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

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

**Agenda item:** 8.8.3

**Source:** Moderator (CATT)

**Title:** Email discussion summary for [98-bis-e][309] NTN\_Solutions\_Part3

**Document for:** Information

# Introduction

This paper addresses Agenda item 8.8.3 (including 8.8.3.1 and 8.8.3.2) for the following topics

* Initial discussion on NTN Network side requirements
* Discussion on UE requirements with the focus on UL frequency synchronization error
  + The aim is to come up with a LS reply to RAN1.

# Topic #1: Title

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2104761**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104761.zip) | CATT | **Proposal 1: It is proposed to consider 4 types of NTN-BS, including NTN-BS type 1-C, NTN-BS type 1-H, NTN-BS type 1-O and NTN-BS type 2-O.**  **Proposal 2: Antenna connector, TAB connector and Radiated interface boundary are used as the reference point for NTN-BS type 1-C, NTN-BS type 1-H, NTN-BS type 1-O& 2-O respectively.**  **Observation 1: The operating temperature and conditions maybe different between NTN-BS and those BSs on the ground.**  **Proposal 3: it is proposed to define NTN BS classes based on satellite type and typical altitude.**  **Proposal 4: It is proposed to determine the issue in 2.1~2.3 before discussing RF requirements.** |
| [**R4-2104762**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104762.zip) | CATT | **Observation 1: The frequency error requirement will not be impacted by frequency pre-compensation.**  **Observation 2: Satellite information, e.g. data of ephemeris, is needed for UE to correctly forecast satellite velocity at its reception time and will be discussed in RAN1/2**  **Observation 3: the UE PVT data accuracy is out of 3GPP scope and can be implicitly tested by frequency error.**  **Observation 4: Majority of the UE RF requirements defined in current UE RF specification can be reused with the following exceptions,**   * **ACLR/ACS** * **REFSENS and FRC** * **Other Receiver requirements that have dependency on REFSENS**   **Proposal: It is proposed to reuse 0.1ppm as the UE frequency error requirement for NTN.**  **Proposal 2: The UE only estimates the frequency pre-compensation for serving link.**  **Proposal 3: It is proposed to consider VSAT as a CPE, new power classes could be defined for VSAT.** |
| [**R4-2104764**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104762.zip) | CATT | **Draft LS response on NTN UL time and frequency synchronization**  **Question 2:** What are the NTN UL frequency synchronization requirements?   * For initial access (i.e. PRACH transmission) * For UL transmissions in RRC Connected State   **Answer 2:** Reuse 0.1ppm as the UE frequency error measurements. |
| [**R4-2106361**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106361.zip) | MediaTek inc. | **Observation 1:** UL frequency error contributed by UE pre-compensate satellite Doppler can be within 3% error budget of ± 0.1ppm, even with relatively infrequent updates to pre-compensation (e.g. 30 s).  **Observation 2**: RAN1 already agreed on an NR NTN UE shall be capable of at least using its acquired GNSS position and satellite ephemeris to calculate frequency pre-compensation to counter shift the Doppler experienced on the service link, in RRC\_CONNECTED, RRC\_IDLE and RRC\_INACTIVE states.  **Proposal 1: In line with RAN1 agreements, RAN4 should define frequency error requirements to cover the case where UE shall be able to pre-compensate the frequency offset to counter shift the Doppler experienced on the service link. The NTN frequency error requirement shall apply for both PRACH transmission and also UL transmission in RRC connected mode.**  **Proposal 2: Reuse the legacy TN UL frequency error requirement of ± 0.1ppm for the NTN UE.** |
| [**R4-2106610**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106610.zip) | ZTE Corporation | **Proposal 1: EVM distortion factor due to wireless feeder link should be taken into account when discussing the highest modulation order and EVM performance for the supported modulation order.**  **Proposal 2: For NTN-gateway without baseband capability with wireless connected with gNB, EVM distortion due to wireless link between NTN-gateway and gNB should be taken into account when specifying the highest supported modulation order and EVM performance for the supported modulation order in addition to proposal 1.**  **Proposal 3: for different NTN architecture, the following RF requirement framework should be defined.**  For **Case A**: general BS requirement on service link is needed to be specified only;  For **Case B**: take RF repeater requirement framework as reference (service link+link between gateway and gNB);  For **Case C**: take relay or IAB requirements framework as reference (service link+link between gateway and gNB). |
| [**R4-2106900**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106900.zip) | Ericsson | **Observation 1: Frequency offset compensation (issue 6-1) has already been addressed in RAN1.**  **Proposal 1: For NTN UE, the modulated carrier frequency shall be accurate to within ±0.1 ppm as observed over a period of 1 ms by the gNB (for 2GHz and assuming UE pre-compensate doppler error is neglectable, see Issue 6-3).**  **Proposal 2: For a NTN UE operating in 2 GHz frequency band, assuming it’s common understanding that the UE pre-compensate doppler error is neglectable comparing to UE frequency error requirement:**   * **This should be captured in TS 38.101.-1.** * **The current UE frequency error requirement limit would also be applicable to NTN UE.**   **Proposal 3: Send the LS Reply proposed in Annex A to RAN1.** |
| [**R4-2107122**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107122.zip) | Qualcomm Incorporated | **Observation 1: With the tight timing requirement between GNSS receiver’s response and UL transmission timing, UE has to read GNSS signals very often which results in a significant UE power consumption.**  **Observation 2: To find a balance between UE power consumption and accuracy of acquiring the location information, UE has to reduce the frequency of reading GNSS information which will lead to the relaxation for frequency synchronization requirements.**  **Proposal 1: RAN4 to discuss the frequency synchronization requirements relaxation for connected mode.**  **Proposal 2: FFS on whether to define a separate frequency synchronization requirement for idle mode.** |
| [**R4-2107275**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107275.zip) | THALES | **Proposal 1:** For initial access (i.e. PRACH transmission) and for UL transmissions in RRC Connected State, the NTN UE modulated carrier frequency shall be accurate to within ±0.1 ppm, as observed over a period of 1 ms by the gNB.  **Proposal 2:** The NTN UE residual frequency error shall be sufficiently low such that it can be considered as included in the tolerated frequency error of ±0.1 ppm already captured in the specification.  **Proposal 3:** RAN4 shall use the maximum tolerated Doppler shift pre-compensation error to derive the precision of ephemeris data such as transmission periodicity, NTN UE acquisition periodicity and the NTN UE prediction parameters (e.g. method, maximum duration, etc.).  **Proposal 4:** RAN4 should assume accurate prediction of satellite trajectories for reliable Doppler compensation.  **Proposal 5:** RAN4 should assume that the NTN infrastructure (NTN control function) can provide updates of the actual Ephemeris at the necessary periodicity to prevent excessive ageing that would prevent successful uplink synchronisation.  **Proposal 6:** RAN4 should consider NTN UE ephemeris acquisition periodicity and NTN UE ephemeris prediction parameters derived based on the maximum allowed UL frequency synchronization error. |

## 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 1-1 network side requirements

Sub-topic description:

There is an ongoing discussion on the NTN architecture of E-mail thread [307]. The conclusion in that thread will have impact on the discussion of BS. To progress the discussion on network side requirements, we made some precondition for each question.

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

**Issue 1-1-1: Assuming E-mail tread# 307 agrees to treat “Satellite + feeder link + NTN-Gateway” as an entity, do you think EVM distortion factor needs to be considered for wireless connection between NTN Gateway and gNB?**

* Proposals
  + Option 1: Yes. EVM distortion should be taken into account for the supported modulation order.
  + Option 2: No.
* Recommended WF
  + TBA

**Issue 1-1-2: Assuming E-mail tread# 307 agrees to treat “Satellite + feeder link + NTN-Gateway + gNB” as an entity, what NTN BS type and reference point should be considered?**

* Proposals
  + Option 1: Taking the current BS requirement structure as the starting point, e.g.
    - Specify NTN BS type 1-C, NTN BS type 1-H, NTN BS type 1-O and NTN BS type 2-O as needed depending on the operating frequency range and antenna connector availability.
    - Using Antenna connector, TAB connector and Radiated interface boundary as the reference point respectively for corresponding NTN BS type.
  + Option 2: Other, please specify.
* Recommended WF
  + TBA

**Issue 1-1-3: Assuming E-mail tread# 307 agrees to treat “Satellite + feeder link + NTN-Gateway + gNB” as an entity, how to develop NTN BS classes?**

* Proposals
  + Option 1: define NTN BS classes according to the NTN/HIBS types and typical altitude
  + Option 2: Other, please specify.
* Recommended WF
  + TBA

**Issue 1-1-4: Do we need to consider special operating condition for NTN BS?**

* Proposals
  + Option 1: Yes. Further input from satellite operators is needed.
  + Option 2: Other, please specify.
* Recommended WF
  + TBA

### Sub-topic 1-2 UE aspects

Sub-topic description:

The main focus of this sub-topic is to discuss NTN UL frequency synchronization requirements. Defer the discussion on other UE requirements.

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

**Issue 1-2-1: Multiple contributions mentioned “residual UE frequency error” which seems a little bit vague. Does it mean addition frequency error caused by pre-compensation to counter shift Doppler?**

* Proposals
  + Option 1: Yes.
  + Option 2: No. Please specify.
* Recommended WF
  + TBA

**Issue 1-2-2: Do you agree UE pre-compensation error for Doppler is negligible compared to 0.1ppm frequency error?**

* Proposals
  + Option 1: Yes.
  + Option 2: No.
* Recommended WF
  + TBA

**Issue 1-2-3: Do you agree to use 0.1 ppm both for initial access (i.e. PRACH transmission) and for UL transmissions in RRC Connected State?**

* Proposals
  + Option 1: Yes. i.e.
    - The NTN UE modulated carrier frequency shall be accurate to within ±0.1 ppm, as observed over a period of 1ms by the gNB.
  + Option 2: No. Please explain.
* Recommended WF
  + TBA

**Issue 1-2-4: Do you think it necessary to further clarify in the spec that NTN UE pre-compensation error for Doppler is negligible?**

* Proposals
  + Option 1: Yes.
  + Option 2: No. It can be included in 0.1ppm and will be implicitly tested by the frequency error test.
* Recommended WF
  + TBA

**Issue 1-2-5: Do you agree to assume that NTN infrastructure (NTN control function) can provide updates of the actual Ephemeris at the necessary periodicity to prevent excessive ageing that would prevent successful uplink synchronisation?**

* Proposals
  + Option 1: Yes. Detailed discussion on ephemeris acquisition periodicity can leave to RAN1.
  + Option 2: No.
* Recommended WF
  + TBA

**Issue 1-2-6: How to consider VSAT if it is in the scope of Rel-17?**

* Proposals
  + Option 1: Treat VSAT as a CPE type of UE. New power class could be considered.
  + Option 2: Treat VSAT as IAB.
  + Option 3: Other, please specify.
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1

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

Sub topic 1-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| MediaTek | 1-2-1: Option 1 – meaning the remaining frequency error observed by uplink receiver once the pre-compensation has been applied by the UE.  1-2-2: Option 1 - please see analysis and Observation 1 in R4-2106361.  1-2-3: Option 1  1-2-4: Option 2  1-2-5: Option 1  1-2-6: Option 3 – needs further discussion in future meetings. |
| Huawei | Issue 1-1-1:  Since we don’t specify the EVM requirements and test them at NTN-Gateway side referring to the current agreement, we can just specify the EVM requirements at satellite side. This issue depend on how to consider the link budget. Do we just calculate it between satellite and UE or between NTN-Gateway and UE?  Issue 1-1-2:  We can give priority to type 1-C considering the reflector antenna. I’m not sure type 1-H, 1-O and 2-O are applicable to the satellite.  Issue 1-1-3:  We can define the satellite classes based on the transmitting power and orbit.  Issue 1-1-4:  Yes. It depends on input from satellite operators. But RAN4 should further discuss whether or how to consider it.  Issue 1-2-1:  Issue 1-2-2:  Option 1: Yes.  Issue 1-2-3:  Option 1: Yes.  Issue 1-2-4:  One alternative is to clarify it in TR or replied LS to RAN1.  Issue 1-2-5:  Option 1  Issue 1-2-6:  Option 3: Need further discussion in the future. At least, it’s not a IAB node. |
| CATT | Issue 1-1-1:  If we treat “Satellite + feeder link + NTN-Gateway” and specify repeater type of requirement, then EVM distortion should be considered. But the precondition is that we shall also specify requirement for the interface between Gateway and gNB which seems not possible since there is no standard interface defined.  Issue 1-1-2:  Take option 1 as starting point. It is also possible to consider priority to some of the classes for the first step. E.g. 1-C for L and S band.  Issue 1-1-3:  Take Option 1 (satellite/HIBS type and their altitude) as the starting point. We are also open for other criteria e.g. power and orbit  Issue 1-1-4:  Option 1. It depends on input from satellite operators.  Issue 1-2-1:  We don’t use this term. As I understand, we should interpret it as option 1.  Issue 1-2-2:  Option 1.  Issue 1-2-3:  Option 1.  Issue 1-2-4:  Option 2. We are fine to clarify it in TR or somewhere in the WF.  Issue 1-2-5:  Option 1  Issue 1-2-6:  Option 1 or 3 depending on further discussion. |
| ZTE | Issue 1-1-1:  EVM distortion should be considered to further determine the supported modulation order.  Issue 1-1-2:  It’s better to start with 1-C.  Issue 1-1-3:  Fine with option 1;  Issue 1-1-4:  Option 1.  Issue 1-2-1:  Option 1  Issue 1-2-2:  Option 1  Issue 1-2-3:  Option 1  Issue 1-2-4:  Option 1  Issue 1-2-5:  This should be left up to RAN1  Issue 1-2-6:  Option 1 |
| Ericsson | Sub-topic 1-1  1-1-1: To avoid useless discussion, it’s better to conclude on the architecture in #307 first.  1-1-2: To avoid useless discussion, it’s better to conclude on the architecture in #307 first.  Option 2: Are BS Type 1-C and 1-H relevant for satellite? Satellite should not have any antenna connector, right? … We might even not need then to use 1-O and 2-O types either as it would only be FR1 NTN and FR2 NTN nodes.  1-1-3: This would need further discussion. How to classify satellites and HAPS is tbd for the time being.  1-1-4: Most likely option 1.  Sub-topic 1-2  1-2-1: Option 1 is our current understanding.  1-2-2: Option 1  1-2-3: Option 1. Btw, what about the LS Reply to RAN1? Part of it (frequency sync) should be handled in this thread…?  1-2-4: Option 1, this should be captured at least in a TR to avoid any discussion at a later stage.  Note that it won’t be tested by the frequency error test as stated in option 2: the current testing procedure doesn’t include any Doppler error.  1-2-5: Option 1, this is more a RAN1 topic.  1-2-6: This is out of scope. Option 3 anyway. |
| Intelsat | 1-2-1: Option 1  1-2-2: Option 1  1-2-3: Option 1  1-2-4: Option 1  1-2-5: Option 1  1-2-6: Option 1 or 3 – needs further discussion in future meetings. |
| Hughes/EchoStar | 1-2-1: Option 1  1-2-2: Option 1  1-2-3: Option 1  1-2-4: Option 2  1-2-5: Option 1  1-2-6: Option 3 – need more discussion |
| THALES | NW Side => Sub-topic 1-1  1-1-1: EVM requirements can be specified at satellite side. Standby for decision on [98-bis-e][307] NTN\_Solutions\_Part1  1-1-2: Standby for decision on [98-bis-e][307] NTN\_Solutions\_Part1  1-1-3: Too early to decide on “NTN BS classes”. However, we can use information from TR 38.821 with Set-1 for satellite node (NTN-Payload) with respective parameters for LEO@600km, LEO@1200km, GEO.  Moreover, these classes can be satellite-specific, since will be included in different TS from 38.104. Please see RAN#91-e agreement, Proposal NTN-2.2 of RP-210791: “New TS capturing the radio transmission and reception requirements for Satellite node”.  1-1-4: Option 1, depending on information from satellite operators.  What does the moderator mean by “**special operating condition**” in the case of satellites?  UE Side => Sub-topic 1-2  1-2-1: Option 1 – please see **[R4-2107275](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107275.zip).**  Question: “Does it mean addition frequency error caused by pre-compensation to counter shift Doppler?”  Answer: The pre-compensation does not add frequency error but does not compensate everything perfectly  1-2-2: Option 1, if the network information (satellite ephemeris) and GNSS location are sufficiently accurate and refresh frequently enough.  1-2-3: Option 1  1-2-4: Option 2. Option 2 may be a valid option from RAN4 spec perspective. However, RAN1 still need frequency requirements definition from RAN4 to make progress on ephemeris format, reacquisition periodicity, …  1-2-5: Option 1. However, the constraint on the Doppler pre-compensation will have impact on the periodicity requirements.  For further exemplification, the maximum tolerated Doppler shift pre-compensation error can be used to derive the precision of ephemeris data such as transmission periodicity, NTN UE acquisition periodicity and the NTN UE prediction parameters (e.g. method, maximum duration, etc.). Please see **[R4-2107275](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107275.zip).**  1-2-6: Option 1 most probably. |

### CRs/TPs comments collection

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

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

## Summary for 1st round

### Open issues

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

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

### CRs/TPs

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

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

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

## Discussion on 2nd round (if applicable)

# Topic #2: Title

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-20xxxxx | Company A | Proposal 1:  Observation 1: |

## 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

*Sub-topic description:*

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

**Issue 2-1: TBA**

* Proposals
  + Option 1: TBA
  + Option 2: TBA
* Recommended WF
  + TBA

### Sub-topic 2-2

*Sub-topic description*

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

**Issue 2-2: TBA**

* Proposals
  + Option 1: TBA
  + Option 2: TBA
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

**Example 1**

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

**Example 2**

Sub topic 1-1

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

Sub topic 1-2

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

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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

## Summary for 1st round

### Open issues

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

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

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

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

**Existing tdocs**

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

Notes:

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

## 2nd round

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

Notes:

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