**3GPP TSG-RAN WG4 Meeting #99-e R4-210XXXX**

**Electronic Meeting, 19th – 27th May, 2021**

**Agenda item:** 9.12.4.3

**Source:** Moderator (Xiaomi)

**Title:** Email discussion summary for [99-e][230] NR\_NTN\_solutions\_RRM\_2

**Document for:** Information

# Introduction

The scope of this email discussion is core timing requirements for NR NTN (AI 9.12.4.3). All the submitted TDocs in this agenda were reviewed and the relevant observations and proposals are included in this email discussion. The following topics will be discussed according to the submitted TDocs.

* AI 9.12.4.3 Timing requirements
* UE specific TA estimation accuracy
* UE transmit timing requirements
  + UE initial transmit timing error
  + Gradual timing adjustment
* TA adjustment accuracy requirements
  + TA adjustment accuracy requirement in RRC\_IDLE mode
  + TA adjustment accuracy requirement in RRC\_CONNECTED mode
* Reply LS for the incoming LS R1-2102263

The following schedule is proposed for email discussions in 1st and 2nd rounds:

* 1st round:
  + Moderator kick off email discussion (Wed. 19 May)
  + Companies provide comments for the 1st round (Wed. 19 May – Fri. 9:00 UTC 12 May)
  + Moderator summarize the status and possible proposals, recommending what decisions can be made for 1st round. A formal t-doc will be used (Fri. 19:00 UTC 12 May)
* 2nd round:
  + Companies provide comments for 2nd round starting from Mon. 3:00 UTC 23 May
  + Companies’ comments shall stop by Wed. 19 UTC, 26 May
  + Moderator provide 2nd round summary with a formal tdoc by Thu. 8:00 UTC, 27 May

In providing comments, companies are encouraged to:

* Be concise
* Provide comments on all topics/sub-topics of interest to them
* Ensure that their comments are inserted in the latest version of the document by checking the folder before uploading
* Use “Track changes” to help identify added comments/changes

# Topic #1: UE timing requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2108971 | Qualcomm Incorporated | **UE specific TA estimation error**  **Proposal 1: RAN4 to investigate whether there is any issue due to a conflict between UE specific TA update periodicity, i.e. open loop TA update, and Network controlled close loop TA update, hence, explicitly resolution and/or spec handling.**  **Proposal 2: RAN4 does not define UE specific TA estimation accuracy requirement.**  **Initial Transmit Timing Error**  **Observation 1: A maximum composite UE initial transmission timing error in NTN consists of maximum of UE position estimation error, maximum of satellite position estimation error, and the current timing error limits.**  **Observation 2: A-GNSS requirements of TS38.171 are not relevant for NR NTN requirement development.**  **Observation 3: Stringent requirements on UE position estimation error will lead to detrimental impacts on overall UE power consumption and a degree of integration of NR transceiver and GNSS receiver.**  **Observation 4: UE power consumption impact due to frequent GNSS measurements and interactions between NR UR transceiver and UE GNSS receiver differs by UE RRC State.**  **Observation 5: Inter-symbol and -carrier orthogonality in uplink can be preserved even with 5Ts relaxation of initial timing error requirement.**  **Observation 6: For handheld type FR1 NTN terminals, a 10Ts relaxation of initial timing error requirement can prolong UE battery life while preserving inter-symbol and -carrier orthogonality in uplink.**  **Proposal 3: NTN UE initial timing error requirements should be relaxed to account for at least 50m of a composite position estimation error.**   * **For FR1 NTN UE in RRC Connected state, the requirement should be further relaxed to accommodate a composite position estimation error up to 100ms.**   **TA Adjustment Accuracy**  **Proposal 4: Request RAN1 whether and how to reflect a propagation delay change, i.e. open loop TA update, from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission. If defined, depending on RAN1 design NTN UE timing advance adjustment accuracy requirements may have to be relaxed to account for UE position and satellite position estimation error. And if it is decided to relax the requirement, the accuracy requirement relaxation shall be the same as that for initial timing error requirement**  **Gradual Timing Adjustment**  **Observation 7: The current gradual timing adjustment requirements cannot be applied to NTN systems.**  **Proposal 5: NTN UE gradual timing adjustment requirements should be differently defined from the legacy ones, and the following aspects should be taken into consideration.**   * **Whether or not different requirements need to be defined for different NTN topologies in terms of, e.g. GEO, MEO, LEO, HAPS, HIBS, altitude, elevation angles for feeder/service links, UE speed, etc.** * **Whether and how to account for feeder link propagation delay time change.** * **A framework on UE timing adjustment which will be provided by RAN1.** |
| R4-2109058 | CATT | **Proposal 1: RAN4 should confirm the accuracy of ephemeris data and accuracy of UE PVT from satellit system and GNSS system, and confirm the accuracy of extrapolation from ephemeris data and GNSS based on ephemeris data mode and UE mobility mode.**  **Proposal 2: Don’t define** **a separate accuracy requirement for UE specific TA estimation accuracy. It will be included in the requirement of total UE transmit timing error.**  **Proposal 3: Defer discussion for specifying UE behavior related to UE specific TA estimation, and wait RAN1 conclusion.**  **Proposal 4: It is not necessery to define the update periodicity of UE specific TA value. It depends on UE implementation. UE should meet the requirement defined in RRM specification for UE transmit timing error with a update rate of ephemeris data.**  **Proposal 5: The NTN UE initial transmit timing error should be relaxed, and may be relaxed to [1/10]CP ~ [1/2]CP for different SCS. The relaxed part is allowed for NTN UE specific estimation accuracy.**  **Proposal 6: The gradual timing adjustment requirements should be different for different NTN topologies.**  **Proposal 7: It is not necessery to define TA adjustment accuracy requirement in RRC\_idle mode. The transmit timing in RRC\_idle mode should meet requirements for NTN UE initial transmit timing error.**  **Proposal 8: The Tq and Tp in TN system can be reused. But the maximum aggregate adjustment rate will be defined based on different NTN topologies, such as Tq per [20] ms for LEO600km cell, but Tq per [60]s for GEO.** |
| R4-2109059 | CATT | RAN4 would like to thank RAN1 for the LS on NTN UL time and frequency synchronization requirements. In last RAN4 meeting, a response LS has sent to RAN1 for NTN UL frequency synchronization requirement and concluded the requirement will be ±0.1ppm. RAN4 further investigated time synchronization requirements and would like to give the following response.  The UE initial transmit timing error need to be relaxed compared to NR requirement in 38.133 based on Te in TN specification. The relaxation is determined by NTN UE specific time advance estimation accuracy and the NTN UE specific time advance estimation accuracy is [TBD]. |
| R4-2109220 | Intel Corporation | Proposal 1: RAN4 defines UE specific TA estimation and update accuracy requirements to guarantee fair UE UL transmission timing.  Proposal 2: An NTN UE is required to correctly estimate and update the UE specific TA value in every certain periodicity, based on its GNSS positions and satellite ephemeris information.  Observation 1: it is RAN1 to decide whether the UE updates the specific TA value by substitute TA values or by TA differences.  Proposal 3: An NTN UE is required to adjust its UL timing towards updated UE specific TA gradually, according to minimum and maximum aggregate adjustment rate requirements.  Observation 2: Open and close loop specific timing requirements are pending other WG discussions. |
| R4-2109254 | Xiaomi | **Proposal 1: Not define a separate accuracy requirement for UE specific TA estimation.**  **Proposal 2: The UE specific TA estimation error is consist of the accuracy of A-GNSS position estimation (ΔUE-pos) and the accuracy of serving-satellite ephemeris (ΔSat-pos).**  **Observation 1: The 2-D position error of A-GNSS requirement defined in TS38.171 is not suitable for UE specific TA estimation error estimation.**  **Proposal 3: the UE specific TA estimation accuracy is defined as 10Ts.**  **Proposal 4: Not to specify the update periodicity for UE specific TA estimation.**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Frequency Range | SCS of SSB signals [kHz] | SCS of uplink signals [kHz] | Te | UE specific TA estimation accuracy | Te\_NTN | | 1 | 15 | 15 | 12\*64\*Tc | 10Ts | 22\*64\*Tc | |  |  | 30 | 10\*64\*Tc | 10Ts | 20\*64\*Tc | |  |  | 60 | 10\*64\*Tc | 10Ts | 18\*64\*Tc | |  | 30 | 15 | 8\*64\*Tc | 10Ts | 18\*64\*Tc | |  |  | 30 | 8\*64\*Tc | 10Ts | 18\*64\*Tc | |  |  | 60 | 7\*64\*Tc | 10Ts | 15\*64\*Tc | | 2 | 120 | 60 | 3.5\*64\*Tc | 10Ts | 10\*64\*Tc | |  |  | 120 | 3.5\*64\*Tc | 10Ts | 10\*64\*Tc | |  | 240 | 60 | 3\*64\*Tc | 10Ts | 8\*64\*Tc | |  |  | 120 | 3\*64\*Tc | 10Ts | 8\*64\*Tc |   **Proposal 5: the Te requirement in NTN is shown in table 1.**  **Observation 2: The gradual timing adjustment step size and adjustment rate need to be revised due to the maximum delay variation in the gradual timing adjustment requirement in NTN.**  **Proposal 6: In LEO scenario, the gradual timing adjustment requirements for NR NTN UE are specified as follows:**  **1) The maximum amount of the magnitude of the timing change in one adjustment shall be Tq\_NTN = 25\*Ts.**  **2) The minimum aggregate adjustment rate shall be Tp\_NTN = 100Ts per 100ms.**  **3) The maximum aggregate adjustment rate shall be Tq\_NTN = 25\*Ts per 20 ms.**  **Proposal 7: In GEO scenario, the existing timing adjustment rules defined in TS38.133 can be applied.**  **Observation 3: The TA update accuracy should consider not only the inaccuracy of the received TA command adjustment, but also the inaccuracy of estimated UE autonomous TA adjustment and the network-controlled common TA adjustment.**  **Proposal 8: RAN4 is to define a relaxed TA adjustment accuracy requirement for NR NTN.** |
| R4-2109493 | CMCC | ***Proposal 1: In order to measure the UE specific TA accuracy, take the following assumptions as the starting point:***   * ***For GNSS accuracy, take 50m as the worst case and 20m as the typical case;*** * ***For PVT accuracy, take the precise PVT information as the starting point, and further update after RAN1 achieving the conclusion.***   ***Proposal 2: Do not define a separate*** ***UE specific TA estimation accuracy requirement.***  ***Proposal 3: Define a minimum update periodicity for the UE specific TA estimation.***  ***Proposal 4: The revisited Te requirement for NTN can take the following tables as the baseline. Further update the values in bracket squares after achieving the conclusions about GNSS accuracy and PVT accuracy.***   |  |  |  |  | | --- | --- | --- | --- | | **Frequency Range** | **SCS of SSB signals (kHz)** | **SCS of uplink signals (kHz)** | **Te (worst-case)** | | 1 | 15 | 15 | (12+[5])\*64\*Tc=[17]\*64\*Tc | |  |  | 30 | [15]\*64\*Tc | |  |  | 60 | [15]\*64\*Tc | |  | 30 | 15 | [13]\*64\*Tc | |  |  | 30 | [13]\*64\*Tc | |  |  | 60 | [12]\*64\*Tc | | 2 | 120 | 60 | [8.5]\*64\*Tc | |  |  | 120 | [8.5]\*64\*Tc | |  | 240 | 60 | [8]\*64\*Tc | |  |  | 120 | [8]\*64\*Tc | | Note 1: Tc is the basic timing unit defined in TS 38.211 [6] | | | |  |  |  |  |  | | --- | --- | --- | --- | | **Frequency Range** | **SCS of SSB signals (kHz)** | **SCS of uplink signals (kHz)** | **Te(typical-case)** | | 1 | 15 | 15 | (12+[2])\*64\*Tc=[14]\*64\*Tc | |  |  | 30 | [12]\*64\*Tc | |  |  | 60 | [12]\*64\*Tc | |  | 30 | 15 | [10]\*64\*Tc | |  |  | 30 | [10]\*64\*Tc | |  |  | 60 | [9]\*64\*Tc | | 2 | 120 | 60 | [5.5]\*64\*Tc | |  |  | 120 | [5.5]\*64\*Tc | |  | 240 | 60 | [5]\*64\*Tc | |  |  | 120 | [5]\*64\*Tc | | Note 1: Tc is the basic timing unit defined in TS 38.211 [6] | | | |   ***Proposal 5: In FR1, The maximum aggregate adjustment rate shall be Tq per Xms, Tq value use [255/200\*X]\*64\*Tc as the baseline, a candidate set of X can be [50ms, 40ms, 20ms], the specific value can be further discussed***  ***Proposal 6: Do not define TA adjustment accuracy requirement in RRC\_IDLE mode.***  ***Proposal 7: Revisit the TA adjustment accuracy requirement in RRC\_CONNECTED mode, the specific relaxed value can be decided after RAN1 achieve the agreements about the timing relationship of TA command.*** |
| R4-2109714 | LG Electronics Inc. | * ***Proposal 1***: Do not define separate UE specific TA estimation accuracy requirement * ***Proposal 2***: Add timing error for the worst case GNSS accuracy to current UE transmit timing error requirement * ***Proposal 3***: Relaxed timing advance adjustment accuracy requirement should be considered with position estimation error of UE and satellite. * ***Proposal 4***: UE specific TA should be updated in the slot before applying timing advance adjustment for its uplink transmission |
| R4-2109752 | ZTE Corporation | **Proposal : Reuse the existing Te requirements defined in TS 38.133.** |
| R4-2109855 | MediaTek inc. | ***Observation 1****: If GNSS inaccuracy of 50ms at the UE is considered, the timing error at satellite reception will be >1/2 CP in several cases with UL SCS of 60 kHz and 12 kHz.*  ***Observation 2****: If the GNSS inaccuracy of 30ms at the UE is considered, the timing error at satellite reception can be <1/2 CP.*  ***Proposal 1:*** *On top of the legacy Te, the NTN Te can be defined based on*   * *For UL SCS of 15/30 kHz: Δp <= 50 m* * *For UL SCS of 60/120 kHz: Δp <= 30 m* * *where Δp is the GNSS inaccuracy at the UE*   ***Observation 3****: The timing adjustment of NTN UE pre-compensation and TN gradual timing adjustment are in opposite directions.*  ***Proposal 2:*** *Legacy gradual timing adjustment cannot directly reused. The direction of timing adjustment for NTN UE pre-compensation should be further clarified in the requirement.*  ***Observation 4****: UL timing error contributed by UE pre-compensate satellite delay can be within 3% error budget of ±Te, with the prediction time up to 10 s ahead for pre-compensation.* |
| R4-2109896 | NEC | **Proposal 1: RAN4 to define a separate UE specific TA estimation accuracy requirement.**  **Proposal 2: RAN4 to further wait for RAN1 progress to define the Te requirements and possible relaxations compared to NR initial timing error requirements.**  **Proposal 3: RAN4 to reuse the existing TA adjustment accuracy requirement defined in TS 38.133 with considering of UL timing quantization accuracy.**  **Proposal 4: RAN4 to define TA adjustment accuracy requirement for RRC\_IDLE mode** |
| R4-2110302 | Huawei, HiSilicon | ***Proposal 1: The UE initial transmit timing error*** ***requirements for NTN network can be defined as (Te + Tpos), where Te is same as the existing Te requirements in TS38.133 and Tpos is defined as the timing error derived from GNSS positioning error.***  ***Proposal 2: It is suggested to define general GNSS positioning accuracy requirements which can be referred for deriving other RRM requirements.***  ***Proposal 3: It is suggested to introduce new gradual timing adjustment requirements for NTN network.***  ***Proposal 4: It is suggested that the gradual timing adjustment requirements for NTN are applied when the values of NTA and NTA,common are unchanged.***  ***Proposal 5: RAN4 need to study which of the following assumptions will be used to define gradual timing adjustment requirements for NTN network.***   * ***Assumption 1: UE performs timing adjustment for downlink reception timing drifting and UE specific TA change separately*** * ***Assumption 2: UE performs timing adjustment with*** ***combining downlink reception timing drifting and UE specific TA change as one adjustment***   ***Proposal 6: It is suggested that the TA adjustment requirements for NTN network are applied when the value of NTA or NTA,common is updated by network indication.***  ***Proposal 7: It is suggested that the existing TA adjustment accuracy requirements for TN network can be applied for NTN network.*** |
| R4-2110416 | Ericsson | **Observation 1: The UE initial transmit timing error is needed to make sure we avoid Inter Symbol Interference and loose UL throughput and capacity.**  **Observation 2: The existing requirements make sure we fulfil intended UL throughput and capacity in NR.**  **Observation 3: the Delay Spread (DS) is listed as < 150 ns NTN across scenarios in the release 15 study report**  **Proposal 1: Use existing UE initial transmit timing error, Te also for NTN as UE specific estimation accuracy for initial access (or make Te\_NTN = 2\*Te)**  **Observation 4: The UE Timing Advance adjustment accuracy is needed to make sure we avoid Inter Symbol Interference and loose UL throughput and capacity.**  **Proposal 2: Use existing TA adjustment accuracyalso for NTN.**  **Observation 5: The parameter Tq will have to be modified. For a period of 200 ms we could have a worst case delay variation of 246 \* 64 Tc.**  **Observation: 6: Either the period has to be shortened from 200 ms to something smaller, or we need to increase Tq.** |
| R4-2110417 | Ericsson | **For initial access (i.e. PRACH transmission):** An NTN UE will have an initial access error of 2\*Te, where Te is the exiting error in TS 38.133, section 7.1.2).  **For UL transmissions in RRC Connected State:** RAN4 has concludes that for TA adjustment accuracy in RRC Connected State Timing Advance adjustment accuracy requirement depends on:  1) The mechanism of TA adjustment step size determined by RAN1 and the total uncertainty budget and  2) Requirement for UE Timing Advance adjustment accuracy. An NTN UE will have will comply to existing requirement for UE Timing Advance adjustment accuracy in TS 38.133 7.3.2. |
| R4-2111075 | Apple | ***Proposal 1: use the worst case of GNSS positioning accuracy requirement (i.e., 2-D position error = 100m) in TS38.171 as baseline to define the UE timing requirement in NTN.***  ***Proposal 2: UE specific TA estimation accuracy is 20.5\*64\*Tc + Tephemeris\_uncertainty. Tephemeris\_uncertainty is the satellite position error due to ephemeris information and UE calculation.***  ***Proposal 3: wait RAN1/RAN2 conclusions on*** ***UE specific TA pre-compensation reporting to determine whether we need to define separate UE specific TA estimation requirement or not.***  ***Proposal 4: No need to define UE behavior for UE specific TA estimation (e.g., estimation periodicity) as a requirement, as long as UE can meet the timing requirement, i.e., Te/Tq/Tp.***  ***Proposal 5: The NTN Te requirement with relaxation shall not exceed (half CP – 8\*64\*Tc) for FR1 and half CP for FR2 on UL.***  ***Proposal 6: when ephemeris information is used to derive UE specific TA in Te requirement, the error due to ephemeris uncertainty shall not be considered.***  ***Proposal 7: the Te requirement for NTN is defined by:***   * ***FR1 NTN Te requirement: min{(legacy Te + 20.5\*64\*Tc), (half CP – 8\*64\*Tc)}*** * ***FR2 NTN Te requirement: min{(legacy Te + 20.5\*64\*Tc), half CP }***  |  |  |  |  |  | | --- | --- | --- | --- | --- | | *Frequency Range* | *SCS of SSB signals (kHz)* | *SCS of uplink signals (kHz)* | *Te for NTN* | Note | | ***1*** | ***15*** | ***15*** | ***32.5\*64\*Tc*** | ***min{(legacy Te + 20.5\*64\*Tc), (half CP – 8\*64\*Tc)}***  ***note: 60kHz FR1 Te is not smaller than FR2 60kHz Te*** | |  |  | ***30*** | ***28\*64\*Tc*** | |  |  | ***60*** | ***18\*64\*Tc*** | |  | ***30*** | ***15*** | ***32.5\*64\*Tc*** | |  |  | ***30*** | ***28\*64\*Tc*** | |  |  | ***60*** | ***18\*64\*Tc*** | | ***2*** | ***120*** | ***60*** | ***18\*64\*Tc*** | ***min{(legacy Te + 20.5\*64\*Tc), half CP }*** | |  |  | ***120*** | ***9\*64\*Tc*** | |  | ***240*** | ***60*** | ***18\*64\*Tc*** | |  |  | ***120*** | ***9\*64\*Tc*** |   ***Proposal 8: RAN4 to define new gradual timing adjustment (Tp/Tq) for NTN.***  ***Proposal 9: the design principle for gradual timing adjustment requirement is:***  ***Tp=Tq***  ***Where,***  ***Tdrift is the UE time drifting during 200ms;***  ***Vrelative is the relative speed between UE and satellite***  ***T\_granularity is the UE UL timing granularity***  ***digRF\_margin is the margin for digital RF, i.e., 1.5\*64\*Tc.***  ***Proposal 10: Not define*** ***TA adjustment accuracy requirement for NTN UE in IDLE mode.***  ***Proposal 11:in RRC connected mode, the legacy NR TA adjustment accuracy requirement could be reused for NTN case.*** |
| R4-2111271 | Nokia, Nokia Shanghai Bell | **Observation 1: The UE GNSS-based time pre-compensation has the main purpose to guarantee that the initial random access attempt falls into the time window for the RACH occasion as defined by the gNB and minimize the interference to adjacent UL time symbols. Frequency pre-compensation shall ensure that the Doppler effect is mitigated so that the preamble can be received without inter-carrier/-user interference.**  **Observation 2: There are several sources of inaccuracy in acquiring time and frequency synchronization between UE and gNB by using GNSS information: lag of the ephemeris information, precision of the ephemeris data, GNSS inaccuracy, orbit perturbations and altitude modelling, delay on GNSS acquisition and information conversion at the UE and atmospheric delays.**  **Proposal 1: RAN4 should discuss how a UE can determine it accuracy from GNSS is accurate enough to fulfil the initial transmission timing error requirements.**  **Observation 3: Using *referenceTimeInfo-R16* and GNSS-provided time reference to calculate TA at the UE will suffer less from the satellite movement and timing errors and can serve as a second source for determining whether the initial transmission timing requirements are fulfilled.**  **Proposal 2: RAN4 should discuss whether the use os the time provided by *referenceTimeInfo-R16* is beneficial to securing that the initial transmission timings are kept by a UE.**  **Proposal 3: RAN4 to set requirements on how open loop TA control in RRC connected mode should be applied in a way that does not impact the closed loop TA control messages.** |
| R4-2111477 | THALES | **Proposal 1:** RAN4 should consider the NTN UE transmit timing error requirements to be the same as the ones already specified for TN UEs.  **Proposal 2:** The NTN UE initial transmission timing error requirement should apply when it is the first transmission in a DRX cycle for PUCCH, PUSCH and SRS or it is the PRACH transmission.  **Proposal 3:** The accuracy of UE specific TA estimation () and self-estimated TA common () is counted into the UE transmit timing error requirement.  **Proposal 4:** UE specific TA estimation () and self-estimated TA common () accuracy shall be also defined as a separate accuracy requirement.  **Proposal 5:** Specify UE behavior related to the combination of UE specific TA estimation () and self-estimated TA common ().  **Proposal 6:** The time reference for the UE transmit timing control requirement shall be the downlink timing of the reference cell minus . Therefore, the UE transmit timing error requirement does not cover the self-TA estimation errors.  **Proposal 7:** For PRACH transmission, the NR NTN UE shall be able to self-estimate with an accuracy better than ± ,  depending on the PRACH format and configuration.  **Proposal 8:** In connected mode, the NR NTN UE shall be able to self-estimate with an accuracy better than ±  depending on the numerology in use.  **Proposal 9:** For PRACH transmission, the NR NTN UE shall be able to self-estimate its with an accuracy better than ± ,  depending on the PRACH format and configuration.  **Proposal 10:** In connected mode, the NR NTN UE shall be able to self-estimate its with an accuracy better than ±  depending on the numerology in use.  **Proposal 11:** For PRACH transmission, the NR NTN UE shall be able to self-estimate with an accuracy better than ± ,  depending on the PRACH format and configuration.  **Proposal 12:** In connected mode, the NR NTN UE shall be able to self-estimate with an accuracy better than ±  depending on the numerology in use.  **Observation 1:** One shall distinguish between orbit determination performance based on past measurements of the satellite trajectory and orbit prediction performance that concerns the future satellite trajectory.  **Observation 2:** As a rule of thumb, it can be assumed that there is a factor of 1000 between the position error (in [m]) and the velocity error (in [m/s]). Is important to keep in mind this rule when allocating an error budget for satellite position and velocity estimations.  **Observation 3:** The orbit prediction accuracy depends on:   1. The accuracy of the orbit determination used to derive the satellite ephemeris; 2. The accuracy of the orbit propagation model; 3. The time horizon over which the prediction is made.   **Observation 4:** The PV accuracy target reference hypothesis could use Position error < 30 m and Velocity error < 30 mm/s.  **Observation 5:** Even for a satellite system with “low quality” orbit determination algorithm, challenging operations relying on accurate prediction of satellite trajectories such as Doppler compensation can be performed reliably. |

## Open issues summary and Companies views’ collection for 1st round

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### UE specific TA estimation error

In last meeting, RAN4 was agreed to The UE specific TA estimation accuracy is counted into the UE transmit timing error requirement, and FFS the UE specific TA estimation accuracy and whether to define a separate accuracy requirement.

* + - The UE specific TA estimation accuracy is counted into the UE transmit timing error requirement
      * UE specific TA estimation accuracy is FFS
      * FFS whether the UE specific TA estimation accuracy shall be also defined as a separate accuracy requirement
      * Specify UE behavior related to UE specific TA estimation and the detailed behavior is FFS
    - FFS on the update periodicity of UE specific TA value

**Issue 1-1-1: Whether to define a separate accuracy requirement for UE specific TA estimation?**

* Option 1: (Intel, NEC, THALES)
  + Yes
* Option 2: (QC, CATT, Xiaomi, CMCC, LGE, QC, CATT)
  + No
* Recommended WF
  + Companies are encouraged to provide their views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-2: UE specific TA estimation accuracy**

* Option 1: (CATT)
  + RAN4 should confirm the accuracy of ephemeris data and accuracy of UE PVT from satellit system and GNSS system, and confirm the accuracy of extrapolation from ephemeris data and GNSS based on ephemeris data mode and UE mobility mode.
* Option 2: (Xiaomi)
  + The UE specific TA estimation error is consist of the accuracy of A-GNSS position estimation (ΔUE-pos) and the accuracy of serving-satellite ephemeris (ΔSat-pos).
  + The UE specific TA estimation accuracy is defined as 10Ts.
* Option 3: (CMCC)
  + In order to measure the UE specific TA accuracy, take the following assumptions as the starting point:
    - For GNSS accuracy, take 50m as the worst case and 20m as the typical case;
    - For PVT accuracy, take the precise PVT information as the starting point, and further update after RAN1 achieving the conclusion.
* Option 4: (Apple)
  + UE specific TA estimation accuracy is 20.5\*64\*Tc + Tephemeris\_uncertainty. Tephemeris\_uncertainty is the satellite position error due to ephemeris information and UE calculation.
* Option 5: (Ericsson)
  + Use existing UE initial transmit timing error, Te also for NTN as UE specific estimation accuracy for initial access.
* Option 6: (THALES)
  + For PRACH transmission, the NR NTN UE shall be able to self-estimate its with an accuracy better than ± ,  depending on the PRACH format and configuration.
  + Proposal 10: In connected mode, the NR NTN UE shall be able to self-estimate its with an accuracy better than ±  depending on the numerology in use.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-3: Whether to define the update periodicity for UE specific TA estimation?**

* Option 1: (Intel, CMCC)
  + Yes
    - An NTN UE is required to correctly estimate and update the UE specific TA value in every certain periodicity, based on its GNSS positions and satellite ephemeris information. (Intel)
* Option 2: (CATT, Xiaomi, Apple)
  + No
* Option 3: (QC)
  + RAN4 to investigate whether there is any issue due to a conflict between UE specific TA update periodicity, i.e. open loop TA update, and Network controlled close loop TA update, hence, explicitly resolution and/or spec handling.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-4: UE behaviour related to UE specific TA estimation**

* Option 1: (CATT)
  + Defer discussion for specifying UE behaviour related to UE specific TA estimation, and wait RAN1 conclusion.
* Option 2: (THALES)
  + Specify UE behaviour related to the combination of UE specific TA estimation () and self-estimated TA common ().
* Option 3 (Apple):
  + No need to define UE behavior for UE specific TA estimation as a requirement, as long as UE can meet the timing requirement, i.e., Te/Tq/Tp.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-5: GNSS related accuracy**

* Option 1: (CATT)
  + RAN4 should confirm the accuracy of ephemeris data and accuracy of UE PVT from satellit system and GNSS system, and confirm the accuracy of extrapolation from ephemeris data and GNSS based on ephemeris data mode and UE mobility mode.
* Option 2: (Nokia)
  + RAN4 should discuss how a UE can determine it accuracy from GNSS is accurate enough to fulfil the initial transmission timing error requirements.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-6: UE specific TA estimation requirement for UE specific TA pre-compensation reporting**

* Option 1: (Apple)
  + Wait RAN1/RAN2 conclusions on UE specific TA pre-compensation reporting to determine whether we need to define separate UE specific TA estimation requirement or not.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-7: whether to define a separate accuracy requirement for self-estimated TA common ()?**

* Option 1: (THALES)
  + Yes.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-8: If yes for issue 1-6, the accuracy requirement for self-estimated TA common ()?**

* Option 1: (THALES)
  + For PRACH transmission, the NR NTN UE shall be able to self-estimate with an accuracy better than ± ,  depending on the PRACH format and configuration.
  + In connected mode, the NR NTN UE shall be able to self-estimate with an accuracy better than ±  depending on the numerology in use.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-9: whether to define a separate accuracy requirement for the combination of ?**

* Option 1: (THALES)
  + Yes.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-10: If yes for issue 1-8, the accuracy requirement for self-estimated TA common ()?**

* Option 1: (THALES)
  + For PRACH transmission, the NR NTN UE shall be able to self-estimate with an accuracy better than ± ,  depending on the PRACH format and configuration.
  + In connected mode, the NR NTN UE shall be able to self-estimate with an accuracy better than ±  depending on the numerology in use.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-11: Whether UE should use the referenceTimeInfo-R16 and GNSS-provided time reference to calculate TA at the UE.**

* Option 1: (Nokia)
  + FFS
    - RAN4 should discuss whether the use os the time provided by referenceTimeInfo-R16 is beneficial to securing that the initial transmission timings are kept by a UE.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

### UE transmit timing requirements

In RAN4#98bis-e meeting, the discussion on UE transmit timing requirements was summarized as follows:

* UE initial transmit timing error (Te)
  + Te requirement in NTN is consist of:
    - Same types of errors as terrestrial UE e.g. DL timing estimation accuracy and UL timing setting accuracy. and;
    - UE specific estimation accuracy;
  + FFS on whether and how much different relaxations are required for different sets of SCS of SSB and SCS of uplink signals
  + It is the total NTN UE Te error that decides UL performance, no matter the source of inaccuracy.
* N\_TA\_offset
  + The existing N\_TA offset value defined in Table 7.1.2-2 in TS38.133 can be reused in NTN
* Gradual timing adjustment
  + FFS whether to define new gradual timing adjustment requirements for NTN UE
    - FFS whether and how to count the maximum delay variation for the round trip delay;
    - FFS: whether define different requirements for different NTN topologies in terms of, e.g. GEO, MEO, LEO, HAPS, HIBS, altitude, elevation angles for feeder/service links, UE speed, etc;
    - FFS the reference timing for the Gradual timing adjustment in NTN
    - One shot timing adjustment
      * Not introduce one shot timing adjustment requirement for NTN UE

**Issue 1-2-1: The composites should be considered for initial transmit timing requirement in NTN (Te\_NTN).**

* Option 1: (QC, Xiaomi)
  + UE position estimation error
  + Serving-satellite position estimation error
  + The current UE transmit timing error requirement
* Option 1a: (LGE, MTK, Huawei)
  + GNSS inaccuracy
  + The current UE transmit timing error requirement
* Option 2: (Apple)
  + legacy Te
  + UE specific TA estimation error (without ephemeris uncertainty)
* Option 3: (THALES)
  + The accuracy of UE specific TA estimation (N\_(TA,UE-specific)) and self-estimated TA common (N\_(TA,common)) is counted into the UE transmit timing error requirement.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-2: Whether A-GNSS requirements of TS38.171 can be referred for Te\_NTN requirement.**

* Option 1: ()
  + Yes
* Option 2: (QC, Xiaomi)
  + No
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-3: GNSS position error assumption for Te\_NTN requirement.**

* Option 1: (QC)
  + at least 50m, and further relax up to 100m
* Option 2: (Xiaomi)
  + 50m
* Option 3: (CMCC)
  + 50m as the worst case and 20m as the typical case
* Option 4: (MTK)
  + For UL SCS of 15/30 kHz: <= 50 m
  + For UL SCS of 60/120 kHz: <= 30 m
* Option 5: (Apple, LGE)
  + The worst case: 100m
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-4:Whether to define general GNSS positioning accuracy requirements?**

* Option 1: (Huawei)
  + Yes, it is suggested to define general GNSS positioning accuracy requirements which can be referred for deriving other RRM requirements.
* Option 2: ()
  + FFS
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-5: Initial transmit timing error (Te\_NTN)**

* Option 1: (QC)
  + NTN UE initial timing error requirements should be relaxed to account for at least 50m of a composite position estimation error.
    - For FR1 NTN UE in RRC Connected state, the requirement should be further relaxed to accommodate a composite position estimation error up to 100ms.
* **Table 3: T’e Timing Error Limit when a total UE positioning error is allowed up to 50m**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals [kHz] | SCS of uplink signals [kHz] | Te | Te [us] | max(Tch) [us] | max(Tch)/Tcp [%] | Max(T’e) |
| 1 | 15 | 15 | 12\*64\*Tc | 0.39 | 3.57 | 76 | 17\*64\*Tc |
|  |  | 30 | 10\*64\*Tc | 0.33 | 1.35 | 58 | 15\*64\*Tc |
|  |  | 60 | 10\*64\*Tc | 0.33 | 0.17 | 15 | 15\*64\*Tc |
|  | 30 | 15 | 8\*64\*Tc | 0.26 | 3.83 | 82 | 13\*64\*Tc |
|  |  | 30 | 8\*64\*Tc | 0.26 | 1.49 | 64 | 13\*64\*Tc |
|  |  | 60 | 7\*64\*Tc | 0.23 | 0.38 | 32 | 12\*64\*Tc |
| 2 | 120 | 60 | 3.5\*64\*Tc | 0.11 | 0.62 | 53 | 8.5\*64\*Tc |
|  |  | 120 | 3.5\*64\*Tc | 0.11 | 0.03 | 6 | 8.5\*64\*Tc |
|  | 240 | 60 | 3\*64\*Tc | 0.098 | 0.64 | 55 | 8\*64\*Tc |
|  |  | 120 | 3\*64\*Tc | 0.098 | 0.06 | 10 | 8\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 | | | | | | |  |

**Table 4: T’e Timing Error Limit when a total UE positioning error is allowed up to 100m**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals [kHz] | SCS of uplink signals [kHz] | Te | Te [us] | max(Tch) [us] | max(Tch)/Tcp [%] | Max(T’e) |
| 1 | 15 | 15 | 12\*64\*Tc | 0.39 | 3.24 | 72 | 22\*64\*Tc |
|  |  | 30 | 10\*64\*Tc | 0.33 | 1.02 | 66 | 20\*64\*Tc |
|  | 30 | 15 | 8\*64\*Tc | 0.26 | 3.5 | 75 | 18\*64\*Tc |
|  |  | 30 | 8\*64\*Tc | 0.26 | 1.16 | 49 | 18\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 | | | | | | |  |

* Option 2: (CATT)
  + The NTN UE initial transmit timing error should be relaxed, and may be relaxed to [1/10]CP ~ [1/2]CP for different SCS. The relaxed part is allowed for NTN UE specific estimation accuracy.
* Option 3: (Xiaomi)
  + The Te requirement in NTN is shown in table 1.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals [kHz] | SCS of uplink signals [kHz] | Te | UE specific TA estimation accuracy | Te\_NTN |
| 1 | 15 | 15 | 12\*64\*Tc | 10Ts | 22\*64\*Tc |
|  |  | 30 | 10\*64\*Tc | 10Ts | 20\*64\*Tc |
|  |  | 60 | 10\*64\*Tc | 10Ts | 18\*64\*Tc |
|  | 30 | 15 | 8\*64\*Tc | 10Ts | 18\*64\*Tc |
|  |  | 30 | 8\*64\*Tc | 10Ts | 18\*64\*Tc |
|  |  | 60 | 7\*64\*Tc | 10Ts | 15\*64\*Tc |
| 2 | 120 | 60 | 3.5\*64\*Tc | 10Ts | 10\*64\*Tc |
|  |  | 120 | 3.5\*64\*Tc | 10Ts | 10\*64\*Tc |
|  | 240 | 60 | 3\*64\*Tc | 10Ts | 8\*64\*Tc |
|  |  | 120 | 3\*64\*Tc | 10Ts | 8\*64\*Tc |

**Table 1: Te requirement in NTN**

* Option 4: (CMCC)
  + The revisited Te requirement for NTN can take the following tables as the baseline. Further update the values in bracket squares after achieving the conclusions about GNSS accuracy and PVT accuracy.

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Range** | **SCS of SSB signals (kHz)** | **SCS of uplink signals (kHz)** | **Te (worst-case)** |
| 1 | 15 | 15 | (12+[5])\*64\*Tc=[17]\*64\*Tc |
|  |  | 30 | [15]\*64\*Tc |
|  |  | 60 | [15]\*64\*Tc |
|  | 30 | 15 | [13]\*64\*Tc |
|  |  | 30 | [13]\*64\*Tc |
|  |  | 60 | [12]\*64\*Tc |
| 2 | 120 | 60 | [8.5]\*64\*Tc |
|  |  | 120 | [8.5]\*64\*Tc |
|  | 240 | 60 | [8]\*64\*Tc |
|  |  | 120 | [8]\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 [6] | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Range** | **SCS of SSB signals (kHz)** | **SCS of uplink signals (kHz)** | **Te(typical-case)** |
| 1 | 15 | 15 | (12+[2])\*64\*Tc=[14]\*64\*Tc |
|  |  | 30 | [12]\*64\*Tc |
|  |  | 60 | [12]\*64\*Tc |
|  | 30 | 15 | [10]\*64\*Tc |
|  |  | 30 | [10]\*64\*Tc |
|  |  | 60 | [9]\*64\*Tc |
| 2 | 120 | 60 | [5.5]\*64\*Tc |
|  |  | 120 | [5.5]\*64\*Tc |
|  | 240 | 60 | [5]\*64\*Tc |
|  |  | 120 | [5]\*64\*Tc |
| Note 1: Tc is the basic timing unit defined in TS 38.211 [6] | | | |

* Option 5: (ZTE, THALES)
  + Reuse the existing Te requirements defined in TS 38.133.
* Option 6: (NEC)
  + RAN4 to further wait for RAN1 progress to define the Te requirements and possible relaxations compared to NR initial timing error requirements.
* Option 7: (Huawei)
  + The UE initial transmit timing error requirements for NTN network can be defined as (Te + Tpos), where Te is same as the existing Te requirements in TS38.133 and Tpos is defined as the timing error derived from GNSS positioning error.
* Option 8: (Ericsson)
  + Te\_NTN = 2\*Te
* Option 9: (Apple)
  + The NTN Te requirement with relaxation shall not exceed (half CP – 8\*64\*Tc) for FR1 and half CP for FR2 on UL.
  + When ephemeris information is used to derive UE specific TA in Te requirement, the error due to ephemeris uncertainty shall not be considered.
  + The Te requirement for NTN is defined by:
    - FR1 NTN Te requirement: min{(legacy Te + 20.5\*64\*Tc), (half CP – 8\*64\*Tc)}
    - FR2 NTN Te requirement: min{(legacy Te + 20.5\*64\*Tc), half CP }

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Frequency Range* | *SCS of SSB signals (kHz)* | *SCS of uplink signals (kHz)* | *Te for NTN* | Note |
| *1* | *15* | *15* | *32.5\*64\*Tc* | *min{(legacy Te + 20.5\*64\*Tc), (half CP – 8\*64\*Tc)}*  *note: 60kHz FR1 Te is not smaller than FR2 60kHz Te* |
|  |  | *30* | *28\*64\*Tc* |
|  |  | *60* | *18\*64\*Tc* |
|  | *30* | *15* | *32.5\*64\*Tc* |
|  |  | *30* | *28\*64\*Tc* |
|  |  | *60* | *18\*64\*Tc* |
| *2* | *120* | *60* | *18\*64\*Tc* | *min{(legacy Te + 20.5\*64\*Tc), half CP }* |
|  |  | *120* | *9\*64\*Tc* |
|  | *240* | *60* | *18\*64\*Tc* |
|  |  | *120* | *9\*64\*Tc* |

* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-6: Whether define different gradual timing adjustment requirements for different NTN topologies** **e.g. GEO, MEO, LEO.**

* Option 1: (CATT, Xiaomi)
  + Yes
* Option 2: (QC, CMCC)
  + FFS
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-7: Which assumptions will be used to define gradual timing adjustment requirements for NTN network?**

* Option 1: (Huawei)
  + Assumption 1: UE performs timing adjustment for downlink reception timing drifting and UE specific TA change separately.
  + Assumption 2: UE performs timing adjustment with combining downlink reception timing drifting and UE specific TA change as one adjustment.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-8: Whether the maximum delay variation should be considered in the gradual timing adjustment requirement in NTN?**

* Option 1: (Xiaomi, CMCC, Ericsson)
  + Yes
* Option 2: ()
  + FFS.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-9: Whether the feeder link propagation delay time change should be considered in the gradual timing adjustment requirement in NTN?**

* Option 1: (QC)
  + FFS
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-10: Whether to define new gradual timing adjustment requirements for NTN network?**

* Option 1: (QC, Xiaomi, CMCC, Huawei, Ericsson, Apple)
  + Yes
* Option 2: ()
  + FFS.
* Recommended WF
  + RAN4 to introduce new gradual timing adjustment requirements for NTN network.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-11: Gradual timing adjustment requirement**

* Option 1: (CATT)
  + The Tq and Tp in TN system can be reused. But the maximum aggregate adjustment rate will be defined based on different NTN topologies, such as Tq per [20] ms for LEO600km cell, but Tq per [60]s for GEO.
* Option 2: (Xiaomi)
  + The maximum amount of the magnitude of the timing change in one adjustment shall be Tq\_NTN = 25\*Ts.
  + The minimum aggregate adjustment rate shall be Tp\_NTN = 100Ts per 100ms.
  + The maximum aggregate adjustment rate shall be Tq\_NTN = 25\*Ts per 20 ms.The Tq and Tp can be reused. The maximum aggregate adjustment rate should be Tq per 20ms.
* Option 3: (CMCC)
  + In FR1, The maximum aggregate adjustment rate shall be Tq per Xms, Tq value use [255/200\*X]\*64\*Tc as the baseline, a candidate set of X can be [50ms, 40ms, 20ms], the specific value can be further discussed
* Option 4: (Ericsson)
  + The parameter Tq will have to be modified. For a period of 200 ms we could have a worst case delay variation of 246 \* 64 Tc.
  + Either the period has to be shortened from 200 ms to something smaller, or we need to increase Tq.
* Option 5: (Apple)
  + the design principle for gradual timing adjustment requirement is:
    - Tp=Tq
    - Where,
      * Tdrift is the UE time drifting during 200ms;
      * Vrelative is the relative speed between UE and satellite
      * T\_granularity is the UE UL timing granularity
      * digRF\_margin is the margin for digital RF, i.e., 1.5\*64\*Tc.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-12: In GEO scenarios, whether the existing gradual timing adjustment requirement can be applied**

* Option 1: (Xiaomi, CMCC)
  + Yes
* Option 2: ()
  + FFS
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-13: The direction of timing adjustment for NTN UE pre-compensation.**

* Option 1: (MTK)
  + The timing adjustment of NTN UE pre-compensation and TN gradual timing adjustment are in opposite directions
  + Legacy gradual timing adjustment cannot directly reused. The direction of timing adjustment for NTN UE pre-compensation should be further clarified in the requirement.
* Option 2: (Intel)
  + An NTN UE is required to adjust its UL timing towards updated UE specific TA gradually, according to minimum and maximum aggregate adjustment rate requirements.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-14: The reference timing for UE transmit timing.**

* Option 1: (THALES)
  + The time reference for the UE transmit timing control requirement shall be the downlink timing of the reference cell minus (N\_TA+N\_(TA,UE-specific) 〖+N〗\_(TA,common) 〖+N〗\_(TA,offset) )×T\_c. Therefore, the UE transmit timing error requirement does not cover the self-TA estimation errors.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

### TA adjustment accuracy requirements

In RAN4#98bis-e meeting, the discussion on UE transmit timing requirements was summarized as follows:

* In RRC\_idle mode
  + FFS whether to define TA adjustment accuracy requirement;
  + In RRC\_CONNECTED mode
    - Option 1: Reuse the existing TA adjustment accuracy requirement defined in TS 38.133 with considering of UL timing quantization accuracy.
    - Option 2: FFS on whether relax the TA adjustment accuracy requirement.
      * FFS on UE position and satellite position estimation error;
      * FFS on propagation delay change from a slot when UE received timing advance command to a slot when the indicated TA.

**Issue 1-3-1: Whether to define TA adjustment accuracy requirement in RRC\_IDLE mode**

* Option 1: (NEC)
  + Yes
* Option 2: (CATT, CMCC, Apple)
  + No
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-3-2: Whether the UE position and satellite position estimation error should be accounted for TA adjustment accuracy requirement?**

* Option 1: (Xiaomi, LGE)
  + Yes
* Option 2: (QC, CMCC)
  + Depends on RAN1 design
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1.2.3-3: TA adjustment accuracy requirement in RRC\_CONNECTED mode**

* Option 1: (NEC, Huawei, Ericsson, Apple)
  + Reuse the existing timing advance adjustment accuracy requirements defined in TS 38.133.
* Option 1a: (NEC)
  + RAN4 to reuse the existing TA adjustment accuracy requirement defined in TS 38.133 with considering of UL timing quantization accuracy.
* Option 2: (Xiaomi, CMCC, LGE)
  + RAN4 is to define a relaxed TA adjustment accuracy requirement for NR NTN
* Option 2a: (QC)
  + Request RAN1 whether and how to reflect a propagation delay change, i.e. open loop TA update, from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission. If defined, depending on RAN1 design NTN UE timing advance adjustment accuracy requirements may have to be relaxed to account for UE position and satellite position estimation error. And if it is decided to relax the requirement, the accuracy requirement relaxation shall be the same as that for initial timing error requirement.
* Recommended WF
  + Companies are encouraged to provide the views on TA adjustment accuracy requirement in RRC\_CONNECTED mode.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-3-4: UE behaviour before applying timing advance adjustment for its uplink transmission.**

* Option 1: (LGE)
  + UE specific TA should be updated in the slot before applying timing advance adjustment for its uplink transmission
* Option 2: ()
  + FFS
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

**Issue 1-3-5: Open and closed loop for TA adjustment.**

* Option 1: (Intel)
  + Open and close loop specific timing requirements are pending other WG discussions.
* Option 2: (Nokia)
  + RAN4 to set requirements on how open loop TA control in RRC connected mode should be applied in a way that does not impact the closed loop TA control messages.
* Recommended WF
  + Companies are encouraged to provide the views on this issue.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

### Reply LS for the incoming LS (R1-2102263)

RAN1 sent the LS (R1-2102263) to ask RAN4 to provide feedback on NTN UL time and frequency sychronization requirements.

Question 1: What are the NTN UL time synchronization requirements?

* For initial access (i.e. PRACH transmission)
* For UL transmissions in RRC Connected State

Question 2: What are the NTN UL frequency synchronization requirements?

* For initial access (i.e. PRACH transmission)
* For UL transmissions in RRC Connected State

According to the chairman’s guidance, Q1, Q2 will be treated separately in RRM session and RF session and then combined into a single LS reply in the end.

**Issue 1-4-1: What are the NTN UL time synchronization requirements?**

* Option 1: (CATT)
  + RAN4 would like to thank RAN1 for the LS on NTN UL time and frequency synchronization requirements. In last RAN4 meeting, a response LS has sent to RAN1 for NTN UL frequency synchronization requirement and concluded the requirement will be ±0.1ppm. RAN4 further investigated time synchronization requirements and would like to give the following response.
  + The UE initial transmit timing error need to be relaxed compared to NR requirement in 38.133 based on Te in TN specification. The relaxation is determined by NTN UE specific time advance estimation accuracy and the NTN UE specific time advance estimation accuracy is [TBD].
* Option 2: (Xiaomi)
  + The UL time synchronization requirements for NTN will be specified in RAN4 are summarized as follows:
    - Initial access
      * Initial transmit timing error requirement (Te), which is specified in TS38.133 Table 7.1.2-1.
      * TA adjustment accuracy requirement due to UE specific TA estimation.
  + The UL time synchronization requirements for NTN will be specified in RAN4 are summarized as follows:
    - Initial access
      * Initial transmit timing error requirement (Te), which is specified in the following table 1.

Table 1: Te requirement for NR NTN

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals [kHz] | SCS of uplink signals [kHz] | Te | UE specific TA estimation accuracy | Te\_NTN |
| 1 | 15 | 15 | 12\*64\*Tc | 10Ts | 22\*64\*Tc |
|  |  | 30 | 10\*64\*Tc | 10Ts | 20\*64\*Tc |
|  |  | 60 | 10\*64\*Tc | 10Ts | 18\*64\*Tc |
|  | 30 | 15 | 8\*64\*Tc | 10Ts | 18\*64\*Tc |
|  |  | 30 | 8\*64\*Tc | 10Ts | 18\*64\*Tc |
|  |  | 60 | 7\*64\*Tc | 10Ts | 15\*64\*Tc |
| 2 | 120 | 60 | 3.5\*64\*Tc | 10Ts | 10\*64\*Tc |
|  |  | 120 | 3.5\*64\*Tc | 10Ts | 10\*64\*Tc |
|  | 240 | 60 | 3\*64\*Tc | 10Ts | 8\*64\*Tc |
|  |  | 120 | 3\*64\*Tc | 10Ts | 8\*64\*Tc |

* + - UL transmissions in RRC\_CONNECTED state
      * Initial transmit timing error requirement (Te), which is specified in above table 1.
      * Gradual timing adjustment for LEO scenario
        + The maximum amount of the magnitude of the timing change in one adjustment shall be Tq\_NTN = 25\*Ts.
        + The minimum aggregate adjustment rate shall be Tp\_NTN = 100Ts per 100ms.
        + The maximum aggregate adjustment rate shall be Tq\_NTN = 25\*Ts per 20 ms.
      * Gradual timing adjustment for GEO scenario
        + The maximum amount of the magnitude of the timing change in one adjustment shall be Tq.
        + The minimum aggregate adjustment rate shall be Tp per second.
        + The maximum aggregate adjustment rate shall be Tq per 200 ms.
        + Where the maximum autonomous time adjustment step Tq and the aggregate adjustment rate Tp are specified in TS38.133 Table 7.1.2.1-1.
      * TA adjustment accuracy requirement, which is consist of the following parts:
        + Received TA command adjustment accuracy
        + Estimated UE specific TA adjustment accuracy
        + Received Common TA adjustment accuracy
* Option 3: (Ericsson)
  + For initial access (i.e. PRACH transmission): An NTN UE will have an initial access error of 2\*Te, where Te is the exiting error in TS 38.133, section 7.1.2).
  + For UL transmissions in RRC Connected State: RAN4 has concludes that for TA adjustment accuracy in RRC Connected State Timing Advance adjustment accuracy requirement depends on:
    - The mechanism of TA adjustment step size determined by RAN1 and the total uncertainty budget and
    - Requirement for UE Timing Advance adjustment accuracy. An NTN UE will have will comply to existing requirement for UE Timing Advance adjustment accuracy in TS 38.133 7.3.2.
    - Finally, RAN has decided to define UE specific TA estimation accuracy requirement, but no details are available at this point.
* Recommended WF
  + Pending on the conclusion on sub-topic 1.2.1, 1.2.2 and 1.2.3.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents