**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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Companies to comment on the yellow highlighted revisions for objective 1 of WID (topics still under discussion)

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| **Company** | **Comment** |
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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