**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-210XXXX**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 8.8.4.2

**Source:** Moderator (Xiaomi)

**Title:** Email discussion summary for [98-bis-e][223] NR\_NTN\_solutions\_RRM\_2

**Document for:** Information

# Introduction

The scope of this email discussion is core timing requirements for NR NTN (AI 8.8.4.2). 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 8.8.4.2 Timing requirements
* UE specific TA estimation error
* UE transmit timing requirements
	+ UE initial transmit timing error
	+ NTA\_offset
	+ UE transmit timing adjustment
		- Gradual timing adjustment
		- One shot 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 (Monday Apr. 12)
	+ Companies provide comments for the 1st round (Apr. 12 – Wednesday 8am UTC Apr. 14)
	+ Moderator summarize the status and possible proposals, recommending what decisions can be made for 1st round. A formal t-doc will be used (Wednesday 11pm UTC, Apr. 14)
* 2nd round:
	+ Companies provide comments for 2nd round starting from Thursday 8am UTC Apr. 15
	+ Companies’ comments shall stop by Monday 11pm UTC, Apr. 19
	+ Moderator provide 2nd round summary with a formal tdoc by Tuesday 9am UTC, Apr. 20

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** |
| R4-2104604 | CMCC | Proposal 1: We support Option3 to define a new requirement for UE self-estimating accuracy. Option1 is also acceptable to us.Proposal 2: • If Option1 is agreed in issue1, then Te requirements should cover the UE-self estimation error;• If Option3 is agreed in issue1, then we can reuse the existing Te requirements defined in TS 38.133, Table 7.1.2-1, which is our preference.Proposal 3: Use the existing NTA\_offset value as a baseline, and further update the table based on real deployment scenario.Proposal 4: 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 discussedProposal 5: Reuse the existing timing advance adjustment accuracy requirements defined in TS 38.133. |
| R4-2104689 | Xiaomi | Proposal 1: The existing Te requirements defined in TS 38.133 Table 7.1.2-1 can be reused in R17 NR NTN.Proposal 2: The existing N\_TA offsetvalue defined in Table 7.1.2-2 in TS38.133 can be reused in NTN.Observation 1: The timing drift due to high satellite speed shall be considered in timing adjustment rules in NTN.Proposal 3: In LEO scenario, RAN4 is to introduce one shot timing adjustment rule to compensate the DL timing drift according to each estimated reference DL timing, and the maximum amount of the magnitude of the timing adjustment can be 18\*64 Tc.Proposal 4: In GEO scenario, the existing timing adjustment rules defined in TS38.133 can be applied.Observation 2: The accuracy of the UE specific TA estimation should be considered for TA adjustment accuracy requirement.Proposal 5: In RRC\_IDLE state, RAN4 is to introduce TA adjustment accuracy due to UE specific TA estimation error for initial PRACH transmission or msgA transmission. Proposal 6: In RRC\_CONNECTED, the TA adjustment accuracy requirement is consist of the following factors: UE specific TA calculation accuracy Common TA estimation accuracy Received TA command adjustment accuracy |
| R4-2105139 | Ericsson | Observation 1: Our position how to define the timing requirements. is close to Option 3, in the list above, but we are not against deriving requirements in other ways, as long as we get an acceptable total budget.Observation 2: A worst case maximum delay variation will trigger a gradual timing adjustment every 10 to 6 m for FR1 and every 3 to 2.5 ms for FR2 given existing gradual timing adjustment requirements.Observation 3: 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.Proposal 1: The parameter Tq and the maximum aggregate adjustment rate will have to be investigated.Observation 4: final analysis of Timing Advance adjustment accuracy has to consider the total error budget for regulating TA during a call: ΔUE-pos, ΔSat-pos, Timing Advance adjustment accuracy and TA command resolution error.Proposal 2: Final Timing Advance adjustment accuracy depends on the mechanism chosen in RAN1 specification and the final total uncertainty budget. However, Timing Advance adjustment accuracy should scale inversely proportional to SCS (and in current specification it is ±1/4 TA-step (at SCS = 15 kHz)).Proposal 3: Regardless of how the final UE specific TA estimation accuracy requirement is defined, it is important to keep the total error budget, i.e., the total TA uncertainty similar to existing terrestrial specification, in order to preserve CP to combat ISI and maintain UL capacity. |
| R4-2104765 | CATT | Observation 1: The existing NTA\_offset value defined in Table 7.1.2-2 in TS38.133 can be reused in NTN.Observation 2: UE will perform transmit timing pre-compensation for propagation delay between UE and satellite, and calculate parameter NTA-UE\_pre-compensation.Observation 3: Whether to use NTA and NTA-Common, how to use NTA and NTA-Common, it should be RAN1 work.Observation 4: The parameter of timing pre-compensation for feeder link propagation delay, represented as NTA-Common, should include value of zero or configuration of that gNB doesn’t configure this signal to UE.Observation 5: The UE transmit timing requirement, Te, will not be impacted by parameters of NTA-Common , NTA , and NTA\_offset signaled to UE.Observation 6: The UE transmit timing requirement, Te, will be impacted by NTA-UE\_pre-compensation accuracy. The UE self-estimating error of NTA-UE\_pre-compensation should be counted into UE transmit timing error.Observation 7: Te might be defined as value defined in table Table 7.1.2-1 in [2] + 2\*∆Pos /c. ∆Pos is the Positioning accuracy which is the error between the estimated position and the true position. It is based on UE A-GNSS capability.Observation 8: The Tq and Tp can be reused. The maximum aggregate adjustment rate should be Tq per 20ms. |
| R4-2104927 | ZTE Corporation | Observation 1: It is observed that reference point placed at gNB is consistent with the current NR baseline of TA mechanism. Observation 2: Reference point placed at gNB could minimize the specification impact and BS implementation complexity.Proposal 1: Reference point at gNB is supported as the baseline for RAN4 to investigate the impact on RRM requirements of NTN system. Proposal 2: RAN4 treats UE specific TA calculation error as one of the contributions to transmission timing error. |
| R4-2104985 | NEC | Proposal 1: RAN4 to agree that UE transmit timing accuracy depends on:• The downlink frame detection accuracy of UE; and • NTA, UE-specific estimation accuracy. Where NTA, UE-specific estimation further depends on UE GNSS position accuracy and satellite position accuracy; and • TA command quantisation accuracy and preceding UL timing accuracy.Proposal 2: RAN4 to agree that NTN timing compensation accuracy has impact on Te timing error requirements for both CONNECTED mode and IDLE mode. Proposal 3: RAN4 to agree that NTA offset value for L-band and S-band to be 0 and NTA offset for Ka-band to be 13792Tc.  |
| R4-2106360 | MediaTek inc. | Observation 1: 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.Observation 2: RAN1 already agreed on an NR NTN UE shall be capable of at least support UE specific TA calculation based at least on its GNSS-acquired position and the serving satellite ephemeris in RRC\_CONNECTED, RRC\_IDLE and RRC\_INACTIVE states.Observation 3: the error in applying NTA,offset + NTA-UE specific+N\_(TA,common) should be accommodated in the requirement for the specified maximum transmission timing error ±Te = ± 0.39 μs (=12\*64\*Tc).Observation 4: The delay drift over the RTD of the service link can be accurately predicted and pre-compensated by the UE, therefore it can also be accommodated in the transmission timing error requirement (i.e. Te).Proposal 1: TA command for the delay drift over the RTD of the service link is not needed.Observation 5: A separate requirements to define the UE self-estimating accuracy of NTA will un-necessarily require specification effort. The core requirement for UE self-estimating accuracy of NTA as discussed in Options 1 can re-use the requirement on the UE transmit timing error (Te), as specified in 7.1.2 in TS 38.133, as discussed above.Proposal 2: NTN UL time synchronization requirements for the service link can be defined as the way of the UE transmit timing error ±Te = ± 0.39 μs (=12\*64\*Tc), as specified in 7.1.2 in TS 38.133, for PRACH transmission and the first transmission in a DRX cycle for PUCCH, PUSCH and SRS. |
| R4-2106444 | 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. |
| R4-2106947 | Huawei, HiSilicon | Proposal 1: It is suggested that UE specific TA estimation error is counted into UE transmit timing error or TA adjustment error.Proposal 2: If UE specific TA estimation error is counted into UE transmit timing error, the following timing requirements need to be specified for NTN networks.- UE initial transmit timing error (Te) requirements- Option 1a: Define relaxed Te requirements if DL timing is estimated based on SSB signals.- Option 1b: Define new Te requirements if DL timing is derived from GNSS signals- UE autonomous timing adjustment (Tq/Tp) requirements- Define new Tq/Tp requirements with considering of both DL timing drift and UE specific TA change, due to relative movement between UE and serving satellite.- TA requirements- Reuse the existing TA adjustment accuracy requirements with considering of UL timing quantization accuracy.Proposal 3: If UE specific TA estimation error is counted into TA adjustment error, the following timing requirements need to be specified for NTN networks.- UE initial transmit timing error (Te) requirements- Option 2a: Reuse the existing Te requirements if DL timing is estimated based on SSB signals.- Option 2b: Define new Te requirements if DL timing is derived from GNSS signals- UE autonomous timing adjustment (Tq/Tp) requirements- Define new Tq/Tp requirements with only considering of DL timing drift due to relative movement between UE and serving satellite.- TA requirements- Define new TA adjustment accuracy requirements with considering of both UL timing quantization accuracy and UE specific TA estimation accuracy.- Introduce UE autonomous TA adjustment requirements, including adjustment step and adjustment rate. |
| R4-2107259 | Nokia, Nokia Shanghai Bell | Proposal 1: Use the existing Te requirements as defined in TS 38.133, Table 7.1.2-1 for NTN Proposal 2: RAN4 to investigate how open and closed loop TA control impact on the Te requirements |
| R4-2107291 | Qualcomm Incorporated | Initial Transmission Timing ErrorObservation 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 1: 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.• FFS on whether and how much different relaxations are required for different sets of SCS of SSB and SCS of uplink signals.TA Adjustment AccuracyProposal 2: RAN4 to discuss whether a propagation delay change from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission needs to be estimated and reflected into the transmission timing adjustment. If supported, NTN UE timing advance adjustment accuracy requirements should be relaxed to account for UE position and satellite position estimation error.• FFS on if the accuracy requirement relaxation shall be the same as that for initial timing error requirement.Gradual Timing AdjustmentObservation 7: The current gradual timing adjustment requirements cannot be applied to NTN systems.Proposal 3: 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. |
| R4-2107277 | 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 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 4: The UE self-estimated TA accuracy requirement shall be defined as a separate accuracy requirement.Proposal 5: For PRACH transmission, the NR NTN UE shall be able to acquire its self-estimated TA with an accuracy better than ± min((CP-Delay\_spread)/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2) [s], depending on the PRACH format and configuration.Proposal 6: In connected mode, the NR NTN UE shall be able to update its self-estimated TA with an accuracy better than ±(CP-Delay\_spread)/2 depending on the numerology in use. |

## Open issues summary

*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 define the requirements for UE specific TA estimation accuracy, and FFS on how to capture this requirement. The following 3 options are proposed to be considered:

* + - Option 1: the UE specific TA estimation accuracy is counted into the UE transmit timing error requirement
		- Option 2: the UE specific TA estimation accuracy is counted into the timing advance adjustment accuracy requirement
		- Option 3: the UE specific TA estimation accuracy is defined as a separate accuracy requirement
		- Other option is not precluded

**Issue 1.2.1-1: How to capture the UE specific TA estimation error**

* Option 1: option 1 (CMCC, ZTE, NEC, MTK, Huawei, QC, CATT)
* Option 2: option 2 (Xiaomi, Ericsson, Huawei)
* Option 3: option 3 (CMCC, Intel, THALES)
* Option 4: (Ericsson)
	+ Our position how to define the timing requirements. is close to Option 3, in the list above, but we are not against deriving requirements in other ways, as long as we get an acceptable total budget.
	+ Final analysis of Timing Advance adjustment accuracy has to consider the total error budget for regulating TA during a call: ΔUE-pos, ΔSat-pos, Timing Advance adjustment accuracy and TA command resolution error.
	+ Regardless of how the final UE specific TA estimation accuracy requirement is defined, it is important to keep the total error budget, i.e., the total TA uncertainty similar to existing terrestrial specification, in order to preserve CP to combat ISI and maintain UL capacity.
* Recommended WF
	+ Companies are encouraged to provide their views on how to capture the UE specific TA estimation error.

**Issue 1.2.1-2: If option 3 in issue 1.2.1-1 is agreed, how to specify the UE specific TA estimation error**

* Option 1: (THALES)
	+ For PRACH transmission, the NR NTN UE shall be able to acquire its self-estimated TA with an accuracy better than ± min((CP-Delay\_spread)/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2 ) [s], depending on the PRACH format and configuration.
	+ In connected mode, the NR NTN UE shall be able to update its self-estimated TA with an accuracy better than ±(CP-Delay\_spread)/2 depending on the numerology in use.
* Recommended WF
	+ Pending on the conclusion of issue 1.2.1-1. It is propose to define the exact UE specific TA estimation error in next meeting if option 3 in issue 1.2.1-1 is agreed.

**Issue 1.2.1-3: the update periodicity of UE specific TA value**

* Option 1: (Intel)
	+ 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.
* Recommended WF
	+ Companies are encouraged to provide the views on the update periodicity of UE specific TA value.

### UE transmit timing requirements

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

* Te: Timing Error Limit
	+ The impact due to DL timing estimation, use existing Te requirements defined in TS 38.133, Table 7.1.2-1, as baseline for R17 NR NTN
	+ RAN4 is to further investigate whether other aspects have impact on the Te requirements for R17 NR NTN
	+ FFS: NTN timing compensation accuracy has impact on Te timing error requirements for CONNECTED mode. FFS for IDLE mode.
		- FFS on whether the existing value defined in Table 7.1.2-2 in TS38.133 can be reused or not
		- Gradual timing adjustment
			* RAN4 is to study the gradual timing adjustment rules for NR NTN including:
				+ Tq (Maximum Autonomous Time Adjustment Step)
				+ Tp (Minimum Aggregate Adjustment rate)

**Issue 1.2.2-1: Initial transmit timing error (Te)**

* Option 1: (Xiaomi, MTK, Nokia, THALES)
	+ The existing Te requirements defined in TS 38.133 Table 7.1.2-1 can be reused in R17 NR NTN.
* Option 1a: (CMCC)
	+ If Option 1 in issue 1.2.1-1 is agreed, then Te requirements should cover the UE-self estimation error;
	+ If Option 3 in issue 1.2.1-1 is agreed, then we can reuse the existing Te requirements defined in TS 38.133, Table 7.1.2-1,
* Option 2: (CATT)
	+ Te+ 2\*∆Pos /c, where ∆Pos is the Positioning accuracy which is the error between the estimated position and the true position
* Option 2a: (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.
		- FFS on whether and how much different relaxations are required for different sets of SCS of SSB and SCS of uplink signals.
* Option 3: (NEC)
	+ UE transmit timing accuracy depends on:
		- The downlink frame detection accuracy of UE; and
		- NTA, UE-specific estimation accuracy. Where NTA, UE-specific estimation further depends on UE GNSS position accuracy and satellite position accuracy; and
		- TA command quantisation accuracy and preceding UL timing accuracy
* Option 4: (Huawei)
	+ If Option 1 in issue 1.2.1-1 is agreed, then UE initial transmit timing error (Te) requirements:
		- Option 1a: Define relaxed Te requirements if DL timing is estimated based on SSB signals.
		- Option 1b: Define new Te requirements if DL timing is derived from GNSS signals
	+ If Option 2 in issue 1.2.1-1 is agreed, then we can reuse the existing Te requirements defined in TS 38.133, Table 7.1.2-1,
		- Option 2a: Reuse the existing Te requirements if DL timing is estimated based on SSB signals.
		- Option 2b: Define new Te requirements if DL timing is derived from GNSS signals
* Recommended WF
	+ Pending on the conclusion of issue 1.2.1-1.
		- If option 1 in issue 1.2.1-1 is agreed, define the relaxed Te requirements.
		- If option 2 or option 3 in issue 1.2.1-1 is agreed, reuse the existing Te requirements defined in TS 38.133 Table 7.1.2-1.

**Issue 1.2.2-2: Whether the timing compensation accuracy has impact on Te?**

* Option 1: Yes (NEC, CATT)
	+ RAN4 to agree that NTN timing compensation accuracy has impact on Te timing error requirements for both CONNECTED mode and IDLE mode. (Nokia)
	+ (CATT)
		- The UE transmit timing requirement, Te, will not be impacted by parameters of NTA-Common , NTA , and NTA\_offset signaled to UE.
		- The UE transmit timing requirement, Te, will be impacted by NTA-UE\_pre-compensation accuracy. The UE self-estimating error of NTA-UE\_pre-compensation should be counted into UE transmit timing error.
* Option 2: No
* Option 3: (Nokia)
	+ RAN4 to investigate how open and closed loop TA control impact on the Te requirements
* Recommended WF
	+ Companies are encouraged to provide the views on the impact on Te due to the timing compensation accuracy.

**Issue 1.2.2-3: value in NTN?**

* Option 1: (CMCC, Xiaomi, CATT)
	+ The existing N\_TA offset value defined in Table 7.1.2-2 in TS38.133 can be reused in NTN.
* Option 2: (NEC)
	+ NTA offset value for L-band and S-band to be 0 and NTA offset for Ka-band to be 13792Tc.
* Recommended WF
	+ The existing N\_TA offset value defined in Table 7.1.2-2 in TS38.133 can be reused in NTN.

**Issue 1.2.2-4: Gradual timing adjustment requirement**

* Option 1: the existing gradual timing adjustment requirements defined in TS38.133 are reused (Xiaomi, CATT)
	+ In GEO scenario, the existing timing adjustment rules defined in TS38.133 can be applied. (Xiaomi)
	+ The Tq and Tp can be reused. The maximum aggregate adjustment rate should be Tq per 20ms. (CATT)
* Option 2: the existing gradual timing adjustment requirements defined in TS38.133 need to be revised (CMCC, Ericsson, Intel, Huawei, QC)
	+ 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. (CMCC)
	+ The parameter Tq and the maximum aggregate adjustment rate will have to be investigated. (Ericsson)
		- A worst case maximum delay variation will trigger a gradual timing adjustment every 10 to 6 m for FR1 and every 3 to 2.5 ms for FR2 given existing gradual timing adjustment requirements.
		- 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.
	+ 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. (Intel)
	+ Define new Tq/Tp requirements with considering (Huawei)
		- Both DL timing drift and UE specific TA change, due to relative movement between UE and serving satellite if Option 1 in issue 1.2.1-1 is agreed.
		- DL timing drift due to relative movement between UE and serving satellite if Option 2 in issue 1.2.1-1 is agreed.
	+ NTN UE gradual timing adjustment requirements should be differently defined from the legacy ones, and the following aspects should be taken into consideration. (QC)
		- 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.
* Recommended WF
	+ Further discuss whether to introduce new UE gradual timing adjustment requirements in NR NTN.

**Issue 1.2.2-5: One shot timing adjustment requirement**

* Option 1: (Xiaomi)
	+ In LEO scenario, RAN4 is to introduce one shot timing adjustment rule to compensate the DL timing drift according to each estimated reference DL timing, and the maximum amount of the magnitude of the timing adjustment can be 18\*64 Tc.
* Recommended WF
	+ Companies are encouraged to provide the views on one shot timing adjustment.

### TA adjustment accuracy requirements

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

* TA adjustment accuracy requirement
	+ Timing Advance adjustment accuracy requirement depends on the mechanism of TA adjustment step size determined by RAN1 and the total uncertainty budget.
	+ FFS: Timing Advance adjustment accuracy scales inversely proportional to SCS
	+ FFS: whether UE specific TA estimation accuracy has impact on timing advance adjustment accuracy requirements.

**Issue 1.2.3-1: TA adjustment accuracy requirement in RRC\_IDLE mode**

* Option 1: (Xiaomi)
	+ In RRC\_IDLE state, RAN4 is to introduce TA adjustment accuracy due to UE specific TA estimation error for initial PRACH transmission or msgA transmission.
* Recommended WF
	+ Companies are encouraged to provide the views on TA adjustment accuracy requirement in RRC\_IDLE mode.

**Issue 1.2.3-2: TA adjustment accuracy requirement in RRC\_CONNECTED mode**

* Option 1: (CMCC)
	+ Reuse the existing timing advance adjustment accuracy requirements defined in TS 38.133.
* Option 2: (Xiaomi)
	+ In RRC\_CONNECTED, the TA adjustment accuracy requirement is consist of the following factors:
		- UE specific TA calculation accuracy
		- Common TA estimation accuracy
		- Received TA command adjustment accuracy.
* Option 3: (Ericsson)
	+ Final Timing Advance adjustment accuracy depends on the mechanism chosen in RAN1 specification and the final total uncertainty budget. However, Timing Advance adjustment accuracy should scale inversely proportional to SCS (and in current specification it is ±1/4 TA-step (at SCS = 15 kHz)).
		- final analysis of Timing Advance adjustment accuracy has to consider the total error budget for regulating TA during a call: ΔUE-pos, ΔSat-pos, Timing Advance adjustment accuracy and TA command resolution error
* Option 4: (Huawei)
	+ If Option 1 in issue 1.2.1-1 is agreed, reuse the existing TA adjustment accuracy requirements with considering of UL timing quantization accuracy.
	+ If Option 2 in issue 1.2.1-1 is agreed,
		- Define new TA adjustment accuracy requirements with considering of both UL timing quantization accuracy and UE specific TA estimation accuracy.
		- Introduce UE autonomous TA adjustment requirements, including adjustment step and adjustment rate.
* Option 5: (QC)
	+ RAN4 to discuss whether a propagation delay change from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission needs to be estimated and reflected into the transmission timing adjustment. If supported, NTN UE timing advance adjustment accuracy requirements should be relaxed to account for UE position and satellite position estimation error.
		- FFS on if 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.

### 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 1.2.4-1: What are the NTN UL time synchronization requirements?**

* Option 1: (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.
	+ UL transmissions in RRC\_CONNECTED state
		- Initial transmit timing error requirement (Te), which is specified in TS38.133 Table 7.1.2-1.
		- Timing adjustment
			* One shot timing adjustment
				+ One shot timing adjustment is to compensate the DL timing drift according to each estimated reference DL timing, and the maximum amount of the magnitude of the timing adjustment can be 18\*64 Tc.
			* Gradual timing adjustment
				+ 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:
			* UE specific TA calculation accuracy
			* Common TA estimation accuracy
			* Received TA command adjustment accuracy
* Option 2: (Ericsson)
	+ For initial access (i.e. PRACH transmission): We can conclude that RAN4 has decided that existing Te requirements defined in TS 38.133, Table 7.1.2-1, will be used as baseline for R17 NR NTN and that RAN4 is to further investigate whether other aspects have impact on the Te requirements for R17 NR NTN.
	+ 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. Existing requirement for UE Timing Advance adjustment accuracy in TS 38.133 7.3.2.2 roughly scales inversely proportional to SCS. It is FFS if Timing Advance adjustment accuracy scales inversely proportional to SCS in NTN.
		- Finally, RAN has decided to define UE specific TA estimation accuracy requirement, but no details are available at this point.
* Option 3: (CATT)
	+ The UE transmit timing error would be current requirements Te plus 2\*∆Pos/c. ∆Pos is the Positioning accuracy which is the error between the estimated position and the true position. It is based on UE A-GNSS capability. And c is light velocity.
* Option 4: (THALES)
	+ For PRACH transmission, the NR NTN UE shall be able to acquire its self-estimated TA with an accuracy better than ± ,  depending on the PRACH format and configuration.
	+ In connected mode, the NR NTN UE shall be able to update its self-estimated TA with an accuracy better than ±  depending on the numerology in use.
* Recommended WF
	+ Pending on the conclusion on sub-topic 1.2.1, 1.2.2 and 1.2.3.

## Companies views’ collection for 1st round

### Open issues

**Issue 1.2.1-1: How to capture the UE specific TA estimation error**

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| **Company** | **Comments** |
| MTK | Option 1. It needs to keep the total TA uncertainty similar to existing terrestrial specification. Option 4 is also fine to keep the total TA uncertainty similar to existing terrestrial specification, in order to preserve CP to combat ISI and maintain UL capacity. Option 3 is less preferred, because UE specific TA is UE self-estimated, which cannot be tested alone. |
| Intel | Support option3. It is not contradicting between option 3 and 1 BTW.The reason to have a separate requirement defined for UE specific TA estimation performance is that this is the best thing we need to test and verify functionally for this feature. Further it is not preferred if only Te is defined since there is no sense to have only a fake test (location info is provided to the UE by TE) which only verifies the same behaviour as the legacy ones but not including the specific TA estimation performance of the UE. As also noted in our paper, another reason that option 1(only) does not work well is that the Te requirements only apply to the first transmission but for other UL transmissions there is no requirement if there is no TA update from the MAC CE. However in NTN, the UE needs to update its TA estimation every certain periodicity due to satellite-UE relative mobility. |
| Xiaomi | Support option 2, as this error is derived from the TA update procedure, thus, it is more reasonable to compensate this error in the TA adjustment accuracy requirement. In addition, according to the 2-D position error defined in 38.171, the estimated TA error can be up to 0.33us = 10Ts. If the TA estimation error is considered in Te, then the ratio between Te and CP length will be larger than 50% for larger SCS case.  |
| CMCC | Generally, we are both OK with Option1 and Option3. Our considerations are as below.For Option1, if the UE specific TA estimation accuracy is counted into the UE transmit timing error requirements, then the application scenario of UE transmit timing error requirements should be updated. Besides, the Te value should be further investigated based on GNSS and PVT accuracy.For Option2, we think the UE specific TA estimation error will cause timing error of UE, instead of timing advance adjustment error. They are different conceptions.For Option3, we prefer this Option at first because it is straightforward to define the UE specific TA estimation performance. However, we also observe that there may have some difficulties to design a test case for this requirement, since the UE specific TA estimation error and Te can not be tested separately. |

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| Huawei | We prefer option 1, but option 2 and option 3 are also acceptable for us. |

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| Ericsson | Our position how to define the timing requirements. is close to Option 3, but we are not against deriving requirements in other ways, as long as we get an acceptable total budget. |

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| Qualcomm | Option 1. |

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| Apple | Option 1. As mentioned by MTK, option 3 is not testable. |
| Nokia | Option 1. |
| THALES | Option 3. Please see R4-2107277. |
| ZTE | Option 1.  |
| NEC | We support option 1 similar to TN. Actual Te may be different from TN.  |
| CATT | Option 1. |

**Issue 1.2.1-2: If option 3 in issue 1.2.1-1 is agreed, how to specify the UE specific TA estimation error**

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| **Company** | **Comments** |
| MTK | More discussion would be needed. The delay spread depends on scenarios, so it may need to dis which scenario should be used for the requirement.  |
| Intel | Option 1 can be a baseline for discussion. Mature requirements depend on further discussion.We proposed that UE behaviour to apply the UE specific TA estimation is also part of the RRM requirements defined for this feature. |
| Xiaomi | Support the recommended WF |
| Ericsson | Option 1 with (CP-delay\_spread)/2 allocates the all what is left of CP after dispersive channel to UE specific TA estimation error. There could be errors in N\_TA\_common and N\_TA to consider to get total T\_TA error under control. Regarding WF, final requirement depends on RAN1 procedure for TA. |
| Apple | Agree with the recommended WF |
| THALES | Option 1. Please see R4-2107277. |
| ZTE | Agree with the recommended WF. Wait for the conclusion of issue 1.2.1-1. |

**Issue 1.2.1-3: the update periodicity of UE specific TA value**

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| **Company** | **Comments** |
| MTK | No need to specify the periodicity to update the UE specific TA, sine UE specific TA is self-estimated, thus update per UL transmission is sufficient.And the time UE to update the timing is a UE implementation issue. In R15, no specific timing that UE should update its timing.  |
| Intel | UE behaviour for applying the estimated TA should be specified together with the error requirement. |
| Xiaomi | No need to specify the update periodicity of UE specific TA, as the requirement of UE specific TA estimation error will be introduced to guarantee the performance of UE specific TA update, and the update periodicity is up to UE implementation. |
| CMCC | Basically, we think when and how to update the UE specific TA value is up to UE implementation, but we also open to study the network configured update methodology. Besides, Intel mentioned about UE behavior for applying the estimated TA, we think it is up to UE implementation. |
| Huawei | The UE specific TA is calculated based on serving satellite and UE position estimations. The update periodicity of UE specific TA value requires the frequency at which UE perform once position estimation.If option 1 in issue 1.2.1-1 is used, we suggest that the update periodicity of UE specific TA is aligned with the UE autonomous timing adjustment rate. |
| Ericsson | Final requirement depends on RAN1 procedure for TA. |
| Qualcomm | Do not think a separate discussion for this is necessary in RAN4 yet. |
| Apple | Leave it to UE implementation and no need to specify it. |
| Nokia | The update periodicity of UE specific TA values is coupled to the periodicity of location estimation.  |
| THALES | There are currently 2 cases that have to be considered, and have to be separated:1. UE autonomous estimation for of TA for initial access and connected mode should preserve/accommodate the CP limit and therefore:
	1. Specific-UE requirements are required (**UE specific TA estimation accuracy is defined as a separate accuracy requirement)**
2. When UE applies the TA for in the first transmission in a DRX cycle for PUCCH, PUSCH and SRS or it is the PRACH transmission. Therefore:
	1. For the first transmission: **the UE specific TA estimation accuracy is counted into the UE transmit timing error requirement**;
	2. For connected mode: **the UE specific TA estimation accuracy is counted into the timing advance adjustment accuracy requirement**

Once the TA is autonomous estimated by the UE, the UE will follow current (existent) procedures for TA.**See proposal 4 from R4-2107277:** The UE self-estimated TA accuracy requirement shall be defined as a separate accuracy requirement. **No need to specify the periodicity.** |
| ZTE | The UE specific TA value should be updated to meet corresponding timing requirements. How to update the UE specific TA value is based on the UE’s behaviour of the acquirement of GNSS and satellite ephemeris information. Suggest to define the periodically reception behaviour for information required for synchronization firstly. |
| NEC | May be early to discuss this. Can come back after framework is finalized in RAN1 (if needed). |
| CATT | No need to define the periodicity. It’s UE’s behavior. |

**Issue 1.2.2-1: Initial transmit timing error (Te)**

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| **Company** | **Comments** |
| MTK | Option 1. One comment on the recommended WF: If option 1 in issue 1.2.1-1 is agreed, it needs more discussion on whether to relax the Te requirements. |
| Intel | Pending prerequisite discussion. |
| Xiaomi | Pending the conclusion of issue 1.2.1-1, if option 1 in issue 1.2.1-1 is agreed, RAN4 needs to discuss whether the Te can be relaxed and how much room Te can be relaxed. If option 2 or option 3 in issue 1.2.1-1 is agreed, reuse the existing Te requirements defined in TS 38.133 Table 7.1.2-1 |
| CMCC | We support Option1a First of all, this issue is depended on the conclusion of issue 1.2.1-1. We can come back to this issue after issue 1.2.1-1 have conclusion.If Option 1 in issue 1.2.1-1 is agreed, then as stated in Option1, Te requirements should cover the UE-self estimation error; and the Te value should be further investigated. Besides, we are also open to the methodology in Option2 and Option2a. |
| Huawei | Agree on the recommended WF.Relaxed Te requirements for option 1 in issue 1.2.1-1, and reuse existing Te requirements for option 2 or 3 in issue 1.2.1-1. |
| Ericsson | Option 1, WF Pending prerequisite discussion. |
| Qualcomm | Option 2a and agree with the recommended WF. For the exact value for the relaxation, we can further discuss. |
| Apple | Agree with the recommended WF. |
| Nokia | The recommended WF is OK. |
| THALES | **Option 1.**RAN4 should consider the NTN UE transmit timing error requirements to be the same as the ones already specified for TN UEs.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. |
| ZTE | Agree with the recommended WF , but whether to relax Te requirement needs more discussion. |
| NEC | May need some relaxation based on other issues conclusion. Exact value of relaxation can be discussed later |
| CATT | Support Option 2. For NTN, additional positioning accuracy needs to be considered. |

**Issue 1.2.2-2: Whether the timing compensation accuracy has impact on Te?**

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| **Company** | **Comments** |
| MTK | Option 2, because based on the simulation result, the impact because of UE timing compensation error is marginal. (0.012 = 3% error budget of Te of 0.39 us in FR1.) |
| Xiaomi | Option 2, from our understanding, the timing compensation accuracy, i.e. UE specific TA estimation error, has been considered in other on-going discussion issues. |
| CMCC | First of all, this issue is depended on the conclusion of issue 1.2.1-1. We can come back to this issue after issue 1.2.1-1 have conclusion.If Option 1 in issue 1.2.1-1 is agreed, we share similar views with CATT. |
| Huawei | It depend on how to capture the UE specific TA estimation accuracy requirements. |
| Ericsson | Option 3. RAN4 to investigate how final TA control (open, closed) affect Te once final mechanism is chosen by RAN1. The WF is fine. |
| Qualcomm | Similar view as CMCC. |
| Apple | Agree with CMCC and QC. |
| Nokia | Options 1 and 3 but can focus on the impact on Te due to the timing compensation accuracy as recommended by the WF. |
| THALES | Not clear if for PRACH transmission, connected mode, if timing compensation with respect to self- estimation of TA or after.In any case, Te should be different with respect to the numerology in use.In connected mode, the maximum allowed error of the round trip propagation delay estimation should be less than the duration of the cyclic prefix. Therefore, the updated TA should accommodate the following requirement: , and depending on the numerology in use. |
| ZTE | Agree with CMCC that this is depended on the conclusion of issue 1.2.1-1.  |
| NEC | Our understanding is option 1 and 3.  |
| CATT | As mentioned in our proposal by NTA-UE\_precompensation accuracy. Yes. |

**Issue 1.2.2-3: value in NTN?**

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| **Company** | **Comments** |
| MTK | Agree with the Recommended WF. |
| Intel | Option 1. Configurable with existing values. |
| Xiaomi | Agree with the Recommended WF. |
| CMCC | We prefer Option1 since TDD may be used for HAPS. |
| Huawei | Agree on the recommended WF. |
| Ericsson | Option 1, Recommended WF is fine. |
| Qualcomm | Agree with the recommended WF |
| Apple | Agree with the recommended WF |
| Nokia | The recommended WF is OK. |
| THALES | Agree with Option 1 and recommended WF. See RAN1 decision:**The Timing Advance applied by an NR NTN UE in RRC\_IDLE/INACTIVE and RRC\_CONNECTED is given by:****When common TA is indicated by the Network:****Where:**   **and are defined as in Release-16.**  **is UE self-estimated TA**    **is network-controlled common TA, and may include any timing offset considered necessary by the network.**   **FFS:  Signaling and the granularity of**    **FFS: When common TA is not indicated**-        **Note-1: Definition of is different from that in  agreement.**-        **Note-4: is the common timing offset as agreed in RAN1 #103-e**  |
| ZTE | Agree on the recommended WF. |
| NEC | We are OK with recommended WF |
| CATT | Agree on the recommended WF |

**Issue 1.2.2-4: Gradual timing adjustment requirement**

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| **Company** | **Comments** |
| MTK | Agree with the recommended WF, more discussion is needed. It needs to discuss how to capture the delay variation (drift). In our view, it would need a requirement or it can be captured as a part of Te requirement.Not ready to agree on Option 2 at this moment. This delay variation (drift) can be expected and pre-compensated. It is not a sudden change as assumed in the legacy gradual timing adjustment requirements. In other words, UE could adjust the timing of 246 \* 64 Tc for pre-compensation but would not be able to adjust 246 \* 64 Tc for a sudden timing change. |
| Intel | Since that the UE needs to update its specific TA estimation there has to be a requirement for gradual adjustment for following updated TA. |
| Xiaomi | Whether the introduce the new gradual timing adjustment requirement depends on the scenario, in GEO scenarios, the delay variation is not an issue, thus, we think the existing gradual timing adjustment requirement can be reused. For LEO scenarios, we are fine to introduce the new gradual timing adjustment requirement by considering the delay variation. |
| CMCC | We support Option2. The existing gradual timing adjustment rule can be reused, while the value of Tp, Tq, and adjustment period should be investigated. For first bullet in Option1, we have same proposal with XiaoMi’s in last meeting, we also agree with it, while whether the timing adjustment rules should be divided to LEO scenario and GEO scenario should be discussed by companies.For second bullet in Option1, we think it is similar with Option2. The difference is the specific values of Tp, Tq and adjustment period. |
| Huawei | The existing gradual timing adjustment requirements are defined based on the assumption that the TA is not changed. Then, UE adjusts UL timing due to DL timing drifting. However, since UE specific TA estimation is introduced for NTN network, RAN4 shall study whether the assumption of unchanged TA is still applicable for gradual timing adjustment requirements. If not, RAN4 need to study whether the UE still perform gradual UL timing adjustment due to UE specific TA change or perform one-shot UL timing adjustment due to UE specific TA change.Since the UE specific TA change is continuous in time and the change rate depends on the relative speed between serving satellite and UE. We suggest to define gradual UL timing adjustment requirements for UE specific TA change. Whether to define the combined UL timing adjustment requirements in considering of both DL timing drift and UE specific TA change depends on which option in issue 1.2.1-1 is used.No matter which option is used, new gradual timing adjustment requirements need to be defined for NTN networks. |
| Ericsson | Option 2.  |
| Qualcomm | Option 2. And the second bullet of Option 1 (from CATT) should be also grouped into Option 2. |
| Apple | Agree with the recommended WF, in general the option 2 is fine without the detailed bullets. |
| Nokia | Option 2. |
| THALES | More discussion is required. |
| ZTE | Need more investigation to see if the current gradual timing adjustment requirements should be revised. |
| CATT | Actually, our proposal is not using legacy requirement directly. As calculated in our discussion paper, the current Tq and Tp can be reused. But the maximum aggregate adjustment rate can be changed to Tq per 20ms. Maximum aggregate adjustment rate is changed. So Please include our proposals in Option 2 also. |

**Issue 1.2.2-5: One shot timing adjustment requirement**

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| **Company** | **Comments** |
| MTK | It depends on the previous discussion about how to capture the UE specific TA estimation accuracy.In our view, the one shot timing adjustment is for the expected timing change, e.g. UE RX beam switch. However, the UE specific TA estimation error is the residual error after *expected* pre-compensation, so it is not one shot timing adjustment in our view. |
| Intel | We see no clear benefit. |
| Xiaomi | Our intention to introduce one shot timing adjustment requirement is to avoid relaxing the Te requirement too much, as there is may not have much room to relax the current Te requirement. In order to maintain the UL timing, the one shot timing adjustment can be introduced to compensate the estimated TA error before each UL transmission. |
| CMCC | In our point of view, it is hard to define separate test cases for “existing gradual timing adjustment requirement” and “the one shot timing adjustment requirement”. |
| Huawei | Same comments as issue 1.2.2-4. |
| Ericsson | RAN1 are working on mechanism candidates. Some have drift factors. |
| Qualcomm | Share a similar understanding as Huawei. |
| Apple | The UE specific TA compensation is also a gradual procedure in our view and one step TA adjustment may not be needed |
| Nokia | The open issue is reasonable, which needs further discussions.  |
| THALES | We should focus on essential aspects for Rel-17. |
| CATT | Not clear for the motivation. Open to discuss. |

**Issue 1.2.3-1: TA adjustment accuracy requirement in RRC\_IDLE mode**

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| **Company** | **Comments** |
| MTK | Pending on the 1.2.1-1. If option 1 in issue 1.2.1-1 is agreed, it seems no need to introduce the separate TA adjustment accuracy requirement in RRC\_IDLE mode. |
| Xiaomi | Pending on the 1.2.1-1. If option 2 in issue 1.2.1-1 is agreed, RAN4 needs to introduce the separate TA adjustment accuracy requirement in RRC\_IDLE mode. |
| CMCC | This issue is depended on the conclusion of issue 1.2.1-1. We can come back to this after issue 1.2.1-1 reaching a conclusion. |
| Huawei | It depend on which option will be used to capture the UE specific TA estimation accuracy.If option 1 is used, then the TA adjustment accuracy for UE specific TA estimation will be counted into initial transmit timing error. If option 2 or 3 is used, TA adjustment accuracy requirements shall be the same for idle mode (PRACH transmission) and connected mode (PUCCH/PUSCH/SRS transmission). |
| Qualcomm | It is a bit unclear what TA adjustment in RRC Idle mode means. In our understanding, TA adjustment requirements apply when UE receives TA command. |
| Apple | Up to the conclusions of issue 1.2.1-1. |
| THALES | Up to the conclusions from 1.2.1-1. |
| NEC | Depends on conclusion of other issues. |
| CATT | No need for idle mode. |

**Issue 1.2.3-2: TA adjustment accuracy requirement in RRC\_CONNECTED mode**

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| **Company** | **Comments** |
| MTK | More discussion is needed. It needs to discuss whether to capture the delay drift, e.g. in Te Gradual timing adjustment, or in TA adjustment accuracy requirement. |
| Xiaomi | Pending on the 1.2.1-1, if option 2 in issue 1.2.1-1 is agreed, the UE specific TA estimation error should be considered in TA adjustment accuracy requirement. Otherwise, the existing TA adjustment accuracy requirements can be reused. |
| CMCC | We support take Option1 as the baseline, and further study the impact due to propagation delay change as stated in Option5. We add a new proposal here:Take the existing timing advance adjustment accuracy requirements defined in TS 38.133 as the baseline, and further discuss whether a propagation delay change from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission needs to be estimated and reflected into the transmission timing adjustment |
| Huawei | Same comments as issue 1.2.2.3-1 |
| Ericsson | Option 4. |
| Qualcomm | RAN4 should first discuss whether a propagation delay change from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission needs to be estimated and reflected into the transmission timing adjustment. Depending on the conclusion, what we should discuss further can be different. |
| Apple | Option 4. TA adjustment accuracy in legacy requirement is a relative adjustment error compared with the signalled TA command regardless of any DL estimation error. |
| Nokia | Option 4 is reasonable.  |
| THALES | Since we need to separate between self-TA estimation error and (other) estimation error, Option 2 seems reasonable.Please also see R4-2107277. 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. The UE self-estimated TA accuracy requirement shall be defined as a separate accuracy requirement. In connected mode, the NR NTN UE shall be able to update its self-estimated TA with an accuracy better than ±  depending on the numerology in use. |
| NEC | Depends on other issues conclusion |

**Issue 1.2.4-1: What are the NTN UL time synchronization requirements?**

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| **Company** | **Comments** |
| MTK | Pending on the conclusion on sub-topic 1.2.1, 1.2.2 and 1.2.3. |
| Intel | Mature requirements need further discussion. Let’s reply to RAN1 meeting by meeting. Intel volunteers to take the drafting if needed. |
| Xiaomi | Pending on the conclusion on sub-topic 1.2.1, 1.2.2 and 1.2.3. |
| CMCC | Support the recommended WF. |
| Huawei | It depends on which option will be used to capture the UE specific TA estimation accuracy. |
| Ericsson | Option2. |
| Qualcomm | Pending on the conclusion on other sub-topics. |
| Apple | Agree with the recommended WF. |
| Nokia | The recommended WF is OK. |
| THALES | It is clear that RAN4 should consider the NTN UE transmit timing error requirements to be the same as the ones already specified for TN UEs. However, for current TN we do not have same issues as for (UE) GNSS-based synchronization. We therefore need to take into account UE self-estimation (which is a stage prior to existent mechanisms), and this has to be defined as separate accuracy requirement.Therefore, propose **Option 4:**For PRACH transmission, the NR NTN UE shall be able to acquire its self-estimated TA with an accuracy better than ± ,  depending on the PRACH format and configuration.In connected mode, the NR NTN UE shall be able to update its self-estimated TA with an accuracy better than ±  depending on the numerology in use. |
| ZTE | Agree with the recommended WF. |
| NEC | Agree with the recommended WF |
| CATT | Support Option 3. Compare to TN system, the UE transmit timing error can be affected by the positioning accuracy based on UE A-GNSS capability in addition. Agree WF that it depends on the outcomes of other open issues. |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
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## 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.*

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

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|  | **Status summary**  |
| **Issue 1.2.1-1:****How to capture the UE specific TA estimation error** | ***First round discussion status:***13 companies provide the comments.11 companies supports the UE specific TA estimation error is captured in Te requirement.3 companies support the UE specific TA estimation error is captured in TA adjustment accuracy requirement.5 companies support the UE specific TA estimation error is captured as a separate requirement.* Option 1: the UE specific TA estimation accuracy is counted into the UE transmit timing error requirement (MTK, Xiaomi, CMCC, Huawei, Ericsson, Qualcomm, Apple, Nokia, ZTE, NEC, CATT)
* Option 2: the UE specific TA estimation accuracy is counted into the timing advance adjustment accuracy requirement. (Xiaomi, Huawei, Ericsson)
* Option 3: the UE specific TA estimation accuracy is defined as a separate accuracy requirement. (Intel, CMCC, Huawei, Ericsson, THALES)

***Candidate options: (****narrow down to option 1 and 3 based on majority views)** Option 1: the UE specific TA estimation accuracy is counted into the UE transmit timing error requirement (MTK, Xiaomi, CMCC, Huawei, Ericsson, Qualcomm, Apple, Nokia, ZTE, NEC, CATT)
* Option 3: the UE specific TA estimation accuracy is defined as a separate accuracy requirement. (Intel, CMCC, Huawei, Ericsson, THALES)

***Recommendations for 2nd round:***Continue the discussion in 2nd round, and the conclusion will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.1-2:** **If option 3 in issue 1.2.1-1 is agreed, how to specify the UE specific TA estimation error** | ***First round discussion status:***7 companies provide the comments.3 companies support the recommended WF which pending on the conclusion of issue 1.2.1-1.2 companies support option 1 can be as the baseline for discussion.1 company suggest more discussion is needed.1 company think the final requirement depends on RAN1 procedure for TA***Candidate options:**** Option 1: (Intel, THALES)
	+ For PRACH transmission, the NR NTN UE shall be able to acquire its self-estimated TA with an accuracy better than ± min((CP-Delay\_spread)/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2 ) [s], depending on the PRACH format and configuration.
	+ In connected mode, the NR NTN UE shall be able to update its self-estimated TA with an accuracy better than ±(CP-Delay\_spread)/2 depending on the numerology in use.
* Option 2: Pending on the conclusion of issue 1.2.1-1. It is propose to define the exact UE specific TA estimation error in next meeting if option 3 in issue 1.2.1-1 is agreed. (Xiaomi, Apple, ZTE)
* Option 3: Need more discussion and depends on RAN1 procedure for TA. (MTK, Ericsson)

***Recommendations for 2nd round:***Continue the discussion in 2nd round, and the conclusion will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.1-3:** **The update periodicity of UE specific TA value** | ***First round discussion status:***13 companies provide the comments.6 companies support not to specify the update periodicity and up to UE implementation.4 companies support to specify the update periodicity.1 company suggest not to have this discussion in RAN4.2 company think the final requirement depends on RAN1 procedure for TA***Candidate options:*** (Provide the following options according to the majority views from companies)* Option 1: Not specify the update periodicity requirement for UE specific TA estimation and leave it to UE implementation. (MTK, Xiaomi, CMCC, Apple, Nokia, THALES)
* Option 2: Specify the update periodicity requirement for UE specific TA estimation. (Intel, Huawei, ZTE, CATT)

***Recommendations for 2nd round:***Continue the discussion in 2nd round, and the conclusion will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.2-1: Initial transmit timing error (Te)** | ***First round discussion status:***13 companies provide the comments.10 companies suggest this issue pending on conclusion of issue 1.2.1-1.3 companies support option 1 which the existing Te requirements defined in TS 38.133 Table 7.1.2-1 can be reused in R17 NR NTN.1 company support option 2.***Candidate options:**** Option 1: If option 1 in issue 1.2.1-1 is agreed, define the relaxed Te requirements.
* Option 2: If option 3 in issue 1.2.1-1 is agreed, reuse the existing Te requirements defined in TS 38.133 Table 7.1.2-1.

***Recommendations for 2nd round:***Continue the discussion in 2nd round, and the conclusion will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.2-2:** **Whether the timing compensation accuracy has impact on Te?** | ***First round discussion status:***11 companies provide the comments.6 companies suggest this issue pending on conclusion of issue 1.2.1-1.2 company support option1, 2 companies support option2, and 3 companies support option 3* Option 1: Yes (NEC, CATT)
	+ RAN4 to agree that NTN timing compensation accuracy has impact on Te timing error requirements for both CONNECTED mode and IDLE mode. (Nokia)
	+ (CATT)
		- The UE transmit timing requirement, Te, will not be impacted by parameters of NTA-Common , NTA , and NTA\_offset signaled to UE.
		- The UE transmit timing requirement, Te, will be impacted by NTA-UE\_pre-compensation accuracy. The UE self-estimating error of NTA-UE\_pre-compensation should be counted into UE transmit timing error.
* Option 2: No
* Option 3: (Nokia)
	+ RAN4 to investigate how open and closed loop TA control impact on the Te requirements

***Candidate options:**** Option 1: Yes.
* Option 2: No.
* Option 3: RAN4 to investigate how open and closed loop TA control impact on the Te requirements

***Recommendations for 2nd round:***Continue the discussion in general during the 2nd round, and the conclusion will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.2-3: value in NTN?** | ***First round discussion status:***13 companies provide the comments. All the companies support option 1 and the recommended WF.* The existing N\_TA offset value defined in Table 7.1.2-2 in TS38.133 can be reused in NTN.

***Candidate options:******Recommendations for 2nd round:***No need to have the discussion in 2nd round, and the agreement will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.2-4: Gradual timing adjustment requirement** | ***First round discussion status:***12 companies provide the comments.9 companies support new gradual timing adjustment requirement should be defined for NTN.3 company support to have more discussion.***Candidate options:**** Option 1: Define new gradual timing adjustment requirement for NTN. (Intel, Xiaomi, CMCC, Huawei, Ericsson, Qualcomm, Apple, Nokia, CATT)
* Option 2: Need more discussion. (MTK, THALES, ZTE)

***Recommendations for 2nd round:***Continue the discussion in 2nd round, and the conclusion will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.2-5: One shot timing adjustment requirement**  | ***First round discussion status:***10 companies provide the comments.6 companies support not to introduce one-shot timing adjustment requirement.1 company support to introduce one-shot timing adjustment requirement.2 company support to have more discussion1 company think RAN1 is working on this.1 company think should focus on essential work in Rel-17***Candidate options:**** Option 1: Introduce one shot timing adjustment rule for NTN.
* Option 2: Not introduce one shot timing adjustment rule for NTN.
* Option 3: Need more discussion.

***Recommendations for 2nd round:***Continue the discussion in 2nd round, and the conclusion will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.3-1:** **TA adjustment accuracy requirement in RRC\_IDLE mode**  | ***First round discussion status:***9 companies provide the comments.8 companies suggest this issue depends on issue 1.2.1-1. 1 company support not to define in idle mode.***Candidate options:******Recommendations for 2nd round:***Continue the discussion in 2nd round if RAN4 has conclusion on issue 1.2.1-1, and the conclusion will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.3-2:** **TA adjustment accuracy requirement in RRC\_CONNECTED mode**  | ***First round discussion status:**** Option 1: (CMCC)
	+ Reuse the existing timing advance adjustment accuracy requirements defined in TS 38.133.
* Option 2: (Xiaomi, THALES)
	+ In RRC\_CONNECTED, the TA adjustment accuracy requirement is consist of the following factors:
		- UE specific TA calculation accuracy
		- Common TA estimation accuracy
		- Received TA command adjustment accuracy.
* Option 3: (Ericsson)
	+ Final Timing Advance adjustment accuracy depends on the mechanism chosen in RAN1 specification and the final total uncertainty budget. However, Timing Advance adjustment accuracy should scale inversely proportional to SCS (and in current specification it is ±1/4 TA-step (at SCS = 15 kHz)).
		- final analysis of Timing Advance adjustment accuracy has to consider the total error budget for regulating TA during a call: ΔUE-pos, ΔSat-pos, Timing Advance adjustment accuracy and TA command resolution error
* Option 4: (Huawei, Ericsson, Apple, Xiaomi, Nokia)
	+ If Option 1 in issue 1.2.1-1 is agreed, reuse the existing TA adjustment accuracy requirements with considering of UL timing quantization accuracy.
	+ If Option 2 in issue 1.2.1-1 is agreed,
		- Define new TA adjustment accuracy requirements with considering of both UL timing quantization accuracy and UE specific TA estimation accuracy.
		- Introduce UE autonomous TA adjustment requirements, including adjustment step and adjustment rate.
* Option 5: (QC)
	+ RAN4 to discuss whether a propagation delay change from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission needs to be estimated and reflected into the transmission timing adjustment. If supported, NTN UE timing advance adjustment accuracy requirements should be relaxed to account for UE position and satellite position estimation error.
		- FFS on if the accuracy requirement relaxation shall be the same as that for initial timing error requirement.
* Option 6: (CMCC)
	+ Take the existing timing advance adjustment accuracy requirements defined in TS 38.133 as the baseline, and further discuss whether a propagation delay change from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission needs to be estimated and reflected into the transmission timing adjustment

***Candidate options:******Recommendations for 2nd round:***Continue the discussion in 2nd round if RAN4 has conclusion on issue 1.2.1-1, and the conclusion will be captured in the WF. |

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|  | **Status summary**  |
| **Issue 1.2.4-1: What are the NTN UL time synchronization requirements?** | ***First round discussion status:***13 companies provide the comments.10 companies support it depends on the conclusions on sub-topic 1.2.1, 1.2.2 and 1.2.3.The reply LS depends on the conclusions on sub-topic 1.2.1, 1.2.2 and 1.2.3. As the moderator, it is suggest to continue the discussion on sub-topic 1.2.1, 1.2.2 and 1.2.3. And RAN4 continue to discuss the reply LS in RAN4#99e meeting.***Candidate options:******Recommendations for 2nd round:***Continue the discussion on sub-topic 1.2.1, 1.2.2 and 1.2.3. And RAN4 continue to discuss the reply LS in RAN4#99e meeting. |

### 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.*

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| **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)

**Issue 1.2.1-1: How to capture the UE specific TA estimation error**

* Option 1: the UE specific TA estimation accuracy is counted into the UE transmit timing error requirement (MTK, Xiaomi, CMCC, Huawei, Ericsson, Qualcomm, Apple, Nokia, ZTE, NEC, CATT)
* Option 3: the UE specific TA estimation accuracy is defined as a separate accuracy requirement. (Intel, CMCC, Huawei, Ericsson, THALES)

Agreements on GTW session:

* + - 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
* ***Recommendations for 2nd round:***
* Continue the discussion based on the agreements in GTW session.

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| **Company** | **Comments** |
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**Issue 1.2.1-2: If option 3 in issue 1.2.1-1 is agreed, how to specify the UE specific TA estimation error**

* Option 1: (Intel, THALES)
	+ For PRACH transmission, the NR NTN UE shall be able to acquire its self-estimated TA with an accuracy better than ± min((CP-Delay\_spread)/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2 ) [s], depending on the PRACH format and configuration.
	+ In connected mode, the NR NTN UE shall be able to update its self-estimated TA with an accuracy better than ±(CP-Delay\_spread)/2 depending on the numerology in use.
* Option 2: Pending on the conclusion of issue 1.2.1-1. It is propose to define the exact UE specific TA estimation error in next meeting if option 3 in issue 1.2.1-1 is agreed. (Xiaomi, Apple, ZTE)
* Option 3: Need more discussion and depends on RAN1 procedure for TA. (MTK, Ericsson)
* ***Recommendations for 2nd round:***
* Continue the discussion in 2nd round, and the conclusion will be captured in the WF.

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| **Company** | **Comments** |
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**Issue 1.2.1-3: The update periodicity of UE specific TA value**

* Option 1: Not specify the update periodicity for UE specific TA estimation and leave it to UE implementation. (MTK, Xiaomi, CMCC, Apple, Nokia, THALES)
* Option 2: Specify the update periodicity for UE specific TA estimation. (Intel, Huawei, ZTE, CATT)
* ***Recommendations for 2nd round:***
* Continue the discussion in 2nd round, and the conclusion will be captured in the WF.

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| **Company** | **Comments** |
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**Issue 1.2.2-1: Initial transmit timing error (Te) for NTN**

* Option 1: Define the relaxed Te requirements.
* Option 2: Reuse the existing Te requirements defined in TS 38.133 Table 7.1.2-1.
* ***Recommendations for 2nd round:***
* Continue the discussion in 2nd round, and the conclusion will be captured in the WF.

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| **Company** | **Comments** |
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**Issue 1.2.2-2: Whether the timing compensation accuracy has impact on Te?**

* Option 1: Yes.
* Option 2: No.
* Option 3: RAN4 to investigate how open and closed loop TA control impact on the Te requirements
* ***Recommendations for 2nd round:***
* Continue the discussion in general during the 2nd round, and the conclusion will be captured in the WF.

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| **Company** | **Comments** |
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**Issue 1.2.2-4: Gradual timing adjustment requirement for NTN**

* Option 1: Define new gradual timing adjustment requirement for NTN. (Intel, Xiaomi, CMCC, Huawei, Ericsson, Qualcomm, Apple, Nokia, CATT)
* Option 2: Need more discussion. (MTK, THALES, ZTE)
* ***Recommendations for 2nd round:***
* Continue the discussion in 2nd round, and the conclusion will be captured in the WF.

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| **Company** | **Comments** |
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**Issue 1.2.2-5: One shot timing adjustment requirement**

* Option 1: Introduce one shot timing adjustment rule for NTN. (Xiaomi)
* Option 2: Not introduce one shot timing adjustment rule for NTN. ()
* Option 3: Need more discussion. ()
* ***Recommendations for 2nd round:***
* Continue the discussion in 2nd round, and the conclusion will be captured in the WF.

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| **Company** | **Comments** |
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**Issue 1.2.3-1: TA adjustment accuracy requirement in RRC\_IDLE mode**

* Option 1: Introduce TA adjustment accuracy requirement in idle mode.
* Option 2: Not introduce TA adjustment accuracy requirement in idle mode.
* ***Recommendations for 2nd round:***
* Continue the discussion in 2nd round if RAN4 has conclusion on issue 1.2.1-1, and the conclusion will be captured in the WF.

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| **Company** | **Comments** |
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**Issue 1.2.3-2: TA adjustment accuracy requirement in RRC\_CONNECTED mode**

* Option 1: (CMCC)
	+ Reuse the existing timing advance adjustment accuracy requirements defined in TS 38.133.
* Option 2: (Xiaomi, THALES)
	+ In RRC\_CONNECTED, the TA adjustment accuracy requirement is consist of the following factors:
		- UE specific TA calculation accuracy
		- Common TA estimation accuracy
		- Received TA command adjustment accuracy.
* Option 3: (Ericsson)
	+ Final Timing Advance adjustment accuracy depends on the mechanism chosen in RAN1 specification and the final total uncertainty budget. However, Timing Advance adjustment accuracy should scale inversely proportional to SCS (and in current specification it is ±1/4 TA-step (at SCS = 15 kHz)).
		- final analysis of Timing Advance adjustment accuracy has to consider the total error budget for regulating TA during a call: ΔUE-pos, ΔSat-pos, Timing Advance adjustment accuracy and TA command resolution error
* Option 4: (Huawei, Ericsson, Apple, Xiaomi, Nokia)
	+ If Option 1 in issue 1.2.1-1 is agreed, reuse the existing TA adjustment accuracy requirements with considering of UL timing quantization accuracy.
	+ If Option 2 in issue 1.2.1-1 is agreed,
		- Define new TA adjustment accuracy requirements with considering of both UL timing quantization accuracy and UE specific TA estimation accuracy.
		- Introduce UE autonomous TA adjustment requirements, including adjustment step and adjustment rate.
* Option 5: (QC)
	+ RAN4 to discuss whether a propagation delay change from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission needs to be estimated and reflected into the transmission timing adjustment. If supported, NTN UE timing advance adjustment accuracy requirements should be relaxed to account for UE position and satellite position estimation error.
		- FFS on if the accuracy requirement relaxation shall be the same as that for initial timing error requirement.
* Option 6: (CMCC)
	+ Take the existing timing advance adjustment accuracy requirements defined in TS 38.133 as the baseline, and further discuss whether a propagation delay change from a slot when UE received timing advance command to a slot when the indicated timing advance shall be applied to uplink transmission needs to be estimated and reflected into the transmission timing adjustment
* ***Recommendations for 2nd round:***
* Continue the discussion in 2nd round if RAN4 has conclusion on issue 1.2.1-1, and the conclusion will be captured in the WF.

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| **Company** | **Comments** |
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# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on timing requirements for NR NTN | Xiaomi |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
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**Existing tdocs**

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

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| **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 |  |
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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