3GPP TSG-RAN WG4 Meeting # 112 R4-2411355

**Maastricht, NL, Aug 19 – 23, 2024**

**Agenda Item:** 8.25.5

**Source:** CATT

**Title:** Topic summary for [112][226] NR\_NTN\_Ph3

**Document for:** Information

# Introduction

This summary focuses on RRM core requirements for [112][226] NR\_NTN\_Ph3 and the following topics are covered, including agenda 8.25.1 and 8.25.4.

* Topic 1: Work plan (8.25.1)
* Topic 2: Downlink coverage enhancements (AI 8.25.4)
* Topic 3: Uplink Capacity/Cell Throughput Enhancement (AI 8.25.4)
* Topic 4: Signaling of the intended service area of a broadcast service (e.g. MBS broadcast) via NR NTN (AI 8.25.4)
* Topic 5: Support of regenerative payload (AI 8.25.4)
* Topic 6: Support of (e)RedCap UEs with NR FR1-NTN (AI 8.25.4)

Recommendation of prioritized topics for online discussion

Sub-topic 5-1: Issue 5-1-1/ 5-2-1

Sub-topic 6-2: Issue 6-2-1/ 6-2-2

Sub-topic 6-3: Issue 6-3-1

Sub-topic 6-4: Issue 6-4-1

Sub-topic 6-5: Issue 6-5-1

Sub-topic 6-6: Issue 6-6-1

Sub-topic 6-7: Issue 6-7-1

Sub-topic 6-8: Issue 6-8-1

# Topic #1: Work plan

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2411355**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411355.zip) | CATT, Thales | Work plan |

## Open issues summary

### Sub-topic 1-1 Work plan

**Issue 1-1-1: Work plan**

* Proposals
	+ Proposal 1: Work plan is provided in R4-2411355.(CATT, Thales)
* Recommendations:
	+ The work plan R4-2411355 will be treated in [112][310] NR\_NTN\_Ph3\_General\_SAN\_RF.

# Topic #2: Downlink coverage enhancements

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **[R4-2411356](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411356.zip)** | CATT | **Proposal 1: If SSB channel enhancement with SSB periodicity extension is considered in RAN1, RAN4 will discuss the impact of RRM** **requirements in NTN operation.*** **RAN4 to wait for more RAN1 progress.**
 |
| [**R4-2411452**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411452.zip) | Apple | ***Proposal 1: RAN4 to decide if corresponding RRM requirement(s) needs to be updated/clarified after RAN1 has concrete conclusion on the SSB periodicity extension for DL coverage enhancement.******Proposal 2: RAN4 to wait more conclusions from RAN1 to decide whether and how NTN RRM can be impacted by DTX/DRX from NES.*** |
| **R4-2411619** | Xiaomi | **Observation 1: Satellite beam activation/deactivation scheme is under discussion in RAN1/2.** **Proposal 1: RAN4 to study the RRM impact of satellite beams activation/deactivation scheme after RAN1/2 reaching more concrete conclusions.****Observation 2: The SSB periodicity enhancement will be considered in RAN1.** **Proposal 2: RAN4 to study the RRM impact of SSB periodicity enhancement once further progress is made in RAN1.** |
| [**R4-2411686**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411686.zip) | LG Electronics Inc. | ***Proposal 1***: After RAN1 concludes the solution for dynamic and flexible power sharing among satellite beams or different satellite beam patterns/size, RAN4 should check whether the outcome from RAN1 is affect RRM requirements. |
| [**R4-2412112**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412112.zip) | Samsung | **Observation 1: The number of active beams is much less than the total number of beams.****Observation 2: There is “off” state which means no any signal which means UE cannot receive DL signal including DL RS during “off” state.** **Observation 3: The legacy RAN4 RRM requirements are mainly based on DL RS including SSB or CSI-RS. If there is no SSB or CSI-RS as the measurement RS, it cannot perform the measurements.** **Proposal 1: If SSB periodicity is extended, almost all RRM requirements should be impacted including idle mode/inactive mode and connected mode such as: cell (re)-selection, L3 measurement/L1 measurement and so on. Need further RAN1 conclusion on whether SSB periodicity is changed.** **Proposal 2: All the measurements related to DL-RS should be impacts in “off” state. RAN4 to discuss and define new RRM requirements to enhance DL coverage. Need further progress from other WGs.** |
| [**R4-2412234**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412234.zip) | Ericsson | Observation 1: There have been preliminary proposals for adding prioritization rules for collision cases 3 and 4 using any of the following alternatives:* Adding a fixed rule in the specification (i.e., no signalling).
* Leaving up to the UE implementation to decide the priority (i.e., Adding a statement in the specification like the one that exists for collision case 6 “the HD-UE can select based on its implementation whether to either transmit … or receive …”).
* Introducing signalling for the network to decide the priority.

**Observation 2: In our understanding, the intention behind defining priorities for collision cases 3 and 4 is eliminating the current uncertainty of those cases being treated as error cases. Thus, adding a fixed rule in the specification seems to be a suitable approach (just as it has been done for most of the existing collision cases).****Observation 3: In relation to the previous observation. Our initial view is that the other alternatives (i.e., up to UE implementation, and signalling) for introducing the priorities of collision cases 3 and 4 are less preferred because of the following reasons:*** **Leaving up to the UE implementation to decide the priority: In terms of eliminating the uncertainty, this alternative keeps the uncertainty and varies from time-to-time (i.e., as per UE’s discretion) what is to be prioritized.**
* **Introducing signalling for the network to decide the priority: The information to be potentially prioritized (e.g., SIB19) takes place during both initial access and connected mode. Thus, using signalling to define priority rules for collision cases 3 and 4 likely will end-up impacting “common control information” for initial access and “UE specific control information” for when the UE has established RRC connection with the network.**

**Proposal 1: RAN4 to check if RRM requirements could be impacted by SSB periodicity extension to a value larger than 20ms during cell search, including the remaining physical channels and signals (e.g., SIB, paging, etc.).****Proposal 2: RAN4 to check if RRM requirements could be impacted by scaled measurement time delay due to extension of SSB/SMTC/DRX periodicity.****Proposal 3: RAN4 to check if beam steering latency other than 0 may impact RRM requirements.** **Proposal 4: RAN4 to check if timing offset/error (between beam switching timing and DL/UL framework) may impact RRM requirements.** **Proposal 5: If applicable, the requirements for quasi-earth\_fixed cell and earth\_ moving cell both shall be studied with respect to the beam hopping scheme.** |
| [**R4-2412672**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412672.zip) | Huawei, HiSilicon | **Proposal 1: RAN4 to wait for more progress from RAN1/2 on SSB periodicity extension and other possible system level enhancements to discuss the RRM impacts of DL coverage enhancement.** |
| [**R4-2413188**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413188.zip) | Qualcomm Incorporated | **Observation 1: According to the performance analyses on Set 1-1, 1-2 and 1-3, SSB periodicity extension may be considered for Set 1-2. As per the updated WID approved in RAN#104, RAN1 will further investigate the impact of the extended SSB periodicity on latency and success rate of initial cell selection. In the scope of ‘downlink coverage enhancement,’ other than SSB periodicity extension, no outstanding issues which potentially affect RRM have been identified.****Proposal 1: For downlink coverage enhancement, RAN4 should wait for further progress from other working groups, particularly regarding SSB periodicity extension.** |

## Open issues summary

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

### Sub-topic 2-1 SSB periodicity enhancement

#### Issue 2-1-1: RRM impact of SSB periodicity enhancement

* Proposals
	+ Proposal 1 (CATT, Apple, Xiaomi, Samsung, HW, QC):
		- RAN4 to wait for more progress from RAN1/2 on SSB periodicity extension and other possible system level enhancements to discuss the RRM impacts of DL coverage enhancement.
		- Proposal 1a (Samsung):
			* If SSB periodicity is extended, almost all RRM requirements should be impacted including idle mode/inactive mode and connected mode such as: cell (re)-selection, L3 measurement/L1 measurement and so on. Need further RAN1 conclusion on whether SSB periodicity is changed.
		- Proposal 1b (Ericsson): RAN4 to check if RRM requirements could be impacted by scaled measurement time delay due to extension of SSB/SMTC periodicity.
			* RAN4 to check if RRM requirements could be impacted by SSB periodicity extension to a value larger than 20ms during cell search, including the remaining physical channels and signals (e.g., SIB, paging, etc.).
* Recommended WF

*Check Proposal 1 is agreeable or not.*

* + Recommend agree on:
		- RAN4 to wait for more progress from RAN1/2 on SSB periodicity extension and other possible system level enhancements to discuss the RRM impacts of DL coverage enhancement.

### Sub-topic 2-2 Network energy saving

#### Issue 2-2-1: RRM impact of DTX/DRX

* Proposals
	+ Proposal 1 (Apple):
		- RAN4 to wait more conclusions from RAN1 to decide whether and how NTN RRM can be impacted by DTX/DRX from NES.
	+ Proposal 2 (Samsung):
		- All the measurements related to DL-RS should be impacts in “off” state. RAN4 to discuss and define new RRM requirements to enhance DL coverage. Need further progress from other WGs.
	+ Proposal 3 (Ericsson):
		- RAN4 to check if RRM requirements could be impacted by scaled measurement time delay due to extension of DRX periodicity.
* Recommended WF
	+ To be discussed.

### Sub-topic 2-3 Dynamic and flexible power sharing

#### Issue 2-3-1: RRM impact of dynamic and flexible power sharing

* Proposals
	+ Proposal 1 (LG):
		- After RAN1 concludes the solution for dynamic and flexible power sharing among satellite beams or different satellite beam patterns/size, RAN4 should check whether the outcome from RAN1 is affect RRM requirements.
	+ Proposal 2 (Xiaomi):
		- RAN4 to study the RRM impact of satellite beams activation/deactivation scheme after RAN1/2 reaching more concrete conclusions.
* Recommended WF
	+ To be discussed.

### Sub-topic 2-4 Other RRM impacts

#### Issue 2-4-1: Beam switching related issues

* Proposals
	+ Proposals (Ericsson):
		- RAN4 to check if beam steering latency other than 0 may impact RRM requirements.
		- RAN4 to check if timing offset/error (between beam switching timing and DL/UL framework) may impact RRM requirements.
		- If applicable, the requirements for quasi-earth\_fixed cell and earth\_ moving cell both shall be studied with respect to the beam hopping scheme.
* Recommended WF
	+ To be discussed.

# Topic #3: Uplink Capacity/Cell Throughput Enhancement

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2411452**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411452.zip) | Apple | ***Proposal 3: No need for RAN4 to discuss RRM requirement for uplink Capacity/Cell Throughput Enhancement.*** |
| [**R4-2411686**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411686.zip) | LG Electronics Inc. | ***Proposal 2***: No RRM related issues on the objective for Uplink Capacity/Cell Throughput Enhancement  |
| [**R4-2412112**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412112.zip) | Samsung | **Proposal 3: For uplink capacity/cell throughput enhancement for FR1-NTN, no RRM impacts.**  |
| [**R4-2412234**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412234.zip) | Ericsson | **Proposal 6: No RRM requirements are affected by uplink enhancement.** |
| [**R4-2413188**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413188.zip) | Qualcomm Incorporated | **Observation 2: The scope of uplink capacity enhancement aims to increase the system level capacity and throughput via multiplexing multiple UEs, up to 4, by means of OCC over the same time/frequency resources. According to the WID and study/work on the item conducted by RAN1, no impact on RRM is expected due to uplink capacity enhancement.****Proposal 2: For uplink capacity enhancement, RAN4 to not discuss RRM impact due to uplink capacity enhancement schemes.** |

## Open issues summary

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

### Sub-topic 3-1 RRM impact for objective#2

#### Issue 3-1-1: RRM impact for uplink Capacity/Cell Throughput Enhancement

* Proposals
	+ Proposal 1 (CATT, Apple, LG, Samsung, Ericsson, QC):
		- No need for RAN4 to discuss RRM requirement for uplink Capacity/Cell Throughput Enhancement.
* Recommended WF

*Check Proposal 1 is agreeable or not.*

* + Recommend agree on:
		- No need for RAN4 to discuss RRM requirement for uplink Capacity/Cell Throughput Enhancement.

# Topic #4: Signaling of the intended service area of a broadcast service (e.g. MBS broadcast) via NR NTN

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2412112**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412112.zip) | Samsung |  **Proposal 3: For objective#3, no RRM impacts.** |
| [**R4-2413188**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413188.zip) | Qualcomm Incorporated | **Observation 6: UE RRM performance impact is not expected due to geofencing based broadcast service.****Proposal 7: RAN4 to not discuss geofencing based broadcast service for RRM requirement definition.** |

## Open issues summary

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

### Sub-topic 4-1 RRM impact for objective#3

#### Issue 4-1-1: RRM impact for objective#3

* Proposals
	+ Proposal 1 (CATT, Samsung, QC):
		- For objective#3, there is no RRM impact.
* Recommended WF

*Check Proposal 1 is agreeable or not.*

* + Recommend agree on:
		- For objective#3, there is no RRM impact.

# Topic #5: Support of regenerative payload

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2411356**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411356.zip) | CATT | **Proposal 2: RAN4 need to discuss whether all of existing requirements defined for NR NTN will be defined for regenerative architecture.*** **If yes, the existing requirements for NR NTN can be a baseline.**

**Proposal 3: RAN4 need to discuss what the RRM impacts on all of existing requirements defined for NR NTN.*** **RAN4 will define specific RRM requirements at least for the parts that effected by regenerative architecture.**

**Observation 1: For time and frequency pre-compensation with** **regenerative payload, the BS will no longer need to compensate for the delay and frequency offset of the feeder link**$, $**and RAN4 only need to consider the time and frequency pre-compensation from the UE side.****Proposal 4: For regenerative payload,** $N\_{TA,adj}^{common}$ **will be always considered as 0 when calculating the reference point for the UE initial transmit timing control requirement.*** **FFS: Due to** $N\_{TA,adj}^{common}$ **is defined in TS 38.211, so it may not affect the spec of TS 38.133 in RAN4.**

**Proposal 5: Whether to update the specific RRM requirements for RRC re-establishment with regenerative payload should wait for RAN2/RAN3 progress.****Proposal 6: Whether to update the specific RRM requirements for inactive state with regenerative payload should wait for RAN2/RAN3 progress.****Proposal 7: RAN4 should define the RRM requirements for RACH-less handover for regenerative architecture.*** **The existing requirements for NR NTN can be a baseline.**
* **Wait for more RAN2 progress on further optimization.**

**Proposal 8: RAN4 should define the RRM requirements for network verified UE positioning for regenerative architecture.*** **The existing requirements for NR NTN can be a baseline.**
 |
| [**R4-2411452**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411452.zip) | Apple | ***Proposal 4: RAN4 to clarify common TA = 0 in timing requirement for regenerative mode of NTN.******Proposal 5: RAN4 to clarify requirement of satellite switching without PCI change is not applied for regenerative mode of NTN.*** |
| [**R4-2411686**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411686.zip) | LG Electronics Inc. | ***Proposal 3***: No additional RRM requirements for regenerative payload are required |
| [**R4-2412112**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412112.zip) | Samsung | **Observation 4: The component of common TA is for the timing component of feeder link delay. If satellite supports regenerative payload which means the gNB function of TA should be from the satellite but not includes feeder link delay.****Observation 5: It is not clear whether RAN will remove common TA or not. Or just set it to zero in this scenario.****Proposal 4: For support of regenerative payload, FFS on any update of timing requirements.** **Proposal 5: For support of regenerative payload, FFS on other RRM requirements such as re-establishment, satellite switch, RACH-less HO etc, further RAN2 progress/conclusion is needed.** |
| [**R4-2412234**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412234.zip) | Ericsson | **Proposal 7: Regenerative payload has no effect on RRM requirements as of yet, we may continue to monitor progress in other WGs.** |
| [**R4-2412672**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412672.zip) | Huawei, HiSilicon | **Proposal 2: RAN4 to assume existing RRM requirements are applicable for regenerative payload as baseline, and it can be revisited based on RAN2 agreements.**  |
| [**R4-2413042**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413042.zip) | ZTECorporation,Sanechips | **Proposal 17: RAN4 shall reuse the legacy multiple SMTCs mechanism for regenerative payload.** **Observation 14: Compared to transparent payload, the reference point is only on payload not on the feeder link and the common TA is 0.****Proposal 18: RAN4 shall clarify that there is little difference between transparent payload and regenerative payload on timing advance.** |
| [**R4-2413188**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413188.zip) | Qualcomm Incorporated | **Observation 7: Signaling enhancements for the support of regenerative payload-based NTN are still under discussion in RAN2 and RAN3.****Proposal 8: RAN4 to wait for further progress on regenerative payload-based NTN until the group can get more clarity on the impact of the feature on RRM requirement definition.** |

## Open issues summary

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

### Sub-topic 5-1 General requirements for regenerative payload

#### Issue 5-1-1: RRM requirements to be defined for regenerative payload

* Proposals
	+ Proposal 1 (CATT, Samsung, Ericsson, QC, ZTE):
		- RAN4 to wait for further progress on regenerative payload-based NTN until the group can get more clarity on the impact of the feature on RRM requirement definition.
	+ Proposal 2 (LG):
		- No additional RRM requirements for regenerative payload are required.
	+ Proposal 3 (CATT, HW, ZTE):
		- RAN4 need to discuss whether all of existing requirements defined for NR NTN will be defined for regenerative architecture.
			* RAN4 will define specific RRM requirements at least for the parts that effected by regenerative architecture.
			* The existing requirements for NR NTN can be a baseline and it can be revisited based on RAN2 agreements. (HW)
* Recommended WF

*Check the following is agreeable or not.*

* + Recommend agree on:
		- The existing requirements for NR NTN can be a baseline and it can be revisited based on agreements from other groups.

### Sub-topic 5-2 Timing requirements

#### Issue 5-2-1: Timing requirements for regenerative payload

* Proposals
	+ Proposal 1 (CATT, Apple, ZTE):
		- $N\_{TA,adj}^{common}$ will be considered as 0 for regenerative mode of NTN.
		- Proposal 1a (Apple, ZTE):
			* RAN4 to clarify common TA = 0 in timing requirement for regenerative mode of NTN.
		- Proposal 1b (CATT):
			* FFS: Due to $N\_{TA,adj}^{common}$ is defined in TS 38.211, so it may not affect the spec of TS 38.133 in RAN4.
* Recommended WF

*Check the following is agreeable or not, and discuss other proposals.*

* + Recommend agree on:
		- $N\_{TA,adj}^{common}$ will be considered as 0 for regenerative mode of NTN.
	+ To be discussed:
		- Whether to clarify $N\_{TA,adj}^{common}$ = 0 for timing requirements in TS 38.133 for regenerative mode of NTN ?
			* Option 1: Yes
			* Option 2: No, it may not affect the spec of TS 38.133 in RAN4.

### Sub-topic 5-3 Mobility requirements for regenerative payload

#### Issue 5-3-1: RRM requirements for RRC\_INACTIVE state mobility with regenerative payload

* Proposals
	+ Proposal 1 (CATT):
		- Whether to update the specific RRM requirements for inactive state with regenerative payload should wait for RAN2/RAN3 progress.
* Recommended WF

*Check Proposal 1 is agreeable or not.*

* + Recommend agree on:
		- Whether to update the specific RRM requirements for inactive state with regenerative payload should wait for RAN2/RAN3 progress.

#### Issue 5-3-2: RRM requirements for RRC Connection Mobility Control with regenerative payload

* Proposals
	+ Proposal 1 (CATT, Samsung):
		- FFS: Whether to update the specific RRM requirements for RRC re-establishment with regenerative payload should wait for RAN2/RAN3 progress.
		- FFS: RAN4 should define the RRM requirements for satellite switch and RACH-less handover for regenerative architecture.
			* The existing requirements for NR NTN can be a baseline.
			* Wait for more RAN2 progress on further optimization.
	+ Proposal 2 (Apple):
		- RAN4 to clarify requirement of satellite switching without PCI change is not applied for regenerative mode of NTN.
* Recommended WF

*Check the following are agreeable or not, and discuss other proposal.*

* + Recommend agree on:
		- Whether to update the specific RRM requirements for RRC re-establishment with regenerative payload should wait for RAN2/RAN3 progress.
		- Whether to update the specific RRM requirements for satellite switch and RACH-less handover with regenerative payload should wait for RAN2 progress.
	+ To be discussed:
		- RAN4 to clarify requirement of satellite switching without PCI change is not applied for regenerative mode of NTN.

### Sub-topic 5-4 Other requirements for regenerative payload

#### Issue 5-4-1: RRM requirements for network verified UE positioning

* Proposals
	+ Proposal 1 (CATT):
		- RAN4 should define the RRM requirements for network verified UE positioning for regenerative architecture.
			* The existing requirements for NR NTN can be a baseline.
* Recommended WF
	+ To be discussed.

#### Issue 5-4-2: Multiple SMTCs mechanism

* Proposals
	+ Proposal 1 (ZTE):
		- RAN4 shall clarify whether the legacy multiple SMTCs mechanism can be used for regenerative payload or not.
* Recommended WF
	+ To be discussed.

# Topic #6: Support of (e)RedCap UEs with NR FR1-NTN

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2411356**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411356.zip) | CATT | **Proposal 9: For RRM requirements, the operating band of (e)Redcap UE with FR1-NTN bands include n256, n255 and n254 defined in Table 5.2-1 in TS 38.108.****Proposal 10: For RRM requirements, both bandwidth with and without reduction should be considered for (e)Redcap UE with FR1-NTN bands.****Proposal 11: For RRM requirements, the number of Rx considered for (e)Redcap UE with FR1-NTN bands support include both 1Rx and 2Rx.** **Proposal 12: For RRM requirements, the satellite types considered for (e)Redcap UE with FR1-NTN bands include both GSO and Non-GSO.****Proposal 13: The (e)Redcap UEs with FR1-NTN bands should support the capability of GNSS and the capability of NR-NTN operation.** **Proposal 14: For RRM requirements, the duplex mode considered for (e)Redcap UE with FR1-NTN bands include both full duplex(FD-FDD) and half duplex FDD(HD-FDD).****Proposal 15: For RRM requirements, the scenario considered for (e)Redcap UE with FR1-NTN bands only supports NR SA operation mode.****Proposal 16: For RRM requirements, the SCS considered for (e)Redcap UE with FR1-NTN support 15kHz, 30kHz and 60kHz.****Proposal 17: A general principle is that to define the RRM requirements for (e)RedCap UE with FR1-NTN bands based on the existing requirements for FR1-NTN.****Proposal 18: The requirements highlighted in green in Table 1 should be defined for (e)RedCap UE with FR1-NTN bands.*** **The requirements highlighted in green is a common part of both NTN and (e)RedCap UE requirements.**

**Proposal 19: For the requirements that have only been defined for NTN, RAN4 needs to discuss whether to define the following FR1-NTN requirements for (e)Redcap:*** **FFS: Minimization of Drive Tests (MDT) in RRC\_IDLE state and RRC\_INACTIVE state**
* **FFS: NR Conditional Handover**
* **FFS: NR SAN Satellite switching with re-synchronization**
* **FFS: Pathloss reference signal switching delay**

**Proposal 20: For the requirements that have only been defined for (e)Redcap and has no relevant definition in FR1-NTN, RAN4 will not discuss them under this objective.****Proposal 21: RAN4 need to consider the impact of HD-FDD, and the following RRM requirements will be affected by HD-FDD for (e)RedCap UE with FR1-NTN bands:*** **Paging reception requirements in RRC\_IDLE/ RRC\_INACTIVE state**
* **Handover interruption time**
* **Random access**
* **SA: RRC Connection Release with Redirection**
* **Minimum requirement for L1 indication for RLM and LR**
* **MAC-CE/DCI/RRC based uplink spatial relation switch delay**
* **Scheduling availability of UE performing intra/inter measurements**
* **Scheduling availability of UE during L1-RSRP measurement**

**Proposal 22: RAN4 should consider the requirement applicability for HD-FDD (e)RedCap UE with FR1-NTN bands.****Proposal 23: The RRM requirements proposed to define respectively for 1Rx and 2Rx (e)Redcap UEs with FR1-NTN bands are listed in Table 2, like for(e)Redcap UE with TN.****Proposal 24: It is suggested to consider the relaxation on the above requirements for 1Rx (e)RedCap UEs with FR1-NTN bands.****Proposal 25: It is suggested to reuse the existing requirements for NTN as a baseline for 2Rx (e)RedCap UEs.****Proposal 26: The eDRX enhancement introduced for (e)RedCap UEs should be considered when defining RRC\_IDLE/RRC\_INACTIVE state mobility requirements for (e)RedCap UEs with FR1-NTN bands.****Proposal 27: RAN4 need to discuss whether the eDRX enhancement for both Rel-17 RedCap and Rel-18 eRedCap UEs should be introduced for (e)RedCap UEs with FR1-NTN bands.*** **Option 1: Only introduce the eDRX enhancement for Rel-17 RedCap UEs.**
* **Option 2: Introduce the eDRX enhancement for both Rel-17 RedCap and Rel-18 eRedCap UEs.**

**Observation 2: For the case where the RedCap specific initial BWP is configured for (e)RedCap UEs in TN network, RAN4 has defined the following specific requirements:*** **RRC Re-establishment delay** $T\_{UE\\_re-establish\\_delay}$
* **RRC connection release with redirection delay Tconnection\_release\_redirect\_NR**

**Proposal 28: RAN4 needs to discuss whether to consider the specific RRM requirements when the RedCap specific initial BWP is configured in NTN network.****Proposal 29: RAN4 needs to discuss whether to consider the impact of NCD-SSB for (e)RedCap UEs with FR1-NTN bands.*** **FFS: Whether to clarify the types of SSB(CD-SSB or NCD-SSB) in the related requirements.**

**Proposal 30: Use the following principles to define the RRM requirements for (e)RedCap UEs with FR1-NTN bands:*** **Define them in the new sections of section number with new suffix X in the specification.**
* **Utilize the reference method for the requirements that can be reused.**
 |
| [**R4-2411452**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411452.zip) | Apple | ***Proposal 6: RAN4 to analyze the RRM requirement impacts from following features for RedCap/eRedCap NTN:*** * ***1Rx***
* ***NCD-SSB***
* ***HD-FDD***
* ***RRM relaxation***
* ***Idle/Inactive mode eDRX with and without PTW window***

***Proposal 7: For 1Rx, NCD-SSB and HD-FDD, the legacy RedCap/eRedCap requirement can be used as baseline for R19 NTN.***  |
| [**R4-2411469**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411469.zip) | MediaTek inc. | **Proposal 1: RAN4 to revisit the following NR NTN RRM requirements, for the impact from (e)Redcap:*** **IDLE/INACTIVE mode, including SDT**
* **CONNECTED Mobility (Handover) and Control**
* **Signaling characteristics, including RLM and Link Recovery**
* **Measurement Procedure**
 |
| **R4-2411619** | Xiaomi | **Proposal 3: RAN4 to define RRM requirements for (e)RedCap UEs with NR NTN on reduced number of UE Rx branches:*** **For 2RX RedCap**
	+ **Take measurement requirements for FR1-NTN as baseline；**
* **For 1RX RedCap**
	+ **Relax measurement requirements from the aspects of extending the number of measurement samples or relaxing the measurement accuracy.**

**Proposal 4: RAN4 to check whether existing HD-FDD related requirements can be reused or not after RAN1 reaching further conclusions.****Proposal 5: RAN4 to discuss whether to define measurement requirements for eDRX feature for NR NTN.****Proposal 6: RAN4 to discuss whether to define relaxed measurement requirements for NR NTN when RedCap UE configured with Rel-17 relaxation criteria.** |
| [**R4-2411686**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411686.zip) | LG Electronics Inc. | ***Proposal 4***: For NTN RRM requirements for RedCap UE,* For 2Rx RedCap UE: Reuse the principle from legacy FR1 NTN RRM requirements
* For 1Rx RedCap UE: Add new NTN RRM requirements should be defined, and the requirements could be based on 1Rx RedCap UE RRM requirements
* For IDLE/INACTIVE mode: Preclude eDRX\_IDLE cycle configuration for RedCap NTN

***Proposal 5***: For HD-FDD, RAN4 needs to check whether the outcome from RAN1 is affect RRM requirements. |
| [**R4-2411763**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411763.zip) | CMCC | ***Proposal 1: For network scenario, consider FR1-NTN bands single carrier and FDD duplex mode of NR NTN network.******Proposal 2: Consider the mobility between TN and NTN network for Redcap UE.******Proposal 3: For R17 full-duplex and half duplex FDD RedCap and R18 eRedCap UEs, consider both 1 Rx and 2Rx for each duplex mode (FD-FDD, HD-FDD) with single searcher.******Proposal 4: Support eDRX configuration for Redcap over NTN, and define following applicability rule for each deployment scenario:**** ***For GEO deployment, all DRX and eDRX cycle can be supported.***
* ***For earth-fixed LEO deployment, requirements are applicable for up to 10.24s eDRX cycle***
* ***For earth-moving LEO deployment, requirements are not applicable for eDRX cycle***

***Proposal 5: For Redcap over NTN, no need to define NCD-SSB specific measurement requirements.******Proposal 6: For the optional NTN features which have impact on RAN4 requirements and need enhanced UE capability, whether Redcap UE could optionally support it and whether RAN4 need to define requirements should be further discussed.******Proposal 7: Slightly prefer to introduce the Redcap over NTN requirements in new subsections in TS 38.133 or new subclauses in current NTN section.*** |
| [**R4-2412112**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412112.zip) | Samsung | **Proposal 6: For objective#5 to support RedCap and eRedCap UEs in FR1-NTN. RAN4 should specify new RRM requirements to consider the impact by using the similar assumption in RedCap and eRedCap.****Proposal 7: RAN4 should define separate sets of RRM requirements for 1Rx and 2 Rx UE.****Proposal 8: To support RedCap/eRedCap in FR1-NTN, RAN4 should to add support eDRX in RRC\_Idle/RRC\_Inactive mode.** **Observation 6: In eDRX\_IDLE cycle, the values are extended to more than 10.24s or even larger one 10485.76s.****Observation 7: In typical LEO scenario such as R=50km and 7.56km/s for satellite speed, not all eDRX can be applicable for NGSO (LEO) scenario.** **Proposal 9: RAN4 to discuss and specify the requirements related to eDRX for GSO and NGSO (LEO) separately. Not all eDRX cycle can be applicable for NGSO (LEO) scenario.****Proposal 10:**  **RAN4 should discuss and specify requirements for RedCap/eRedCap for FR1-NTN including:*** **HO based RACH**
* **RACH-less HO**
* **Time/location-based CHO with/without L3 measurement**
* **Satellite switching with re-sync**

**to consider 1Rx and NCD-SSB****Proposal 11: To support RedCap/eRedCap in FR1-NTN, for RRC Re-establishment/RRC connection Release with re-direction, new requirements should be introduced. For 2Rx, legacy NTN FR1 requirements can be reused.****Proposal 12: To support RedCap/eRedCap in FR1-NTN, decide whether to support NCD-SSB. For timing requirements, no big RRM impacts.****Proposal 13: For RLM/BFD/CBD requirements, to support RedCap/eRedCap in FR1-NTN:*** **RAN4 to define the new requirements to consider 1RX. TN RedCap 1Rx can be used as baseline.**
* **RAN4 to add support for half-duplex.**

**Proposal 14: For Scell/PSCell/Interruption etc, no RRM impacts because NTN only supports single carrier.****Proposal 15: For measurement procedure requirements, to support RedCap/eRedCap in FR1-NTN:*** **RAN4 to define the new requirements to consider 1RX.**
* **RAN4 to add support for half-duplex.**

**Proposal 16: For CSI-RS based L3 measurement, to support RedCap/eRedCap in FR1-NTN, no RRM impacts.****Proposal 17: For L1-RSRP requirements, to support RedCap/eRedCap in FR1-NTN:*** **RAN4 to define the new requirements to consider 1RX.**
* **RAN4 to add support for half-duplex.**

**Proposal 18: In summary, the potential RRM impact is as below:**

|  |  |  |
| --- | --- | --- |
| Topic | Description | RRM impact |
| Downlink coverage enhancements | In “off” state, no DL-RS transmissionWait for conclusion of SSB periodicity extension | YES |
| Uplink Capacity/Cell Throughput Enhancement for FR1-NTN | OCC support for PUSCH | NO |
| Specify signaling of the intended service area of a broadcast service (e.g. MBS broadcast) via NR NTN | Signaling support for broadcast | NO |
| Regenerative payload | Support of regenerative payload | FFS |
| Support of Rel-17 RedCap and Rel-18 eRedCap UEs with NR NTN operating in FR1-NTN bands | Support of Rel-17 RedCap and Rel-18 eRedCap UEs with NR NTN operating in FR1-NTN bands | YES |

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| [**R4-2412234**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412234.zip) | Ericsson | **Proposal 8: RRM requirements for RedCap UE in NTN can be started by taking RedCap UE in TN as baseline.****Proposal 9: The requirements and enhancements for NR NTN in Rel-17 and Rel-18 shall be introduced for RedCap UE in NTN.****Proposal 10: RedCap and eRedCap UE are less capable devices, by definition and we prefer not to add a more detailed total TA-report at this stage and instead focus on adding a fixed rule in specification, in RAN1, in order to to handle HD-FDD (e)RedCap collision cases in NTN for collision cases 3 & 4.** |
| [**R4-2412601**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412601.zip) | vivo | **Proposal 1: RAN4 to use the current NTN requirement as the framework of Redcap NTN and further discuss the necessary adaptations, which potentially including:** * **Introduce corresponding RRM requirements for 1 Rx and current requirements for Redcap UE with 1Rx can be the reference**
* **Determine if redcap specific features introduced in idle/inactive mode can be supported in Redcap NTN, which including eDRX, RRM relaxatoin, etc.**
* **Determine if NCD-SSB is supported in Redcap NTN**
* **Determine if CSSF and concurrent gap is supported in Redcap NTN**
* **Determine mobility related, e.g., RACH-less (C)HO, time-based/location cell reselection/CHO, Unchanged PCI are supported**
 |
| [**R4-2412672**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412672.zip) | Huawei, HiSilicon | **Proposal 3: For RedCap UE operating in NTN, RAN4 to start with the following requirements.*** **Cell reselection**
* **Connected mode mobility: HO, RACH, Re-establishment and Re-direction**
* **Timing**
* **BWP and TCI switching**
* **RLM/BFD**
* **L1-RSRP and CBD**
* **L3 measurement**

**Proposal 4a: RAN4 to support the following RedCap features in RedCap + NTN requirements.*** **1RX**
* **HD-FDD**

**Proposal 4b: RAN4 to discuss whether to support the following in RedCap + NTN requirements.** * **eDRX**
* **NCD-SSB**
* **R17 relaxed measurement**
* **FH in PRS measurement**

**Proposal 5: RAN4 to support all NTN features in RedCap + NTN requirements except the support of multiple SMTCs.** |
| [**R4-2413042**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413042.zip) | ZTECorporation,Sanechips | **Observation 1: The reduced number of UE Rx branches and half-duplex FDD operation impact the definition of RedCap UEs' requirements in the NTN scenario.****Observation 2: Legacy RedCap UE requirements were defined under FD-FDD, HD-FDD and TDD. In NR NTN phase 3, only FDD operation shall be discussed.** **Proposal 1: RAN4 shall only study the FDD operation and no TDD discussion in NR NTN scenario based on WID description.****Proposal 2: RAN4 shall focus on reduced number of UE Rx branches and HD-FDD operation with legacy NTN requirements in order to study and define the new requirements for RedCap UE in NR NTN scenario.****Observation 3: The legacy requirements on VSAT UE above 10GHz are out of scope.****Proposal 3: RAN4 shall consider R17 legacy NR NTN requirements and R18 normal UE mobility requirements with RedCap UE, and VSAT UE above 10GHz shall not be considered.****Observation 4: There are three cases shall be considered and the priority is from low to high:*** Unique requirements for RedCap, e.g. random access based small data transmission;
* Unique requirements for NR NTN, e.g. conditional handover;
* Shared requirements for RedCap and NR NTN, e.g. cell re-selection.

**Proposal 4: RAN4 shall decide whether to consider the requirements which are only defined in RedCap UE.** **Proposal 5: RAN4 shall firstly study the shared requirements for RedCap and NTN, then consider whether to define the requirements only defined in NTN scenario or not.****Proposal 6: 1Rx RedCap UE measurement capability in NTN shall be the same as legacy RedCap 1Rx UE.** **Proposal 7: 2Rx redcap UE measurement capability in NTN shall be same as normal UE in legacy TN.****Observation 5: RAN2 is discussing TN to NTN (LTE to NR) cell re-selection and there has been not RAN4 RRM impact so far.****Observation 6: Although the measurement requirements are same, the conditions for 1Rx and 2Rx shall be distinguished.****Proposal 8: The cell re-selection inter-frequency and inter-RAT measurement requirements in legacy NTN can be reused for 2Rx and 1Rx RedCap UEs considering TN to NTN and NTN to TN.****Proposal 9: RAN4 shall reuse the 1dB offset as legacy for 1Rx RedCap UE in NR NTN.****Proposal 10: The cell re-selection intra-frequency and inter-frequency measurement requirements in legacy NTN can be reused for 2Rx and 1Rx RedCap UEs considering NTN to NTN cell re-selection.****Observation 7: When considering handover and conditional handover requirements, TN to NTN or NTN to TN scenarios are out of scope since these scenarios have not been discussed for normal UE in R17/R18 NR NTN discussion.** **Observation 8: For conditional handover, no related requirements have been defined for RedCap UE in legacy.****Proposal 11: RAN4 shall study feasibility issues when considering to define conditional handover for RedCap UEs in FR1-NTN bands.****Proposal 13: RAN4 shall define the handover requirements for RedCap UEs in NR NTN scenario.****Proposal 12: RAN4 shall consider the timing requirements for RedCap UEs in NTN scenario and the legacy NR NTN timing requirements shall be as the baseline.****Observation 9: The legacy NR NTN evaluation period is the same as legacy TN evaluation period.****Observation 10: In RedCap WI, the evaluation period will not change for 2Rx and the evaluation period of 1Rx is extended by factor 2.****Proposal 13: RAN4 shall define the Qout requirements for RedCap UEs in FR1-NTN bands. The evaluation period for 2Rx shall be reused and the evaluation period shall be extended for 1Rx by factor 2. Qin shall be reused.****Observation 11: RAN2 introduced the multiple SMTCs based on time and frequency difference in NTN not the type of UEs.****Observation 12: The legacy NR NTN requirements and the legacy requirements for 2Rx RedCap UE are the same as legacy requirements. For 1Rx RedCap UE, the time period are relaxed.****Proposal 14: RAN4 shall define time period of PSS/SSS detection and time index detection. The requirements for 1Rx and 2Rx RedCap UE shall reuse the legacy RedCap requirements.****Observation 13：The measurement period requirements for legacy TN/ legacy RedCap UE/legacy NR NTN are same in TS 38.133.****Proposal 15: The RedCap UEs with 1Rx and 2Rx in NTN shall own the same measurement period requirements as legacy RedCap UE.****Proposal 16: The legacy requirements and applicable conditions can be as baseline for defining requirements of RedCap UE in NTN scenario.**  |
| [**R4-2413188**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413188.zip) | Qualcomm Incorporated | **RedCap UEs - General****Observation 3: There are the following distinctions between (e)RedCap and non-RedCap UEs.*** **The number of cell search and measurement engines**
* **Support of the concurrent measurement gaps introduced in Rel-17**
* **The number of Rx antenna ports**
* **Limited BW up to 20MHz**

**Proposal 3: For 1Rx RedCap NTN UE, RAN4 to adopt the same requirement relaxations and modifications as follows:*** **Extended delays for PSS/SSS detection and SSB index identification (PBCH decoding)**
* **Handover delay Extension**
* **Extended RLM OOS and BFD evaluation periods**
* **Aggregation level of 16 for RLM/BFD hypothetical PDCCH parameters**
* **Measurement accuracy relaxation for SS-RSRP, SS-RSRQ, SS-SINR, L1-RSRP**

**Proposal 4: Unless NCD-SSB based RedCap support is justified in NR NTN, RAN4 to not discuss the following aspects which were considered in RedCap due to limited UE BW up to 20MHz.*** **Measurements with NCD-SSB**
* **BWP specific serving cell MO**
* **RedCap specific initial UL/DL BWP**

**eRedCap UEs****Observation 4: According to Rel-18 eRedCap UE RRM requirement definition, no RRM impact is foreseen for the following two different types of eRedCap UEs.*** **20MHz + PR1 (aka peak data rate reduction)**
* **BW3/PR3 + PR1 (aka BB bandwidth reduction​)**

**Proposal 5: For eRedCap UE, RAN4 can consider the following aspect for RRM requirement definition if necessary and applicable for NR NTN support.*** **Enhanced eDRX in RRC INACTIVE**

**HD-RedCap and -eRedCap UEs****Observation 5: For HD RedCap and eRedCap UEs, the following enhancements are still under investigation in RAN1.*** **Priority rules for DL-UL collision cases which were regarded as error cases in the existing TN (e)RedCap features**
* **Mitigation of the impact on performance due to TA mismatch between actual TA used by the UE and assumed TA for the UE at the gNB**
* **Mitigation of the impact on performance due to continuous SIB19 re-acquisition of which time instance is unknown to the serving cell**

**Proposal 6: RAN4 to wait for further RAN1 process on the enhancements for HD RedCap and eRedCap Ues which may potentially impact on the following aspects:*** **Additional latencies, Scheduling/Measurement restrictions, etc. due to DL/UL collisions.**
 |

## Open issues summary

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

### Sub-topic 6-1 Applicability clarification

#### Issue 6-1-1: The operating band of (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT):
		- For RRM requirements, the operating band of (e)Redcap UE with FR1-NTN bands include n256, n255 and n254 defined in Table 5.2-1 in TS 38.108.
	+ Proposal 2 (CMCC, ZTE):
		- RAN4 shall only study the FDD operation and no TDD discussion in NR NTN scenario based on WID description.
* Recommended WF

*Check the following are agreeable or not.*

* + Recommend agree on:
		- For RRM requirements, the operating band of (e)Redcap UE with FR1-NTN bands include n256, n255 and n254 defined in Table 5.2-1 in TS 38.108.
		- For RRM requirements, RAN4 shall only study the FDD operation and no TDD discussion in NR NTN scenario.

#### Issue 6-1-2: The bandwidth of (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT):
		- Both bandwidth with and without reduction of R18 eRedCap UE should be supported for (e)RedCap UE with FR1-NTN bands. (RF conclusion)
* Recommended WF

*Check the following are agreeable or not.*

* + Recommend agree on:
		- Both bandwidth with and without reduction of R18 eRedCap UE should be supported for (e)RedCap UE with FR1-NTN bands.
		- Note: There is no RRM impact on the two different types of eRedCap UEs (bandwidth with and without reduction).

#### Issue 6-1-3: The satellite types considered for (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT):
		- For RRM requirements, the satellite types considered for (e)Redcap UE with FR1-NTN bands include both GSO and Non-GSO.
* Recommended WF

*Check Proposal 1 is agreeable or not.*

* + Recommend agree on:
		- For RRM requirements, the satellite types considered for (e)Redcap UE with FR1-NTN bands include both GSO and Non-GSO.

#### Issue 6-1-4: The capability considered for (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT):
		- The (e)Redcap UEs with FR1-NTN bands should support the capability of GNSS and the capability of NR-NTN operation.
* Recommended WF

*Check Proposal 1 is agreeable or not.*

* + Recommend agree on:
		- The (e)Redcap UEs with FR1-NTN bands should support the capability of GNSS and the capability of NR-NTN operation.

#### Issue 6-1-5: The network scenario considered for (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT):
		- For RRM requirements, the scenario considered for (e)Redcap UE with FR1-NTN bands only supports NR SA operation mode.
	+ Proposal 2 (CMCC, Samsung):
		- For network scenario, consider FR1-NTN bands single carrier of NR NTN network.
* Recommended WF

*Check the following is agreeable or not.*

* + Recommend agree on:
		- For scenario considered for (e)Redcap UE with FR1-NTN bands, RAN4 only supports NR SA operation mode with single carrier.

#### Issue 6-1-6: The SCS considered for (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT):
		- For RRM requirements, the SCS considered for (e)Redcap UE with FR1-NTN support 15kHz, 30kHz and 60kHz.
* Recommended WF

*Check Proposal 1 is agreeable or not.*

* + Recommend agree on:
		- For RRM requirements, the SCS considered for (e)Redcap UE with FR1-NTN support 15kHz, 30kHz and 60kHz.

### Sub-topic 6-2 General consideration on RRM requirements

#### Issue 6-2-1: The general principle for defining the RRM requirements for (e)RedCap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT, MTK, Xiaomi, Samsung, HW, vivo, ZTE):
		- A general principle is that to define the RRM requirements for (e)RedCap UE with FR1-NTN bands based on the existing requirements for FR1-NTN.
	+ Proposal 2 (Ericsson):
		- RRM requirements for RedCap UE in NTN can be started by taking RedCap UE in TN as baseline.
		- The requirements and enhancements for NR NTN in Rel-17 and Rel-18 shall be introduced for RedCap UE in NTN.
* Recommended WF
	+ To be discussed

#### Issue 6-2-2: What RRM requirements are defined for (e)RedCap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT):
		- The common requirements for both NTN and (e)RedCap UE requirements should be defined for (e)RedCap UE with FR1-NTN bands.
		- For the requirements that have only been defined for NTN, RAN4 needs to discuss whether to define the following FR1-NTN requirements for (e)Redcap:
			* FFS: Minimization of Drive Tests (MDT) in RRC\_IDLE state and RRC\_INACTIVE state
			* FFS: NR Conditional Handover
			* FFS: NR SAN Satellite switching with re-synchronization
			* FFS: Pathloss reference signal switching delay
		- For the requirements that have only been defined for (e)Redcap and has no relevant definition in FR1-NTN, RAN4 will not discuss them under this objective.
		- FR2 related requirements shall not be defined for (e)RedCap UE with FR1-NTN bands.
		- Proposal 1a (ZTE):
			* RAN4 shall decide whether to consider the requirements which are only defined in RedCap UE.
			* RAN4 shall firstly study the shared requirements for RedCap and NTN, then consider whether to define the requirements only defined in NTN scenario or not.
	+ Proposal 2 (MTK):
		- RAN4 to revisit the following NR NTN RRM requirements, for the impact from (e)Redcap:
			* IDLE/INACTIVE mode, including SDT
			* CONNECTED Mobility (Handover) and Control
			* Signaling characteristics, including RLM and Link Recovery
			* Measurement Procedure
	+ Proposal 3 (CMCC):
		- Consider the mobility between TN and NTN network for Redcap UE.
	+ Proposal 4 (Samsung):
		- RAN4 should discuss and specify requirements for RedCap/eRedCap for FR1-NTN including:
			* HO based RACH
			* RACH-less HO
			* Time/location-based CHO with/without L3 measurement
			* Satellite switching with re-sync

to consider 1Rx and NCD-SSB

* + - To support RedCap/eRedCap in FR1-NTN, for RRC Re-establishment/RRC connection Release with re-direction, new requirements should be introduced.
		- For RLM/BFD/CBD requirements, to support RedCap/eRedCap in FR1-NTN.
		- For Scell/PSCell/Interruption etc, no RRM impacts because NTN only supports single carrier.
		- For measurement procedure requirements, to support RedCap/eRedCap in FR1-NTN.
		- For CSI-RS based L3 measurement, to support RedCap/eRedCap in FR1-NTN, no RRM impacts.
		- For L1-RSRP requirements, to support RedCap/eRedCap in FR1-NTN.
	+ Proposal 5 (vivo):
		- Determine mobility related, e.g., RACH-less (C)HO, time-based/location cell reselection/CHO, Unchanged PCI are supported
	+ Proposal 6 (HW):
		- For RedCap UE operating in NTN, RAN4 to start with the following requirements.
			* Cell reselection
			* Connected mode mobility: HO, RACH, Re-establishment and Re-direction
			* Timing
			* BWP and TCI switching
			* RLM/BFD
			* L1-RSRP and CBD
			* L3 measurement
	+ Proposal 7 (ZTE):
		- RAN4 shall consider R17 legacy NR NTN requirements and R18 normal UE mobility requirements with RedCap UE, and VSAT UE above 10GHz shall not be considered.
		- RAN4 shall study feasibility issues when considering to define conditional handover for RedCap UEs in FR1-NTN bands.
		- RAN4 shall define the handover requirements for RedCap UEs in NR NTN scenario.
		- RAN4 shall consider the timing requirements for RedCap UEs in NTN scenario and the legacy NR NTN timing requirements shall be as the baseline.
		- RAN4 shall define the Qout requirements for RedCap UEs in FR1-NTN bands.
		- RAN4 shall define time period of PSS/SSS detection and time index detection.
* Recommended WF

*Discuss start with the following.*

* + To be discussed:
		- The common requirements for both NTN and (e)RedCap UE requirements should be defined for (e)RedCap UE with FR1-NTN bands, including the following:
			* Cell Re-selection for RRC\_IDLE state mobility
			* Cell Re-selection for RRC\_INACTIVE state mobility
			* NR Handover
* NR FR1 – NR FR1 Handover
	+ - * RRC Connection Mobility Control
* SA: RRC Re-establishment
* Random access
* SA: RRC Connection Release with Redirection
	+ - * Timing
* UE transmit timing
* UE timer accuracy
* Timing advance
	+ - * Signalling characteristics
* Radio Link Monitoring
* Link Recovery Procedures
* Active BWP switch delay
* Active TCI state switching delay
* UE-specific CBW change
	+ - * Measurement Procedure
* General measurement requirement
* NR intra-frequency measurements
* NR inter-frequency measurements
* L1-RSRP measurements for Reporting
* NR measurements for positioning
	+ - For the requirements that have only been defined for NTN, RAN4 needs to discuss whether to define the following FR1-NTN requirements for (e)Redcap:
			* FFS: Minimization of Drive Tests (MDT) in RRC\_IDLE state and RRC\_INACTIVE state
			* FFS: NR Conditional Handover
			* FFS: NR SAN Satellite switching with re-synchronization
			* FFS: Pathloss reference signal switching delay
		- The requirements that have only been defined for (e)Redcap and not been defined for FR1-NTN will not be discussed in this objective, including the following:
			* Configured Grant based Small Data Transmissions (CG-SDT)
			* NR measurements for positioning in RRC\_INACTIVE state
			* Random access based Small Data Transmissions (RA-SDT)
			* NR Handover to other RATs
			* RRC connection release with redirection to E-UTRAN
			* deriveSSB-IndexFromCell tolerance
			* Uplink spatial relation switch delay
			* Inter-RAT measurements
			* PRS-RSRPP measurements
			* NR measurements with autonomous gaps
		- FR2 related requirements shall not be defined for (e)RedCap UE with FR1-NTN bands.

#### Issue 6-2-3: Features to be considered for (e)RedCap UE with FR1-NTN

* Proposals
	+ Proposal 1 (Apple):
		- RAN4 to analyze the RRM requirement impacts from following features for RedCap/eRedCap NTN:
			* 1Rx
			* NCD-SSB
			* HD-FDD
			* RRM relaxation
			* Idle/Inactive mode eDRX with and without PTW window
		- Proposal 1a (Apple):
			* For 1Rx, NCD-SSB and HD-FDD, the legacy RedCap/eRedCap requirement can be used as baseline for R19 NTN.
	+ Proposal 2 (Xiaomi):
		- RAN4 to discuss whether to define relaxed measurement requirements for NR NTN when RedCap UE configured with Rel-17 relaxation criteria.
		- RAN4 to discuss whether to define measurement requirements for eDRX feature for NR NTN.
	+ Proposal 3 (CMCC):
		- For the optional NTN features which have impact on RAN4 requirements and need enhanced UE capability, whether Redcap UE could optionally support it and whether RAN4 need to define requirements should be further discussed.
		- For R17 full-duplex and half duplex FDD RedCap and R18 eRedCap UEs, consider both 1 Rx and 2Rx for each duplex mode (FD-FDD, HD-FDD) with single searcher.
	+ Proposal 4 (vivo):
		- RAN4 to use the current NTN requirement as the framework of Redcap NTN and further discuss the necessary adaptations, which potentially including:
			* Introduce corresponding RRM requirements for 1 Rx and current requirements for Redcap UE with 1Rx can be the reference
			* Determine if redcap specific features introduced in idle/inactive mode can be supported in Redcap NTN, which including eDRX, RRM relaxatoin, etc.
			* Determine if NCD-SSB is supported in Redcap NTN
			* Determine if CSSF and concurrent gap is supported in Redcap NTN
			* Determine mobility related, e.g., RACH-less (C)HO, time-based/location cell reselection/CHO, Unchanged PCI are supported
	+ Proposal 5 (HW):
		- Proposal 5a: RAN4 to support the following RedCap features in RedCap + NTN requirements. (ZTE)
			* 1RX
			* HD-FDD
		- Proposal 5b: RAN4 to discuss whether to support the following in RedCap + NTN requirements.
			* eDRX
			* NCD-SSB
			* R17 relaxed measurement
			* FH in PRS measurement
		- Proposal 5c: RAN4 to support all NTN features in RedCap + NTN requirements except the support of multiple SMTCs.
	+ Proposal 6 (QC):
		- There are the following distinctions between (e)RedCap and non-RedCap UEs.
			* The number of cell search and measurement engines
			* Support of the concurrent measurement gaps introduced in Rel-17
			* The number of Rx antenna ports
			* Limited BW up to 20MHz
		- Unless NCD-SSB based RedCap support is justified in NR NTN, RAN4 to not discuss the following aspects which were considered in RedCap due to limited UE BW up to 20MHz.
			* Measurements with NCD-SSB
			* BWP specific serving cell MO
			* RedCap specific initial UL/DL BWP
		- For eRedCap UE, RAN4 can consider the following aspect for RRM requirement definition if necessary and applicable for NR NTN support.
			* Enhanced eDRX in RRC INACTIVE
* Recommended WF

*Just determine the potential impacts, and discuss the detail of features separately in the related sub-topics.*

* + To be discussed:
		- RAN4 to analyze the RRM requirement impacts from following features for (e)RedCap UE with FR1-NTN:
			* 1Rx
			* FFS: NCD-SSB
			* HD-FDD
			* FFS: R17 relaxed measurement
			* FFS: RRC\_IDLE/RRC\_INACTIVE mode eDRX enhancement
			* FFS: Determine if CSSF and concurrent gap is supported in Redcap NTN
			* FFS: FH in PRS measurement
			* Single cell search and measurement engine

### Sub-topic 6-3 Reduction in the number of UE Rx branches

#### Issue 6-3-1: The principle for defining the requirements for 2Rx/1Rx (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT, Samsung, ZTE):
		- For RRM requirements, the number of Rx considered for (e)Redcap UE with FR1-NTN bands support both 1Rx and 2Rx.
		- RAN4 should define separate sets of RRM requirements for 1Rx and 2 Rx (e)Redcap UE.
	+ Proposal 2 (CATT, Xiaomi, ZTE):
		- For 2Rx (e)RedCap UEs with FR1-NTN: Reuse the existing requirements for NTN as a baseline.
		- For 1Rx (e)RedCap UEs with FR1-NTN: Consider the relaxation on the above requirements for 2Rx UEs.
		- Proposal 2a (CATT):
			* At least the following requirements will be defined separately for 1Rx and 2 Rx UE:

|  |
| --- |
| **SA: RRC\_IDLE/ RRC\_INACTIVE state mobility**  |
| * Cell Selection in RRC\_IDLE state
* Cell Re-selection in RRC\_IDLE/ RRC\_INACTIVE state
 |
| **SA: RRC\_CONNECTED state mobility** |
| * NR Handover
	+ NR FR1 - NR FR1 Handover
* RRC Connection Mobility Control
	+ SA: RRC Re-establishment
	+ Random access
	+ SA: RRC Connection Release with Redirection
 |
| **Signalling characteristics** |
| * Radio Link Monitoring
* Link Recovery Procedures
 |
| **Measurement Procedure** |
| * NR intra-frequency measurements
* NR inter-frequency measurements
* L1-RSRP measurements for Reporting
* NR measurements for positioning
 |

* + Proposal 3 (LG):
		- For 2Rx RedCap UE: Reuse the principle from legacy FR1 NTN RRM requirements
		- For 1Rx RedCap UE: Add new NTN RRM requirements should be defined, and the requirements could be based on 1Rx RedCap UE RRM requirements.
	+ Proposal 4 (ZTE):
		- 2Rx redcap UE measurement capability in NTN shall be same as normal UE in legacy TN.
		- 1Rx RedCap UE measurement capability in NTN shall be the same as legacy RedCap 1Rx UE.
		- The cell re-selection inter-frequency and inter-RAT measurement requirements in legacy NTN can be reused for 2Rx and 1Rx RedCap UEs considering TN to NTN and NTN to TN.
		- The cell re-selection intra-frequency and inter-frequency measurement requirements in legacy NTN can be reused for 2Rx and 1Rx RedCap UEs considering NTN to NTN cell re-selection.
		- RAN4 shall define time period of PSS/SSS detection and time index detection. The requirements for 1Rx and 2Rx RedCap UE shall reuse the legacy RedCap requirements.
		- The RedCap UEs with 1Rx and 2Rx in NTN shall own the same measurement period requirements as legacy RedCap UE.
* Recommended WF

*Check Proposal 1 is agreeable or not, and discuss the other proposals.*

* + Recommend agree on:
		- For RRM requirements, the number of Rx considered for (e)Redcap UE with FR1-NTN bands support include both 1Rx and 2Rx.
		- RAN4 should define separate sets of RRM requirements for 1Rx and 2 Rx (e)Redcap UE.
	+ To be discussed:
		- For 2Rx (e)RedCap UEs with FR1-NTN: Reuse the existing requirements for NTN as a baseline.
		- For 1Rx (e)RedCap UEs with FR1-NTN: Consider the relaxation on the above requirements for 2Rx UEs.
			* At least the following requirements will be defined separately for 1Rx and 2 Rx UE:
* Cell Selection in RRC\_IDLE state
* Cell Re-selection in RRC\_IDLE/ RRC\_INACTIVE state
* NR Handover
* RRC Connection Mobility Control

- SA: RRC Re-establishment

- Random access

- SA: RRC Connection Release with Redirection

* Signalling characteristics

- Radio Link Monitoring

- Link Recovery Procedures

* Measurement Procedure

- NR intra-frequency measurements

- NR inter-frequency measurements

- L1-RSRP measurements for Reporting

- NR measurements for positioning

#### Issue 6-3-2: How to relax the requirements for 1Rx (e)RedCap UEs with FR1-NTN ?

* Proposals
	+ Proposal 1 (vivo, ZTE):
		- Introduce corresponding RRM requirements for 1 Rx and current requirements for Redcap UE with 1Rx can be the reference.
	+ Proposal 2 (Xiaomi):
		- For 1RX RedCap: Relax measurement requirements from the aspects of extending the number of measurement samples or relaxing the measurement accuracy.
	+ Proposal 3 (ZTE):
		- RAN4 shall define the Qout requirements for RedCap UEs in FR1-NTN bands. The evaluation period for 2Rx shall be reused and the evaluation period shall be extended for 1Rx by factor 2. Qin shall be reused.
		- RAN4 shall reuse the 1dB offset as legacy for 1Rx RedCap UE in NR NTN.
	+ Proposal 4 (QC):
		- For 1Rx RedCap NTN UE, RAN4 to adopt the same requirement relaxations and modifications as follows:
			* Extended delays for PSS/SSS detection and SSB index identification (PBCH decoding)
			* Handover delay Extension
			* Extended RLM OOS and BFD evaluation periods
			* Aggregation level of 16 for RLM/BFD hypothetical PDCCH parameters
			* Measurement accuracy relaxation for SS-RSRP, SS-RSRQ, SS-SINR, L1-RSRP
* Recommended WF
	+ To be discussed.

### Sub-topic 6-4 HD-FDD

#### Issue 6-4-1: The specific impact of HD-FDD for (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT, Xiaomi, ZTE):
		- RAN4 need to consider the impact of HD-FDD, and to check whether existing HD-FDD applicable conditions can be reused after RAN1 reaching further conclusions.
		- Proposal 1a (CATT): RAN4 need to consider the impact of HD-FDD, and the following RRM requirements will be affected by HD-FDD for (e)RedCap UE with FR1-NTN bands:
			* Paging reception requirements in RRC\_IDLE/ RRC\_INACTIVE state
			* Handover interruption time
			* Random access
			* SA: RRC Connection Release with Redirection
			* Minimum requirement for L1 indication for RLM and LR
			* MAC-CE/DCI/RRC based uplink spatial relation switch delay
			* Scheduling availability of UE performing intra/inter measurements
			* Scheduling availability of UE during L1-RSRP measurement
		- Proposal 1b (ZTE):
			* The legacy requirements and applicable conditions can be as baseline for defining requirements of RedCap UE in NTN scenario.
	+ Proposal 2 (Ericsson):
		- RedCap and eRedCap UE are less capable devices, by definition and we prefer not to add a more detailed total TA-report at this stage and instead focus on adding a fixed rule in specification, in RAN1, in order to to handle HD-FDD (e)RedCap collision cases in NTN for collision cases 3 & 4.
	+ Proposal 3 (LG, QC):
		- For HD-FDD, RAN4 needs to check whether the outcome from RAN1 is affect RRM requirements.
		- Proposal 3a: RAN4 to wait for further RAN1 process on the enhancements for HD RedCap and eRedCap Ues which may potentially impact on the following aspects:
			* Additional latencies, Scheduling/Measurement restrictions, etc. due to DL/UL collisions.
* Recommended WF

*Check the following are agreeable or not.*

* + Recommend agree on:
		- RAN4 need to consider the impact of HD-FDD for (e)Redcap UE with FR1-NTN.
			* The legacy HD-FDD related requirements and applicable conditions defined for (e)RedCap UE can be as a baseline.
		- RAN4 to wait for further RAN1 process on mitigating issues caused by TA mismatch between actual TA used by the UE and assumed TA for the UE at the gNB for HD-FDD (e)RedCap UEs, and check whether the conclusions will further affect RRM requirements.

### Sub-topic 6-5 eDRX enhancement

#### Issue 6-5-1: How to consider the impact of eDRX enhancement for (e)Redcap UE with FR1-NTN?

* Proposals
	+ Proposal 1 (CATT, CMCC, Samsung):
		- The eDRX enhancement introduced for (e)RedCap UEs should be considered when defining RRC\_IDLE or/and RRC\_INACTIVE state mobility requirements for (e)RedCap UEs with FR1-NTN bands.
		- Proposal 1a (CATT): RAN4 need to discuss whether the eDRX enhancement for both Rel-17 RedCap and Rel-18 eRedCap UEs should be introduced for (e)RedCap UEs with FR1-NTN bands.
			* Option 1: Only introduce the eDRX enhancement for Rel-17 RedCap UEs.
			* Option 2: Introduce the eDRX enhancement for both Rel-17 RedCap and Rel-18 eRedCap UEs.
		- Proposal 1b (CMCC): Support eDRX configuration for Redcap over NTN, and define following applicability rule for each deployment scenario:
			* For GEO deployment, all DRX and eDRX cycle can be supported.
			* For earth-fixed LEO deployment, requirements are applicable for up to 10.24s eDRX cycle
			* For earth-moving LEO deployment, requirements are not applicable for eDRX cycle
		- Proposal 1c (Samsung):
			* RAN4 to discuss and specify the requirements related to eDRX for GSO and NGSO (LEO) separately. Not all eDRX cycle can be applicable for NGSO (LEO) scenario.
		- Proposal 1d (QC): For eRedCap UE, RAN4 can consider the following aspect for RRM requirement definition if necessary and applicable for NR NTN support.
			* Enhanced eDRX in RRC INACTIVE
	+ Proposal 2 (LG):
		- For NTN RRM requirements for RedCap UE,
			* For IDLE/INACTIVE mode: Preclude eDRX\_IDLE cycle configuration for RedCap NTN
* Recommended WF

*Check Proposal 1 is agreeable or not, and discuss the detail start with Proposal 1b/1c.*

* + Recommend agree on:
		- The eDRX enhancement introduced for (e)RedCap UEs should be considered when defining RRC\_IDLE or/and RRC\_INACTIVE state mobility requirements for (e)RedCap UEs with FR1-NTN bands.
	+ To be discussed.

### Sub-topic 6-6 NCD-SSB

#### Issue 6-6-1: The impact of NCD-SSB for (e)RedCap UEs with FR1-NTN

* Proposals
	+ Proposal 1 (Apple):
		- For NCD-SSB, the legacy RedCap/eRedCap requirement can be used as baseline for R19 NTN.
	+ Proposal 2 (CMCC, QC):
		- For Redcap over NTN, no need to define NCD-SSB specific measurement requirements.
* Recommended WF
	+ To be discussed

### Sub-topic 6-7 Bandwidth reduction

#### Issue 6-7-1: The impact of bandwidth reduction for (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT):
		- RAN4 needs to discuss whether to consider the specific RRM requirements when the RedCap specific initial BWP is configured in NTN network.
	+ Proposal 2 (QC):
		- Unless NCD-SSB based RedCap support is justified in NR NTN, RAN4 to not discuss the following aspects which were considered in RedCap due to limited UE BW up to 20MHz.
			* Measurements with NCD-SSB
			* BWP specific serving cell MO
			* RedCap specific initial UL/DL BWP

Recommended WF

* + To be discussed:
		- Whether to discuss the following aspects which were considered in RedCap due to limited UE BW up to 20MHz.
			* Measurements with NCD-SSB
			* BWP specific serving cell MO
			* RedCap specific initial UL/DL BWP

### Sub-topic 6-8 Specification structure

#### Issue 6-8-1: Specification structure for (e)Redcap UE with FR1-NTN

* Proposals
	+ Proposal 1 (CATT, CMCC):
		- Use the following principles to define the RRM requirements for (e)RedCap UEs with FR1-NTN bands:
			* Define them in the new sections of section number with new suffix X in the specification.
			* Utilize the reference method for the requirements that can be reused.
	+ Proposal 2 (CMCC):
		- Slightly prefer to introduce the Redcap over NTN requirements in new subsections in TS 38.133 or new subclauses in current NTN section.
* Recommended WF

*Check Proposal 1 is agreeable or not.*

* + Recommend agree on:
		- Use the following principles to define the RRM requirements for (e)RedCap UEs with FR1-NTN bands:
			* Define them in the new sections of section number with new suffix X in the specification.
			* Utilize the reference method for the requirements that can be reused.