**3GPP TSG-RAN WG4 Meeting # 97-e R4-201XXXX**

**Electronic Meeting, 2nd Nov. – 13th Nov, 2020**

**Agenda item:** 12.8.4

**Source:** THALES

**Title:** Email discussion summary for [97e][232] NR\_NTN\_solutions\_RRM

**Document for:** Information

# Introduction

This lead summary document captures issues related to NR NTN RRM. It contains a summary of the contributions under section 12.8.4 at TSG-RAN WG4 #97e, together with identified key open issues and recommends topics/questions to be handled via email discussions. The goal of this document is also to provide recommendation on prioritization of discussion and whether any issues should be postponed.

Please also note the TSG-RAN WG4 #97e meeting agenda provided in R4-2014000 with respect to NTN topic:

*12.8 Solutions for NR to support non-terrestrial networks (NTN) [NR\_NTN\_solutions]*

*12.8.1 General and work plan [NR\_NTN\_solutions]*

*12.8.2 Use cases, deployment scenarios, and regulatory information [NR\_NTN\_solutions-Core]*

*\* Include exemplary bands discussion*

*12.8.3 Coexistence aspects [NR\_NTN\_solutions -Core]*

*12.8.3.1 Simulation assumptions [NR\_NTN\_solutions -Core]*

*12.8.3.2 UE requirements aspects [NR\_NTN\_solutions -Core]*

*12.8.3.3 BS requirements aspects [NR\_NTN\_solutions -Core]*

*12.8.4 RRM requirements [NR\_NTN\_solutions-Core]*

According to RAN4#97-e E-meeting Arrangements and Guidelines, the following schedule has been proposed in R4-2016599:

* + *Stage 1: Moderators kick off email discussion (Monday Nov. 2)*
	+ *Stage 2: Companies provide comments for the 1st round (Nov. 2 – Wednesday 6pm UTC Nov. 4)*
	+ *Stage 3: Moderators summarize the status and possible proposals, recommending what decisions can be made for 1st round. A formal t-doc will be used (Thursday 6pm UTC, Nov. 5)*
	+ *Stage 4: After receiving the summary from moderators, session chair may approve documents, make agreements or assign new CRs, WFs, LSs, etc. (no later than Monday 8am UTC, Nov. 9)*
	+ *Stage 5: Companies provide comments for 2nd round.*
		- *Draft WF/LS and revised CRs/TPs shall be shared by Wednesday 1am UTC, Nov. 11.*
		- *Commenting shall stop by Wednesday 11pm UTC, Nov. 11.*
		- *Formal tdocs of WF/LS/CRs/TPs shall be uploaded to the Inbox (except Cat A CRs) by Thursday 1am UTC, Nov. 12.*
		- *Draft moderator summary shall be shared by Thursday 9am UTC, Nov. 12, but moderators are strongly encouraged to share it earlier if possible and delegates to comment as early as possible.*
	+ *Stage 6: Moderators provide 2nd round summary with a formal tdoc by Thursday 6pm UTC, Nov. 12.*
	+ *Stage 7: Session chairs announce close of sessions (no later than 6pm UTC, Nov. 13). Final decisions will be captured in Chairman meeting report (to be shared after the meeting is closed)*

A total of 6 TDOCs have been provided for this agenda:

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| --- | --- | --- | --- | --- | --- |
| ***TDoc Number*** | ***TDoc Type*** | ***Title*** | ***Company*** | ***Status*** | ***General Purpose*** |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | *discussion* | *NTN RRM and Demodulation KPIs* | *THALES* | *available* | *Discussion* |
| [*R4-2016037*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016037.zip) | *other* | *NTN impact on RRM* | *Ericsson* | *available* | *Approval* |
| [*R4-2015730*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015730.zip) | *discussion* | *Initial discussion on NTN RRM requirements* | *Nokia, Nokia Shanghai Bell* | *available* | *Approval* |
| [*R4-2014875*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014875.zip) | *discussion* | *Discussion on RRM requirements in NTN* | *MediaTek inc.* | *available* | *Discussion* |
| [*R4-2014928*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014928.zip) | *discussion* | *Satellite Position Accuracy* | *Eutelsat S.A.* | *available* | *Decision* |
| [*R4-2014658*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014658.zip) | *discussion* | *Initial discussion on RRM impact for NR NTN system* | *Xiaomi* | *available* | *Discussion* |

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

# Topic #1: General RAN4 RRM NTN related aspects

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

General RAN4 RRM NTN related aspects discussions are required to decide on the way forward, and to provide an initial RRM list of parameters to be considered by RAN4 RRM work.

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | THALES | **Proposal 1:** RAN4 should use RAN1 framework when defining requirements for UE UL synchronization and TA mechanisms.**Proposal 4:** RAN4 should start considering a list of potential RRM and demodulation KPIs with respect to considered NTN use cases.**Proposal 5:** RRM & demodulation KPIs may include (at least):- Specific NTN requirements in terms of accuracy estimation for satellite position/velocity;- Specific NTN requirements for handover KPIs (e.g. interruption time);- Specific NTN testing configurations with NTN specific Doppler;- Specific NTN requirements in terms of timing accuracy;- Specific NTN requirements for RSRP/RSRQ measurement accuracy.**Proposal 7:** Down-scope from TS 38.133 Stand-Alone mobility states parameters related to Cell-Reselection, MDT, HO, CHO.**Proposal 8:** Down-scope from TS 38.133 Timing and Signaling Characteristics parameters.**Proposal 9:** Down-scope from TS 38.133 with respect to Measurement Procedures and Measurement Performance Requirements parameters. |
| [*R4-2016037*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016037.zip) | Ericsson | **Observation 1 :** NTN RRM requirements need to consider that NTN can operate in FR1 or FR2 ranges**Proposal 3 :** RAN4 further discusses measurements in NTN operation for both idle and connected mode once further progress is made in RAN1 and RAN2.**Proposal 4 :** RAN4 to discuss about measurements supporting TN / NTN mobility, once the Intra NTN mobility has sufficiently progressed. Intra NTN mobility refers to idle and connected mode mobility between NTN cells (e.g. intra or inter satellite).**Observation 7 :** If gNB is time and synchronization reference then we get a requirement set which is more compatible with existing release-17 baseline.**Proposal 5 :** RAN4 to investigate the impact on existing gNB requirements for the cases when satellite and gNB is time and frequency reference. |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | Nokia, Nokia Shanghai Bell | **Observation 1 :** The NTN WI defines several communication scenarios: LEO, GEO and implicit support for HAPS and ATG. These scenarios are significantly different, for example, in term of cell-coverage, round trip time, differential delay and max Doppler shift, which might impact on RRM core / Demodulation requirements.**Observation 4 :** Considering the enhancements proposed in the WID, Table 2 provides initial views on the possible impact to RAN4 RRM requirements (pending the progress in RAN1 and 2) which can be considered by RAN4 when starting the NTN work: Table 2 - Preliminary assessment of the impact of the NTN WID on the requirements in TS 38.133For LEO only:* Idle/Inactive state mobility

For both GEO & LEO:* Connected state mobility
* Random Access
* UE transmit timing
* Measurement Procedure

**Proposal 1:** RAN4 to study at least the LEO and GEO scenarios in order to determine whether the same RRM / Demodulation requirements can be defined.**Observation 5 :** The discussion about UL time and frequency synchronization has just started in RAN1. The agreements in RAN1 #102 include at least the support for UEs which can derive based on their GNSS implementation one or more of: its position, a reference time and frequency. It is still open for discussion which additional information signalled from the network can aid in the computation of timing and frequency.  |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | MediaTek inc. | **Proposal 1**: RAN4 to further discuss RRM requirements for NTN.**Proposal 4:** RAN4 to wait for RAN1’s input on whether and how to specify UL transit requirement when common Doppler shift pre-compensation is applied by the gNB. |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | Eutelsat S.A. | **Proposal 1:** limits apply to a UE positioned at the center of a satellite beam. |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | Xiaomi | **Observation 1:** The existing cell reselection mechanism defined for TN system is not suitable for NTN system due to the unobvious near-far effect.**Proposal 1:** The RRM requirements for satellite/HAPS ephemeris based cell selection and reselection should be defined in RAN4. |

## Open issues summary

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

From provided documents, some general open issues have been identified and should be considered for decision/agreed working assumptions/possible WF:

* RAN4 should use RAN1/RAN2 NTN framework when defining NTN RRM requirements
* Use cases and scenarios should be considered from [97e][312] NTN\_Solutions
* Reference point (RP) to be considered by time and frequency synchronization: satellite and/or gNB
* Specific NTN requirements in terms of accuracy estimation for satellite position/velocity;
* RAN4 should start considering a list of potential RRM KPIs with respect to considered NTN use cases. Moreover:
	+ Down-scope from TS 38.133 Stand-Alone mobility states parameters related to Cell-Reselection, MDT, HO, CHO.
	+ Down-scope from TS 38.133 Timing and Signaling Characteristics parameters.
	+ Down-scope from TS 38.133 with respect to Measurement Procedures and Measurement Performance Requirements parameters.

### Sub-topic 1-1 : RAN4 should use RAN1/RAN2 NTN framework when defining NTN RRM requirements

*Sub-topic description: Ongoing RAN1 work on solutions to be adopted for time and frequency synchronization based on GNSS (with at least 2-3 identified options). Ongoing RAN2 work for NTN HO (with several on-going options).*

*Open issues and candidate options before e-meeting:*

**Issue 1-1:** RAN1/RAN2 NTN framework

* Proposals
	+ Option 1: RAN4 should use RAN1/RAN2 NTN framework when defining NTN RRM requirements
	+ Option 2: TBA
* Recommended WF
* RAN4 should use RAN1/RAN2 NTN framework when defining NTN RRM requirements

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| --- | --- |
| **Company** | **Comments**[Note1 (general): Options are not exclusive. Companies may answer “Yes” or “No” to multiple options.][Note2: If possible, companies are encouraged to provide justification for their choices.] |
| Xiaomi | Agree with the recommended WF |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 1-2 : NTN Use cases and scenarios

*Sub-topic description: Several scenarios have been considered with LEO, GEO, HAPS, etc. and different exemplary bands in FR1 and FR2.*

*Open issues and candidate options before e-meeting:*

**Issue 1-2:** NTN Use cases and scenarios

* Proposals
	+ Option 1: Use cases and scenarios should be considered from [97e][312] NTN\_Solutions
	+ Option 2: TBA
* Recommended WF
	+ Use cases and scenarios should be considered from [97e][312] NTN\_Solutions

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1 (general): Options are not exclusive. Companies may answer “Yes” or “No” to multiple options.][Note2: If possible, companies are encouraged to provide justification for their choices.] |
| Xiaomi | The recommended WF is generally fine with us. We still need to consider RAN1/RAN2 design when defining RRM related requirements. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 1-3 : Reference point (RP) to be considered by time and frequency synchronization

*Sub-topic description: The RP to be used concerns only Rel-17 with transparent payload.*

*Open issues and candidate options before e-meeting:*

**Issue 1-3:** Reference point (RP) to be considered by time and frequency synchronization

* Proposals
	+ Option 1: RP on Satellite
	+ Option 2: RP on gNB
	+ Option 3: both options with RP on Satellite and RP on gNB to be included in Rel-17 for time and frequency synchronization
* Recommended WF
	+ Decision based on RAN1 work

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1 (general): Options are not exclusive. Companies may answer “Yes” or “No” to multiple options.][Note2: If possible, companies are encouraged to provide justification for their choices.] |
| XXX | Option 1: Option 2:Option 3:  |
| Xiaomi | Agree with the recommended WF, it should be decided by RAN1 |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 1-4 : Accuracy for satellite position/velocity

*Sub-topic description: RAN4 needs to assume some accuracy for satellite position/velocity estimation*

*Open issues and candidate options before e-meeting:*

**Issue 1-4:** Accuracy for satellite position/velocity

* Proposals
	+ Option 1: Specific NTN requirements in terms of satellite position/velocity accuracy estimation;
	+ Option 2: TBA
* Recommended WF
	+ Specific NTN requirements in terms of satellite position/velocity accuracy estimation

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| --- | --- |
| **Company** | **Comments**[Note1 (general): Options are not exclusive. Companies may answer “Yes” or “No” to multiple options.][Note2: If possible, companies are encouraged to provide justification for their choices.] |
| XXX | Option 1:  |
| Xiaomi | Depends on RAN1 agreement on how the satellite provide the positioning information to UE, RAN1 is still under discussion on whether LEO broadcast ephemeris information or PVT information to UE. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 1-5 : RAN4 should start considering a list of potential RRM KPIs with respect to considered NTN use cases

*Sub-topic description: An initial list with potential (core) NTN RRM KPIs should be considered*

*Open issues and candidate options before e-meeting:*

**Issue 1-5:** Potential list of NTN-related RRM KPIs

* Proposals
	+ Option 1: RAN4 should start to establish a list with (preliminary) RRM parameters for NTN
	+ Option 2: TBA
* Recommended WF
	+ Use TS 38.133 for choosing RRM parameters to be considered with priority for NTN
	+ Companies are invited to select/recommend parameters to be considered with priority for NTN
	+ Where is possible, down-scope parameters only to some essential NTN parameters

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1 (general): Options are not exclusive. Companies may answer “Yes” or “No” to multiple options.][Note2: If possible, companies are encouraged to provide justification for their choices.] |
| XXX | Option 1:  |
| Xiaomi | Some initial discussion on RRM requirement for NTN based on TS38.133 is needed. However we also need to discuss some potential discussion on NTN specific requirement according to RAN1/2 conclusion. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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**Question: Which of the following parameters/requirements should be treated with priority? Please provide your answer(s) e.g. “Yes” only if parameter should be treated with priority.**

Table 1: NTN Parameters related to SA mobility states

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| --- | --- | --- | --- | --- |
| SA Mobility States | Essential Parameter | Parameter Name | Comment/explanation | **Company view** [please add comment only if the parameter should be treated with priority] |
| RRC\_IDLE state mobility | Cell Re-selection | UE measurement capability | Capability of NTN UE to monitor intra-frequency and inter-frequency (NTN or TN) carrier. | Company A:Company B:Company C: |
| Measurement and evaluation of serving cell | The NTN UE shall be able to measure the SS-RSRP and SS-RSRQ level of the serving cell and evaluate the cell selection criterion. UE filtering of the SS-RSRP and SS-RSRQ measurements of the serving cell using at least X measurements, where X FFS. | Company A:Company B:Company C: |
| Measurements of intra-frequency NR cells | The NTN UE shall be able to identify new intra-frequency cells and perform SS-RSRP and SS-RSRQ measurements of the identified intra-frequency cells without an explicit intra-frequency neighbor list containing physical layer cell identities. The NTN UE shall measure SS-RSRP and SS-RSRQ at least every Tmeasure,NR\_Intra equivalent parameter. NTN UE filtering of the SS-RSRP and SS-RSRQ measurements of the serving cell using at least X measurements, where X FFS. |  |
| Measurements of inter-frequency NR cells | The NTN UE shall be able to identify new inter-frequency cells and perform SS-RSRP or SS-RSRQ measurements of identified inter-frequency cells if carrier frequency information is provided by the serving cell, even if no explicit neighbour list with physical layer cell identities is provided. If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ then the NTN UE shall search for inter-frequency layers of higher priority at least every (NTN equivalent) Thigher\_priority\_search. Conditions to perform equal priority reselection need to be defined. |  |
| Maximum interruption in paging reception | NTN UE shall perform the cell re-selection with minimum interruption in monitoring downlink channels for paging reception.At intra-frequency and inter-frequency cell re-selection, the NTN UE shall monitor the downlink of serving cell for paging reception until the NTN UE is capable to start monitoring downlink channels of the target intra-frequency and inter-frequency cell for paging reception. The interruption time shall not exceed a specific NTN defined value. |  |
| Minimum requirement at transitions | Tmeasure,NR\_Intra, Tevaluate,NR\_Intra, Tmeasure,NR\_Inter, Tevaluate,NR\_Inter |  |
| Measurements of intra-frequency NR cells for UE configured with relaxed measurement criterion | N/A for NTN, since it concerns:Measurements for UE fulfilling low mobility criterionMeasurements for UE fulfilling not-at-cell edge criterionMeasurements for UE fulfilling low mobility and not-at-cell edge criteria |  |
| Minimization of Drive Tests (MDT) | Measurement Requirements | FSS, potentially N/A for NTN |  |
| Requirements for Relative Time Stamp Accuracy | FSS, potentially N/A for NTN |  |
| Requirements for Relative Time Stamp Accuracy for RRC Connection Establishment Failure Log Reporting | FSS, potentially N/A for NTN |  |
| Requirements for Relative Time Stamp Accuracy for Radio Link Failure and Handover Failure Log Reporting | FSS, potentially N/A for NTN |  |
| RRC\_INACTIVE state mobility | Cell Re-selection | UE measurement capability | Same as the ones for IDLE. |  |
| Measurement and evaluation of serving cell | Same as the ones for IDLE. |  |
| Measurements of intra-frequency NR cells | Same as the ones for IDLE. |  |
| Measurements of inter-frequency NR cells | Same as the ones for IDLE. |  |
| Maximum interruption in paging reception | Same as the ones for IDLE. |  |
| Minimization of Drive Tests (MDT) | Measurement Requirements | Same as the ones for IDLE. |  |
| Requirements for Relative Time Stamp Accuracy | Same as the ones for IDLE. |  |
| Requirements for Relative Time Stamp Accuracy for RRC Connection Establishment Failure Log Reporting | Same as the ones for IDLE. |  |
| Requirements for Relative Time Stamp Accuracy for Radio Link Failure and Handover Failure Log Reporting | Same as the ones for IDLE. |  |
| Requirements for Relative Time Stamp Accuracy for RRC Resume Failure Log Reporting | Same as the ones for IDLE. |  |
| RRC\_CONNECTED state mobility | Handover Parameters - NR Handover | NR FR1 - NR FR1 Handover | Specific-NTN definition for Handover delaySpecific-NTN definition for Interruption time |  |
| NR FR2- NR FR1 Handover | N/A (or FFS) |  |
| NR FR2- NR FR2 Handover | Specific-NTN definition for Handover delaySpecific-NTN definition for Interruption time |  |
| NR FR1- NR FR2 Handover | N/A (or FFS) |  |
| Handover Parameters - NR DAPS (Dual-Active Protocol Stack) Handover | NR FR1 - NR FR1 DAPS Handover | FFS  |  |
| NR FR2- NR FR1 DAPS Handover | FFS |  |
| NR FR1- NR FR2 DAPS Handover | FFS |  |
| Handover Parameters - NR Conditional Handover | NR FR1 – NR FR1 conditional handover | Specific-NTN definition for Handover delaySpecific-NTN definition for Measurement timeSpecific-NTN definition for Preparation timeSpecific-NTN definition for Interruption time |  |
| NR FR2 – NR FR1 conditional handover | FFS |  |
| NR FR2 – NR FR2 conditional handover | Specific-NTN definition for Handover delaySpecific-NTN definition for Measurement timeSpecific-NTN definition for Preparation timeSpecific-NTN definition for Interruption time |  |
| NR FR1 – NR FR2 conditional handover | FFS |  |
| RRC Connection Mobility Control | SA: RRC Re-establishment | Specific-NTN UE Re-establishment delay requirement |  |
| Random access | Specific-NTN Requirements for 4-step RA typeSpecific-NTN Requirements for 2-step RA type |  |
| SA: RRC Connection Release with Redirection | Specific-NTN RRC connection release with redirection to NR |  |
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**Question: Which of the following parameters/requirements should be treated with priority? Please provide your answer(s) e.g. “Yes” only if parameter should be treated with priority.**

Table 2: NTN Parameters related to Timing and Signaling Characteristics

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| Essential Parameter | Parameter Name | **Company view** [please add comment only if the parameter should be treated with priority] |
| Timing Parameter | UE transmit timing | Company A:Company B:Company C: |
| UE timer accuracy | Company A:Company B:Company C: |
| Timing advance | Company A:Company B:Company C: |
| Cell phase synchronization accuracy |  |
| Maximum Transmission Timing Difference |  |
| Maximum Receive Timing Difference |  |
| *deriveSSB-IndexFromCell* tolerance |  |
| Signalling characteristics Parameter | Radio Link Monitoring |  |
| Interruption |  |
| SCell Activation and Deactivation Delay |  |
| UE UL carrier RRC reconfiguration delay |  |
| Link Recovery Procedures |  |
| Active BWP switch delay |  |
| PSCell Change |  |
| Uplink spatial relation switch delay |  |
| UE-specific CBW change |  |

**Question: Which of the following parameters/requirements should be treated with priority? Please provide your answer(s) e.g. “Yes” only if parameter should be treated with priority.**

Table 3: NTN Parameters related to Measurement Procedures

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| --- | --- | --- |
| Parameter Name | Specific parameter requirement | **Company view** [please add comment only if the parameter should be treated with priority] |
| General measurement requirement | Measurement gap | Company A:Company B:Company C: |
| UE Measurement capability | Company A:Company B:Company C: |
| Capabilities for Support of Event Triggering and Reporting Criteria |  |
| Carrier-specific scaling factor |  |
| Minimum requirement at transitions |  |
| NR intra-frequency measurements | Requirements applicability |  |
| Number of cells and number of SSB |  |
| Measurement Reporting Requirements |  |
| Intra-frequency measurements without measurement gaps |  |
| Intra-frequency measurements with measurement gaps |  |
| NR inter-frequency measurements | Requirements applicability |  |
| Number of cells and number of SSB |  |
| Inter-frequency measurement with measurement gaps |  |
| Inter-frequency measurements reporting requirements |  |
| Inter-frequency SFTD measurement requirements |  |
| Inter frequency measurements without measurement gaps |  |
| L1-RSRP measurements for Reporting | Requirements applicability |  |
| Measurement Reporting Requirements (Periodic, Semi-Persistent, Aperiodic) |  |
| L1-RSRP measurement requirements |  |
| Measurement restriction for CSI-RS and SSB for L1-RSRP measurement |  |
| Scheduling availability of UE during L1-RSRP measurement |  |
| Cross Link Interference measurements | SRS-RSRP measurements |  |
| CLI-RSSI measurements |  |
| Scheduling availability of UE during CLI measurements |  |
| L1-SINR measurements for Reporting | Requirements applicability |  |
| Measurement Reporting Requirements (Periodic, Semi-Persistent, Aperiodic) |  |
| L1-SINR measurement requirements |  |
| Measurement restriction for L1-SINR measurement |  |
| Scheduling availability of UE during L1-SINR measurement |  |
| NR measurements for positioning | RSTD measurements (Requirements Applicability, Measurement Capability, Measurement Reporting Requirements) |  |
| PRS-RSRP measurements (Requirements Applicability, Measurement Capability, Measurement Reporting Requirements) |  |
| UE Rx-Tx time difference measurements (Requirements Applicability, Measurement Capability, Measurement Reporting Requirements, Measurement Period Requirements) |  |
| E-CID measurements (Measurement Requirements, Measurement Reporting Delay) |  |
| CSI-RS based L3 measurements | Requirements applicability |  |
| CSI-RS based Inter-frequency measurements |  |
| NR measurements with autonomous gaps | FFS |  |

**Question: Which of the following parameters/requirements should be treated with priority? Please provide your answer(s) e.g. “Yes” only if parameter should be treated with priority.**

Table 4: NTN Parameters related to Measurement Performance Requirements (NR Measurements only)

|  |  |
| --- | --- |
| Parameter Name/Accuracy Requirement | **Company view** [please add comment only if the parameter should be treated with priority] |
| Intra-frequency RSRP accuracy requirements for FR1: * Specific-NTN Absolute SS-RSRP Accuracy
* Specific-NTN Relative SS-RSRP Accuracy
 | Company A:Company B:Company C: |
| Intra-frequency RSRP accuracy requirements for FR2* Specific-NTN Absolute SS-RSRP Accuracy
* Specific-NTN Relative SS-RSRP Accuracy
 |  |
| Inter-frequency RSRP accuracy requirements for FR1* Specific-NTN Absolute SS-RSRP Accuracy
* Specific-NTN Relative SS-RSRP Accuracy
 |  |
| Inter-frequency RSRP accuracy requirements for FR2* Specific-NTN Absolute SS-RSRP Accuracy
* Specific-NTN Relative SS-RSRP Accuracy
 |  |
| RSRP Measurement Report Mapping |  |
| Intra-frequency RSRQ accuracy requirements for FR1* Absolute SS-RSRQ Accuracy in FR1
 |  |
| Intra-frequency RSRQ accuracy requirements for FR2* Absolute SS-RSRQ Accuracy in FR2
 |  |
| Inter-frequency RSRQ accuracy requirements for FR2 |  |
| RSRQ report mapping |  |
| Intra-frequency SINR accuracy requirements for FR1 |  |
| Intra-frequency SINR accuracy requirements for FR2 |  |
| Inter-frequency SINR accuracy requirements for FR1 |  |
| Inter-frequency SINR accuracy requirements for FR2 |  |
| SINR report mapping |  |
| Power Headroom |  |
| PCMAX,c,f |  |
| L1-RSRP accuracy requirements for FR1 |  |
| L1-RSRP accuracy requirements for FR2 |  |
| SFTD accuracy requirements |  |
| CLI measurement accuracy requirements |  |
| RSTD Measurements * Measurement accuracy requirements
* Report mapping
 |  |
| PRS-RSRP Measurements* Measurement accuracy requirements
* Report mapping
 |  |
| UE Rx-Tx Time Difference Measurements* Measurement accuracy requirements
* Report mapping
 |  |
| FR2 P-MPR report* Report mapping
 |  |
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## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1: Sub topic 1-2:Sub topic 1-3:Sub topic 1-4:Sub topic 1-5:….Others: |
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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.*

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

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: GNSS requirements

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

The topic should at least cover:

* GNSS used on UE, precision and accuracy requirements
* GNSS used on Satellite, precision and accuracy requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | THALES | **Proposal 2:** For FR1 frequency range, GNSS-based UL synchronization and TA mechanisms using pre-compensation shall use a GNSS accuracy assumption of TFOM value 4, which considers an Estimated Time Error (ETE) between 100 ns and 1 µs.**Proposal 3:** For FR2 frequency range, GNSS-based UL synchronization and TA mechanisms using pre-compensation shall use a GNSS accuracy assumption of TFOM value 3, which considers an Estimated Time Error (ETE) between 10 ns and 100 ns. |
| [*R4-2016037*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016037.zip) | Ericsson | **Observation 5 :** It is practically feasible to receive GNSS positioning signals without any measurement gap or interruption in 3GPP radio reception or transmission**Proposal 1 :** No interruptions or measurement gaps are allowed for GNSS measurements during NTN operation.**Proposal 2 :** RAN4 shall consider requirements for A-GNSS in 38.171 as a starting point when defining requirements for further RRM procedures based on UE position. RAN4 needs to verify if existing A-GNSS requirements are sufficient, considering the impact that positioning will have on the further RRM requirements which assume knowledge of UE position |
| [*R4-2015730*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015730.zip) | Nokia, Nokia Shanghai Bell | **Observation 5 :** The discussion about UL time and frequency synchronization has just started in RAN1. The agreements in RAN1 #102 include at least the support for UEs which can derive based on their GNSS implementation one or more of: its position, a reference time and frequency. It is still open for discussion which additional information signalled from the network can aid in the computation of timing and frequency. **Observation 6 :** There are several sources of inaccuracy for estimating the time/frequency synchronization between UE and gNb by using GNSS location: lag of the ephemeris information, precision of the ephemeris data, GNSS inaccuracy, orbit perturbations and altitude modelling, delay on GNSS-information conversion at the UE and atmospheric delays. **Proposal 2:** RAN4 to investigate the required accuracy of external reference to be used for UE timing & frequency pre-compensation and how this compares with the accuracy provided by GNSS in a practical setup. |
| [*R4-2014875*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014875.zip) | MediaTek inc. | **Observation 3:** The UE pre-compensation accuracy is mainly dependent on the accuracy of the position and satellite velocity signaled by the Gateway and on the device propagation accuracy of this information.**Observation 4:** Autonomous adjustment of the TA before UL transmission by the UE avoids need for frequent TA update due to satellite time drift, which significantly reduces signaling overhead in connected mode.**Observation 6**: The connected UE can autonomously predict and pre-compensate the Doppler shift drift before transmitting on the UL. |
| [*R4-2014928*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014928.zip) | Eutelsat S.A. | **Observation 1**: LEO satellites are typically equipped with onboard GNSS receivers with position accuracy in the order of 10 meters and velocity accuracy in the order of 10 cm / s. **Observation 2**: Satellite position, Velocity, and Time (PVT) information can be transmitted to the gateway via an auxiliary channel in real-time in a typical report of size 28 bytes every 10 seconds.**Observation 3**: Satellite PVT report can be propagated by Gateway over a period of 2 hours with a position accuracy of < 1 m. |
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## Open issues summary

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

### Sub-topic 2-1 GNSS usage

*Sub-topic description: Which entity can be assumed using GNSS*

*Open issues and candidate options before e-meeting:*

**Issue 2-1:** Should GNSS be used on UE, on satellite or both?

* Proposals
	+ Option 1: GNSS on UE
	+ Option 2: GNSS on LEO satellite
	+ Option 3: GNSS on both UE and LEO satellite
* Recommended WF
	+ GNSS capability at least on UE

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| --- | --- |
| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2:Option 3:  |
| Xiaomi | The recommended WF is fine for us, as agreed in RAN2#111e meeting, only UEs with GNSS capabilities are supported in Rel-17. FFS on LEO satellite. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 2-2 GNSS precision

*Sub-topic description: Some GNSS precision has to be assumed*

*Open issues and candidate options before e-meeting:*

**Issue 2-2:** GNSS accuracy assumption for (testing) UL synchronization and TA mechanisms

* Proposals
	+ Option 1:
		- For FR1 frequency range, GNSS-based UL synchronization and TA mechanisms using pre-compensation shall use a GNSS accuracy assumption of TFOM value 4, which considers an Estimated Time Error (ETE) between 100 ns and 1 µs.
		- For FR2 frequency range, GNSS-based UL synchronization and TA mechanisms using pre-compensation shall use a GNSS accuracy assumption of TFOM value 3, which considers an Estimated Time Error (ETE) between 10 ns and 100 ns.
	+ Option 2: RAN4 shall consider requirements for A-GNSS in 38.171 as a starting point when defining requirements for further RRM procedures based on UE position. RAN4 needs to verify if existing A-GNSS requirements are sufficient, considering the impact that positioning will have on the further RRM requirements which assume knowledge of UE position
	+ Option 3:
		- There are several sources of inaccuracy for estimating the time/frequency synchronization between UE and gNb by using GNSS location (GNSS related): GNSS inaccuracy, delay on GNSS-information conversion at the UE and atmospheric delays.
		- RAN4 to investigate the required accuracy of external reference to be used for UE timing & frequency pre-compensation and how this compares with the accuracy provided by GNSS in a practical setup.
* Recommended WF
	+ Distinguish between FR1 & FR2 required GNSS precision
	+ Assume (at least) TFOM value 4 for FR1 and TFOM value 3 for FR2

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| --- | --- |
| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2:Option 3:  |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 2-3 GNSS measurement

*Sub-topic description: GNSS measurement*

*Open issues and candidate options before e-meeting:*

**Issue 2-3:** GNSS measurement

* Proposals
	+ Option 1:
		- It is practically feasible to receive GNSS positioning signals without any measurement gap or interruption in 3GPP radio reception or transmission
		- No interruptions or measurement gaps are allowed for GNSS measurements during NTN operation.
	+ Option 2:
		- LEO satellites are typically equipped with onboard GNSS receivers with position accuracy in the order of 10 meters and velocity accuracy in the order of 10 cm / s.
		- Satellite position, Velocity, and Time (PVT) information can be transmitted to the gateway via an auxiliary channel in real-time in a typical report of size 28 bytes every 10 seconds.
		- Satellite PVT report can be propagated by Gateway over a period of 2 hours with a position accuracy of < 1 m.
* Recommended WF
	+ No interruptions or measurement gaps are allowed for GNSS measurements during NTN operation.
	+ GNSS measurements or GNSS measurement report periodicities are FFS

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| --- | --- |
| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2: |
| Xiaomi | Option 1: fineOption 2: Depends on RAN1 agreement on this issue, RAN1 is still under discussion on whether LEO broadcast ephemeris information or PVT information to UE.  |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
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## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 2-1: Sub topic 2-2:Sub topic 2-3: ….Others: |
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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.*

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

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: PVT Satellite precision

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | THALES | **Proposal 5:** RRM & demodulation KPIs may include (at least):- Specific NTN requirements in terms of accuracy estimation for satellite position/velocity;**Proposal 10:** The UE shall be able to acquire its User specific TA with an accuracy better than **±min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2)** depending on the PRACH format and configuration.The NTN-specific PRACH used format (if different from TN), PRACH CP, PRACH GP, and zero-correlation zone parameters (and other similar) are for the time being FSS.**Proposal 11:** The UE 3D positioning error ΔU and the satellite 3D positioning error ΔS shall accommodate the following requirement: **ΔU+ΔS < c/2 \* min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2)**. |
| [*R4-2016037*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016037.zip) | Ericsson | **Observation 12:** 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 10:** 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 $\pm \frac{1}{4}$ TA-step (at SCS = 15 kHz)). |
| [*R4-2015730*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015730.zip) | Nokia, Nokia Shanghai Bell | **Observation 6 :** There are several sources of inaccuracy for estimating the time/frequency synchronization between UE and gNb by using GNSS location: lag of the ephemeris information, precision of the ephemeris data, GNSS inaccuracy, orbit perturbations and altitude modelling, delay on GNSS-information conversion at the UE and atmospheric delays.  |
| [*R4-2014875*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014875.zip) | MediaTek inc. | **Proposal 1**: RAN4 to further discuss RRM requirements for NTN.**Observation 1**: UE pre-compensation of satellite delay within an accuracy of $\pm \frac{CP}{4}$ of RACH preamble format corresponding to a satellite position accuracy (ΔU) of $\pm \frac{CP}{4}c$ is sufficient for UL time synchronization* For FR1, $∆U<\pm 7735 m$.
* For FR2, $∆U<\pm 378 m$.

**Observation 2:** UE pre-compensation of satellite Doppler shift within an accuracy of ±0.02ppm included in the total frequency error for UL transmission of ±0.1 ppm is sufficient for UL frequency synchronization. In term of satellite position accuracy (ΔU) and satellite velocity accuracy ΔV, this corresponds to * For LEO
	+ $∆U<\pm 120m $
	+ $∆V<\pm 1.5 m/sec$
* For GEO
	+ $∆U< \pm 21 km $
	+ $∆V< \pm 2.7 m/sec$

**Observation 3:** The UE pre-compensation accuracy is mainly dependent on the accuracy of the position and satellite velocity signaled by the Gateway and on the device propagation accuracy of this information.**Proposal 3**: Define a test for UE pre-compensation with device using device position and using serving satellite ephemeris broadcast on SIB, where device reads satellite ephemeris on SIB at time t0, propagate satellite position and velocity to time t0+T, determines and pre-compensates corresponding satellite delay and Doppler shift before transmiting on the UL at time t0+T. |
| [*R4-2014928*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014928.zip) | Eutelsat S.A. | **Proposal 2:** The required accuracy of satellite position and satellite velocity broadcast by the Gateway is:* Position accuracy <120 m for PVT info in SIB signaling for UE pre-compensation
* Velocity accuracy <1.5m/s for PVT info in SIB signaling for UE pre-compensation

**Observation 1**: LEO satellites are typically equipped with onboard GNSS receivers with position accuracy in the order of 10 meters and velocity accuracy in the order of 10 cm / s. **Observation 2**: Satellite position, Velocity, and Time (PVT) information can be transmitted to the gateway via an auxiliary channel in real-time in a typical report of size 28 bytes every 10 seconds.**Observation 3**: Satellite PVT report can be propagated by Gateway over a period of 2 hours with a position accuracy of < 1 m. |
| [*R4-2014658*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014658.zip) | Xiaomi | **Proposal 1:** The RRM requirements for satellite/HAPS ephemeris based cell selection and reselection should be defined in RAN4. |
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## Open issues summary

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

### Sub-topic 3-1 Required satellite position accuracy (ΔU) and satellite velocity accuracy (ΔV)

*Sub-topic description:* Required satellite position accuracy (ΔU) and satellite velocity accuracy (ΔV)

*Open issues and candidate options before e-meeting:*

**Issue 3-1:** Satellite position accuracy (ΔU) and satellite velocity accuracy (ΔV)

* Proposals
	+ Option 1: (required) satellite position accuracy (ΔU) and satellite velocity accuracy (ΔV)
		- For LEO
			* ∆U<±120m
			* ∆V<±1.5 m/sec
		- For GEO
			* ∆U< ±21 km
			* ∆V< ±2.7 m/sec
	+ Option 2:
		- The required accuracy of satellite position and satellite velocity broadcast by the Gateway is:
			* Position accuracy <120 m for PVT info in SIB signaling for UE pre-compensation
			* Velocity accuracy <1.5m/s for PVT info in SIB signaling for UE pre-compensation
	+ Option 3:
		- * LEO satellites are typically equipped with onboard GNSS receivers with position accuracy in the order of 10 meters and velocity accuracy in the order of 10 cm / s.
			* Satellite position, Velocity, and Time (PVT) information can be transmitted to the gateway via an auxiliary channel in real-time in a typical report of size 28 bytes every 10 seconds.
			* Satellite PVT report can be propagated by Gateway over a period of 2 hours with a position accuracy of < 1 m.
	+ Option 4:
		- * RRM & demodulation KPIs may include (at least): Specific NTN requirements in terms of accuracy estimation for satellite position/velocity;
	+ Option 5:
		- * The RRM requirements for satellite/HAPS ephemeris based cell selection and reselection should be defined in RAN4.
	+ Option 6:
		- * There are several sources of inaccuracy for estimating the time/frequency synchronization between UE and gNb by using GNSS location (ephemeris and PVT related): lag of the ephemeris information, precision of the ephemeris data, orbit perturbations and altitude modelling
* Recommended WF
	+ Consider as worst case LEO constellation with position accuracy (ΔU) and satellite velocity accuracy (ΔV):
		- * ∆U<±120m
			* ∆V<±1.5 m/sec
	+ Consider LEO potentially equipped with GNSS

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

|  |  |
| --- | --- |
| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2:Option 3:Option 4: Option 5:Option 6:  |
| Xiaomi | Depends on RAN1 agreement on this issue, RAN1 is still under discussion on whether LEO broadcast ephemeris information or PVT information to UE. It is too early to discuss the accuracy requirement for PVT. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
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## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 3-1: ….Others: |

## 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:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #4: NTN UL Time synchronization requirements

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | THALES | **Proposal 10:** The UE shall be able to acquire its User specific TA with an accuracy better than **±min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2)** depending on the PRACH format and configuration.The NTN-specific PRACH used format (if different from TN), PRACH CP, PRACH GP, and zero-correlation zone parameters (and other similar) are for the time being FSS.**Proposal 11:** The UE 3D positioning error ΔU and the satellite 3D positioning error ΔS shall accommodate the following requirement: **ΔU+ΔS < c/2 \* min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2)**. |
| [*R4-2016037*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016037.zip) | Ericsson | **Observation 2 :** In LEO satellite deployments there is a very large and time varying Doppler shift due to the high relative motion between UE and satellite, and the satellite and the NTN gateway (ground station)**Observation 3 :** Round trip time (RTT) is extremely large for GEO satellite deployments, and very large for LEO satellite deployments**Observation 4 :** Due to the large cell size, maximum differential delay in NTN is large**Observation 6 :** The delay in the TA control loop corresponds to significant part of CP already at SCS = 15 kHz.**Assumption 1 :** The effect of the RTT in the TA control loop is not considered in this contribution since that is a function of the final mechanism chosen in RAN1. However CP will still have to be preserved.**Observation 7 :** If gNB is time and synchronization reference then we get a requirement set which is more compatible with existing release-17 baseline.**Proposal 5 :** RAN4 to investigate the impact on existing gNB requirements for the cases when satellite and gNB is time and frequency reference.**Observation 8 :** It is important to control the size of Te. The reason for this is that we have to preserve CP.**Proposal 6 :** Keep existing Te requirements as defined in TS 28.133, Table 7.1.2-1: Te Timing Error Limit**Observation 9 :** In order to preserve CP, we get that ΔUE-pos + ΔSat-pos + ΔUE\_timing\_estimate < Te**Observation 10 :** A worst case maximum delay variation will trigger a gradual timing adjustment every 10 to 6 ms for FR1 and every 3 to 2.5 ms for FR2 given existing gradual timing adjustment requirements.**Observation 11 :** 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 7:** The parameter Tq and the maximum aggregate adjustment rate will have to be investigated.**Proposal 8 :** Keep  as in existing TS 38.133 specification [3].**Proposal 9 :** Keep UE timer accuracy as in existing TS 38.133 specification [3].**Observation 12:** 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 10:** 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 $\pm \frac{1}{4}$ TA-step (at SCS = 15 kHz)). |
| [*R4-2015730*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015730.zip) | Nokia, Nokia Shanghai Bell | **Observation 3 :** In the transparent architecture, the UE might have simultaneously 2 feeder links. This might impact some timing issues and requirements might need to be discussed in RAN4**Observation 4 :** Considering the enhancements proposed in the WID, Table 2 provides initial views on the possible impact to RAN4 RRM requirements (pending the progress in RAN1 and 2) which can be considered by RAN4 when starting the NTN work: Table 2 - Preliminary assessment of the impact of the NTN WID on the requirements in TS 38.133For LEO only:* Idle/Inactive state mobility

For both GEO & LEO:* Connected state mobility
* Random Access
* UE transmit timing
* Measurement Procedure

**Proposal 1:** RAN4 to study at least the LEO and GEO scenarios in order to determine whether the same RRM / Demodulation requirements can be defined.**Observation 5 :** The discussion about UL time and frequency synchronization has just started in RAN1. The agreements in RAN1 #102 include at least the support for UEs which can derive based on their GNSS implementation one or more of: its position, a reference time and frequency. It is still open for discussion which additional information signalled from the network can aid in the computation of timing and frequency.  |
| [*R4-2014875*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014875.zip) | MediaTek inc. | **Observation 1**: UE pre-compensation of satellite delay within an accuracy of $\pm \frac{CP}{4}$ of RACH preamble format corresponding to a satellite position accuracy (ΔU) of $\pm \frac{CP}{4}c$ is sufficient for UL time synchronization* For FR1, $∆U<\pm 7735 m$.
* For FR2, $∆U<\pm 378 m$.

**Issue 1:** Impact on signalling of frequent TA update**Observation 4:** Autonomous adjustment of the TA before UL transmission by the UE avoids need for frequent TA update due to satellite time drift, which significantly reduces signaling overhead in connected mode.**Issue 2**: Timing drift within NTN RTD exceeds the maximum specified transmission timing error**Observation 5:** The connected UE can autonomously adjust the TA to compensate the impact of the timing drift within specified maximum transmission timing error ±Te = ± 0.39 μs corresponding to a position error of ±117 m.**Proposal 3**: Define a test for UE pre-compensation with device using device position and using serving satellite ephemeris broadcast on SIB, where device reads satellite ephemeris on SIB at time t0, propagate satellite position and velocity to time t0+T, determines and pre-compensates corresponding satellite delay and Doppler shift before transmiting on the UL at time t0+T. |
| [*R4-2014928*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014928.zip) | Eutelsat S.A. | **Proposal 1:** The target requirements to achieve for feeder link and UE uplink pre-compensation are [8]:• Time delay < 0.4 µs These limits apply to a UE positioned at the center of a satellite beam. |
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## Open issues summary

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

### Sub-topic 4-1 Acceptable TA error for initial access

*Sub-topic description: UE-specific TA accuracy for initial access*

*Open issues and candidate options before e-meeting:*

**Issue 4-1:** Acceptable TA error for initial access

* Proposals
	+ Option 1:
		- The UE shall be able to acquire its User specific TA with an accuracy better than **±min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2)** depending on the PRACH format and configuration.
		- The UE 3D positioning error ΔU and the satellite 3D positioning error ΔS shall accommodate the following requirement: **ΔU+ΔS < c/2 \* min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2)**.
	+ Option 2:
		- 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.
		- 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)).
	+ Option 3:
		- UE pre-compensation of satellite delay within an accuracy of ±CP/4 of RACH preamble format corresponding to a satellite position accuracy (ΔU) of ±CP/4 c is sufficient for UL time synchronization
			* For FR1, ∆U<±7735 m.
			* For FR2, ∆U<±378 m.
		- Autonomous adjustment of the TA before UL transmission by the UE avoids need for frequent TA update due to satellite time drift, which significantly reduces signaling overhead in connected mode.
* Recommended WF
	+ Consider
		- TA accuracy better than ±min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2) depending on the PRACH format and configuration.
		- UE 3D positioning error ΔU and satellite 3D positioning error ΔS shall accommodate the following requirement: ΔU+ΔS < c/2 \* min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2).

OR

* + Choose the most restrictive option from mentioned options.
	+ In order to have comparable results, use the same unit (e.g. CP, Tc, distance) to measure accuracy

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2:Option 3:  |
| Xiaomi | Maybe we can have some general analysis on the impact on timing related requirement for NTN system, including requirement of initial transmit timing error and adjustment, accuracy requirement of Timing Advance etc. And we can have some discussion on whether we need to define other time related requirement for NTN-specific scenario, e.g. time pre-compensation related requirement (accuracy&adjustment requirement) |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 4-2 Timing Error Limit and others

*Sub-topic description: Te, Tq, NTAoffset, timer accuracy*

*Open issues and candidate options before e-meeting:*

**Issue 4-2:** Timing Error Limits

* Proposals
	+ Option 1:
		- Keep existing Te requirements as defined in TS 28.133, Table 7.1.2-1: Te Timing Error Limit
		- In order to preserve CP, we get that ΔUE-pos + ΔSat-pos + ΔUE\_timing\_estimate < Te
	+ Option 2:
		- The parameter Tq and the maximum aggregate adjustment rate will have to be investigated.
	+ Option 3:
		- Keep  as in existing TS 38.133 specification [3].
	+ Option 4:
		- Keep UE timer accuracy as in existing TS 38.133 specification [3].
	+ Option 5:
		- Keep legacy UL demodulation performance requirements, UL timing error requirements for NR NTN when UE pre-compensate satellite delay.
	+ Option 6:
		- Timing drift within NTN RTD exceeds the maximum specified transmission timing error.
		- The connected UE can autonomously adjust the TA to compensate the impact of the timing drift within specified maximum transmission timing error ±Te = ± 0.39 μs corresponding to a position error of ±117 m.
	+ Option 7:
		- The target requirements to achieve for feeder link and UE uplink pre-compensation are [8]: Time delay < 0.4 µs
		- These limits apply to a UE positioned at the center of a satellite beam.
* Recommended WF
	+ Use UL timing error requirements for NR NTN when UE pre-compensate satellite delay;
	+ Investigate Tq and the maximum aggregate adjustment rate

OR

* + Decide if existent TN framework could be reused or new NTN framework/requirements should be taken into account
	+ Verify which the most restrictive option from mentioned options is.
	+ In order to have comparable results, use the same unit (e.g. CP, Tc, distance)

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2:Option 3:Option 4: Option 5:Option 6:Option 7: |
| Xiaomi | Te: Some investigation is needed due to the high Doppler shift between satellite and UE. If the frequency pre-compensation is introduced, whether Te shall consider the impact of frequency pre-compensation accuracy.Tq: we also think Tq and Tp should be investigated for NTN scenario.NTA\_offset: Agree with option 3, keep NTA\_offset as in existing TS 38.133 specification.UE timer accuracy: Agree with option 4, keep UE timer accuracy as in existing TS 38.133 specification.Cell phase error: keep the same requirement as in existing TS 38.133 specification. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 4-3 Timing Issues and Requirements for UE with 2 feederlinks

*Sub-topic description: In the transparent architecture, the UE might have simultaneously 2 feeder links. This might impact some timing issues and requirements might need to be discussed in RAN4*

*Open issues and candidate options before e-meeting:*

**Issue 4-3:** Timing Issues and Requirements for UE with 2 feederlinks

* Proposals
	+ Option 1: In the transparent architecture, the UE might have simultaneously 2 feeder links. This might impact some timing issues and requirements might need to be discussed in RAN4.
	+ Option 2: TBA
* Recommended WF
	+ Timing issues and requirements to be discussed in RAN4 when 2 simultaneous feeder links are involved.

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1:  |
| Xiaomi | Agree with the recommended WF, some study is needed for this case. Maybe the TAE or cell phase synchronization error should be considered for this case. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 4-4 UE Time alignment behaviour

*Sub-topic description:* UE Time alignment behaviour

*Open issues and candidate options before e-meeting:*

**Issue 4-4:** UE Time alignment behaviour

* Proposals
	+ Option 1: It is still open for discussion which additional information signalled from the network can aid in the computation of timing.
	+ Option 2: The effect of the RTT in the TA control loop is not considered in this contribution since that is a function of the final mechanism chosen in RAN1. However CP will still have to be preserved.
* Recommended WF
	+ Wait for RAN1 decision.

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2: |
| Xiaomi | Agree with the recommended WF, we may need more conclusion from RAN1 on TA estimation. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 4-5 Test definition

*Sub-topic description:* Test definition for satellite delay pre-compensation

*Open issues and candidate options before e-meeting:*

**Issue 4-5:** Test definition

* Proposals
	+ Option 1: Define a test for UE pre-compensation with device using device position and using serving satellite ephemeris broadcast on SIB, where device reads satellite ephemeris on SIB at time t0, propagate satellite position and velocity to time t0+T, determines and pre-compensates corresponding satellite delay before transmitting on the UL at time t0+T.
	+ Option 2: TBA
* Recommended WF
	+ Consider defining test for UE pre-compensation with device using device position and using serving satellite ephemeris broadcast on SIB
	+ However, wait for RAN1 decision first.

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1:  |
| Xiaomi | It is too early to discuss test related issue in core part. It should be discussed in performance part. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| XXX | Sub topic 4-1: Sub topic 4-2:Sub topic 4-3: Sub topic 4-4:Sub topic 4-5:….Others: |

## 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:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #5: NTN UL frequency synchronization requirement

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | THALES | **Proposal 1:** RAN4 should use RAN1 framework when defining requirements for UE UL synchronization and TA mechanisms.**Proposal 5:** RRM & demodulation KPIs may include (at least):- Specific NTN testing configurations with NTN specific Doppler;**Proposal 6:** RRM & demodulation KPIs may include (at least):- Specific NTN requirements in terms of achievable throughput for each modulation expressed in terms of percentage of max throughput and per given modulation;**Proposal 12:** UE shall be able to compensate the frequency offset due to the satellite mobility when generating its UL carrier frequency. **Proposal 13:** The UE modulated carrier frequency shall be accurate to within ±0.1 ppm as observed over a period of 1 ms by the gNB. **Proposal 14:** The UE residual frequency error shall be sufficiently low such that it can be considered included in the tolerated frequency error of ±0.1 ppm already captured in the specification. |
| [*R4-2016037*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016037.zip) | Ericsson | **Observation 1 :** NTN RRM requirements need to consider that NTN can operate in FR1 or FR2 ranges**Observation 2 :** In LEO satellite deployments there is a very large and time varying Doppler shift due to the high relative motion between UE and satellite, and the satellite and the NTN gateway (ground station) |
| [*R4-2015730*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015730.zip) | Nokia, Nokia Shanghai Bell | **Observation 5 :** The discussion about UL time and frequency synchronization has just started in RAN1. The agreements in RAN1 #102 include at least the support for UEs which can derive based on their GNSS implementation one or more of: its position, a reference time and frequency. It is still open for discussion which additional information signalled from the network can aid in the computation of timing and frequency. **Observation 6 :** There are several sources of inaccuracy for estimating the time/frequency synchronization between UE and gNb by using GNSS location: lag of the ephemeris information, precision of the ephemeris data, GNSS inaccuracy, orbit perturbations and altitude modelling, delay on GNSS-information conversion at the UE and atmospheric delays. **Proposal 2:** RAN4 to investigate the required accuracy of external reference to be used for UE timing & frequency pre-compensation and how this compares with the accuracy provided by GNSS in a practical setup. |
| [*R4-2014875*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014875.zip) | MediaTek inc. | **Observation 2:** UE pre-compensation of satellite Doppler shift within an accuracy of ±0.02ppm included in the total frequency error for UL transmission of ±0.1 ppm is sufficient for UL frequency synchronization. In term of satellite position accuracy (ΔU) and satellite velocity accuracy ΔV, this corresponds to * For LEO
	+ $∆U<\pm 120m $
	+ $∆V<\pm 1.5 m/sec$
* For GEO
	+ $∆U< \pm 21 km $
	+ $∆V< \pm 2.7 m/sec$

**Proposal 2**: Keep legacy UL demodulation performance requirements, UL timing error requirements, and UL frequency error requirements for NR NTN when UE pre-compensate satellite delay and Doppler.**Observation 6**: The connected UE can autonomously predict and pre-compensate the Doppler shift drift before transmitting on the UL.**Observation 7**: The UE will need to know the common Doppler shift pre-compensation applied by the gNB and subtracts it from the UE-specific Doppler shift determined autonomously before applying pre-compensation of residual Doppler shift prior to UL transmission. The indication of the common Doppler compensated by gNB is a RAN1 discussion.**Proposal 3**: Define a test for UE pre-compensation with device using device position and using serving satellite ephemeris broadcast on SIB, where device reads satellite ephemeris on SIB at time t0, propagate satellite position and velocity to time t0+T, determines and pre-compensates corresponding satellite delay and Doppler shift before transmiting on the UL at time t0+T.**Proposal 4:** RAN4 to wait for RAN1’s input on whether and how to specify UL transit requirement when common Doppler shift pre-compensation is applied by the gNB.  |
| [*R4-2014928*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014928.zip) | Eutelsat S.A. | **Proposal 1:** The target requirements to achieve for feeder link and UE uplink pre-compensation are [8]: • Doppler shift < +/- 20 HzThese limits apply to a UE positioned at the center of a satellite beam. |
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## Open issues summary

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

### Sub-topic 5-1 NTN UL Synchronization Requirement

*Sub-topic description:* NTN UL Synchronization Requirement

*Open issues and candidate options before e-meeting:*

**Issue 5-1:** NTN UL Synchronization Requirement

* Proposals
	+ Option 1:
		- UE shall be able to compensate the frequency offset due to the satellite mobility when generating its UL carrier frequency.
		- The UE modulated carrier frequency shall be accurate to within ±0.1 ppm as observed over a period of 1 ms by the gNB.
		- The UE residual frequency error shall be sufficiently low such that it can be considered included in the tolerated frequency error of ±0.1 ppm already captured in the specification.
	+ Option 2:
		- Keep legacy UL demodulation performance requirements and UL frequency error requirements for NR NTN when UE pre-compensate satellite Doppler.
		- UE pre-compensation of satellite Doppler shift within an accuracy of ±0.02ppm included in the total frequency error for UL transmission of ±0.1 ppm is sufficient for UL frequency synchronization.
	+ Option 3:
		- The target requirements to achieve for feeder link and UE uplink pre-compensation are [8]: Doppler shift < +/- 20 Hz
		- These limits apply to a UE positioned at the center of a satellite beam.
* Recommended WF
	+ UE shall be able to compensate the frequency offset due to the satellite mobility when generating its UL carrier frequency.
	+ The UE modulated carrier frequency shall be accurate to within ±0.1 ppm as observed over a period of 1 ms by the gNB.
	+ The UE residual frequency error shall be sufficiently low such that it can be considered included in the tolerated frequency error of ±0.1 ppm already captured in the specification.

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2:Option 3: |
| Xiaomi | The frequency error is defined in 38.101, thus this issue should be discussed in RF session. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 5-2 NTN UL Synchronization Behaviour

*Sub-topic description* NTN UL Synchronization Behaviour

*Open issues and candidate options before e-meeting:*

**Issue 5-2:** NTN UL Synchronization Behaviour

* Proposals
	+ Option 1: It is still open for discussion which additional information signalled from the network can aid in the computation of timing and frequency.
	+ Option 2: RAN4 to wait for RAN1’s input on whether and how to specify UL transit requirement when common Doppler shift pre-compensation is applied by the gNB.
* Recommended WF
	+ Wait for RAN1 decision

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2: |
| Xiaomi | Agree with the recommended WF, wait for RAN1 decision. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 5-3 Test definition

*Sub-topic description:* Test definition for Doppler shift pre-compensation

*Open issues and candidate options before e-meeting:*

**Issue 5-3:** Test Definition

* Proposals
	+ Option 1: Define a test for UE pre-compensation with device using device position and using serving satellite ephemeris broadcast on SIB, where device reads satellite ephemeris on SIB at time t0, propagate satellite position and velocity to time t0+T, determines and pre-compensates corresponding satellite Doppler shift before transmiting on the UL at time t0+T.
	+ Option 2: RRM & demodulation KPIs may include (at least): Specific NTN testing configurations with NTN specific Doppler;
* Recommended WF
	+ Required Doppler compensation test in UL
	+ The way the UE pre-compensates in UL is FFS

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| --- | --- |
| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2: |
| Xiaomi | Test should be discussed in performance part |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| XXX | Sub topic 5-1: Sub topic 5-2:Sub topic 5-3:….Others: |

## 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:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #6: NTN Measurements

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | THALES | **Proposal 5:** RRM & demodulation KPIs may include (at least):- Specific NTN requirements for handover KPIs (e.g. interruption time);- Specific NTN requirements for RSRP/RSRQ measurement accuracy.**Proposal 7:** Down-scope from TS 38.133 Stand-Alone mobility states parameters related to Cell-Reselection, MDT, HO, CHO.**Proposal 9:** Down-scope from TS 38.133 with respect to Measurement Procedures and Measurement Performance Requirements parameters. |
| [*R4-2016037*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016037.zip) | Ericsson | **Proposal 3 :** RAN4 further discusses measurements in NTN operation for both idle and connected mode once further progress is made in RAN1 and RAN2.**Proposal 4 :** RAN4 to discuss about measurements supporting TN / NTN mobility, once the Intra NTN mobility has sufficiently progressed. Intra NTN mobility refers to idle and connected mode mobility between NTN cells (e.g. intra or inter satellite). |
| [*R4-2015730*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015730.zip) | Nokia, Nokia Shanghai Bell | **Observation 2 :** The long propagation delay, time-varying delay difference between neighbour satellites and different time synchronization between them requires enhancements on the SMTC configuration and measurement gap configuration, to avoid the situation that the reference signals are missed.**Observation 4 :** Considering the enhancements proposed in the WID, Table 2 provides initial views on the possible impact to RAN4 RRM requirements (pending the progress in RAN1 and 2) which can be considered by RAN4 when starting the NTN work: Table 2 - Preliminary assessment of the impact of the NTN WID on the requirements in TS 38.133For LEO only:* Idle/Inactive state mobility

For both GEO & LEO:* Connected state mobility
* Measurement Procedure

**Proposal 1:** RAN4 to study at least the LEO and GEO scenarios in order to determine whether the same RRM / Demodulation requirements can be defined. |
| [*R4-2014875*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014875.zip) | MediaTek inc. | **Proposal 1**: RAN4 to further discuss RRM requirements for NTN. |
| [*R4-2014658*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014658.zip) | Xiaomi | **Observation 1:** The existing cell reselection mechanism defined for TN system is not suitable for NTN system due to the unobvious near-far effect.**Proposal 1:** The RRM requirements for satellite/HAPS ephemeris based cell selection and reselection should be defined in RAN4.**Proposal 2:** RAN4 should study measurement gap enhancement in NTN system. |

## Open issues summary

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

### Sub-topic 6-1 Measurements identified potential issues

*Sub-topic description:* Measurements identified potential issues

*Open issues and candidate options before e-meeting:*

**Issue 6-1:** Measurement-related potential issues

* Proposals
	+ Option 1: RRM & demodulation KPIs may include (at least): Specific NTN requirements for RSRP/RSRQ measurement accuracy.
	+ Option 2:
		- Enhancements on the SMTC configuration and measurement gap configuration, to avoid the situation that the reference signals are missed.
		- Definition of TNT-specific measurement procedures for both LEO & GEO
		- The existing cell reselection mechanism defined for TN system is not suitable for NTN system due to the unobvious near-far effect.
	+ Option 3:
		- The RRM requirements for satellite/HAPS ephemeris based cell selection and reselection should be defined in RAN4.
		- RAN4 should study measurement gap enhancement in NTN system.
* Recommended WF
	+ At least a specific SMTC enhancement, measurement gap enhancements & RSRP/RSRQ measurement accuracy need to be considered.

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2:Option 3: |
| Xiaomi | According to RAN2 agreement that Satellite/HAPS ephemeris based cell selection and reselection should be defined for NTN. Thus, RAN4 can have some initial discussion on RRM requirements for satellite/HAPS ephemeris based cell selection and reselection.Regarding the enhancements on the SMTC configuration and measurement gap configuration, as SMTC configuration was defined in RAN1, thus, the enhancement on SMTC configuration can be discussed in RAN1, and RAN4 can discuss the enhancement on measurement gap configuration due to the propagation delay difference. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 6-2 Measurement types

*Sub-topic description* Measurement types to be considered

*Open issues and candidate options before e-meeting:*

**Issue 6-2:** Measurement types

* Proposals
	+ Option 1:
		- RAN4 to discuss about measurements supporting TN / NTN mobility, once the Intra NTN mobility has sufficiently progressed.
		- Intra NTN mobility refers to idle and connected mode mobility between NTN cells (e.g. intra or inter satellite).
	+ Option 2: TBA
* Recommended WF
	+ All scenarios NTN-to-NTN, NTN-to-TN and TN-to-NTN need to be considered

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1:  |
| Xiaomi | Ok with the recommended WF, both intra-NTN mobility requirement and NT-NTN mobility requirement should be introduced according to RAN2 conclusion. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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### Sub-topic 6-3 Measurement way forward

*Sub-topic description* Measurement way forward

*Open issues and candidate options before e-meeting:*

**Issue 6-3:** Measurement way forward

* Proposals
	+ Option 1: RAN4 further discusses measurements in NTN operation for both idle and connected mode once further progress is made in RAN1 and RAN2.
	+ Option 2: RAN4 to further discuss RRM requirements for NTN.
	+ Option 3:
		- Down-scope from TS 38.133 Stand-Alone mobility states parameters related to Cell-Reselection, MDT, HO, CHO.
		- Down-scope from TS 38.133 with respect to Measurement Procedures and Measurement Performance Requirements parameters.
* Recommended WF
	+ Choose at least a list of essential (core) measurement parameters to be considered in priority by RAN4.

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2:Option 3: |
| Xiaomi | Need more discussion case by case. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| XXX | Sub topic 6-1: Sub topic 6-2:Sub topic 6-3:….Others: |

## 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:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #6: RRM requirements for beam switching

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

## Companies’ contributions summary

|  |  |  |
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| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | THALES | **Proposal 5:** RRM & demodulation KPIs may include (at least):- Specific NTN requirements for handover KPIs (e.g. interruption time);**Proposal 7:** Down-scope from TS 38.133 Stand-Alone mobility states parameters related to Cell-Reselection, MDT, HO, CHO. |
| [*R4-2015730*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015730.zip) | Nokia, Nokia Shanghai Bell | **Observation 4 :** Considering the enhancements proposed in the WID, Table 2 provides initial views on the possible impact to RAN4 RRM requirements (pending the progress in RAN1 and 2) which can be considered by RAN4 when starting the NTN work: Table 2 - Preliminary assessment of the impact of the NTN WID on the requirements in TS 38.133For LEO only:* Idle/Inactive state mobility

For both GEO & LEO:* Connected state mobility

 |
| [*R4-2014875*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014875.zip) | MediaTek inc. | **Proposal 1**: RAN4 to further discuss RRM requirements for NTN. |
| [*R4-2014658*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014658.zip) | Xiaomi | **Proposal 3:** RAN4 should define RRM requirements for beam switching in NTN system. |

## Open issues summary

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

### Sub-topic 7-1 beam switching

*Sub-topic description:* RRM requirements for beam switching

*Open issues and candidate options before e-meeting:*

**Issue 7-1:** Beam switching RRM requirements

* Proposals
	+ Option 1: RAN4 to further discuss RRM requirements for NTN.
	+ Option 2: RAN4 should define RRM requirements for beam switching in NTN system.
* Recommended WF
	+ Further discuss essential/core parameters to be considered by RRM requirements for NTN
	+ Wait for RAN1 & RAN2 for solutions with respect to beam(s)-to-cell mapping, is same PCI for several satellite beams, or if one PCI per satellite beam.

**Question: Which option (listed above) do you prefer? Please provide your answer(s) e.g. “Yes” or “No”.**

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| **Company** | **Comments**[Note1: Options are not necessary exclusive.][Note2: **Companies are encouraged to provide justification** for their choices.] |
| XXX | Option 1: Option 2: |
| Xiaomi | If RAN1 agreed that the frequency reuse factor is larger than 1, the satellite may use different beam to provide service to UE, thus the UE is required to connect the new beam in new frequency band. And the corresponding delay and interruption requirements should be defined in RAN4. |
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**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

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| **Company** | **Agree, agree partially, disagree** | **Comments** |
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## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| XXX | Sub topic 7-1: ….Others: |

## 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:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Appendix: Companies contribution summary

Contribution summaries are as follows:

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [*R4-2015946*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015946.zip) | THALES | **Proposal 1:** RAN4 should use RAN1 framework when defining requirements for UE UL synchronization and TA mechanisms.**Proposal 2:** For FR1 frequency range, GNSS-based UL synchronization and TA mechanisms using pre-compensation shall use a GNSS accuracy assumption of TFOM value 4, which considers an Estimated Time Error (ETE) between 100 ns and 1 µs.**Proposal 3:** For FR2 frequency range, GNSS-based UL synchronization and TA mechanisms using pre-compensation shall use a GNSS accuracy assumption of TFOM value 3, which considers an Estimated Time Error (ETE) between 10 ns and 100 ns.**Proposal 4:** RAN4 should start considering a list of potential RRM and demodulation KPIs with respect to considered NTN use cases.**Proposal 5:** RRM & demodulation KPIs may include (at least):- Specific NTN requirements in terms of accuracy estimation for satellite position/velocity;- Specific NTN requirements for handover KPIs (e.g. interruption time);- Specific NTN testing configurations with NTN specific Doppler;- Specific NTN requirements in terms of timing accuracy;- Specific NTN requirements for RSRP/RSRQ measurement accuracy.**Proposal 6:** RRM & demodulation KPIs may include (at least):- Specific NTN requirements in terms of achievable throughput for each modulation expressed in terms of percentage of max throughput and per given modulation;**Proposal 7:** Down-scope from TS 38.133 Stand-Alone mobility states parameters related to Cell-Reselection, MDT, HO, CHO.**Proposal 8:** Down-scope from TS 38.133 Timing and Signaling Characteristics parameters.**Proposal 9:** Down-scope from TS 38.133 with respect to Measurement Procedures and Measurement Performance Requirements parameters.**Proposal 10:** The UE shall be able to acquire its User specific TA with an accuracy better than **±min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2)** depending on the PRACH format and configuration.The NTN-specific PRACH used format (if different from TN), PRACH CP, PRACH GP, and zero-correlation zone parameters (and other similar) are for the time being FSS.**Proposal 11:** The UE 3D positioning error ΔU and the satellite 3D positioning error ΔS shall accommodate the following requirement: **ΔU+ΔS < c/2 \* min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2)**.**Proposal 12:** UE shall be able to compensate the frequency offset due to the satellite mobility when generating its UL carrier frequency. **Proposal 13:** The UE modulated carrier frequency shall be accurate to within ±0.1 ppm as observed over a period of 1 ms by the gNB. **Proposal 14:** The UE residual frequency error shall be sufficiently low such that it can be considered included in the tolerated frequency error of ±0.1 ppm already captured in the specification. |
| [*R4-2016037*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016037.zip) | Ericsson | **Observation 1 :** NTN RRM requirements need to consider that NTN can operate in FR1 or FR2 ranges**Observation 2 :** In LEO satellite deployments there is a very large and time varying Doppler shift due to the high relative motion between UE and satellite, and the satellite and the NTN gateway (ground station)**Observation 3 :** Round trip time (RTT) is extremely large for GEO satellite deployments, and very large for LEO satellite deployments**Observation 4 :** Due to the large cell size, maximum differential delay in NTN is large**Observation 5 :** It is practically feasible to receive GNSS positioning signals without any measurement gap or interruption in 3GPP radio reception or transmission**Proposal 1 :** No interruptions or measurement gaps are allowed for GNSS measurements during NTN operation.**Proposal 2 :** RAN4 shall consider requirements for A-GNSS in 38.171 as a starting point when defining requirements for further RRM procedures based on UE position. RAN4 needs to verify if existing A-GNSS requirements are sufficient, considering the impact that positioning will have on the further RRM requirements which assume knowledge of UE position**Proposal 3 :** RAN4 further discusses measurements in NTN operation for both idle and connected mode once further progress is made in RAN1 and RAN2.**Proposal 4 :** RAN4 to discuss about measurements supporting TN / NTN mobility, once the Intra NTN mobility has sufficiently progressed. Intra NTN mobility refers to idle and connected mode mobility between NTN cells (e.g. intra or inter satellite).**Observation 6 :** The delay in the TA control loop corresponds to significant part of CP already at SCS = 15 kHz.**Assumption 1 :** The effect of the RTT in the TA control loop is not considered in this contribution since that is a function of the final mechanism chosen in RAN1. However CP will still have to be preserved.**Observation 7 :** If gNB is time and synchronization reference then we get a requirement set which is more compatible with existing release-17 baseline.**Proposal 5 :** RAN4 to investigate the impact on existing gNB requirements for the cases when satellite and gNB is time and frequency reference.**Observation 8 :** It is important to control the size of Te. The reason for this is that we have to preserve CP.**Proposal 6 :** Keep existing Te requirements as defined in TS 28.133, Table 7.1.2-1: Te Timing Error Limit**Observation 9 :** In order to preserve CP, we get that ΔUE-pos + ΔSat-pos + ΔUE\_timing\_estimate < Te**Observation 10 :** A worst case maximum delay variation will trigger a gradual timing adjustment every 10 to 6 ms for FR1 and every 3 to 2.5 ms for FR2 given existing gradual timing adjustment requirements.**Observation 11 :** 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 7:** The parameter Tq and the maximum aggregate adjustment rate will have to be investigated.**Proposal 8 :** Keep  as in existing TS 38.133 specification [3].**Proposal 9 :** Keep UE timer accuracy as in existing TS 38.133 specification [3].**Observation 12:** 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 10:** 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 $\pm \frac{1}{4}$ TA-step (at SCS = 15 kHz)). |
| [*R4-2015730*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015730.zip) | Nokia, Nokia Shanghai Bell | **Observation 1 :** The NTN WI defines several communication scenarios: LEO, GEO and implicit support for HAPS and ATG. These scenarios are significantly different, for example, in term of cell-coverage, round trip time, differential delay and max Doppler shift, which might impact on RRM core / Demodulation requirements.**Observation 2 :** The long propagation delay, time-varying delay difference between neighbour satellites and different time synchronization between them requires enhancements on the SMTC configuration and measurement gap configuration, to avoid the situation that the reference signals are missed.**Observation 3 :** In the transparent architecture, the UE might have simultaneously 2 feeder links. This might impact some timing issues and requirements might need to be discussed in RAN4**Observation 4 :** Considering the enhancements proposed in the WID, Table 2 provides initial views on the possible impact to RAN4 RRM requirements (pending the progress in RAN1 and 2) which can be considered by RAN4 when starting the NTN work: Table 2 - Preliminary assessment of the impact of the NTN WID on the requirements in TS 38.133For LEO only:* Idle/Inactive state mobility

For both GEO & LEO:* Connected state mobility
* Random Access
* UE transmit timing
* Measurement Procedure

**Proposal 1:** RAN4 to study at least the LEO and GEO scenarios in order to determine whether the same RRM / Demodulation requirements can be defined.**Observation 5 :** The discussion about UL time and frequency synchronization has just started in RAN1. The agreements in RAN1 #102 include at least the support for UEs which can derive based on their GNSS implementation one or more of: its position, a reference time and frequency. It is still open for discussion which additional information signalled from the network can aid in the computation of timing and frequency. **Observation 6 :** There are several sources of inaccuracy for estimating the time/frequency synchronization between UE and gNb by using GNSS location: lag of the ephemeris information, precision of the ephemeris data, GNSS inaccuracy, orbit perturbations and altitude modelling, delay on GNSS-information conversion at the UE and atmospheric delays. **Proposal 2:** RAN4 to investigate the required accuracy of external reference to be used for UE timing & frequency pre-compensation and how this compares with the accuracy provided by GNSS in a practical setup. |
| [*R4-2014875*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014875.zip) | MediaTek inc. | **Proposal 1**: RAN4 to further discuss RRM requirements for NTN.**Observation 1**: UE pre-compensation of satellite delay within an accuracy of $\pm \frac{CP}{4}$ of RACH preamble format corresponding to a satellite position accuracy (ΔU) of $\pm \frac{CP}{4}c$ is sufficient for UL time synchronization* For FR1, $∆U<\pm 7735 m$.
* For FR2, $∆U<\pm 378 m$.

**Observation 2:** UE pre-compensation of satellite Doppler shift within an accuracy of ±0.02ppm included in the total frequency error for UL transmission of ±0.1 ppm is sufficient for UL frequency synchronization. In term of satellite position accuracy (ΔU) and satellite velocity accuracy ΔV, this corresponds to * For LEO
	+ $∆U<\pm 120m $
	+ $∆V<\pm 1.5 m/sec$
* For GEO
	+ $∆U< \pm 21 km $
	+ $∆V< \pm 2.7 m/sec$

**Proposal 2**: Keep legacy UL demodulation performance requirements, UL timing error requirements, and UL frequency error requirements for NR NTN when UE pre-compensate satellite delay and Doppler.**Observation 3:** The UE pre-compensation accuracy is mainly dependent on the accuracy of the position and satellite velocity signaled by the Gateway and on the device propagation accuracy of this information.**Issue 1:** Impact on signalling of frequent TA update**Observation 4:** Autonomous adjustment of the TA before UL transmission by the UE avoids need for frequent TA update due to satellite time drift, which significantly reduces signaling overhead in connected mode.**Issue 2**: Timing drift within NTN RTD exceeds the maximum specified transmission timing error**Observation 5:** The connected UE can autonomously adjust the TA to compensate the impact of the timing drift within specified maximum transmission timing error ±Te = ± 0.39 μs corresponding to a position error of ±117 m.**Observation 6**: The connected UE can autonomously predict and pre-compensate the Doppler shift drift before transmitting on the UL.**Observation 7**: The UE will need to know the common Doppler shift pre-compensation applied by the gNB and subtracts it from the UE-specific Doppler shift determined autonomously before applying pre-compensation of residual Doppler shift prior to UL transmission. The indication of the common Doppler compensated by gNB is a RAN1 discussion.**Proposal 3**: Define a test for UE pre-compensation with device using device position and using serving satellite ephemeris broadcast on SIB, where device reads satellite ephemeris on SIB at time t0, propagate satellite position and velocity to time t0+T, determines and pre-compensates corresponding satellite delay and Doppler shift before transmiting on the UL at time t0+T.**Proposal 4:** RAN4 to wait for RAN1’s input on whether and how to specify UL transit requirement when common Doppler shift pre-compensation is applied by the gNB.  |
| [*R4-2014928*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014928.zip) | Eutelsat S.A. | **Proposal 1:** The target requirements to achieve for feeder link and UE uplink pre-compensation are [8]:• Time delay < 0.4 µs • Doppler shift < +/- 20 HzThese limits apply to a UE positioned at the center of a satellite beam.**Proposal 2:** The required accuracy of satellite position and satellite velocity broadcast by the Gateway is:* Position accuracy <120 m for PVT info in SIB signaling for UE pre-compensation
* Velocity accuracy <1.5m/s for PVT info in SIB signaling for UE pre-compensation

**Observation 1**: LEO satellites are typically equipped with onboard GNSS receivers with position accuracy in the order of 10 meters and velocity accuracy in the order of 10 cm / s. **Observation 2**: Satellite position, Velocity, and Time (PVT) information can be transmitted to the gateway via an auxiliary channel in real-time in a typical report of size 28 bytes every 10 seconds.**Observation 3**: Satellite PVT report can be propagated by Gateway over a period of 2 hours with a position accuracy of < 1 m. |
| [*R4-2014658*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014658.zip) | Xiaomi | **Observation 1:** The existing cell reselection mechanism defined for TN system is not suitable for NTN system due to the unobvious near-far effect.**Proposal 1:** The RRM requirements for satellite/HAPS ephemeris based cell selection and reselection should be defined in RAN4.**Proposal 2:** RAN4 should study measurement gap enhancement in NTN system.**Proposal 3:** RAN4 should define RRM requirements for beam switching in NTN system. |