Rel-17 maintenance for NR over NTN Nokia, Nokia Shanghai Bell