**3GPP TSG-RAN WG4 Meeting # 97-e R4-2017031**

**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:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***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

|  |  |  |
| --- | --- | --- |
| **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”.**

|  |  |
| --- | --- |
| **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 |
| LGE | Option 1: Yes |
| Panasonic | Option 1: Yes |
| Qualcomm | Option 1. |
| MediatTek | Option 1 |
| Ericsson | Option1. RAN4 conform to RAN1/RAN2 framework in general.  |
| Apple | Option 1 |
| Nokia, Nokia Shanghai Bell | Option 1 is OK. |
| Huawei | Option1. RAN4 shoud follow RAN1/RAN2 NTN framework to define the RRM requirements. |
| Thales | Yes for Option 1. |

**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
| XXX |  |  |
| Panasonic | Agree |  |
| Samsung | Agree | Agree with the recommended WF. |
| Qualcomm | Agree | A question for moderator, what is expected if we disagree with Option 1? What is the implication of “partially agree”?  |
| MediatTek | Agree |  |
| Ericsson | Agree | The WF is fine. RAN4 conform to RAN1/RAN2 framework in general.  |
| Apple | Agree | Fine with the recommended WF |
| Nokia, Nokia Shanghai Bell | Agree |  |
| Huawei | Agree. |  |
| Thales | Agree | The implication of “Partially agree” may be for example only RAN1 in a first step. We might also want to down-scope/consider in RAN4 only some of the options from RAN1 in Rel-17 (for example for UE using GNSS there are currently multiple options under consideration). |

Based on the feedbacks, moderator suggestion:

**Proposal 1-1.1:** RAN4 should use RAN1/RAN2 NTN framework when defining NTN RRM requirements.

### 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”.**

|  |  |
| --- | --- |
| **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. |
| Panasonic | Option 1: Yes |
| Qualcomm | Do not clearly understand what Option 1 exactly means and how it will be interpreted down the road. |
| MediatTek | Fine with Option 1 and the recommended WF. |
|  |  |
| Ericsson | Option 1. This is a very general WF, but thread #312 does contain agenda 12.8.2 use cases and will be discussed there. The WF is fine.  |
| Apple | Fine with recommended WF |
| Nokia, Nokia Shanghai Bell | Option 1 is Ok but will create a dependency. The scenarios from thread 312 should additionally be aligned with the scenarios in RAN1 and RAN2. |
| Huawei | Maybe Option1 is at the end of the day. But we prefer not to have the agreement at current stage. It is better for RRM people to review the agreement for use case and scenarios further when discussing which requirements will be specified. |
| Thales | Yes.Explanation for proposal: There were some contributions for RRM part describing other (potential) scenarios than the ones described in RF session.The purpose of this proposal was to discuss/agree only once the NTN scenarios and use cases in RF session (for coexistence or simulations for example), and then re-use agreed scenarios for the RRM session. |

**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
| XXX |  |  |
| Panasonic | Agree |  |
| Samsung | Agree | Agree with the recommended WF. |
| Qualcomm |  | What is the implication (impact on RAN4 discussion) of “fully” or “partially” or “do not” agree with the WF? |
| MediatTek | Agree |  |
| Ericsson | Agree | This is a very general WF, but thread #312 does contain agenda 12.8.2 use cases and will be discussed there. The WF is fine.  |
| Apple | Agree |  |
| Nokia, Nokia Shanghai Bell | Agree | Further clarifications are needed based on our comments above. |
| Huawei | Partially agree. | We would like to defer making agreement for this WF until there are agreements on use case and scenarios in the other session. It is better to look at the concrete use cases and scenarios before making the general agreements. |
| Thales | Agree |  |

Moderator suggestion:

**Proposal 1-2.1:** Select and define NTN use cases and scenarios. Please also refer to [97e][312] NTN\_Solutions.

### 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”.**

|  |  |
| --- | --- |
| **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 |
| Qualcomm | Agree with WF. And just to be safe, we can also include RAN2 because it may have to do with network architecture. |
| MediaTek | From UE requirement perspective, prefer to Option 1, because it is the last hop to the UE. Either follow RAN1’s conclusion or take Option 1 as RAN4’s assumption are fine to us. |
| Ericsson | Option 2: Reference point for time and frequency synchronization impact gNB requirements. Ericsson’s position is that the gNB shall be considered as reference point. The reference point for time in baseline rel-16 specification are the gNB Conducted and radiated requirement reference points in TS 38.104 section 4.3, so final decision depends both on RAN1 and RAN4 work.Frequency synchronization is primarily BS RF issue and not only RRM. So reference point for frequency synchronization should be first discussed in RF session.  |
| Apple | Fine with recommended WF |
| Nokia, Nokia Shanghai Bell | The recommended WF differs from the options. None of the options are acceptable but the WF seems OK. |
| Huawei | Agree with WF. In our understanding, NTN UE should follow the synchronization source from satellite rather from gNB unless the same spectrum is shared by satellite and IMT. So the reference point should be on satellite. But it is better to wait from RAN1 input. |
| Thales | Ok. |

**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
| XXX |  |  |
| Panasonic | Agree |  |
| Samsung | Agree | Agree with the recommended WF. |
| Ericsson | Agree partially | Reference point for time and frequency synchronization impact gNB requirements. Ericsson’s position is that the gNB shall be considered as reference point. The reference point for time in baseline rel-16 specification are the gNB Conducted and radiated requirement reference points in TS 38.104 section 4.3, so final decision depends both on RAN1 and RAN4 work.Frequency synchronization is primarily BSRF issue and not only RRM. So reference point for frequency synchronization should be first discussed in RF session. |
| Apple | Agree |  |
| Nokia, Nokia Shanghai Bell | Agree  | RAN4 should design requirements based on RAN1 decision about the reference point. |
| Huawei | Agree |  |
| Thales | Agree |  |

Moderator suggestion:

**Proposal 1-3.1:** Wait for the Reference Point (RP) to be defined by RAN1

### 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”.**

|  |  |
| --- | --- |
| **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. |
| Qualcomm | Does Option 1 mean RAN1 can define satellite PVT accuracy requirements? Or does it mean RAN4 will develop requirements based on a given specific NTN PVT accuracy? |
| MeidaTek | Support option 1 to consider specific NTN requirements in terms of satellite position/velocity accuracy estimation.This requirement is not need to check directly with the satellite position/velocity, which would be not reported to network. It can check through UE time/freq. sync requirement.  |
| Ericsson | Option 2 (TBA): We should start from a total error budget (for timing for example) and work from there. RAN1 physical layer mechanism and CP, RAN4 timing requirements are related to the needed requirements on UE position, which in turn are related to allowed error satellite position and velocity. We can discuss where the primary requirement is, but if we decide to keep existing UE timing requirements (at initial access, TA setting accuracy etc.) then satellite positioning and accuracy becomes more of a derived requirement, than a primary one. From this point of view it could be too early to say if we need Specific NTN requirements in terms of satellite position/velocity accuracy estimation. |
| Apple | Need more RAN1 agreement/conclusion. |
| Nokia, Nokia Shanghai Bell | For Option 1 and the WF, further clarifications are needed regarding what they mean. Any specific requirements will be developed based on RAN1 agreements and the context need to be clarified. For example, are those requirements to be used based on the ephemeris information in combination with GNSS of the user? This would depend on the agreements in RAN1. Therefore, we could agree to a more general proposal, such as: “RAN4 to define specific NTN requirements in terms of satellite position / velocity accuracy estimation based on the framework to be defined in RAN1”.  |
| Huawei | Option 2 (TBA)If our understanding is correct, the proposal is to define the RRM requirements of estimation accuracy for satellite position and velocity for NTN UE. Firstly it depends on RAN1 conclusion about the frequency compensation and/or timing advance scheme. Secondly, it depends on whether the corresponding measurement and reporting will be specified. If no reporting is specified and UE only do estimation of satellite position and velocity for transmission or reception (which we guess so), it is difficulty to verify UE behavior. Maybe some core requirement with implicit test method, e.g., providing a DL signal with much higher Doppler shift and testing whether UE can do synchronization and transmit with a small value of Doppler shift compared to the nominal frequency, could be considered. But it is too early to conclude that such requirement should be specified at the current stage. |
| Thales | Clarification: RRM requirements for PVT UE estimation.Probably we first need to define the requirements related to UL time synchronization and UL Frequency synchronization, and then discuss the implication of these requirements on the expected accuracy of the satellite position and velocity knowledge at UE side.It is preferred that RAN1/RAN4 first clarify the UL timing and frequency requirement for both initial access and UL transmissions in connected mode. From there, it would be possible (methodology to be discussed) to derive the implication of these requirements on the tolerated accuracy on the satellite position and velocity when performing UL pre-compensation. Of course, the effective pre-compensation error will be different depending on the scenario (UE pre-compensation implementation, SIB configuration, satellite ephemeris format, satellite orbit, …). Whether it is required and how to define a testing method for UE pre-compensation can be further investigated by RAN4. |

**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
| XXX |  |  |
| MeidaTek | Agree |  |
| Ericsson | Agree partially, disagree | This is hard to decide at this stage. We should start from a total error budget (for timing for example) and work from there. RAN1 physical layer mechanism and CP, RAN4 timing requirements are related to the needed requirements on UE position, which in turn are related to allowed error satellite position and velocity. We can discuss where the primary requirement is, but if we decide to keep existing UE timing requirements (at initial access, TA setting accuracy etc.) then satellite positioning and accuracy becomes more of a derived requirement, than a primary one. From this point of view it could be too early to say if we need Specific NTN requirements in terms of satellite position/velocity accuracy estimation. |
| Nokia, Nokia Shanghai Bell | Disagree | The WF is unclear. |
| Huawei | Agree partially | Although it would be hard to say disagree and preclude such requirement, it seems too early to make such decision at the current stage. |
| Thales | Agree |  |
|  |  |  |
|  |  |  |

Moderator suggestion:

**Proposal 1-4.1:** FFS the required PVT accuracy. Need more RAN1 agreement/conclusion.

### 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”.**

|  |  |
| --- | --- |
| **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. |
| LGE | RRM parameters in TS 38.133 with considering priority can be baseline for discussion. We think that parameters related to measurement, mobility and timing should be considered. |
| Qualcomm | We first have to discuss and identify deployment scenarios, use case, etc. For instance, UE type, whether UE needs to consider CA, DC, simultaneous support of GEO and LEO, etc. |
| MeidaTek | The spec impact on TS38.133 caused by NTN should analyzed. Use cases and scenrios, e.g. CA, DC, should be identified.  |
| Ericsson | Option 2 (TBA): It is not clear what is meant by RRM parameters? We assume proponent means list of RRM requirements. The starting point would be existing rel-16 set of parameters and then we remove or add to that, if and when needed, based on analysis. There might also be additional requirements depending on the RAN1/RAN2 work. However there is significant dependency of RRM on RAN1 and RAN2 work and also on the progress in the RF. Therefore, RRM related agreements can be done once RAN1/RAN2 design has sufficiently progressed and there are agreements on RF on scenarios etc.  |
| Apple | Based on the TU plan RAN4 can start preliminary discussion but so far the conclusions from RAN1/2 is limited and we also need the use case/scenario conclusion from RF session. |
| Nokia, Nokia Shanghai Bell | RRM core requirements in TS 38.133 are not necessary the same for FR1 and FR2. Consequently, there is a dependency on RF discussions. The question is would satellite and HAPS share the same set of requirements.  |
| Huawei | Option 2 (TBA)We can gradually start identifying necessary RRM requirements according to RAN1 and RAN2 design. RRM work usually would start after major agreements in RAN1 and RAN2 were reached and the scenarios and use case were clear in RAN4 main/RF session. We should understand what kind of new measurement, procedures and/or schemes should be taken into account when discussing the RRM requirements based on those inputs. Otherwise, RAN4 work may not be aligned with other working groups.  |
| Thales | We can start to identify RRM requirements to be considered based on RAN1/RAN2 work and we can gradually start identifying necessary RRM requirements. |

**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
| Samsung | Partially | We basically agree with the principles to work on this aspect. However, given the progress in other RAN WGs, as well as that of [97e][312] NTN\_Solutions, consideration and selection of potential RRM KPIs should be conducted later to await results of relative discussions. |
| Ericsson | Disagree | The starting point would be existing rel-16 set of parameters and then we remove or add to that, if and when needed, based on analysis.  |
| Nokia, Nokia Shanghai Bell | Disagree  | It is not possible to discuss prioritization of the agreements, or down-scoping without knowing at least the scenarios and the enhancements that will be defined in RAN1 and RAN2. Consequently, it is too early to discuss the list of RRM requirements in the table below. |
| Huawei |  | We can have discussion on the necessary RRM requirement list based on companies’ inputs one by one to see which requirements could be done independent of RAN1/RAN2.  |
| Thales |  | We can have discussion. |
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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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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. | MTK: with priority.Huawei: may needed.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:Huawei: may needed |
| 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. | MTK: with priority. FFS whether it is same or different from Rel-16 NR. May consider the usage of satellite assistance to improve cell selection/reselection (e.g. satellite ephemeris)Huawei: may needed but depends on the agreements in other working group. |
| 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. | MTK: with priority, and it may be pending on RAN2’s conclusion. Huawei: may needed but depends on the agreements in other working group. |
| 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. | MTK: with priority, and it may be pending on RAN2’s conclusion.Huawei: may needed but depends on the agreements in other working group. |
| 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 | MTK: with priority. Take NTN to NTN as a starting point. Regarding TN-NTN / NTN-TN, only need to consider inter-f HO, and it may be pending on RAN2’s conclusion.Huawei: may needed but depends on the agreements in other working group. |
| 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 | MTK: with priority, and it should be aligned with RAN2’s discussion.Huawei: may needed but depends on the agreements in other working group. |
| Random access | Specific-NTN Requirements for 4-step RA typeSpecific-NTN Requirements for 2-step RA type | MTK: with priority\Huawei: may needed but depends on the agreements in other working group. |
| SA: RRC Connection Release with Redirection | Specific-NTN RRC connection release with redirection to NR | MTK: with priority, but it should be aligned with RAN2’s discussion.Huawei: may needed but depends on the agreements in other working group. |
|  |  |  |  |  |

**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

|  |  |  |
| --- | --- | --- |
| 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:MTK: with priority. FFS whether it is same or different from Rel-16 NR. May consider UE Pre-compensation for UL Synchronization.Huawei: may needed but depends on the agreements in other working group. |
| UE timer accuracy | Company A:Company B:Company C:Huawei: may needed but depends on the agreements in other working group. |
| Timing advance | Company A:Company B:Company C:MTK: with priority. FFS whether it is same or different from Rel-16 NR. May consider autonomous TA.Huawei: may needed but depends on the agreements in other working group. |
| Cell phase synchronization accuracy |  |
| Maximum Transmission Timing Difference |  |
| Maximum Receive Timing Difference |  |
| *deriveSSB-IndexFromCell* tolerance |  |
| Signalling characteristics Parameter | Radio Link Monitoring | Huawei: may needed but depends on the agreements in other working group. |
| 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

|  |  |  |
| --- | --- | --- |
| 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:Huawei: may needed but depends on the agreements in other working group. |
| UE Measurement capability | Company A:Company B:Company C:Huawei: may needed but depends on the agreements in other working group. |
| Capabilities for Support of Event Triggering and Reporting Criteria |  |
| Carrier-specific scaling factor |  |
| Minimum requirement at transitions |  |
| NR intra-frequency measurements | Requirements applicability | MTK: with priority. FFS whether to apply with DRX. We reckon LEO with long DRX is not practical. It would be pending on RAN2 discussion on the applicability of DRX.Huawei: may needed but depends on the agreements in other working group. |
| 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 | MTK: with priority. FFS whether to apply with DRX. We reckon LEO with long DRX is not practical. It would be pending on RAN2 discussion on the applicability of DRX. |
| 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:Huawei: may needed but depends on the agreements in other working group. |
| 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 | Huawei: may needed but depends on the agreements in other working group. |
| 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
 |  |
|  |  |

Moderator suggestion:

**Proposal 1-5.1:** Agree on following working method:

* 1st step: Establish list of candidate RRM requirements for NTN based on existing Rel-16 set of parameters (e.g. TS 38.133);
* 2nd step: Based on use cases/scenarios definition as well as RAN1/2 framework definition, down-select the requirements to be considered with priority for NTN in Rel-17 and consider the need to add some additional ones.

## 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**  |
| **Issue 1-1:** RAN1/RAN2 NTN framework | *Tentative agreements:* RAN4 should use RAN1/RAN2 NTN framework when defining NTN RRM requirements. *Candidate options:-**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 1-2:** NTN Use cases and scenarios | *Tentative agreements:* Select and define NTN use cases and scenarios. Please also refer to [97e][312] NTN\_Solutions.*Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 1-3:** Reference point (RP) to be considered by time and frequency synchronization | *Tentative agreements:* Wait for the Reference Point (RP) to be defined by RAN1*Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 1-4:** Accuracy for satellite position/velocity | *Tentative agreements:* FFS the required PVT accuracy. Need more RAN1 agreement/conclusion.*Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 1-5:** Potential list of NTN-related RRM KPIs | *Tentative agreements:* Agree on following working method:* 1st step: Establish list of candidate RRM requirements for NTN based on existing Rel-16 set of parameters (e.g. TS 38.133);
* 2nd step: Based on use cases/scenarios definition as well as RAN1/2 framework definition, down-select the requirements to be considered with priority for NTN in Rel-17 and consider the need to add some additional ones.

*Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
|  |  |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Email discussion summary for [97e][232] NR\_NTN\_solutions\_RRM 2nd Round | WF |

## 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”.**

|  |  |
| --- | --- |
| **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. |
| LGE | GNSS on UE is default. Need more discussion on GNSS on LEO. |
| Qualcomm | Option 2 is not valid based on WID in RP-201256“UEs with GNSS capabilities are assumed.”And regarding whether LEO satellite is quipped with GNSS, the question should be whether RAN4 should consider transceivers that require LEO satellites’ PVT. It should be up to RAN1/2 design. |
| MeidaTek | Agree with Option 1 and the WF, which is aligned with RAN1&2 discussion.  |
| Ericsson | Option 1 and option 3 are fine. GNSS receivers are implemented in many commercially available UEs and 3GPP has already specified A-GNSS assistance signaling for TN. UE GNSS capability would simplify the design of random access and timing advance maintenance and perhaps reduce the need to signal to UE.  |
| Apple | In WID RP-201256 it agreed that “UEs with GNSS capabilities are assumed.” So we are fine with option 1 and we are wondering if the LEO capability shall be discussed in RAN1 or RAN4. |
| Nokia | The recommended WF is OK. Additionally, we also understand that the UE should be aware of the position of the satellite, but it is not needed to specify if this position is obtained by GNSS or other methods |
| Huawei | Suggested way forward is OK, since it is aligned with RAN2 agreements. Not sure if all the satellites, which falls in the NTN interested band and now rotated in the space, are equipped with GNSS. And there are multiple types of GNSS. RAN4 should be careful to make decision on the topics which are being discussed also in the other working group. |
| Thales | Aligned with WID. |

**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
| Ericsson | Agree | GNSS receivers are implemented in many commercially available UEs and 3GPP has already specified A-GNSS assistance signaling for TN. UE GNSS capability would simplify the design of random access and timing advance maintenance and perhaps reduce the need to signal to UE.  |
| Nokia, Nokia Shanghai Bell | Agree |  |
| Thales | Agree |  |
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Moderator suggestion:

**Proposal 1:** UEs with GNSS capabilities are assumed.

**Proposal 2:** Further discuss the need for 3GPP to assume GNSS capability on board of satellites.

### 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”.**

|  |  |
| --- | --- |
| **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:  |
| MeidaTek | Support Option 2, by considering the minimum UE impact.  |
| Ericsson | Option 3: The required GNSS precision depends on SCS in FR1 and FR2, since CP become smaller. |
| Apple | Need more discussion. Not sure if this error assumption shall be evaluated/decided by RF session |
| Nokia | Option 1: No. This is the first meeting for this topic, and we need time to understand these proposals. The accuracy will depend on the method used to obtain this data (only GNSS; or GNSS combined with other methods?) we need to wait for RAN1 agreements before assuming the accuracy. Option 2: No. This proposal could be further clarified. What does it mean to consider the requirements in 38.171 as baseline? To consider only the metrics or also the values that are defined there? It has not been agreed in RAN1 that the UE needs to get assistance data (where would the UE get this information from in case it has not been active for a long time). One option would be that it will be broadcasted in the SIB – but that would mean that this SIB would always need to be transmitted in NTN. We need to wait for RAN1 discussion.Option 3: Yes. The location information will likely impact further RRM requirements which assume knowledge of UE position. Our view is that this information can be imperfect, so we need to understand the inaccuracy first, before agreeing on any values.  |
| Huawei | Option 2.It would be OK to reuse A-GNSS specification 38.171 as a starting point. We would like to think it over on the enhancement of A-GNSS requirements. One reason is that GNSS is not a 3GPP technique.More discussion is needed on recommended WF. Need input from RF session on use case and scenario related to FR1&FR2. |
| Thales | Option 1 would be required to propose a test for UL Timing and Doppler pre-compensation. This is highly relevant, since the current RAN1 assumptions consider GNSS-based UL pre-compensation, and the UL performance will be highly dependent on GNSS precision.Option 2 & 3 are not precluded. We will probably need to consider some information with respect to GNSS accuracy in a practical setup. |
|  |  |

**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** |
| Ericsson | Disagree | The required GNSS precision depends on SCS in FR1 and FR2 (since CP becomes smaller) and not only if it is FR1 or FR2. Ericsson agrees with Nokia in R4-2015730 “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”.  |
| Nokia | Disagree  | In our view, we should first give time for companies to investigate the accuracy in relation to the requirements that will be impacted by the location information at the UE. We think it is too early to agree on any values, considering that the RAN1 / RAN2 discussions have only started. |
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Moderator suggests:

**Proposal 1:** Further discuss the required accuracy (depending on the scenarios) 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.

### 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.  |
| Qualcomm | Option 1: It is likely but premature yet to say “No Interruption” |
| MediaTek | Fine with Option 1 and recommended WF.  |
| Ericsson | 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. |
| Apple | Option 1: we may need more discussion. We need to check if there would be IDC interference between GPS band and NR band; and then we can decide the interruption would be needed or not.Option 2: Need more info from RAN1. |
| Nokia | General comment: We believe that the options should be captured in different issues. Option 1 refers to UE measurements, and option 2 refers to the satellite. These should be discussed separately. Option 1: OKOption 2: Depends on RAN1 decision, as commented by Xiaomi. |
| Huawei | Option 1 seems aligned with our thinking. In our understanding, the separate hardware is used for NR and GNSS. They do not impact each other in terms of measurements. We think that no measurement requirement for GNSS is needed. The first bullet of recommended WF is acceptable for us. We do not need discussing the second bullet. RAN2/1 needs to discuss which measurement and reporting are needed and also the related scheme. |
| Thales | Aligned with Option 1.Option 2 depends on RAN1 decision. |

**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** |
| Ericsson | Agree | 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. |
| Nokia, Nokia Shanghai Bell | Agree  |  |
| Huawei | Agree partially. | The first bullet of recommended way forward is acceptable. |
| Thales | Agree |  |
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Moderator suggests:

**Proposal 1:** It is assumed that there are no interruptions of GNSS measurements during NTN operation.

**Proposal 2:** FFS GNSS measurement & report required periodicities.

## Companies views’ collection for 1st round

### Open issues

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| **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**  |
| **Issue 2-1:** Should GNSS be used on UE, on satellite or both? | *Tentative agreements:***Proposal 1:** UEs with GNSS capabilities are assumed.**Proposal 2:** Further discuss the need for 3GPP to assume GNSS capability on board of satellites.*Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 2-2:** GNSS accuracy assumption for (testing) UL synchronization and TA mechanisms | *Tentative agreements:* Further discuss the required accuracy (depending on the scenarios) 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.*Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 2-3:** GNSS measurement | *Tentative agreements:* **Proposal 1:** It is assumed that there are no interruptions of GNSS measurements during NTN operation.**Proposal 2:** FFS GNSS measurement & report required periodicities.*Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
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*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Email discussion summary for [97e][232] NR\_NTN\_solutions\_RRM 2nd Round |  |

## 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 #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”.**

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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:  |
| 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. |
| MediaTek | Agree with the recommended WF. |
| Ericsson | Option 7 (added, since not listed): Final Timing Advance adjustment accuracy depends on the mechanism chosen in RAN1 specification and the final total uncertainty budget. We should start from a total error budget (for timing for example) and work from there. RAN1 physical layer mechanism and CP, RAN4 timing requirements are related to the needed requirements on UE position, which in turn are related to allowed error satellite position and velocity. In both Thales and Mediatek analysis it is presupposed that CP/2 can be used as uncertainty bound, this is quite large compared to existing TS 38.133 section 7 bounds (in relation to CP). CP is required to deal with time dispersive channel to keep ICI under control. What is the foundation to use CP/2 as error margin, instead of a smaller fraction of CP? |
| Apple | Agree with Xiaomi, more discussion is needed |
| Nokia, Nokia Shanghai Bell | Too early to decide on these options except for Option 5 which is OK as it was decided that “Satellite/HAPS ephemeris based cell selection and reselection should be defined for NTN” at the last RAN2 meeting.  |
| Huawei | We would like to wait for RAN1/RAN2 agreement on the measurement and reporting procedure. |
| Thales | Agree but more discussion may be needed. |

**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** |
| Ericsson | Disagree | The ∆U and ∆V requirements listed in WF are derived from UL frequency accuracy requirement. But there are other cases which also set requirements like Te at initial access (to preserve CP). In R4-2014875 obs. 5, Mediatek show that Te for SCS = 15 kHz leads to requirement of positioning error of +/- 117 meters. However, for larger SCS Te is even stricter.Final Timing Advance adjustment accuracy depends on the mechanism chosen in RAN1 specification and the final total uncertainty budget. We should start from a total error budget (for timing for example) and work from there. RAN1 physical layer mechanism and CP, RAN4 timing requirements are related to the needed requirements on UE position, which in turn are related to allowed error satellite position and velocity.  |
| Nokia, Nokia Shanghai Bell | Disagree  |  |
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Moderator suggests: The topic is not yet mature to be discussed. We should wait for RAN1 decisions.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **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**  |
| **Issue 3-1:** Satellite position accuracy (ΔU) and satellite velocity accuracy (ΔV) | *Tentative agreements:-**Candidate options:-**Recommendations for 2nd round:* The topic is not yet mature to be discussed. We should wait for RAN1 decisions. |

*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. |
|  |  |  |

## 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”.**

|  |  |
| --- | --- |
| **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) |
| MediaTek | Fine with the 1st option of the recommended WF ”TA accuracy better than ±min(CP/2,GP/2,(Minimal Relative Cyclic Shift Duration)/2)”. In principle we are fine with the 2nd option, but we need clarity on what is exactly the most restrictive option |
| Ericsson | 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.  |
| Nokia, Nokia Shanghai Bell | Option 1: Not ok. This is the first time this discussion is taking place in RAN4 RRM. The RAN1 framework is not even agreed yet. It is way too early to decide the exact accuracy levels.Option 2: Partially ok. We can agree to final analysis of Timing Advance adjustment accuracy has to consider at least 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. Option 3: Not ok. Same comments as for option 1. |
| Huawei | Option 2 could be used as starting point for discussion. Both impact on system performance and feasibility whether such accuracy could be achieved need be analyzed. The inputs on TA scheme and the scenarios are needed. |
| Thales | Open to any suggestion for 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** |
| Ericsson | Disagree | CP fulfills an important role in OFDM to manage a time dispersive channel to limit ICI and should be preserved. We object to the CP/2 as an assumption in WF and prefers existing rel-16 TS 38.133 section 7 requirements as baseline for analysis.Ericsson does not necessarily want to pick the most restrictive of all options, we simply want to start from the total error budget: ΔUE-pos, ΔSat-pos, Timing Advance adjustment accuracy and TA command resolution error, in relation to existing timing requirements in TS 38.133, section 7. When looking at the total, perhaps some requirements will have to be stricter than today. |
| Nokia, Nokia Shanghai Bell | Disagree  |  |
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Moderator suggests:

**Proposal 1:** Analysis of Timing Advance adjustment accuracy requirement shall consider at least the total error budget for regulating TA during a call: ΔUE-pos, ΔSat-pos, Timing Advance adjustment accuracy and TA command resolution error.

### 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. |
| MediaTek | In general, agree with the 1st option of the recommend WF “Use UL timing error requirements for NR NTN when UE pre-compensate satellite delay”. Also ok to investigate the UL timing error requirements.  |
| Ericsson | 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. |
| Apple | Need more discussion for Te and Tq. Regarding TA offset, in current TS38.133, we have *N*TA offset=25600Tc for FR1 FDD due to the possibility of FDD+TDD CA case; however, we are not sure if we shall consider FDD+TDD CA deployment in NTN or not, and if not, then the TA offset might be a bit different from legacy NR. Regarding UE timer and cell phase error, we are fine to reuse them from legacy ones in TS38.133. |
| Nokia, Nokia Shanghai Bell | Too early to discuss as this might depend on RAN1. |
| Huawei | In recommended WF, we can agreed on the second half part. In sum, more analysis should be conducted. But the existing requirements anyway can be used as a starting point. |
| Thales | Open for any suggestion for WF |

**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** |
| Ericsson | Disagree | Ericsson does not want to pick the most restrictive of all options, we simply want to start from the total error budget: ΔUE-pos, ΔSat-pos, Timing Advance adjustment accuracy and TA command resolution error, in relation to existing timing requirements in TS 38.133, section 7. When looking at the total, perhaps some requirements will have to be stricter than today.Ericsson is closer to WF option “Use UL timing error requirements for NR NTN when UE pre-compensate satellite delay. Investigate Tq and the maximum aggregate adjustment rate”, if UL timing error requirements means the sam thing as keeping existing requirements in TS 38.133 section 7, but we prefer to analyse from total error budget. |
| Nokia, Nokia Shanghai Bell | disagree |  |
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Moderator suggestion:

**Proposal 1:** Proposed issue is valid; however it requires more discussion in RAN1.

### 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. |
| MediaTek | Agree with the recommended WF to study it. |
| Ericsson | Timing issues and requirements to be discussed in RAN4 when 2 simultaneous feeder links are involved. |
| Apple | Fine with recommended WF. |
| Nokia, Nokia Shanghai Bell | Option 1 means the satellite might be connected to 2 feeder links. And this might have an impact in timing issues depending on where the reference timing is: satellite, gNB or both. |
| Huawei | We should be careful about considering defining the requirements related to feeder link. In our view, the discussion in 3GPP should focus on service link. We are not sure how widely such use case exists, i.e., one service link (one frequency) but with 2 feeder links on satellite. We would like to fully understand the related scheme before analyzing the impact on RAN4. |
| Thales | Ok for option 1. |

**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** |
| Ericsson | Agree | This will depend on RAN2 discussion on whether the feeder link switch is soft switch or hard switch.  |
| Nokia, Nokia Shanghai Bell | Agree |  |
| Huawei | Disagree | The requirement should focus on service link rather than the feeder link between satellite and gateway. |
| Thales | Agree |  |
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Moderator suggestion:

**Proposal 1:** The identified requirement is valid.

**Proposal 2:** Requirement related to service link, and depending if the feederlink switch is soft or hard.

### 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. |
| LGE | Option 1: Yes. |
| MeidaTek | Agree with the recommended WF |
| Ericsson | Both option 1 and option 2 should be considered in analysis, however we are dependent on RAN1 decisions on mechanisms. |
| Apple | Fine with recommended WF. |
| Nokia, Nokia Shanghai Bell | Options 1 and 2 seem to be observations. |
| Huawei | Agree with the recommended way forward. |
| Thales | Agree |

**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** |
| Ericsson | Agree partially. | RAN4 is dependent on RAN1 decisions on mechanisms and physical layer design, like CP length. However it is up to up to RAN4 to develop requirements that adhere to RAN1 design, like preserving CP. |
| Nokia, Nokia Shanghai Bell | Agree |  |
| Huawei |  | We can agree to further discuss the potential issue based on RAN1 input. |
| Thales | Agree |  |
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Moderator suggestion:

**Proposal 1:** RAN4 may develop requirements to preserve CP.

### 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. |
| MediaTek | Option 1, to consider defining test for UE pre-compensation with device using device position and using serving satellite ephemeris broadcast on SIB. This provides an example how this timing requirement can be tested.  |
| Ericsson | Option 2: TBA. It is too early to decide test. This is done in performance/conformance part of WI once core requirements are settled. |
| Apple | The test can be delayed to discuss in performance stage. |
| Nokia, Nokia Shanghai Bell | This will be discussed once the core requirements are completed.  |
| Huawei | We would like to wait for RAN1 agreement. No decision needs be made at the current stage. |
| Thales | Test definition should be considered for delay compensation. |

**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** |
| Ericsson | Agree partly | The test proposal is fine, but it is too early to decide test. This is done in performance/conformance part of WI once core requirements are settled. |
| Nokia, Nokia Shanghai Bell | Disagree  |  |
| Thales | Agree | The point of the proposal is not to decide how the test is to be performed. Is to simply agree that a test should be considered for this aspect. |
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Moderator suggestion:

**Proposal 1:** Test definition should be considered by RAN4 for NTN delay compensation. The test can be discussed once the core requirements are completed.

## 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**  |
| **Issue 4-1:** Acceptable TA error for initial access | *Tentative agreements:* Analysis of Timing Advance adjustment accuracy requirement shall consider at least the total error budget for regulating TA during a call: ΔUE-pos, ΔSat-pos, Timing Advance adjustment accuracy and TA command resolution error.*Candidate options:**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 4-2:** Timing Error Limits | *Tentative agreements:* -*Candidate options:-**Recommendations for 2nd round:* Proposed issue is valid; however it requires more discussion in RAN1. |
| **Issue 4-3:** Timing Issues and Requirements for UE with 2 feederlinks | *Tentative agreements:* **Proposal 1:** The identified requirement is valid.**Proposal 2:** Requirement related to service link, and depending if the feederlink switch is soft or hard.*Candidate options:-**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 4-4:** UE Time alignment behaviour | *Tentative agreements:* RAN4 may develop requirements to preserve CP.*Candidate options:-**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 4-5:** Test definition for satellite delay pre-compensation | *Tentative agreements:* Test definition should be considered by RAN4 for NTN delay compensation. The test can be discussed once the core requirements are completed. *Candidate options:-**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |

*Suggestion on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Email discussion summary for [97e][232] NR\_NTN\_solutions\_RRM 2nd Round | WF |

## 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 #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. |
| MediaTek | Agree with the recommended WF. Also fine to discuss it in RF session since frequency error is defined in 38.101. |
| Ericsson | Option 4: Ericsson has a similar view as expressed in option 3, ie to set requirements both on gNB feeder link and UE service link, however it is to early to lock requirement t333o +/- 20 Hz. Final requirements depends on structure of specification and reference points. This is outlined in Ericsson R4-2015905. |
| Apple | The frequency error might be discussed in RF session, and the demodulation part can be discussed in performance stage. |
| Nokia, Nokia Shanghai Bell | This does not seem to be an RRM issue.  |
| Huawei | This issue should be discussed in RF session. And how to compensate the Doppler shift from satellite needs more consideration when defining the requirements. We also think this issue is related to reference point for the synchronization. |
| Thales | The UL synchronization may depend on pre-compensation method using GNSS. |

**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** |
| Ericsson | Agree partly | That the UE shall be able to compensate the frequency offset due to the satellite mobility when generating its UL carrier frequency, depends on reference point chosen. Ericsson prefer to have the gNB as reference point in rel-17 NTN, in the same way gNB is reference point in rel-16. If gNB is reference, then UE has to be able to compensate for satellite Doppler as well.“The UE modulated carrier frequency shall be accurate to within ±0.1 ppm as observed over a period of 1 ms by the gNB. ”: Again, this depends on specification structure. If gNB is reference, then this is fine to meet at 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.”. If gNB is reference, then we need to analyze requirements at UE to fulfill this at gNB, before we set UE requirement. |
| Nokia, Nokia Shanghai Bell | Disagree |  |
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Moderator suggestion:

**Proposal 1:** Even if UE Doppler UL pre-compensation method is based on GNSS, NTN UL Synchronization Requirement can be considered in RF session.

### 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. |
| MediaTek | According to RAN1’s agreement, the additional information (e.g., serving satellite ephemeris or timestamp) can be assumed, as below. RAN4 can proceed with either serving satellite ephemeris or timestamp. RAN1#102eAgreement:* In Rel-17 NR NTN, at least support UE which can derive based on its GNSS implementation one or more of:
	+ its position
	+ a reference time and frequency
* And, based on one or more of these elements together with additional information (e.g., serving satellite ephemeris or timestamp) signalled by the network, can compute timing and frequency, and apply timing advance and frequency adjustment at least for UE in RRC idle/inactive mode.
* FFS:  Details on additional information signalled from network
 |
| Ericsson | Both option1 and option 2 are valid. |
| Apple | Fine with the recommended WF |
| Nokia, Nokia Shanghai Bell | The WF is OK. |
| Huawei | OK with the recommended way forward. |
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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** |
| Ericsson | Agree | Wait for RAN1 decision. |
| Thales | Agree |  |
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Moderator suggestions:

**Proposal 1:** wait for RAN1 decision.

### 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 |
| MediaTek | Agree with recommended WF to FFS the the way the UE pre-compensates in UL. |
| Ericsson | Option 3: It is too early to decide test. This is done in performance/conformance part of WI once core requirements are settled. |
| Apple | Discuss test in performance stage |
| Nokia, Nokia Shanghai Bell | This will be discussed in the RRM performance when the core requirements are completed. |
| Huawei | Need wait for the agreement from other working groups. |
| Thales | Some Doppler pre-compensation test would be required. |

**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** |
| Ericsson | Disagree | It is too early to decide test. This is done in performance/conformance part of WI once core requirements are settled. |
| Nokia | Disagree |  |
| Thales | Agree | The point of the proposal is not to decide how the test is to be performed. Is to simply agree that a test should be considered for this aspect. |
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Moderator suggestion:

**Proposal 1:** Test definition should be considered by RAN4 for NTN Doppler compensation. The test can be discussed once the core requirements are completed.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **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**  |
| **Issue 5-1:** NTN UL Synchronization Requirement | *Tentative agreements:*Even if UE Doppler UL pre-compensation method is based on GNSS, NTN UL Synchronization Requirement can be considered in RF session.*Candidate options: -**Recommendations for 2nd round:* Have an agreement in 2nd round if possible to consider this requirement in RF session. |
| **Issue 5-2:** NTN UL Synchronization Behaviour | *Tentative agreements:*Wait for RAN1 decision.*Candidate options: -**Recommendations for 2nd round:* - |
| **Issue 5-3:** Test definition for Doppler shift pre-compensation | *Tentative agreements:*Test definition should be considered by RAN4 for NTN Doppler compensation. The test can be discussed once the core requirements are completed. *Candidate options: -**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Email discussion summary for [97e][232] NR\_NTN\_solutions\_RRM 2nd Round | WF |

## 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

|  |  |  |
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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);- 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. |
| LGE | Option 2: YesOption 3: Yes |
| Qualcomm | There are relevant ongoing discussion in other working groups. |
| MediaTek | Agree with recommended WF, except for SMTC enhancement as RAN1 would be the better place to discuss it.  |
| Ericsson | Option 1: During core work item we should only work on RRM core issues, and both demodulation and RSRP/RSRQ measurement accuracy are performance issues that can be addressed in the performance phase. We have understood that there would be significant work needed on core RRM requirements needed as well however. The initial task would be to identify the necessary NTN specific core requirements and work on them to the extent that is possible given current RAN1/2 status. At the same time RAN4 should track relevant decisions made in other WG and take account in the RAN4 RRN work. A minor issue on terminology is that we have not referred to KPI before but rather requirement; our understanding is that they are somewhat equivalent, so it might be better to use this terminology e.g. in any agreements or way forward documents so that there are no misunderstandings that KPI is different (I believe it isn’t).Option 2: It is too early to conclude on option 2, and our assumption is that there needs to be a signaling solution to give SMTC or MG enough flexibility to avoid that SSB is missed. So it depends on a RAN2 solution and our view is that RAN4 shall define the measurement requirements when this solution is used.Option 3: Similar comment to option 2; there is very significant signaling impact to provide ephemeris data and RAN4 cannot define its content (such as whether it includes ephemeris of serving satellite and/or which other satellites in the constellation and how often it is updated). RAN2 has already considered contributions and our understanding of the RAN2#111e meeting was Agreements:1. Cell selection / reselection in NR is the baseline in NTN idle mode procedure.
2. Satellite/HAPS ephemeris based cell selection and reselection should be defined for NTN (FFS what the term satellite/HAPS ephemeris actually means). FFS when this ephemeris based cell selection / reselection can be used. FFS whether UE location (and/or other information) based cell selection and reselection should be introduced for NTN
3. The satellite ephemeris should be provided to UE, at least for Satellite/HAPS ephemeris based cell selection and reselection (FFS what the term satellite/HAPS ephemeris actually means).

So given this status we do not think RAN4 can do much on RRM requirements right now. Another comment is that for TN RAN4 has only defined requirements for cell reselection, and cell selection has no requirements even though there are cell selection criteria in RAN2. So if we assume the same approach for NTN (which isn’t a given, but would be expected unless there is strong justification to do otherwise) we would need to define RRM requirements for satellite/HAPS ephemeris based reselection only and not requirements for ephemeris cell selection (even though the UEs will do that to access the NW initially),We have similar view on measurement gap and SMTC. It is understood to us that MG or SMTC measurements of a neighbor cell (on a different satellite) would need to be made at quite different timing to SMTC / MG of the serving cell, and that the offset would vary significantly depending on the relative propagation delays. However, given the level of agreement on signaling it seems that we are still waiting to understand what the solution(s) are. |
| Apple | Need more discussion on those enhancements. Not sure if those enhancement needs to be discussed in RAN1/2. |
| Nokia, Nokia Shanghai Bell | RSRP/RSRQ is RRM performance requirements which depend on which RRM requirements are selected from 38.133.Option 3 is OK but the following should be added “based on the discussions in RAN2” in both bullet points, to make it clear that RAN4 will wait for their decision. |
| Huawei | Part of the options seem beyond RAN4 scope. In our view, RAN4 should first specify the essential RRM core requirement in the first release for NTN and consider the enhancement in future. |
| Thales | All options are valid. |

**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** |
| Ericsson | Disagree | As indicated, we think RAN4 work would begin by identifying the list of necessary RRM core requirements and starting to study agreements in RAN1/2 to understand how the related procedures work.  |
| Nokia, Nokia Shanghai Bell  | Disagree |  |
| Thales | Agree |  |
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Moderator suggestions:

**Proposal 1:** At least NTN-specific RSRP measurement accuracy should be considered.

**Proposal 2:** Consider RAN2 proposals for new HO procedures.

### 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”.**

|  |  |
| --- | --- |
| **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. |
| Qualcomm | Agree that we need further study on mobility. However, use case and deployment scenario should be first discussed. |
| MediaTek | It would be good to prioritize NTN-to-NTN, as a starting point. Other scenario will be discussed based on RAN2’s discussion. |
| Ericsson | Option 1: We have understood that RAN2 already agreed something quite similar5. For TN/NTN mobility, the UE is not required to connect to both TN and NTN at the same time. 6. RAN2 to discuss about trigger(s) of 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).So we think option 1 is good, because it aligns with the agreement on triggers for TN/NTN mobility. The second bullet looks more like a definition of intra NTN mobility however I think there is one aspect we need to be slightly careful about. In TN we separately talk about L3 mobility and beam management. Some part of “intra satellite mobility” refers I think to what we would call beam management in TN, ie based on procedures like L1 RSRP measurement, beam failure detection and candidate beam detection. Reading some of the papers, I also think there may be some terminology difference in the opposite way as well; I noted that it was stated that satellites often don’t use frequency reuse = 1 and different beams are on different frequencies. In TN terminology that would make changing beam an interfrequency handover, and at least in TN that is considered as mobility and triggered by L3 measurements (or blindly by the network). |
| Apple | RAN2 agreed that “RAN2 to discuss about trigger(s) of 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).” So we think mobility scenario shall be determined by RAN2, and RAN4 can wait more conclusions from RAN2 for TN/NTN mobility. We can firstly focus on intra NTN mobility at the beginning. |
| Nokia, Nokia Shanghai Bell | The proposed option is OK if it is clarified that “Intra-NTN” mobility does not include mobility between different NTN networks. |
| Huawei | Seems to us beyond RAN4 scope. |
| Thales | We propose to wait for RAN2 final agreement. Intra-NTN should be for mobility between different service links of the same NTN constellation/network. It can be between different sattelites (inter-satellite) or between cells/beams of the same satellite (intra-satellite). |

**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
| LGE | Agree | All scenarios need to be considered |
| Ericsson | Agree | As indicated option 1 is aligned with the existing agreement for triggers in RAN2, so perhaps with clarification on the bullet about intra NTN definition we support a similar agreement in RAN4.Regarding the recommended WF our understanding is that all scenarios mentioned are in the scope of the WID objective and as such RAN4 should of course consider them. However this does not mean we have to consider all in parallel and indeed option 1 proposes the opposite. So we think we need to agree on both option 1 and the recommended WF as a package. |
| Nokia, Nokia Shanghai Bell | Agree partially |  |
| Huawei |  | For my clarification, by saying NTN-to-TN and TN-to-NTN, do we include the scenario that the NTN spectrum is shared between satellite and terrestrial system and then UE can do intra-frequency handover between satellite and terrestrial system? |
| Thales | Agree | To Huawei: for the time being such option is not considered. We try to propose a RAN4 exemplary band (at least FR1) where such coexistence situation (sharing spectrum) will not be considered. So probably no intra-frequency handover NTN-TN. |
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Moderator suggestions:

**Proposal 1:** Use RAN2 final agreement.

**Proposal 2:** All scenarios NTN-to-NTN, NTN-to-TN and TN-to-NTN need to be considered for measurement types to be considered in RAN4 RRM for defining requirements.

**Proposal 3;** 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).

### 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”.**

|  |  |
| --- | --- |
| **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. |
| MediaTek | R15 mandatory measurements can be the baseline. |
| Ericsson | Option 1: We agree with this as a proposalOption 2: We agree with this a a proposalOption 3: “Downscoping” and “parameters” are unclear to us ; in principle we don’t see that we start with TN requirements and NTN requirements are a subset – there may be functionalities and corresponding RRM requirements which are not needed for TN until rel17 but are relevant for NTN operation. Then we do not know what are “stand alone mobility states parameters” in 38.133.The recommended WF itself looks a good suggestion (perhaps with some tweaks) |
| Apple | Fine with option 1. |
| Nokia, Nokia Shanghai Bell  | Option 1: OKOption 2: OKOption 3: pending on the progress in RAN1/2 and discuss each case. |
| Huawei | In principle, we can start discussion on the list of essential RRM requirements. But more input from other work groups are needed. |
| Thales | Agree |

**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** |
| Ericsson | Agree with modification | As an observation, core RAN4 RRM requirements are ones which should be complete when RAN1/2 core WI are completed and completion allows the important implementation design decisions to be made in UE and network. Performance requirements are measurement accuracies and test cases. These are also “essential” to meet/pass in terms of the proper operation of the system. So we suggest the WF could read* + Choose at least a list of core RRM requirements to be considered in the NTN work item by RAN4.

Regarding “priority” I deleted that word as it might be better not to get too stuck in that discussion. It can be controversial as saying a requirement is “low priority” is going to mean it is pushed out to the end of the WI by the higher priority work with the corresponding risk that it ends up falling out of the release. So maybe it is better just to identify the list for now without a discussion on some aspects being more or less prioritized, given that we should be aiming to complete them all anyway if they are agreed. |
| Nokia, Nokia Shanghai Bell  | Agree partially | If it clarifies that the priority of essential core requirements is defined after sufficient progress is made in RAN1 / RAN2. |
| Thales | Agree |  |
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Moderator suggestion:

**Proposal 1:** Choose at least a list of essential (core) measurement requirements to be considered in priority by RAN4. The priority of essential core requirements is defined after sufficient progress is made in RAN1 / RAN2.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **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.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Issue 6-1:** Measurement-related potential issues | *Tentative agreements:* **Proposal 1:** At least NTN-specific RSRP measurement accuracy should be considered.**Proposal 2:** Consider RAN2 proposals for new HO procedures.*Candidate options:-**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 6-2:** Measurement types | *Tentative agreements:* **Proposal 1:** Use RAN2 final agreement.**Proposal 2:** All scenarios NTN-to-NTN, NTN-to-TN and TN-to-NTN need to be considered for measurement types to be considered in RAN4 RRM for defining requirements.**Proposal 3;** 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).*Candidate options:-**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |
| **Issue 6-3:** Measurement way forward | *Tentative agreements:* **Proposal 1:** Choose at least a list of essential (core) measurement requirements to be considered in priority by RAN4. The priority of essential core requirements is defined after sufficient progress is made in RAN1 / RAN2.*Candidate options:-**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |

*Suggestion on WF/LS assignment*

|  |  |  |
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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Email discussion summary for [97e][232] NR\_NTN\_solutions\_RRM 2nd Round | WF |

## 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 #6: RRM requirements for beam switching

*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);**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”.**

|  |  |
| --- | --- |
| **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. |
| MediaTek | need RAN1’s input regarding NTN specific BM enhancement. |
| Ericsson | Option 1: Option 2: The RRM requirements in TN are on the UE, not on the system, and we expect the same would be true in NTN. We expect that beam management requirements are needed; it should be better understood what the exact procedures are. For instance, what was referred to as beam switch in contributions was between different carrier frequencies, and if we refer to TN procedures a switch between different frequencies is an L3 interfrequency handover, controlled by RRC.  |
| Apple | Fine with the recommended WF. |
| Nokia, Nokia Shanghai Bell | Option 1 is OK. The context of beam switching should be clarified as it depends on deployment scenarios, FR1 or FR2, etc. There is also a dependency on RAN1/2. |
| Huawei | We are not sure what is the beam switching and how beam switching can be done. Usually UE is within a footprint formed by one satellite analog/digital Tx beam. UE moves from one footprint to the other, which seems to us like inter-frequency handover.  |
| Thales | Beam switching might be useful to reduce normal HO delay/interruption time. RAN4 to further discuss RRM requirements for NTN. However, it depends on the deployment solution. |

**Question: Do you partially agree/disagree with the recommended way forward stated above? Please provide your views on the recommended Way Forward stated above.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree, agree partially, disagree** | **Comments** |
| Ericsson | Partially | Agree RAN4 should define necessary beam management RRM requirements for UEs supporting NTN. Possibly certain common (existing) requirements with scope increased to cover both TN and NTN scope are sufficient in some cases if RAN1 reuses some parts of TN BM functionality. |
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Moderator suggestions:

**Proposal 1:** RAN4 should define necessary beam management RRM requirements for UEs supporting NTN, depending on the selected NTN solution, e.g. beam(s)-to-cell mapping, is same PCI for several satellite beams, if one PCI per satellite beam etc.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **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.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Issue 7-1:** Beam switching RRM requirements | *Tentative agreements:* RAN4 should define necessary beam management RRM requirements for UEs supporting NTN, depending on the selected NTN solution, e.g. beam(s)-to-cell mapping, is same PCI for several satellite beams, if one PCI per satellite beam etc.*Candidate options:**Recommendations for 2nd round:* Have an agreement in 2nd round if possible. |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Email discussion summary for [97e][232] NR\_NTN\_solutions\_RRM 2nd Round | WF |

## 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”* |

# Appendix: Companies contribution summary

Contribution summaries are as follows:

|  |  |  |
| --- | --- | --- |
| **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. |