**3GPP TSG RAN Meeting #106 RP-24xxxx**

**Madrid, Spain, Dec 9-12, 2024**

**Agenda Item: 9.3.2.2**

**Source: Rapporteur (Thales)**

**Title: Moderator summary on Rel-19 NR NTN**

**Document for: Discussion and decision**

# Introduction

In RAN#106, 10 contributions address the checkpoint on the objective for downlink coverage enhancements of the release 19 work item on enhancements for NR NTN. This document summarizes the proposals made in those contributions for discussion towards an update of the work item scope.

# Background (WID, WG agreements)

**Current WID objective #1 [1]**

Study and specify if beneficial downlink coverage enhancements targeting support for additional reference satellite payload parameters covering both GSO and NGSO constellations operating in FR1-NTN or FR2-NTN [RAN1, RAN2, RAN4]

* Define additional reference satellite payload parameters assuming power sharing among satellite beams or different satellite beam patterns/size (i.e. wide or narrow) across the satellite footprint, such that satellite beams may not all be simultaneously active or may be active below the nominal EIRP density per satellite beam (see section 6.1.1 in TR 38.821) due to limited power and limited feeder link bandwidth.
* Define the corresponding power sharing assumptions and necessary link level and system level evaluation methodology and relevant KPIs for evaluations of the coverage, to allow for identification of physical channels/signals and system-level aspects that need enhancements and the corresponding needed improvements.
* Study and if needed specify solutions, including link level enhancements for FR1-NTN (e.g. for PDCCH, PDSCH) and/or system level enhancements for FR1-NTN and/or FR2-NTN, allowing dynamic and flexible power sharing between satellite beams or different satellite beam patterns/size (i.e. wide or narrow) across the satellite footprint.
	+ RAN1 to report at the latest by RAN#106 with the list of targeted physical channels/signals for link level enhancements (if any), and with the targeted system-level enhancements (if any)
	+ RAN1 should report on impact to backward compatibility, if any, for potential extension of the SSB periodicity at the latest by RAN#106, in conjunction with the targeted system-level enhancements.
* Notes for this objective:
	+ SSB channel enhancement other than SSB periodicity extension is not considered
		- RAN1 should consider issues such as UE’s cell search complexity and impact to initial cell selection, latency and success rate, for the above extension
	+ The SSB periodicity enhancements potentially defined in this WID only apply to NTN operation
	+ Antenna gain of UE shall be assumed to be -5.5dBi in case of smartphone in FR1-NTN, the UE is assumed to be a full duplex UE, and at least 2Rx are considered at the UE
	+ NGSO to be considered in priority: LEO Set-1 @ 600 km
	+ Rel-18 network energy saving techniques should be considered as baseline in the system level study

**Relevant RAN1 agreements on objective #1:**

Agreement (RAN1#118bis)

For NR NTN, support extended periodicity of the half frames with SS/PBCH blocks assumed by UE during initial access.

* The maximum of the additional default value (apart from the existing 20ms value) is at least 160 ms.
	+ FFS: whether 320ms can be supported as the maximum of the additional default value instead of or in addition to 160ms

**Observation (RAN1#119)**

Backward compatibility for legacy UEs (i.e. Rel-17 and Rel-18 UEs) assuming a default SSB periodicity of 20ms is not guaranteed when SS/PBCH blocks periodicity is larger than 20ms within the cell used for initial frequency scan.

Legacy UEs (i.e. Rel-17 and Rel-18 UEs) are not expected to be able to camp on a cell with SS/PBCH blocks periodicity larger than 160 ms.

Agreement (RAN1#119)

For PDSCH with Msg4 Link level enhancement:

* Support PDSCH repetition
	+ FFS: signalling design including number of repetitions
	+ FFS: impact on UE capability
* Note: the target coverage enhancement to bridge the gap with respect to single Msg4 transmission is 2.8 dB
* Focus on coverage enhancement for set 1-3 with a target CNR of -8 dB for NR NTN DL coverage enhancements at link level.

Agreement (RAN1#119)

For link level enhancement of PDSCH with SIB1:

* Support PDSCH repetitions within 20 ms duration
	+ The number of repetitions is fixed to 2 repetitions
	+ Further discuss the specification impact for at least the following:
		- Procedure and signaling (enabling repetitions, associated time resource determination, etc.)
* Note 1: without the above PDSCH repetitions, the coverage gap is 2.2 dB to 4.6 dB depending on SIB1 size.
* Note 2: Focus on coverage enhancement for set 1-3 with a target CNR of -8 dB for NR NTN DL coverage enhancements at link level.
* Note 3: the above is not related to multiple SIB1 transmissions across 20 ms periodicities of SSB, which may not be available when the SSB periodicity is 160 ms or larger (if supported) depending on the SSB and CORESET multiplexing pattern.

Agreement (RAN1#119)

For PDCCH CSS (except Type-3) link level enhancements, support only PDCCH repetition for NTN.

* FFS: intra-slot and/or inter-slot

# Discussion

Most proposals are asking for updating the WID to reflect the RAN1 decisions on the targeted system-level and link-level enhancements. Some contributions ask for continuing discussions on aspects being studied by RAN1 but not agreed to be supported by RAN1.

Monday morning decision from RAN Chair is to continue discussing the potential support of 320 ms extended SSB periodicity in RAN1, and no up-scoping of the WI is allowed

**Proposed updates to WID objective #1**

Specify downlink coverage enhancements targeting support for additional reference satellite payload parameters covering both GSO and NGSO constellations operating in FR1-NTN or FR2-NTN [RAN1, RAN2, RAN4]

* Define additional reference satellite payload parameters assuming power sharing among satellite beams or different satellite beam patterns/size (i.e. wide or narrow) across the satellite footprint, such that satellite beams may not all be simultaneously active or may be active below the nominal EIRP density per satellite beam (see section 6.1.1 in TR 38.821) due to limited power and limited feeder link bandwidth.
* Define the corresponding power sharing assumptions and necessary link level and system level evaluation methodology and relevant KPIs for evaluations of the coverage, to allow for identification of physical channels/signals and system-level aspects that need enhancements and the corresponding needed improvements.
* Specify solutions, including link level enhancements for FR1-NTN and system level enhancements for FR1-NTN and FR2-NTN, allowing dynamic and flexible power sharing between satellite beams or different satellite beam patterns/size (i.e. wide or narrow) across the satellite footprint.
	+ Link level enhancements are to be specified for the following channels:
		- PDCCH CSS (except for Type-3) via PDCCH repetition
		- PDSCH with Msg4 via PDCCH repetition
		- PDSCH with SIB1 via 2 PDSCH repetitions within 20 ms duration
	+ System-level enhancements are to be specified for the following:
		- Specify solutions to support extended periodicity of the half frames with SS/PBCH blocks.
			* The maximum of the additional default value (apart from the existing 20ms value) is at least 160 ms
			* FFS: whether 320ms can be supported as the maximum of the additional default value instead of or in addition to 160ms
		- Consider (if beneficial) enhancements on DTX/DRX
		- FFS: Potential enhancements for transmitting the DL common channels using a wider beam footprint, while DL/UL dedicated channels (incl. PRACH) may be transmitted using a narrower beam footprint
* Notes for this objective:
	+ SSB channel enhancement other than SSB periodicity extension is not considered
		- RAN1 should consider issues such as UE’s cell search complexity and impact to initial cell selection, latency and success rate, for the above extension
	+ The SSB periodicity enhancements potentially defined in this WID only apply to NTN operation
	+ Antenna gain of UE shall be assumed to be -5.5dBi in case of smartphone in FR1-NTN, the UE is assumed to be a full duplex UE, and at least 2Rx are considered at the UE
	+ NGSO to be considered in priority: LEO Set-1 @ 600 km
	+ Backward compatibility for legacy UEs (i.e. Rel-17 and Rel-18 UEs) assuming a default SSB periodicity of 20ms is not guaranteed when SS/PBCH blocks periodicity is larger than 20ms within the cell used for initial frequency scan. Legacy UEs (i.e. Rel-17 and Rel-18 UEs) are not expected to be able to camp on a cell with SS/PBCH blocks periodicity larger than 160 ms.

# Discussion

Companies to comment on the NON highlighted revisions for objective 1 of WID (on topics reflecting RAN4 agreements)

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| **Company** | **Comment** |
| DOCOMO | Assuming this intends to the revision based on RAN1 agreements (not RAN4), we have comment on link level enhancements.As discussed in our contribution RP-242817, there is FFS in previous RAN1 agreement as shown below, and there seems no common understanding on whether the current spec is sufficient or not for PDCCH for CSS type 3 and USS. We prefer to keep the door open for this FFS to allow further RAN1 discussion, while current updated WID precludes it. We propose to add the same FFS in the updated WID, or add note that “It is not precluded to study, and specify if necessary, enhancements of PDCCH for CSS type 3 and USS”---AgreementSupport PDCCH CSS Link level enhancement in Rel-19 for all CSS types except type 3. * The following techniques are for further study:
	+ PDCCH repetition, including:
		- Option 1: Intra-slot PDCCH repetition
		- Option 2: Inter-slot PDCCH repetition
	+ CORESET length (i.e. number of OFDM symbols) extension
	+ DCI format optimization (e.g. size reduction, etc)
* Note: the same technique is intended to apply to all search space types targeted for link level enhancements
* For the above techniques, at least the following aspects should be discussed for the relevant candidate techniques:
	+ Configuration
	+ Backward compatibility and UE behaviour of legacy UE
	+ Linked Search Space
	+ Blocking probability
	+ DCI format size budget
	+ Resource overhead
	+ Impact on CORESET0
* Focus on coverage enhancement for set 1-3 with a target CNR of -8 dB for NR NTN DL coverage enhancements at link level.
* FFS: whether to apply the selected solution to PDCCH CSS type3 and PDCCH USS
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| **Spreadtrum** | **Editorial change: PDSCH with Msg4 via ~~PDCCH~~ PDSCH repetition** |
| **Xiaomi** | **We are fine with non highlighted revisions for objective 1 and second Spreadtrum’s comments to correct the typo.** |
| CATT | The non-highlighted revisions are aligned with RAN1 agreements and we are supportive in general.We propose to highlight the following yellow parts for further check depending on the final outcome of the enhancements.* Specify solutions, including link level enhancements for FR1-NTN and system level enhancements for FR1-NTN and FR2-NTN, allowing dynamic and flexible power sharing between satellite beams or different satellite beam patterns/size (i.e. wide or narrow) across the satellite footprint.

We agree with the editorial change proposed by Spreadtrum.We prefer to not include PDCCH repetition for PDCCH CSS type3 and PDCCH USS given that there is no RAN1 agreement to support that. |
| LGE | We propose the following green-marked modifications to ensure clear alignment with the agreements made by RAN1.* Specify solutions, including link level enhancements for FR1-NTN and system level enhancements for FR1-NTN and FR2-NTN, allowing dynamic and flexible power sharing between satellite beams or different satellite beam patterns/size (i.e. wide or narrow) across the satellite footprint.
	+ Link level enhancements are to be specified for the following channels:
		- PDCCH CSS (except for Type-3) via PDCCH repetition
		- PDSCH with Msg4 via PDSCH repetition
		- PDSCH with SIB1 via 2 PDSCH repetitions within 20 ms duration
	+ System-level enhancements are to be specified for the following:
		- Specify solutions to support extended periodicity of the half frames with SS/PBCH blocks assumed by UE during initial access.
		- The maximum of the additional default value (apart from the existing 20ms value) is at least 160 ms
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Companies to comment on the yellow highlighted revisions for objective 1 of WID (topics still under discussion)

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| **Company** | **Comment** |
| **Spreadtrum** | **It should be cell DTX/DRX in the following bullet:** ** Consider (if beneficial) enhancements on cell DTX/DRX** |
| **xiaomi** | **First of all, the objective of WID should be specific and clear. We don’t think any FFS points should be captured in any objective.****For the first FFS point, it should be deleted and leave it to RAN1 discussion, as we discussed in online session wherein clear more companies prefer to leave it to WG discussion. From our understanding, the statement of the parallel sub bullet is sufficient, i.e., ‘**The maximum of the additional default value (apart from the existing 20ms value) is at least 160 ms**’. 320 ms periodicity is not precluded and can be discussed in pending WG meeting.****For the second FFS point, we are OK with the direction of support switching between wide beam and narrow band. On the other hand, the specification impacts are not clear. From our understanding, it is possible to achieve this switch via specification transparent mechanism. If it does have certain specification impacts, we worry about the workload coming along. Hence, we prefer to delete the second FFS point as well and leave it to WG discussion.** |
| **Samsung** | **We think FFS bullets should be removed. RAN#106 is checkpoint for study aspects and if there is no clear observations and agreements for 320 ms and wide and narrow beams in RAN1, we don’t need to add in this WID update.** |
| **Viasat** | * + - FFS: Potential enhancements for transmitting the DL common channels using a wider beam footprint, while DL/UL dedicated channels (incl. PRACH) may be transmitted using a narrower beam footprint

**We do not think that this should have a “FFS”. Since the phrase “potential enhancements” is there, it clearly indicates that these are not decided and is up to RAN1 to decide after discussion. Putting a FFS indicates uncertainty as to whether RAN1 can discuss this or not. A WID should be clear. This has already been discussed and so putting FFS at this point makes very ambiguous..****This feature is important for operators for reasons outlined in previous Tdocs from Inmarsat/Viasat. Certainly specification impact and alternate ways of achieving the same outcome will be considered in RAN1 discussions.****To summarize: We are supporting of deleting just “FFS” from the highlighted portion and leaving the rest of the statement.** |
| **Huawei/HiSilicon** | **First FFS (for 320 ms periodicity) is in the RAN1 agreement, RAN Chair guideline is to align WID with RAN1 agreement and let RAN1 to discuss 320 ms SSB periodicity further. Therefore the first FFS should be kept in the WID.** |
| CATT | For 320ms SSB periodicity, it should be included in the WID and we suggest revising the bullet as below to reflect the discussions.* + - * ~~FFS:~~ whether 320ms can be supported as the maximum of the additional default value instead of or in addition to 160ms is to be decided in RAN1

For cell DTX/DRX, we do not think it can improve coverage and there is no RAN1 agreement to support that. We therefore propose to delete the bullet.For the wide beam bullet, the details and the benefits are not clear. In addition, we share the same view with xiaomi that it can be achieved by implementation without specification impact. We propose to delete this bullet. |
| LGE | For the options marked in gray below, one has already been discussed in RAN1 but failed to reach a consensus on its support, and the other has not even been agreed upon in RAN1 to be considered as part of system/link level enhancements. In this sense, we do not see a strong motivation to describe them on WID and would prefer to remove them from WID. Note that it is questionable whether RAN1 will have time to work on other options beyond working out the details of the options it has already agreed to support during its only three remaining meetings.Regarding the option marked in cyan below, since the wording of "at least 160ms” is explicitly present in the relevant RAN1 agreement, for the sake of progress, we can accept that a final decision on whether to support this option would be made through further discussion in RAN1. To capture this direction on WID, we would like to add a note like "RAN1 further discusses whether 320ms can be supported as the maximum of the additional default value instead of or in addition to 160ms".* Specify solutions, including link level enhancements for FR1-NTN and system level enhancements for FR1-NTN and FR2-NTN, allowing dynamic and flexible power sharing between satellite beams or different satellite beam patterns/size (i.e. wide or narrow) across the satellite footprint.
	+ Link level enhancements are to be specified for the following channels:
		- PDCCH CSS (except for Type-3) via PDCCH repetition
		- PDSCH with Msg4 via PDCCH repetition
		- PDSCH with SIB1 via 2 PDSCH repetitions within 20 ms duration
	+ System-level enhancements are to be specified for the following:
		- Specify solutions to support extended periodicity of the half frames with SS/PBCH blocks.
			* The maximum of the additional default value (apart from the existing 20ms value) is at least 160 ms
			* Note: RAN1 further discusses whether 320ms can be supported as the maximum of the additional default value instead of or in addition to 160ms
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# Conclusions

# References

1. RP-241789 Rel-19 WID NR NTN phase 3\_v05
2. RP-242464 Revised WID: Non-Terrestrial Networks (NTN) for NR Phase 3 THALES, CATT
3. RP-242554 On NTN DL Coverage Enhancements Qualcomm Incorporated
4. RP-242800 Discussion on WID scope for NR NTN OPPO
5. RP-242807 Discussion on NTN for NR Phase 3 in Rel-19 LG Electronics
6. RP-242817 Discussion on NR NTN for Rel-19 NTT DOCOMO, INC.
7. RP-242889 Checkpoint on Rel-19 NR NTN downlink coverage enhancements Huawei, HiSilicon
8. RP-242964 Discussion on the check point of Rel-19 Non-Terrestrial Networks (NTN) for NR Phase 3 CMCC
9. RP-243113 SSB periodicity extension on R19 NR NTN CATT, CSCN, CAICT, Baicells, HONOR, Lenovo, OPPO, Spreadtrum, TCL, xiaomi
10. RP-243169 Discussion on the scope of NR-NTN ZTE Corporation, Sanechips
11. RP-243174 On Rel-19 NR NTN Apple