3GPP TSG-RAN WG1 Meeting #108-e R1- 220xxxx

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

Agenda Item: 8.4.2

Source: Moderator (Thales)

Title: FL Summary #1: Maintenance on UL time and frequency synchronization for NR NTN

Document for: Discussion

# Introduction

This feature lead summary document captures the remaining/maintenance issues related to UL time and frequency synchronization in NR NTN. It contains a summary of the contributions under 8.4.2 at TSG-RAN WG1 #108-e. together with identified remaining key open issues and recommends topics/questions to be handled via email discussions.

A total of 21 TDocs have been identified for discussion in [108-e-R17-NR-NTN-02]: please see the Appendix for the details, with all the observations and proposals.

Identified topics and issues are listed within the table of content below.

|  |
| --- |
| Please note the following checkpoints for agreements:  [108-e-R17-NR-NTN-02] Email discussion for maintenance on UL time and frequency synchronization – Mohamed (Thales)   * 1st check point: February 25 * Final check point: March 3 |

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# [Active] Topic#1 NTA at Initial access

The following Working assumption was made at RAN1#107-e:

|  |
| --- |
| Working assumption:  When TAC () in msg2/msgB is received, UE receives the first adjustment and is updated as:   * Option 1: .   Where, is the TAC field in msg2/msgB |

This working assumption is to be revisited in current meeting.

## Companies’ contributions summary

|  |  |
| --- | --- |
| **Companies** | **Proposals** |
| THALES | Proposal 3:  Confirm the following working assumption made at RAN1#107-e:  When TAC () in msg2/msgB is received. UE receives the first adjustment and is updated as:  .  Where. is the TAC field in msg2/msgB |
| CATT | 1. Confirm working assumption:   When TAC ( in msg2/msgB is received, UE receives the first adjustment and is updated as follows:  .  .   1. 5bit of TAC can be used to support the scope of in the initial access considering different subcarrier intervals. |
| NTT DOCOMO, INC. | **Proposal 3:** Confirm the working assumption made in 107-e meeting: When TAC ( in msg2/msgB is received, UE receives the first adjustment and is updated as:   , where is the TAC field in msg2/msgB |
| Spreadtrum Communications | **Proposal 1:** Confirm the Working assumption on on TA update in RRC\_CONNECTED state:  Working assumption:  When TAC () in msg2/msgB is received, UE receives the first adjustment and is updated as:   * Option 1: .   where, is the TAC field in msg2/msgB |
| Apple | **Proposal 1:** Confirm the working assumption that when TAC () in msg2/msgB is received, UE receives the first adjustment and is updated as , where is the TAC field in msg2/msgB. |
| CMCC | Proposal 2:Confirm the above working assumption. When TAC ( in msg2/msgB is received, UE receives the first adjustment and is updated as follows:  where, is the TAC field in msg2/msgB. |
| Samsung | **Proposal 1**: Confirm the following working assumption:  When TAC () in msg2/msgB is received, UE receives the first adjustment and is updated as:   * Option 1: ,   where, is the TAC field in msg2/msgB. |
| Qualcomm | **Proposal 1:** When TAC ( in msg2/msgB is received, UE receives the first adjustment and is updated as follows:   ,  . |
| LG Electronics | Proposal 1. Confirm the following working assumption:  Working assumption:  When TAC () in msg2/msgB is received, UE receives the first adjustment and is updated as:   * Option 1: .   where, is the TAC field in msg2/msgB |

## Initial proposal and companies views’ collection for 1st round

The situation remains the same as in previous RAN1 meeting:

* The vast majority is supportive of option 1 and proposed to confirm the working assumption.
* [Qualcomm] proposed to support a negative old NTA value when is updated at the UE after receiving TAC (T\_A) in msg2/msgB is received. The reason given by Qualcomm is recopied hereafter:

|  |
| --- |
| **R1-2202138** – Qualcomm:  During initial access, a PRACH transmission may arrive earlier than the start of a PRACH occasion. Without the support of TA commands of negative values (i.e., delays), subsequent UE UL transmissions can all have negative timing until a TA command with a negative timing advance is received during connected mode. According to RAN4 LS R1-2200869 [R1-2200869/R4-2120311], the transmit timing error requirements for FR1 are established for both PRACH transmission and the first transmission in a DRX cycle. The required timing accuracy is well within half of the CP. However, for FR2 or FR3, same accuracy requirement may lead to a timing error close to or larger than the CP. Further tightening of the requirement for PRACH transmission would mean unnecessarily tight requirement on GNSS accuracy.  Hence, without further delay of the specification and to avoid different specification on the subject between FR1 and FR2, negative NTA values in Msg2/MsgB should be supported. |

Moderator view: As long as the UE initial transmission error does not exceed Te\_NTN specified by RAN4 (At FR1: 30% of CP in case of SCS of uplink signals is 30 kHz and only 18% of CP in case of 15 kHz) an over-estimation of Initial TA estimation is not a major issue, at least at FR1.

The Initial proposal 1 is made as follows:

**Initial Proposal 1:**

Confirm the following working assumption made at RAN1#107-e:

When TAC () in msg2/msgB is received. UE receives the first adjustment and is updated as:

.

Where. is the TAC field in msg2/msgB

Companies are encouraged to provide views within the following table:

|  |  |
| --- | --- |
| **Companies** | **Comments and Views** |
|  |  |
|  |  |

# [Active] Topic#2 Combination of open and closed loop TA control

## Companies’ contributions summary

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| --- | --- |
| **Companies** | **Proposals** |
| MediaTek Inc. | **Proposal 3**: RAN4 can further discuss and conclude on combination of open and closed loop TA control in NTN. |
| CATT | 1. On the double-correction of close-loop TA and open-TA, implementation specific way can be used to resolve this issue. |
| Spreadtrum Communications | **Proposal 2:** The solution to resolve the issue on combination of open and closed loop TA control is up to the UE implementation to meet the RAN4 gradual timing adjustment requirement. |
| Nokia, Nokia Shanghai Bell | **Observation 1:** Operation of closed loop and open loop TA control in RRC connected state needs careful design to avoid instability due to erroneous calculation of the UE-specific TA value by the UE.  **Observation 2:** If TAC is generated to fix a temporary deviation in the UE transmission timing, when UE updates their autonomous components on the timing advance formula, there may be an overcompensation of the timing advance, generating a similar deviation on the opposite direction (Figure 8).  **Observation 3:** If TAC is generated to introduce an offset in UE timing due to gNB internal optimizations, the TAC should be applied regardless of UE accuracy for timing estimation.  **Observation 4:** In order to guarantee TA update loop stability, two operation states for TAC update are needed.  **Proposal 1:** The update rate that the UE applies for both the UE-specific TA and Common TA should be such that the applied TA fulfilles the RAN4 time synchronization requirements.  **Proposal 2:** The Common TA should be calculated in a deterministic way and applied at the same time for all UEs.  **Proposal 3:** For UE in RRC connected mode, in case closed loop TA control is used, open loop TA control should be applied only in a way that does not impact the stability and accuracy as provided by closed loop TA control.  **Proposal 4:** The gNB should be able to use the closed-loop solution (Timing Advance Commands over DL MAC-CE) at any time.  **Proposal 5:** The TAC should operate in two different states to allow both differential and absolute indication of the TAC updates.  **Proposal 18:** RAN1 to send LS to RAN4 in order to clarify the additional aspects that would need to be considered related to the sudden jumps in the UE transmit timing due to UE reading updated information for the serving satellite ephemeris. |
| Apple | **Proposal 2:** For the double correction issue, RAN1 to wait for RAN4’s final decision before concluding the RAN1 discussion.   * In case gradual timing adjustment requirement applies, RAN1 to define the reference timing when new GNSS position or new ephemeris parameters are applied. |
| Xiaomi | **Proposal 1:** The solution to resolve the issue on combination of open and closed loop TA control is up to the UE implementation to meet the RAN4’s requirements. |
| Samsung | **Proposal 2**: Each of the following options are supported based on the gNB configuration:   * Closed-loop TA control * Open-loop TA control * Combination of open&closed-loop TA control |
| Baicells | **Observation 1:** Due to the large RTT in NTN, repeated TA adjustment may be a more prominent problem in NTN.  **Proposal 1:** To ensure TA adjustment can handle both the large TAC latency and high speed UE movement, RAN1 shall wait for the RAN4’s requirement and determine whether RAN1 need additional measures to solve this issue. |
| NEC | **Proposal 2.** The combination of open and closed loop TA control is up to the UE implementation to meet the RAN4 gradual timing adjustment requirement. |

## Initial proposal and companies views’ collection for 1st round

The issue related to the combination of open and closed loop TA control and the possible “double-correction” was discussed in 9 contributions:

According to [MediaTek, Apple, Baicells ] RAN4 can further discuss. RAN1 will re-examine the issue after RAN4 reply.

For [CATT, Spreadtrum Communications, Xiaomi, NEC] the issue can be solved by UE implementation to meet the RAN4 gradual timing adjustment requirement.

[Nokia, Nokia Shanghai Bell] proposed for RAN1 to send LS to RAN4 in order to clarify the additional aspects that would need to be considered related to the sudden jumps in the UE transmit timing due to UE reading updated information for the serving satellite ephemeris

Moderator note: The Reply LS R1-2200870(R4-2120417) from RAN4 was already discussed at RAN1#107-e. The issue is still within the hands of RAN4. RAN1 to wait for RAN4’s final decision before concluding the RAN1 discussion.

**Initial Proposal 2:**

RAN1 to wait for RAN4’s final decision before concluding the RAN1 discussion on “double-correction” issue

Companies are encouraged to provide views within the following table:

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| **Companies** | **Comments and Views** |
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# [Active] Topic#3 Maintenance on Serving satellite ephemeris format bit allocations

The following working assumption on serving satellite ephemeris format bit allocations was made at RAN1#106-bis-e meeting and confirmed at RAN1#107-e [1]:

|  |
| --- |
| **Agreement**  Confirm the working assumption made at RAN1#106-bis-e on serving satellite ephemeris bit allocations for LEO/MEO/GEO based non-terrestrial access network:   * Support serving satellite ephemeris format bit allocations for LEO/MEO/GEO based non-terrestrial access network:   + Position and velocity state vector ephemeris format is 17 bytes payload.     - The field size for position (m) is 78 bits       * Position range is driven by GEO : +/- 42 200 km       * The quantization step is 1.3m for position     - The field size for velocity (m/s) is 54 bits       * Velocity range is driven by LEO@600 km: +/- 8000 m/s       * The quantization step is 0.06 m/s for Velocity   + Orbital parameter ephemeris format 18 byte payload     - Semi-major axis α (m) is 33 bits       * Range: [6500, 43000]km     - Eccentricity e is 19 bits       * Range: ≤ 0.015     - Argument of periapsis ω (rad) is 24 bits       * Range: [0, 2π]     - Longitude of ascending node (Ω rad) is 21 bits       * Range: [0, 2π]     - Inclination i (rad) is 20 bits       * Range: [- π/2 , + π/2]     - Mean anomaly M (rad) at epoch time to is 24 bits       * Range: [0, 2π] |

## Companies’ contributions summary

Companies proposals regarding Topic#1 submitted to RAN1#108-e are collected in the following table:

|  |  |
| --- | --- |
| **Companies** | **Proposals** |
| Thales | **Observation 2.** When the network indicates ephemeris using Keplerian/orbital parameter format with the bit allocation agreed in RAN1#107-e. satellite position errors at the UE are high. An optimal quantization step is needed for Keplerian orbital parameters.  **Observation 3.** An optimal bit allocation in 21 bytes (instead of the 18 bytes as agreed in RAN#107-e) improves significantly the Satellite position and velocity prediction at the UE.  Proposal 1:  Modify bit allocations for orbital parameters ephemeris format as follows:   * Orbital parameters are indicated in 21 bytes payload:   + - Semi-major axis α (m) is 33 bits       * Range: [6500. 43000]km       * The quantization step is 4.2 m     - Eccentricity e is 20 bits       * Range: ≤ 0.015       * The quantization step is 1.4     - Argument of periapsis ω (rad) is 28 bits       * Range: [0. 2π]       * The quantization step is 2.3 rad     - Longitude of ascending node (Ω rad) is 28 bits       * Range: [0. 2π]       * The quantization step is 2.3 rad     - Inclination i (rad) is 27 bits       * Range: [- π/2 . + π/2]       * The quantization step is 2.3 rad     - Mean anomaly M (rad) at epoch time to is 28 bits       * Range: [0. 2π]       * The quantization step is 2.3 rad |

## Initial proposal and companies views’ collection for 1st round

Moderator note: Based on the simulation provided by Thales in [R1-2201011], the quantization step used for Keplerian/orbital parameter format with the bit allocation agreed in RAN1#107-e is non-optimal.

For Keplerian/orbital parameter format, an optimal bit allocation in 21 bytes (instead of the 18 bytes as agreed in RAN#107-e) improves significantly the satellite position and velocity prediction at the UE.

Hopefully we can converge on this issue in first week of the meeting. Indeed, an agreement on this topic is also needed for LS reply to RAN2 (R1-2200875 LS on NTN-specific SIB) and to update RRC parameters list.

The initial proposal is made as follows:

**Initial Proposal 3**

Modify bit allocations for orbital parameters ephemeris format as follows:

* **Orbital parameters are indicated in 21 bytes payload:**
  + - **Semi-major axis α (m) is 33 bits**
      * **Range: [6500. 43000]km**
      * **The quantization step is 4.2 m**
    - **Eccentricity e is 20 bits**
      * **Range: ≤ 0.015**
      * **The quantization step is 1.4**
    - **Argument of periapsis ω (rad) is 28 bits**
      * **Range: [0. 2π]**
      * **The quantization step is 2.3 rad**
    - **Longitude of ascending node (Ω rad) is 28 bits**
      * **Range: [0. 2π]**
      * **The quantization step is 2.3 rad**
    - **Inclination i (rad) is 27 bits**
      * **Range: [- π/2 . + π/2]**
      * **The quantization step is 2.3 rad**
    - **Mean anomaly M (rad) at epoch time to is 28 bits**
      * **Range: [0. 2π]**
      * **The quantization step is 2.3 rad**

Companies are encouraged to provide inputs within the following table:

|  |  |
| --- | --- |
| **Companies** | **Comments and Views** |
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# [Active] Topic#4 Ephemeris format for HAPS

## Companies’ contributions summary

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| --- | --- |
| **Companies** | **Proposals** |
| NTT DOCOMO, INC. | **Observation 4:** The position and velocity state vector ephemeris format for HAPS scenario should be introduced with different bit allocations  **Proposal 7:** The position and velocity state vector ephemeris format for HAPS is supported as the following.   * Position and velocity state vector ephemeris format 12 bytes payload.   + The field size for position [m] is 54 bits     - Position range is driven by HAPS: +/- 50 km     - The quantization step is 0.38m for position   + The field size for velocity [m/s] is 42 bits     - Velocity range is driven by HAPS: +/- 140 m/s     - The quantization step is 0.017 m/s for Velocity |
| InterDigital, Inc. | **Proposal-1:** Ephemeris format is determined based on NTN scenario without indication.  **Proposal-3:** State vector ephemeris format is supported for HAPS.  **Proposal-2:** State vector is used for GEO/HAPS and orbital elements is used for LEO |
| Ericsson | **Observation 1** It is unclear if serving satellite ephemeris is needed for HAPS since the propagation delay and Doppler shift are similar or equivalent to those in a terrestrial network.  **Observation 2** If serving satellite ephemeris is broadcast for a HAPS, the UE must be aware that the non-terrestrial node is a HAPS rather than a satellite since satellite orbit propagation models do not work for HAPS.  [Proposal 5 If serving satellite ephemeris is broadcast for a HAPS, one of the existing serving satellite ephemeris formats can be used without modification.](#_Toc95768508)  [Proposal 6 It can be left to UE implementation to detect that a non-terrestrial node is a HAPS.](#_Toc95768509) |
| ZTE | **Proposal 3:** Confirm that the agreed position and velocity state vector ephemeris format for LEO/MEO/GEO is also applied for HAPS/ATG. |

## Initial proposal and companies views’ collection for 1st round

Moderator note: The agreement on the satellite ephemeris format bit allocations for LEO/MEO/GEO was made in the last RAN1#107-e meeting. However RAN1#107-e agreement does not include serving satellite ephemeris information format for HAPS. Further discussion on Topic#4 is still needed.

NTT DOCOMO proposed a PV state vector based ephemeris format with an optimal bit allocation: 12 bytes payload instead of 17 bytes payload as agreed for LEO/GEO at RAN1#107-e.

Moderator view: An optimal payload for ephemeris format for HAPS may save 5 bytes compared to the bit allocation for PV state vector agreed in RAN1#107-e. However, as observed by Ericsson, the UE must be aware that the NTN is a HAPS. This may lead to further discussion on indicating a NTN-type flag to be indicated in SIB. But as already discussed in previous RAN1 meeting, an unified satellite ephemeris signalling is enough to make the system working, although it is not optimal and further optimization can be done in subsequent Release.

Moderator shares the same view as ZTE. The following Proposal is made:

**Initial Proposal 4:**

**Confirm that the agreed position and velocity state vector ephemeris format for LEO/MEO/GEO is also applied for HAPS/ATG**.

Companies are encouraged to provide views within the following table:

|  |  |
| --- | --- |
| **Companies** | **Comments and Views** |
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|  |  |

# [Active] Topic#5 Validity duration for GEO

The following agreement was made at RAN1#107-e. And it is FFS whether additional NTN validity duration(s) is (are) needed for GEO NTN deployment.

|  |
| --- |
| Agreement  NTN validity 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, Infinity}   + Unit is second   + FFS (to be resolved in current meeting): Additional values for GEO |

## Companies’ contributions summary

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| --- | --- |
| **Companies** | **Proposals** |
| THALES | **Observation 4.** In Case of GEO based NTN. ntnUlSyncValidityDuration can be set to 15mn if the serving satellite ephemeris format is Keplerian-based with optimal bit allocation.  Proposal 2  NTN validity duration is indicated to the UE in 4 bits with:  Value range { 5. 10. 15. 20. 25. 30. 35. 40. 45. 50. 55. 60. 120. 180. 240.900}  Unit is second |
| MediaTek Inc. | **Proposal 2:** 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 |
| PANASONIC R&D Center Germany | **Proposal 1**: NTN validity 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, Infinity} * Unit is second * Note: An infinite validity duration is subject to clause 5.2.2.2.1 in TS 38.331 on SIB validity setting it equal to a maximum of 3 hours. |
| NTT DOCOMO, INC. | **Proposal 5:** One additional large value other than “infinity” could be added on the value range of validity duration for GEO. |
| InterDigital, Inc. | **Proposal-4:** Support a larger value of validity timer for GEO scenario. |
| Apple | **Proposal 3:** An additional NTN validity duration value longer than 240 seconds is supported for GEO scenario. |
| Ericsson | **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} |
| CMCC | **Proposal 3:** ForNTN validity duration configuration, larger values than 240 seconds are needed for GEO scenario.  **Proposal 4:** “Infinity” is not needed in the NTN validity duration value range for the case of GEO. |
| ZTE | **Proposal 1:** Additional validity duration value for GEO is not supported. |

## Initial proposal and companies views’ collection for 1st round

Companies views within the contributions submitted to RAN1#108-e can be summarized as follows:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Additional value (s) for GEO | X = # bits | Comment |
| Thales | One additional value**:** 900 s | X = 4 bits | In Case of GEO based NTN. ntnUlSyncValidityDuration can be set to 15mn if the serving satellite ephemeris format is Keplerian-based with optimal bit allocation |
| MediaTek | {300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800} | X = 5 bits | MediaTek Observed that since the max Doppler shift is 0.93 ppm and 24 ppm for GEO and LEO respectively, the validation timer duration can be expected to be in the order of 30 (=~24 ppm/0.93 ppm) longer for GEO than for LEO. A validity timer duration of 30 seconds for LEO could be a reasonable target, so a reasonable target for GEO can be in the order of 900 seconds. The longer validity timer duration of 1800 seconds may be achievable depending on the UE complexity. |
| PANASONIC | Infinity = 3 hours. | X = 4 bits | An infinite validity duration is subject to clause 5.2.2.2.1 in TS 38.331 on SIB validity setting it equal to a maximum of 3 hours. |
| NTT DOCOMO | One additional value. But not infinity | X = 4 bits | One additional large value other than “infinity” could be add |
| InterDigital | One additional value | X = 4 bits | support much larger value than 240s for GEO case or if validity timer is not configured, a UE may assume that satellite ephemeris/common TA related parameters are not change over time (or up to UE implementation). |
| Apple | One additional value**:** 600 s | X = 4 bits | An additional NTN validity duration value longer than 240 seconds is supported for GEO scenario: A possible candidate validity duration could be 600 seconds |
| Ericsson | {900 s, 1800 s, 3600 s, 7200 s} | X = 4 bits | larger validity duration values should be added e.g., {900 s, 1800 s, 3600 s, 7200 s}. Other values could be removed, e.g., {25 s, 35 s, 45 s, 55 s} |
| CMCC | One or more additional values But not infinity | X= 4 or 5 | larger values than 240 seconds are needed for GEO scenario. “Infinity” is not needed. |
| ZTE | No additional value | X = 0 | Additional validity duration value for GEO is not supported. The legacy SIB update procedure can be adopted for updating the ephemeris and common TA parameters. |

Moderator view: The determination of range/values for **ntnUlSyncValidityDuration** should take into account the timing error due to:

1. Serving-satellite position estimation error due to orbit propagation at NCC/gNB
2. Serving-satellite position estimation error due to orbit propagation at UE: RAN1 made a conclusion that orbit propagation model is left to implementation. Thus it is reasonable for the network to assume a simple orbit propagator model at the UE to determine the validity timer value range.
3. Quantization error linked to bit allocation for serving satellite ephemeris format
4. Common TA estimation error at the UE.

Most importantly, for GEO NTN based deployment we may need to consider a low quality Precision Orbit Determination (POD). Indeed. in case of GEO. although GNSS-based measurements can be also performed on-board to enhance the POD, the number of GNSS satellites in view can be limited in case of GEO (GPS satellites fly in medium Earth orbit at an altitude of approximately 20,200 km and Galileo at 23 222 km) and thereby the POD might be degraded. Therefore, a low quality POD is to be considered for GEO.

Hence a reasonable WF is to consider one additional value = 600 s (10mn, as proposed by Apple) or 900 s (15mn as proposed by Thales). Further, the network may not configure ntnUlSyncValidityDuration, update the Ephemeris data and common TA parameters periodically (e.g every 5mn) and the SIB update procedure(by incrementing ValueTag in SIB1) can be used to indicate that the content of **NTN SIBx** has changed.

Moderator Note: Hopefully we can converge on this issue in first week of the meeting. Indeed, an agreement on this topic is also needed for LS reply to RAN2 (R1-2200875 LS on NTN-specific SIB) and to update RRC parameters list.

Further discussions are needed to align companies views. The following proposal is made:

**Initial Proposal 5**

**Option 1** (APPLE, NTT DOCOMO, CMCC, InterDigital) : **Add one additional NTN validity duration value for GEO i.e. 600 s. X = 4 bits**

**Option 2** (Thales, NTT DOCOMO, CMCC, InterDigital) : **Add one additional NTN validity duration value for GEO i.e. 900 s. X = 4 bits**

**Option 3** (Panasonic): **Add one additional NTN validity duration value for GEO i.e. Infinity = 3 hours. X = 4 bits**

**Option 4** (Ericsson, CMCC): **Add additional NTN validity duration values for GEO e.g., {900 s, 1800 s, 3600 s, 7200 s}. X = 4 bits**

**Option 5** (MediaTek, CMCC, InterDigital) : **Add additional NTN validity duration values for GEO i.e. {300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800}. X = 5 bits.**

**Option 6** (ZTE, InterDigital): **No need to introduce additional validity duration values for GEO. Instead, ntnUlSyncValidityDuration is not indicated and the legacy SIB update procedure can be adopted for updating the ephemeris and common TA parameters. X = 0 bits.**

**Option 7** (Moderator):

* **Add one additional NTN validity duration value for GEO i.e. 900 s. X = 4 bits.**
* **The Network may not indicate ntnUlSyncValidityDuration. If it is not indicated, SIB update procedure (by incrementing ValueTag in SIB1) can be used to indicate that NTN SIB carrying the ephemeris and common TA parameters has changed.**

Companies are encouraged to provide views/preferred option (s) within the following table:

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| --- | --- |
| **Companies** | **Comments and Views** |
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# [Active] Topic#6 UE behaviour w.r.t Validity timer expiry

## Companies’ contributions summary

|  |  |
| --- | --- |
| **Companies** | **Proposals** |
| MediaTek Inc | **Observation 1:** UE’s behaviour needs to be specified when UL synchronization is lost, due to expiry of the UL validity timer**.**  **Observation 2:** Before expiry of UL validity timer, the connected UE can read the NTN-specific SIBx to re-acquire new assistance information.  **Proposal 1:** RAN2 can discuss on how to acquire new or additional assistance information if new or additional assistance information (i.e. serving satellite ephemeris data or Common TA parameters) is not available within the associated validity duration.  **Observation 3**: There is no limitation in NR NTN for UE to re-acquire the NTN-specific SIB when UL synchronization is lost.  **Observation 4:** On NTN cell access when paged, a UE may need to read the NTN-specific SIB within a typical time in the order of a second. It may not be necessary to re-acquire SIB-1 or SIB-2 assuming these SIBs have not changed within the current system information notification period. |
| Nokia, Nokia Shanghai Bell | **Observation 5:** Even if the UE has obtained new serving satellite ephemeris and Common TA related parameters prior to the time of the validity timer expiring, the UE may lose synchronization if the current validity timer expires before the Epoch time of the new serving satellite ephemeris and Common TA.  **Observation 6:** The network is not able to know whether the validity timer has expired at the UE side or is about to expire soon. This may lead to situations where the UE is not able to fulfil the requirements associated to the scheduling commands (PUCCH and PUSCH transmissions).  **Observation 7:** RAN1 and RAN2 have different understandings of the applicability of the validity timer/validity duration.  **Observation 8:** Is seems that RAN1 and RAN2 have different understandings of UE actions prior to the validity timer expiry.  **Observation 9:** There may be periods with uncertainty related to UE’s UL synchronization status if the UE is allowed to read serving satellite ephemeris and Common TA related parameters after the expiry of the validity timer  **Proposal 6:** If a UE has obtained new serving satellite ephemeris and Common TA related parameters prior to the time of the validity timer expiring, the UE is allowed to maintain its UL synchronization until the new Epoch time is reached. For this, the time interval from the expiration of the validity timer until the new Epoch time must not be larger than the new validity duration. In this case,   * The UE restarts the validity timer before the new Epoch time, or, * The UE suspends the timer during this period such that it does not expire.   **Proposal 7:** The UE shall at any time be able to guarantee that is has a valid UL synchronization.  **Proposal 8:** In case the validity timer is about to expire, the UE informs the gNB that it will lose synchronization soon.  **Proposal 9:** Upon receiving a signal from the UE that the UE’s validity timer will expire soon, the gNB either   * Stops scheduling the UE in the uplink and broadcast ephemeris information and Common TA as planned via SIB. * Provides UE-specific assistance signal including ephemeris information of the satellite, the relevant associated Common TA parameters.   **Proposal 10:** After having received UE-specific synchronization information or after having read the SIB again while having earlier informed the gNB on an oncoming validity timer expiration, the UE indicates to the gNB that it has maintained or re-established UL synchronization and that it has reset the validity timer.  **Proposal 11:** To reduce the signalling overhead for UE reporting, UE only informs gNB to maintain the validity timer status when there is potential UL or DL data transmission.  **Proposal 12:** Inform RAN2 that the validity duration is only intended to be applicable for serving satellite ephemeris and common TA related parameters.  **Proposal 13:** Inform RAN2 that under normal operation, a UE is expected to have read new and updated serving satellite ephemeris information prior to the expiry of the validity timer. |

## Initial proposal and companies views’ collection for 1st round

Moderator note: UE behaviour w.r.t Validity timer expiry was discussed in RAN1#106-e and #106-bis-e meetings:

* **RAN1#106-e**: FFS: Associated UE behaviour if the UE does not read the ephemeris within the validity duration.
* **RAN1#106-bis-e**:

Agreement:

The UE assumes that it has lost uplink synchronization if new or additional assistance information (i.e. serving satellite ephemeris data or Common TA parameters) is not available within the associated validity duration.

* FFS: details on how to acquire new or additional assistance information

Moderator notes: w.r.t topic#6,

* Figure 3 below shows the normal operation 🡪 the connected UE can read the NTN-specific SIBx to re-acquire new assistance information: MediaTek: **Observation 2.** Nokia: **Proposal 7, Proposal 13.**
* Figure 1: New assistance information is not available before expiry of the UL validity timer 🡪UL synchronization is lost 🡪 There is no limitation in NR NTN for UE to re-acquire the NTN-specific SIB : MediaTek: **Observation 3**
* Figure 2: Shows the case where new assistance information is available but not within the associated validity duration 🡪 the UE may lose synchronization if the current validity timer expires before the Epoch time of the new serving satellite ephemeris and Common TA: Nokia: **Observation 5**. **Proposal 6.**



Figure 1 Case 1: New assistance information is not available before expiry of the UL validity timer



Figure 2 Case 2: New assistance information is available but not within the associated validity duration



Figure 3 Case 3: New assistance information is available before expiry of the UL validity timer

* Other proposal from Nokia (Proposal 12 and Proposal 13) can be considered in the discussions on RAN2 LS on NTN-specific SIB.

Moderator view: The UE can always re-acquire new assistance information (read the NTN-specific SI) before expiry of UL validity timer (Case 3 which is the normal mode of operation). But if not, there could be 2 cases:

* Case 1: New assistance information is not available before expiry of the UL validity timer. Uplink sync is lost and the UE needs to wait next SI period: Periodicity of SIx window assigned to NTN SIBx (given in # radio frames: 8, 16, 32, 64, 128, 256, 512) should be configured to small value to reduce the access latency.
* Case 2: raised by Nokia, new assistance information is available but not within the associated validity duration. As workaround: Moderator shares the same view as proposed by Nokia (proposal 6 from Nokia) or the group can revise the agreement on Epoch time as follows:

|  |
| --- |
| * 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 start of the SI window during which the SI message is transmitted. |

**Initial Proposal 6**

**Option 1 (Nokia, Nokia Shanghai Bell):**

**If a UE has obtained new serving satellite ephemeris and Common TA related parameters prior to the time of the validity timer expiring, the UE is allowed to maintain its UL synchronization until the new Epoch time is reached. For this, the time interval from the expiration of the validity timer until the new Epoch time must not be larger than the new validity duration. In this case,**

* **The UE restarts the validity timer before the new Epoch time, or,**
* **The UE suspends the timer during this period such that it does not expire.**

**Option 2 (Moderator):**

**Revise the agreement on Epoch time made at RAN1#107e as follows:**

**When assistance information (i.e. Serving satellite ephemeris and Common TA parameters) is indicated in NTN SIB, Epoch time is implicitly known as the end start of the SI window Carrying the NTN SIB.**

Companies are encouraged to provide views within the following table:

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| **Companies** | **Comments and Views** |
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# [Active] Topic#7 Unit of Common TA parameters

## Companies’ contributions summary

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| --- | --- |
| **Companies** | **Proposals** |
| NTT DOCOMO, INC. | **Observation 3:** Based on the indicated common TA parameters and the agreed one-way propagation time formular, the calculated common TA at UE side could be absolute TA value which is not in unit of Tc directly.  **Proposal 4:** Revise the TA equation as TTA = (NTA+NTA,offset+ NTA,adjUE)\*Tc + TTA,adjcommon, where TTA,adjcommon equals 2∙. |

## Initial proposal and companies views’ collection for 1st round

NTT DOCOMO made the following observation: Based on the indicated common TA parameters and the agreed one-way propagation time formula, the calculated common TA at UE side could be absolute TA value which is not in unit of Tc directly.

Then NTT DOCOMO proposed to revise the TA equation as TTA = (NTA+NTA,offset+ NTA,adjUE)\*Tc + TTA,adjcommon, where TTA,adjcommon equals 2∙.

Moderator view: Range, granularity and bits allocation for Higher-layer parameters TACommon, TACommonDrift, TACommonDriftVariation were agreed in previous RAN1 meeting. These parameters are given in unit of: μs for Common TA, μs⁄s for TACommonDrift and μs⁄s^2 for TACommonDriftVariation.

The interpretation/definition of these parameters is clear by considering the formula/agreement on made at previous RAN1 meeting:

The unit of is of course in μs.

Then, is derived by the UE based on . It is not yet specified how the UE derives (will be discussed under topic#12) but obviously whatever the method used should be divided Tc.

From moderator perspective: No revision of TA equation is needed. Alternatively, the Common TA related parameters can be indicated in absolute value (similar to TAC in MAC CE), thereby, the group may revise the unit of Common TA parameters if deemed necessary.

**Initial Proposal 7:**

**Companies are encouraged to comment on all the below WFs:**

**WF 1: Revise the unit of Common TA parameters: to be divided by Tc.**

**WF 2: (**NTT DOCOMO)**: Revise the TA equation as TTA = (NTA+NTA,offset+ NTA,adjUE)\*Tc + TTA,adjcommon, where TTA,adjcommon equals 2∙.**

**WF 3: No revision is deemed necessary.**

Companies are encouraged to provide views within the following table:

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| **Companies** | **Comments and Views** |
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# [Active] Topic#8 Revision of Epoch time agreement

The following agreement was made at RAN1#107-e:

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| --- |
| **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. |

## Companies’ contributions summary

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| --- | --- |
| **Companies** | **Proposals** |
| CATT | 1. Correct the description on the implicit epoch time as following:   Otherwise, when not 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. |

## Initial proposal and companies views’ collection for 1st round

Moderator note: Based on CATT proposal, the second bullet of RAN1#107-e agreement on Epoch time needs to be clarified.

Initial Proposal 8 is made as follows:

**Initial Proposal 8**

**Modify second bullet of RAN1#107-e agreement on Epoch time as follows:**

* **Revision 1: Otherwise, when not 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 NTN SIB SI message is transmitted.**
* **Revision 2: When assistance information (i.e. Serving satellite ephemeris and Common TA parameters) is indicated in NTN SIB, Epoch time is implicitly known as the end of the SI window Carrying the NTN SIB.**
* **Revision 3 (depending on topic#6 conclusion): When assistance information (i.e. Serving satellite ephemeris and Common TA parameters) is indicated in NTN SIB, Epoch time is implicitly known as the start of the SI window Carrying the NTN SIB.**

Companies are encouraged to provide views within the following table:

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| **Companies** | **Comments and Views** |
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# [Active] Topic#9 Support of Common TA third order derivative

## Companies’ contributions summary

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| **Companies** | **Proposals** |
| NTT DOCOMO, INC. | **Observation 1:** With the validity duration of 10 seconds, Common TA, Common TA drift rate and Common TA drift rate variation are enough for LEO-600km for FR1. Common TA third order derivative is needed LEO-600km for FR2.  **Observation 2:** Different combinations of common TA parameters are needed for different NTN types and UE capability on NTN type. For example,   1. LEO: Common TA, Common TA drift rate and Common TA drift rate variation are necessary for moderate validity duration and FR1. 2. GEO: Common TA is enough due to its feature of stationary location to earth 3. HAPS: Common TA (and Common TA drift rate optionally) may be needed   **Proposal 1:** Common TA third order derivative is optionally supported based on the validity duration and carrier frequency.  **Proposal 2:** Based on NTN type and UE capability on NTN type, UE assumes that following combination of common TA parameters are included at least in SIB message:   1. LEO: Common TA, Common TA drift rate and Common TA drift rate variation in mandatory, and Common TA third order derivative optionally based on carrier frequency. 2. GEO: Common TA in mandatory 3. HAPS: Common TA in mandatory, Common TA drift rate optionally |

## Initial proposal and companies views’ collection for 1st round

Support of a third order derivative (TACommonThirdOrder) was discussed in last RAN1 meetings. Based on previous discussions on this topic, few companies do not see the need of Common TA third order derivation support. Even optionally by the network.

Within its contribution submitted to RAN1#108-e, NTT DOCOMO proposed to re-discuss this issue and proposed that TACommonThirdOrder may be optionally supported.

The Initial Proposal 9 is made as follows:

**Initial Proposal 9 (NTT DOCOMO)**

**Common TA third order derivative is optionally supported based on the validity duration and carrier frequency**

Companies are encouraged to provide views within the following table:

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| **Companies** | **Comments and Views** |
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# [Active] Topic#10 BWP switching in TS 38.213

## Companies’ contributions summary

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| --- | --- |
| **Companies** | **Proposals** |
| LG Electronics | Proposal 2. The common TA () and the UE specific TA () should be considered in addition to the TA command value in BWP switching for NR NTN UE. |

## Initial proposal and companies views’ collection for 1st round

Issue on BWP switching in TS 38.213 was raised by LG. The issue description is recopied hereafter:

|  |
| --- |
| R1- 2202286- LG Electronics:  In TS 38.213 [2], the legacy NR UE can change the UL timing based on the TA command value during BWP switching.  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.  For the NR NTN UE, however, the UL timing is calculated together, including common TA () and/or UE specific TA () in addition to the TA command value. Therefore, when the NR NTN UE switches its BWP, it is reasonable to consider not only TA command value but also common TA and/or UE specific TA. |

Based on the above, the Initial Proposal 10 is made as follows:

**Initial Proposal 10 (LGE)**

**The common TA () and the UE specific TA () should be considered in addition to the TA command value in BWP switching for NR NTN UE.**

Companies are encouraged to provide views within the following table:

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| **Companies** | **Comments and Views** |
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# [Active] Topic#11 CRs/TPs for 3GPP TS 38.211

Original CR can be found in [R1-2112921 CR 38.211 NR\_NTN\_solutions-Core](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Docs/R1-2112921.zip).

## Companies’ contributions summary

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| --- | --- |
| **Companies** | **Proposals** |
| MediaTek Inc. | **Proposal 4**: Agree Pseudo CR to TS 38.211 Section 4.3.1 to update Figure 4.1.1-1: Uplink-downlink timing relation with . |
| OPPO | **Proposal 1: Adopt TP#1.**  ------------------------------------ TP#1 TS 38.211 (in bleu)----------------------------------------------  4.3.1 Frames and subframes  Downlink, uplink, and sidelink transmissions are organized into frames with duration, each consisting of ten subframes of duration. The number of consecutive OFDM symbols per subframe is N\_"symb" ^("subframe" ,μ)=N\_"symb" ^"slot" N\_"slot" ^("subframe" ,μ). Each frame is divided into two equally-sized half-frames of five subframes each with half-frame 0 consisting of subframes 0 – 4 and half-frame 1 consisting of subframes 5 – 9.  There is one set of frames in the uplink and one set of frames in the downlink on a carrier.  Uplink frame number for transmission from the UE shall start  T\_"TA" =(N\_"TA" +N\_"TA,offset" +N\_"TA,adj" ^"common" +N\_"TA,adj" ^"UE" ) T\_"c"  before the start of the corresponding downlink frame at the UE where  - N\_"TA" and N\_"TA,offset" are given by clause 4.2 of [5, TS 38.213], except for msgA transmission on PUSCH where N\_"TA" =0 shall be used;  - N\_"TA,adj" ^"common" is derived from the higher-layer parameters TACommon, TACommonDrift, and TACommonDriftVariation if configured, otherwise N\_"TA,adj" ^"common" =0; a UE may determine the one-way propagation time used for N\_"TA,adj" ^"common" calculation as follows:  , where, , , and , are provided by TACommon, TACommonDrift, and TACommonDriftVariation, respectively; and is 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 ;  - N\_"TA,adj" ^"UE" is computed by the UE based on satellite-ephemeris-related higher-layers parameters if configured, otherwise N\_"TA,adj" ^"UE" =0.  -------------------------------- end of TP#1------------------------------------------------------------------  **Proposal 2: Adopt TP#2.**  ------------------------------------ TP#2 TS 38.211 (in bleu)-----------------------------------------------  4.3.1 Frames and subframes  Downlink, uplink, and sidelink transmissions are organized into frames with duration, each consisting of ten subframes of duration. The number of consecutive OFDM symbols per subframe is N\_"symb" ^("subframe" ,μ)=N\_"symb" ^"slot" N\_"slot" ^("subframe" ,μ). Each frame is divided into two equally-sized half-frames of five subframes each with half-frame 0 consisting of subframes 0 – 4 and half-frame 1 consisting of subframes 5 – 9.  There is one set of frames in the uplink and one set of frames in the downlink on a carrier.  Uplink frame number for transmission from the UE shall start  T\_"TA" =(N\_"TA" +N\_"TA,offset" +N\_"TA,adj" ^"common" +N\_"TA,adj" ^"UE" ) T\_"c"  before the start of the corresponding downlink frame at the UE where  - N\_"TA" and N\_"TA,offset" are given by clause 4.2 of [5, TS 38.213], except for msgA transmission on PUSCH where N\_"TA" =0 shall be used;  - N\_"TA,adj" ^"common" is derived from the higher-layer parameters TACommon, TACommonDrift, and TACommonDriftVariation if configured, otherwise N\_"TA,adj" ^"common" =0;  - N\_"TA,adj" ^"UE" is computed by the UE based on satellite-ephemeris-related higher-layers parameters if configured, otherwise N\_"TA,adj" ^"UE" =0.  The provided highe layer parameters TACommon, TACommonDrift,TACommonDriftVariation and satellite-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 N\_(TA,offset).  -------------------------------- end of TP#2------------------------------------------------------------------- |
| CATT | 1. Adopt the two following CRs on timing relationship and parameter descriptions:   **Updated CR 38.211:**   |  | | --- | | Uplink frame number  for transmission from the UE shall start  before the start of the corresponding downlink frame at the UE where  -  - , , and are given by clause 4.2 of [5, TS 38.213]. | |
| Sony | **Proposal 1:** The agreed equation of and epoch time definition in RAN1 107-e should be captured in specification.  **Proposal 2:** Following the text proposal can be considered for TS38.211 specification:  >>>>>>>>>>>>>>>>>>>>>>>>>>>> unchanged text omitted >>>>>>>>>>>>>>>>>>>>>>>>>>>>  Uplink frame number  for transmission from the UE shall start before the start of the corresponding downlink frame at the UE where  - and are given by clause 4.2 of [5, TS 38.213], except for msgA transmission on PUSCH where shall be used;  - is derived from two times one-way propagation time which is calculated from TAInfo-r17 if configured. If TAInfo-r17 is not configured, ;   * the used for is calculated as follows:   Where:   * , and * is derived as follows:   + EpochTime-r17 when configured through [SIB] or [dedicated signaling].   + 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.   - is computed by the UE based on satellite-ephemeris-related higher-layers parameters if configured, otherwise .  >>>>>>>>>>>>>>>>>>>>>>>>>>>> unchanged text omitted >>>>>>>>>>>>>>>>>>>>>>>>>>>> |
| Ericsson | [Proposal 2 Adopt the following TP for 3GPP TS 38.211:](#_Toc95768505)  --------------------------------- Start of TP for 3GPP TS 38.211 --------------------------------- 4.3.1 Frames and subframes <Unchanged Text Omitted>  Uplink frame number  for transmission from the UE shall start before the start of the corresponding downlink frame at the UE where  - and are given by clause 4.2 of [5, TS 38.213], except for msgA transmission on PUSCH where shall be used;  - is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured, otherwise ;  - is computed by the UE to pre-compensate for the two-way delay between the UE and the serving satellite, based on UE position and serving satellite-ephemeris-related higher-layers parameters if configured, otherwise .  --------------------------------- End of TP for 3GPP TS 38.211 ----------------------------------  [Proposal 4 Adopt the following TP for 3GPP TS 38.211:](#_Toc95768507)  ---------------------------------- Start of TP for 3GPP TS 38.211 ---------------------------------- 4.3.1 Frames and subframes <Unchanged Text Omitted>  Uplink frame number  for transmission from the UE shall start before the start of the corresponding downlink frame at the UE where  - and are given by clause 4.2 of [5, TS 38.213], except for msgA transmission on PUSCH where shall be used;  - is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* as specified in [5, TS 38.213] if configured, otherwise ;  - is computed by the UE based on satellite-ephemeris-related higher-layers parameters if configured, otherwise .  ---------------------------------- End of TP for 3GPP TS 38.211 ----------------------------------- |

## Initial proposal and companies views’ collection for 1st round

Regarding CRs/TPs for 3GPP TS 38.211, based on the companies contributions recopied in section 11.1 Initial proposal 11 is made hereafter.

Let’s work as group to provide an appropriate wording for this TP:

**Initial proposal 11**

**Adopt the following TP for 3GPP TS 38.211:**

|  |
| --- |
| ---------------------------------- Start of TP for 3GPP TS 38.211 ----------------------------------  **3.1 Frames and subframes**  <Unchanged Text Omitted>  Uplink frame number  for transmission from the UE shall start  before the start of the corresponding downlink frame at the UE where  - and are given by clause 4.2 of [5, TS 38.213], except for msgA transmission on PUSCH where shall be used;  - is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* as specified in [5, TS 38.213] if configured, otherwise ;  - is computed by the UE to pre-compensate for the two-way delay between the UE and the serving satellite, based on UE position and serving satellite-ephemeris-related higher-layers parameters if configured, otherwise .    Figure 4.3.1-1: Uplink-downlink timing relation.  ---------------------------------- End of TP for 3GPP TS 38.211 ----------------------------------- |

Companies are encouraged to provide views and comments within the following table:

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| **Companies** | **Comments and Views** |
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# [Active] Topic#12 CRs/TPs for 3GPP TS 38.213

The original CR can be found in [R1-2112934](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Docs/R1-2112934.zip).

## Companies’ contributions summary

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| --- | --- |
| **Companies** | **Proposals** |
| CATT | Updated CR 38.213 with added wording in red color:   |  | | --- | | **4.2 Transmission timing adjustments**  UE periodically reads SIB message to acquire assisted information including satellite ephemeris and commonTA parameter, and timing advance is adjusted according to UE GNSS position information and assistance information indicated by the network. The network broadcast the validity duration for assistance information by high-level parameter ntnUlSyncValidityDuration in the SIB message. The UE assumes that it has lost uplink synchronization if serving satellite ephemeris and Common TA parameter are not available within the associated validity duration.  A UE can be provided a value 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 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 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 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.  is derived from the higher-layer parameters TACommon, TACommonDrift, and TACommonDriftVariation if configured, otherwise .  is UE self-estimated TA to pre-compensate for the service link delay. And it is computed by the UE based on satellite-ephemeris-related higher-layers parameters if configured, otherwise is updated automatically by UE based on orbit modelling.  is Timing advance adjust value and updated based on TA Command field in msg2/msgB and MAC CE TA command. It is defined as 0 for PRACH.  For a SCS of  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 . The start timing of the random access preamble is described in [4, TS 38.211]. | |
| Ericsson | [Proposal 3 Adopt the following TP for 3GPP TS 38.213:](#_Toc95768506)  --------------------------------- Start of TP for 3GPP TS 38.213 ---------------------------------- 4.2 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 38.213 --------------------------------- |

## Initial proposal and companies views’ collection for 1st round

Moderator view: the formula of 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 . From this perspective, the agreement on 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 from 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.

I had an offline discussion with specs editors during RAN1#107e meeting. It could be useful to have in mind their feedback, recalled hereafter:

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| **Some feedback from 38.211 spec editor during the 107e email discussions**:  I am not sure how to capture this in the 211/213 specs, maybe because I have not followed the detailed discussion during the meeting.  First, the agreement says “the UE can”, not “the UE shall”. I interpret this as different algorithms can be used as long as the UE fulfills the requirements (“can” in specifications “indicates that something is possible”). Furthermore, as Aris points out, what does “ is derived by the UE based on ” mean from a specification perspective? t\_epoch and “uplink time synchronization reference point” also needs to be defined if we are to capture this as mandatory text in 211 or 213. In 38.211 we currently have the text “ is derived from the higher-layer parameters *TACommon*, *TACommonDrift*, and *TACommonDriftVariation* if configured , otherwise ” which I think decently well reflects the agreement. The agreements says that “ is derived by the UE based on ” so the only difference between 38.211 and the agreements is calculation of the intermediate variable , but since we anyway has not defined of to use that intermediate variable I don’t see much of a difference between 211 and the agreements.  So far my 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.  **Some feedback from 38.213 spec editor during the 107e email discussions:**  I’m unsure of what needs to be in 213 and how it can be captured.  For example, I expected TACommon, TACommonDrift and TACommonDriftVariation to be in 211.  Then, what does “ is derived by the UE based on ” mean from a specification perspective?  How is the derivation done? |

Let’s work as group to provide an appropriate wording for this TP.

By considering the TPs from CATT and Ericsson, the following proposal is made:

**Initial proposal 12**

**Adopt the following TP for 3GPP TS 38.213:**

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| --------------------------------- Start of TP for 3GPP TS 38.213 ---------------------------------- 4.2 Transmission timing adjustments <Unchanged Text Omitted>  A UE can be provided a value 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 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 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 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.  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.  For a SCS of  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 . The start timing of the random access preamble is described in [4, TS 38.211].  ---------------------------------- End of TP for 3GPP TS 38.213 --------------------------------- |

Companies are encouraged to provide views and comments within the following table:

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| **Companies** | **Comments and Views** |
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# [Active] Topic#13 Reply LS on NR NTN Neighbour Cell and Satellite Information

## Companies’ contributions summary

RAN2 has requested input from RAN1 on whether common TA parameters of the neighbour cells need to be provided to the UEs for neighbour cell measurements. Response LS needed

R1-2200883- Reply LS on NR NTN Neighbour Cell and Satellite Information - RAN2, Qualcomm is recopied hereafter.

Original LS from RAN4 can be found in R4-2120309 LS on NR NTN Neighbor Cell and Satellite Information.

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| **R1-2200883/ R2-2201884:**  **1. Overall Description:**  RAN2 would like to thank RAN4 for the LS. RAN2 would like to provide following response.  Question-1: Would the parameters listed above be relevant to measurements and mobility? If the answer is dependent on satellite types, e.g. GSO and NGSO, and RRC state, what would be the answers to the respective satellite types?    RAN2 answer: For measurement purpose, SMTCs, ephemeris, epoch time and DL polarization information would be relevant regardless of satellite types and RRC state.  RAN2 has agreed the assumption that feeder link delay is known to and compensated by the network. The network can compensate feeder link delay to configure SMTCs to UEs in the connected mode. In addition, RAN2 has agreed for IDLE mode measurements that UE autonomously adjusts the SMTCs based on location and ephemeris. It is FFS whether network assistance information is provided to UEs.  RAN2 think feeder link delay (i.e., common TA and K\_MAC) of the neighbor cell should also be provided to UE for neighbor cell SMTC adjustment. However, RAN1 feedback is needed to decide whether common TA parameters (*TACommon*, *TACommonDrift*, *TACommonDriftVariation* and [*TACommonThirdOrder*]) of the neighbor cells need to be provided to the UEs for neighbor cell measurements.  RAN2 assumes it is up to network whether to use PVT format or Keplerian format for both serving and neighbor cells. RAN1 feedback is needed to decide whether the validity timer information for serving and neighbor/target cell needs to be different or whether there will be separate validity timers for PVT parameters and orbital parameters.  RAN1-107e had made the conclusion that DL frequency compensation by gNB for the service link Doppler is not supported in Release 17, therefore, (A4) and (B4) are not needed.  For handover, a UE would need those parameters listed in the LS regardless of satellite types except (B4).  Question-2: Would there be parameters that are not listed but necessary for measurements and mobility from RAN2 perspective? If the answer is dependent on satellite types, e.g. GSO and NGSO, and RRC state, what would be the answers to the respective satellite types?  RAN2 answer: For neighbor cell measurement, please see the response to the Question 1. Additionally for IDLE mode measurement trigger in NGSO fixed cell, (A6): serving cell stop time and reference location are also needed.  For handover, following additional parameters are also needed.  (B7): Epoch time of the ephemeris  (B8): Kmac (to determine UE-gNB RTT and perform RACH to target),  Question-3: Would the parameters be available to UE, e.g. provided by serving cell, for measurements and mobility? If the answer is dependent on satellite types, e.g. GSO and NGSO, and RRC state, what would be the answers to the respective satellite types?  RAN2 answer: Yes.  Questions-4: What would be the expected UE behavior from the perspective of handover, measurement, and measurement reporting if any or all of the information listed above is not provided to the UE by a serving cell or if any of all of the provided information cannot be used by the UE because, e.g. the validity timer expires? If the answer is dependent on satellite types, e.g. GSO and NGSO, and RRC state, what would be the answers to the respective satellite types?  RAN2 answer: RAN2 assumes all the information needed for measurement and handover would be provided to the UE by the network. If any of the information is not available or is not valid, then the UE would have to acquire the system information of the target or neighbor cell which is not desirable from handover interruption time point of view.  **2. Actions:**  **To** **RAN4.**  **ACTION:** RAN2 respectfully asks RAN4 to take into account the above information and provide feedback if needed.  **To RAN1.**  **ACTION:** RAN2 respectfully asks RAN1 to take into account the above information and provide answer to the Question 1 on whether following parameters need to be provided to UEs for neighbor cell measurements and handover   1. A2/B2 (common TA parameters), 2. A3/B3 (Validity timer information for neighbor cell measurements/target cell mobility, e.g. if it is different from that for serving cell open loop TA control), 3. Separate validity durations for PVT parameters and Orbital parameters, and 4. A5/B5 (DL and UL Polarization information). |

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| **Companies** | **Proposals** |
| Xiaomi | **Proposal 2:** The common TA parameters of neighbour cells need to be provided to the UEs if the feeder link delay is not compensated by the network. The common TA parameters of neighbour cells is not needed to the UEs if the feeder link delay is compensated by the network.  **Proposal 3:** The validity timer information for serving and neighbour/target cell can be different. |
| PANASONIC R&D Center Germany | **Proposal 4:** Contents of NTN SIB of the target cell including common TA parameters would need to be indicated to the UE. Discussion on how these parameters are indicated to the UE is necessary.  **Proposal 3:** Because epoch time is expressed by SFN and subframe number, discussion on how the UE obtains the neighbor cell SFN would be necessary. The following options should be considered.  Option 1: gNB provides information on the neighbor cell SFN together with the epoch time  Option 2: UE determines the epoch time based on the SFN obtained from the neighbor cell’s MIB. |
| NTT DOCOMO, INC. | **Proposal 6:** Support dedicated signalling to provide the NTN validity duration together with common TA parameters and satellite ephemeris, which has the same information as NTN-specific SIB, to a UE in RRC\_CONNECTED. |
| Nokia, Nokia Shanghai Bell | **Proposal 14:** The need for providing A2/B2 should be evaluated by RAN4 rather than RAN1, as it relates to the UE’s ability to track SSB transmissions that are drifting in time relative to serving satellite transmissions if the cells are not transmitted from the same satellite.  **Proposal 15:** For neighbor measurements for cells that are not co-located in the same satellite, the validity timer (A3/B3) should be associated to the neighbor satellite rather than the serving satellite.  **Proposal 16:** PVT and Orbital parameters (and Common TA related parameters) share a single validity duration.  **Proposal 17:** DL and UL Polarization information may be supported for neighbor cell measurements. |

## Initial proposal and companies views’ collection for 1st round

In original LS from RAN4, the parameters are categorized into two groups as follows:

**For NTN UE measurements, e.g. neighbor cell measurement within- or inter-satellite**:

(A1) Neighbor cell Ephemeris information and the format, e.g. PVT format or Keplarian format

(A2) Common TA

(A3) Validity timer information for neighbor cell measurements, e.g. if it is different from that for serving cell open loop TA control

- Would the timer length, if provided, be different from that for serving cell? For example, a required accuracy of service and/or feeder link delay information for neighbor cell measurement may not need to be as accurate as that for serving cell open loop TA control.

(A4) The amount of frequency compensation, if DL frequency compensation for the service link Doppler is applied

(A5) DL Polarization information

**For NTN UE mobility, e.g. target cell measurement, synchronization, and (conditional) handover within- or inter-satellite**:

(B1) Target cell Ephemeris information and the format, e.g. PVT format or Keplarian format

(B2) Common TA

(B3) Validity timer information for target cell mobility, e.g. if it is different from that for serving cell open loop TA control

(B4) The amount of frequency compensation, if DL frequency compensation for the service link Doppler is applied

(B5) DL and UL Polarization information

(B6) K\_offset

**Initial Proposal 13:**

**Companies are encouraged to provide answer to the Question 1 on whether following parameters need to be provided to UEs for neighbor cell measurements and handover:**

1. **A2/B2 (common TA parameters),**
2. **A3/B3 (Validity timer information for neighbor cell measurements/target cell mobility, e.g. if it is different from that for serving cell open loop TA control),**
3. **Separate validity durations for PVT parameters and Orbital parameters, and**
4. **A5/B5 (DL and UL Polarization information).**

Companies are encouraged to provide views within the following table:

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| **Companies** | **Comments and Views** |
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# Proposals for GTW on Feb 23rd

# Conclusion

The following RAN1 agreements, TPs on UL time and frequency synchronization for NR NTN were made at RAN1 Meeting #108-e:

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# References

1. R1-2112890 3GPP TSG-RAN WG1 Agreements under 8.4 up to eMeeting RAN1#107-e. WI rapporteur (Thales). November 2021
2. R1-2200938 Maintenance on UL time and frequency synchronization enhancement for NTN Huawei, HiSilicon
3. R1-2201011 Maintenance on UL timing and frequency synchronization in NTN THALES
4. R1-2201216 Enhancements on UL Time and Frequency Synchronisation for NR-NTN MediaTek Inc.
5. R1-2201272 Discussion on remaining issue for UL time and frequency synchronization OPPO
6. R1-2201359 Remaining issues on UL time and frequency synchronization enhancement for NTN CATT
7. R1-2201387 Enhancements on UL time and frequency synchronization PANASONIC R&D Center Germany
8. R1-2201477 Remaining issues on UL time and frequency synchronization enhancements for NTN NTT DOCOMO, INC.
9. R1-2201547 Discussion on enhancements on UL time and frequency synchronization for NTN Spreadtrum Communications
10. R1-2201581 Discussion on ambiguity of common TA calculation Sony
11. R1-2201646 Maintenance aspects of time and frequency synchronization for Rel-17 NR over NTN Nokia, Nokia Shanghai Bell
12. R1-2201745 Remaining issues on UL time/frequency synchronization for NTN InterDigital, Inc.
13. R1-2201772 Remaining Issues of Uplink Time and Frequency Synchronization for NR NTN Apple
14. R1-2201805 On UL time and frequency synchronization maintenance issues for NTN Ericsson Hungary Ltd
15. R1-2201853 Remaining issues on enhancements on UL time and frequency synchronization for NTN CMCC
16. R1-2201922 Remaining issues on UL time and frequency synchronization for NTN Xiaomi
17. R1-2202012 Maintenance issues on UL time and frequency synchronization for NTN Samsung
18. R1-2202138 Remaining issues on UL time and frequency synchronization for NTN Qualcomm Incorporated
19. R1-2202207 Remaining issues of UL synchronization for NR-NTN ZTE
20. R1-2202286 Remaining issues on UL time and frequency synchronization enhancements in NTN LG Electronics
21. R1-2202359 Remaining issues on UL time and frequency synchronization enhancement for NTN Baicells
22. R1-2202361 Remaining issues on UL time synchronization for NR NTN NEC

# Appendix I: RAN1 agreements on UL time and frequency synchronization for NR NTN

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| **RAN1 agreements on UL time and frequency synchronization for NR NTN achieved in RAN1 Meeting #107-e:**  **Agreement**  The serving satellite ephemeris and common TA related parameters are signalled in the same SIB message and have the same epoch time.  **Agreement**  A single validity duration for both serving satellite ephemeris and common TA related parameters is broadcast on the SIB.  **Working assumption**  Higher-layer parameters TACommon, TACommonDrift, TACommonDriftVariation and [TACommonThirdOrder] are indicated with the following range, granularity and bits allocation:   | **Parameter name** | **Value range** | **Granularity** | **Bits allocation** | | --- | --- | --- | --- | |  | 0 ...66485757  (i.e: 0… 270.73 ms) |  | **26 bits** | | **TACommonDrift** | - 261935… + 261935  **(i.e: --53.33 … +-53.33 )** |  | **19 bits** | | **TACommonDriftVariation** | 0…29470  **(0…0.60 )** |  | **15 bits** | | **[TACommonThirdOrder]** | -4912…+4912  (-0.015 …+0.015 ) |  | **14 bits** | | * **Value ranges are given in unit of corresponding granularity** | | | |   **Agreement**  NTN validity 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~~, Infinity~~} * Unit is second * FFS (to be resolved in current meeting): Additional values for GEO   **Agreement**  Confirm the working assumption made at RAN1#106-bis-e on serving satellite ephemeris bit allocations for LEO/MEO/GEO based non-terrestrial access network:   * Support serving satellite ephemeris format bit allocations for LEO/MEO/GEO based non-terrestrial access network:   + Position and velocity state vector ephemeris format is 17 bytes payload.     - The field size for position (m) is 78 bits       * Position range is driven by GEO : +/- 42 200 km       * The quantization step is 1.3m for position     - The field size for velocity (m/s) is 54 bits       * Velocity range is driven by LEO@600 km: +/- 8000 m/s       * The quantization step is 0.06 m/s for Velocity   + Orbital parameter ephemeris format 18 byte payload     - Semi-major axis α (m) is 33 bits       * Range: [6500, 43000]km     - Eccentricity e is 19 bits       * Range: ≤ 0.015     - Argument of periapsis ω (rad) is 24 bits       * Range: [0, 2π]     - Longitude of ascending node (Ω rad) is 21 bits       * Range: [0, 2π]     - Inclination i (rad) is 20 bits       * Range: [- π/2 , + π/2]     - Mean anomaly M (rad) at epoch time to is 24 bits       * Range: [0, 2π]   **Agreement**  The reference point of the epoch time for assistance information (i.e. Serving satellite ephemeris and Common TA parameters) should be known by UE.   * FFS: the definition of the reference point   **Conclusion**    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.   **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.   **Agreement**  Confirm the Working assumption on granularity and bits allocation for Common TA parameters: Value range, granularity and bits allocation of Higher-layer parameters TACommon, TACommonDrift, TACommonDriftVariation are as follows:   | **Parameter name** | **Value range** | **Granularity** | **Bits allocation** | | --- | --- | --- | --- | |  | 0 ...66485757  (i.e: 0… 270.73 ms) |  | 26 bits | | TACommonDrift | - 261935… + 261935  (i.e: --53.33   … +-53.33 ) |  | 19 bits | | TACommonDriftVariation | 0…29470  (0…0.60 ) |  | 15 bits | | * Value ranges are given in unit of corresponding granularity | | | |   **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.   **Agreement**  The reference point for epoch time of the serving satellite ephemeris and Common TA parameters is the uplink time synchronization reference point.  Working assumption:  When TAC () in msg2/msgB is received, UE receives the first adjustment and is updated as:   * Option 1: .   Where, is the TAC field in msg2/msgB  **Conclusion**  DL frequency compensation by gNB for the service link Doppler is not supported in Release 17.  **RAN1 agreements on UL time and frequency synchronization for NR NTN achieved in RAN1 Meeting #106-bis-e:**  Agreement:  Confirm the working assumption:  Common TA may include parameter(s) indicating timing drift.   * The UE will apply common TA according to the parameters provided by the network (if any). No offset between the common TA according to the parameters provided by the network and the actual feeder link RTT is considered when defining UE UL timing error requirements.     Agreement:  Common TA Epoch time is implicitly known as a reference time defined by the starting time of a DL slot and/or frame.   * FFS: Whether this starting time is given by predefined rule or it is indicated by the Network   + Note: “implicitly known” means that UTC is not provided to define the Common TA epoch time.   Agreement:  The UE assumes that it has lost uplink synchronization if new or additional assistance information (i.e. serving satellite ephemeris data or Common TA parameters) is not available within the associated validity duration.   * FFS: details on how to acquire new or additional assistance information   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)  Agreement:  A single validity duration for both serving satellite ephemeris and common TA related parameters is defined at least if serving satellite ephemeris and common TA related parameters are signaled in the same SIB message.  Agreement:  In NTN, the Network may optionally indicate one or more of the following parameters:   * Common TA , Common TA drift rate and Common TA drift rate variation. * FFS: Common TA third order derivative. * FFS: Details of combination of Common TA parameters   Agreement:   * The granularity of Common TA is set to be * μ is the highest allowed numerology supported for data, for the given Frequency Range   Conclusion:  Do not define a TA margin.  Working assumption:   * Support serving satellite ephemeris format bit allocations for LEO/MEO/GEO based non-terrestrial access network.:   + Position and velocity state vector ephemeris format [17 bytes payload].     - The field size for position [m]  is [78 bits]       * Position range is driven by GEO : +/- 42 200 km       * The quantization step is [1.3m] for position     - The field size for velocity [m/s] is [54 bits]       * Velocity range is driven by LEO@600 km: +/- 8000 m/s       * The quantization step is [0.06 m/s] for Velocity   + Orbital parameter ephemeris format [18 byte payload]     - Semi-major axis α [m] is [33 bits]       * Range: [6500, 43000]km     - Eccentricity e is [19 bits]       * Range: ≤ 0.015     - Argument of periapsis ω [rad] is [24 bits]       * Range: [0, 2π]     - Longitude of ascending node Ω [rad] is [21 bits]       * Range: [-180o , +180o]     - Inclination i [rad] is [20 bits]       * Range: [-90o  , +90o ]     - Mean anomaly M [rad] at epoch time to is [24 bits]       * Range: [0, 2π] * FFS: Additional enhancement to optimize the signalling overhead. * FFS: Ephemeris format bit allocations for HAPS   **RAN1 agreements on UL time and frequency synchronization for NR NTN achieved in RAN1 Meeting #106-e:**  Working assumption:  Common TA may include parameter(s) indicating timing drift.   * The UE will apply common TA according to the parameters provided by the network (if any). No offset between the common TA according to the parameters provided by the network and the actual feeder link RTT is considered when defining UE UL timing error requirements.   Agreement:   * A validity duration configured by the network for satellite ephemeris data indicates the maximum time during which the UE can apply the satellite ephemeris without having acquired new satellite ephemeris.   + FFS: Associated UE behaviour if the UE does not read the ephemeris within the validity duration. * FFS: Whether the same validity duration can be applied for Common TA.   Conclusion:  Indication of common post-compensation frequency offset for Uplink is not needed.  Agreement:  Confirm the working assumption on non-extension of TAC 12-bit field in msg2 (or msgB) and that the UE follows the requirements on UL time pre-compensation for Msg1/MsgA transmission as defined by RAN4.  Agreement:  Serving satellite ephemeris Epoch time is implicitly known as a reference time defined by the starting time of a DL slot and/or frame.   * FFS: Whether this starting time is given by predefined rule or it is indicated by the Network   Agreement:  In NTN, to avoid that the UE over pre-compensates its TA during RACH procedure, down-select one option from below:   * Option 1: PRACH transmission is delayed by * Option 2: TA margin can be considered and it is explicitly indicated to the UE * Option 3: TA margin can be considered and it is included within the Common TA * Option 4: UE handles it via implementation   Agreement:   * in NR NTN, NTA update based on TA Command  field in msg2/msgB and MAC CE TA command is used for UL timing alignment correction as follows: * When TAC ( in msg2/msgB is received,  UE receives the first adjustment and is updated as follows:    , FFS: the value of ,   * When TACs ( provided within the MAC CE is received, is updated as follows:   ,  **RAN1 agreements on UL time and frequency synchronization for NR NTN achieved in RAN1 Meeting #105-e:**  Agreement:  Specifications should support delivery of ephemeris information using both ephemeris formats, i.e., state vectors and orbital elements.  Agreement:  RAN1 should send an LS to SA3, SA1 and possibly SA3-LI to get more inputs regarding the security/regulatory aspects if the NTN GW/gNB position is broadcast or possible to be derived by the UE with assistance information from the network, and on any aspects related to accuracy of the position.  Conclusion:  The Doppler shift over the feeder link and any transponder frequency error for both Downlink and Uplink is compensated by the GW and satellite-payload without any specification impacts in Release 17.  **RAN1 agreements on UL time and frequency synchronization for NR NTN achieved in RAN1 Meeting #104-bis-e:**  Agreement:  The Timing Advance applied by an NR NTN UE in RRC\_IDLE/INACTIVE and RRC\_CONNECTED is given by:  Where:   * is defined as 0 for PRACH and updated based on TA Command field in msg2/msgB and MAC CE TA command.   + FFS: details of NTA update/accumulation. * is UE self-estimated TA to pre-compensate for the service link delay. * is network-controlled common TA, and may include any timing offset considered necessary by the network. * with value of 0 is supported.   + FFS:  details of signaling including granularity. * is a fixed offset used to calculate the timing advance.   Note-1: Definition of  is different from that in RAN1#103-e agreement.  Note-2: UE might not assume that the RTT between UE and gNB is equal to the calculated TA for Msg1/Msg A.  Note-3:  is the common timing offset X as agreed in RAN1 #103-e.  Agreement:  Support serving-satellite ephemeris broadcast based on one or more of the following:   * Set 1: Satellite position and velocity state vectors:   + position X,Y,Z in ECEF (m)   + velocity VX,VY,VZ in ECEF (m/s) * Set 2: At least the following parameters in orbital parameter ephemeris format:   + Semi-major axis α [m]   + Eccentricity e   + Argument of periapsis ω [rad]   + Longitude of ascending node Ω [rad]   + Inclination i [rad]   + Mean anomaly M [rad] at epoch time to     - FFS: Whether pre-provisioned ephemeris based on orbital elements can be used as reference. Thereby, only delta corrections can be broadcast in order to reduce the overhead * FFS: The field size for each parameter * FFS: The impact on signaling due to the required accuracy of serving-satellite ephemeris * FFS: Whether down-selection is needed or both sets are supported   **Conclusion:**  The orbital propagator model to be used at UE side can be left to implementation.  **RAN1 Meeting #104-e (e-Meeting, January 25th – February 5th, 2021):**  Agreement:  An NTN UE in RRC\_CONNECTED state is required to support UE specific TA calculation based at least on its GNSS-acquired position and the serving satellite ephemeris.  FFS: Operation of closed loop and open loop TA control  Agreement:  For TA update in RRC\_CONNECTED state, combination of both open (i.e. UE autonomous TA estimation, and common TA estimation) and closed (i.e., received TA commands) control loops shall be supported for NTN.  FFS: Details of the combination of open and closed loop TA control  Conclusion:  It is up to RAN4 to decide whether interruptions or measurement gaps are required for GNSS measurements during NTN operation  Agreement:  RAN1 should send an LS to RAN4 with the following questions:  Question 1: RAN1 would like to ask RAN4, to indicate what are the NTN UL time synchronization requirements?   * For initial access (i.e. PRACH transmission) * For UL transmissions in RRC Connected State   Question 2: RAN1 would like to ask RAN4, to indicate what are the NTN UL frequency synchronization requirements?   * For initial access (i.e. PRACH transmission) * For UL transmissions in RRC Connected State   Conclusion:  If DL frequency compensation for the service link Doppler is applied, indication of the amount of frequency compensation is necessary.   * FFS: support of DL frequency compensation for the service link Doppler.   Agreement:   * RAN1 to support satellite ephemeris broadcast based at least on one of the following format options:   + Option 1: Ephemeris format based on satellite position and velocity state vectors     - FFS: Details on state vectors formats     - FFS: Details on time reference provisioning/format   + Option 2: Ephemeris format based on orbital elements     - FFS: Details on orbital elements formats     - FFS: Details on time reference provisioning/format * FFS: Whether down-selection is needed or both options are supported   **RAN1 Meeting #103-e (e-Meeting, October 26th – November 13th, 2020):**  Agreement:  An NTN UE in RRC\_IDLE and RRC\_INACTIVE states is required to at least support UE specific TA calculation based at least on its GNSS-acquired position and the serving satellite ephemeris.  Agreement:  An NR NTN UE in RRC\_IDLE and RRC\_INACTIVE states shall be capable of at least using its acquired GNSS position and satellite ephemeris to calculate frequency pre-compensation to counter shift the Doppler experienced on the service link.  Agreement:   * In NTN, the network may broadcast * A common timing offset value   + FFS details of the common timing offset * FFS: A common timing drift rate * Before Msg1/MsgA transmission, the NR NTN UE in idle/inactive mode calculates its TA as follows:   Where:  is derived from the User specific TA self-estimation  is derived at least from the common timing offset value if broadcasted by the network. The granularity of and whether is indicated as a Timing Advance or as a Timing Offset value [unit] are FFS. Upon resolving the FFS, one of the X in the equation will be removed.   * depends on band and LTE/NR coexistence and is specified in TS 38.213 section 4.2. * is specified in TS 38.211 section 4.1. * Note: UE will not assume that the RTT between UE and gNB is equal to the calculated TA for Msg1/Msg A.   Working assumption:  It is assumed that the requirement on UL time pre-compensation for Msg1/MsgA transmission of an NR NTN UE in idle/inactive mode will be defined such that the existing TAC 12-bit field in msg2 (or msgB) can be reused without any extension.    Agreement:  An NR NTN UE in RRC\_CONNECTED states shall be capable of at least using its acquired GNSS position and satellite ephemeris to perform frequency pre-compensation to counter shift the Doppler experienced on the service link.  **RAN1 Meeting #102-e (e-Meeting, August 17th – 28th, 2020):**  Agreement:  • In Rel-17 NR NTN, at least support UE which can derive based on its GNSS implementation one or more of:  o its position  o a reference time and frequency  • And, based on one or more of these elements together with additional information (e.g., serving satellite ephemeris or timestamp) signalled by the network, can compute timing and frequency, and apply timing advance and frequency adjustment at least for UE in RRC idle/inactive mode.  • FFS: Details on additional information signalled from network  Agreement:  In case of GNSS-assisted TA acquisition in RRC idle/inactive mode, the UE calculates its TA based on the following potential contributions:  • The User specific TA which is estimated by the UE:  o Option 1: The User specific TA is estimated by the UE based on its GNSS acquired position together with the serving satellite ephemeris indicated by the network:   FFS: Details on serving satellite ephemeris indication  o Option 2: The User specific TA is estimated by the UE based on the GNSS acquired reference time at UE together with reference time as indicated by the network  • The Common TA if indicated by the network:  o FFS: The need and details of Common TA indication  • FFS: The TA margin, if needed and indicated by the network (in order to account for the TA estimation uncertainty) |

# Appendix II: Summary of proposals

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