**3GPP TSG RAN WG1 #118 R1-240xxxx**

**Maastricht, NL, August 19th – 23rd, 2024**

**Source: CMCC**

**Title:** **Moderator’s summary on the discussion of the reply LS on DL coverage enhancements**

**Agenda item: 5**

**Document for: Discussion & Decision**

# Introduction

RAN2 has sent a LS to RAN1 regarding the DL coverage enhancements in NTN scenarios [1]. In the LS, RAN2 provides questions on DL coverage enhancements related to SSB, common control signaling, UL beams and beam status. The specific content of the LS is quoted as below.

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| RAN2 has started to study on RAN2 aspects of DL coverage enhancement. To progress the study, RAN2 has identified questions to RAN1 for aspects where the input is required.Related to this, RAN2 would like to request RAN1 to provide feedback on the following questions.**Question 1 :** Can RAN1 provide the information on their progress on whether the existing SSB pattern for an NR cell (e.g. SSB position in burst, SSB index number, etc.) is changed in Rel-19 NR NTN, and whether the SSB periodicity is extended compared with existing TN values?**Question 2 :** Can RAN1 provide the information on whether/how the solution RAN1 is investigating is expected to impact common control signalling for UEs in RRC idle / RRC inactive?**Question 3 :**  Can RAN1 provide the feedback on whether UL beam hopping is also being studied in RAN1 (and whether this is separate from DL beam hopping)?**Question 4 :** RAN2 would like to remind RAN1 that satellite beams are currently not visible to UEs and any decision about different beam status (i.e. "off", "common messages only" and "active traffic") will likely have to relate to beams visible to the UE (e.g. SSB beams). RAN2 would also like to know whether RAN1 intends to define beam status for beams not visible to the UE or to define new beam status for beams visible to the UE.**Question 5 :** Can RAN1 provide the feedback on whether the beam status in different beams (visible to the UE) of one cell are the same or can be different in any given time, i.e.. the beam status is cell specific or beam specific?**Actions:****To RAN1:**RAN2 kindly request RAN1 to provide feedback on above questions. |

# Discussion

20 contributions [4-23] were submitted to discuss the questions from RAN2 on DL enhancements. Some companies provided the draft reply LS and some companies provided there discussion in the paper under the agenda 9.11.1. Based on the inputs from the companies, the answers/replies to RAN2’s LS are drafted as below.

**2.1 Discussion on Question 1**

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| **Question1 :** Can RAN1 provide the information on their progress on whether the existing SSB pattern for an NR cell (e.g. SSB position in burst, SSB index number, etc.) is changed in Rel-19 NR NTN, and whether the SSB periodicity is extended compared with existing TN values? |

**FL’s proposal 1:**

**Answer to Q1:**

**According to the updated WID (RP-241667), SSB channel enhancement other than SSB periodicity extension is not considered. The enhancements to the existing SSB patterns, e.g. SSB position in burst, SSB index number, are not within the scope. The extension of the SSB periodicity is allowed and is still under RAN1’s discussion.**

**Based on RAN1’s research in the previous meetings, it was observed that the with the extension of the SSB periodicity and beam hopping, the coverage ratio can be improved.**

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| Observation(117)Based on the results of DL coverage ratio evaluation at system level collected from 7 sources for all the three LEO600km satellite parameter sets where the beam footprint diameter is 50 km:* For Set 1-1/1-3, the coverage ratio can be improved from 10% to 100% if the SSB periodicity is increased from 20ms to 80ms and beam hopping is applied
* For Set 1-2, the coverage ratio can be improved from 1.5% to 96.8% if the SSB periodicity is increased from 20ms to 320ms and beam hopping is applied.
* Note: coverage ratio is N2+N3/ total beam footprints
* Note: the baseline assumes no beam hopping. TDM between SIB1 and SIB19 is assumed in those results, following current specs.

Based on the results of DL coverage ratio evaluation at system level collected from 3 sources for a deployment scenario implementing wide beam footprint:* 1 source reports that with a deployment of wide beam covering 4 narrow (of 50km size) beams, which means Set 1-2 FR1 with additional EIRP reduction of 6dB, using SSB periodicity of 80 ms can provide coverage ratio of 96.8%, and Set 1-1/1-3 FR1 with additional EIRP reduction of 6dB, SSB periodicity of 80 ms can provide coverage of 100%.
* 1 source observed that for Set 1-1, 1-2 and 1-3, the coverage ratio can be improved from 1.5% to 100% using the legacy default SSB periodicity of 20ms during initial access, by choosing a wide beam footprint with beam footprint sizes of 84 km and 56 km respectively.
	+ Note: the PDCCH and the PDSCH for SIB19 is assumed to be transmitted within 2 OFDM symbols and 5 MHz bandwidth. the PDSCH for SIB1 is assumed to be transmitted within 3 OFDM symbols and 5 MHz bandwidth. This assumes no SIB1 and SIB19 transmission in N2 beam footprints. This assumes non-aligned SFN timing across different beams.
* 1 source observed, for Set 1-1 with increased beam size, that the legacy SSB periodicity of 20ms during initial access is usable with NTN beam hopping, by choosing a deployment scenario implementing wide beam footprint with beam footprint sizes of 70.7 km and 86.6 km, leading to a total of 529 and 353 beam footprints within the satellite coverage area, respectively, and the coverage ratio is 80% and 90%, respectively, and a ratio of simultaneously active beam footprints to the total number of beam foot prints equal to 20% and 30%.
	+ Note: Beam footprint size is increased by increasing only the *adjacent beam spacing* without increasing the 3dB beamwidth.

Note: RAN1 will further investigate the impact of SSB periodicity extensionNote: Any needed clarification “SSB channel enhancement is not considered” in the WID is up to RAN plenaryNote: RAN1 will further investigate the impact of wider beam of SSB and/or other channels on performance (e.g. link budget, capacity...) |

The proposal is drafted based on the inputs and the latest progress before RAN1#118 meeting. If agreements related to the SSB periodicity extension are achieved during this meeting, the proposal will be updated accordingly. The agreements related SSB periodicity extension will be also attached. Companies are encouraged to provide your views in the table below.

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| Company | Do you support the proposal or can you live with the proposal ?(Yes/No) | If not, please provide views and the updates |
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**2.2 Discussion on Question 2**

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| **Question 2 :** Can RAN1 provide the information on whether/how the solution RAN1 is investigating is expected to impact common control signalling for UEs in RRC idle / RRC inactive? |

**FL’s proposal 2:**

**Answer to Q2:**

**Currently RAN1 does not have any conclusion on the enhancements to the common control channel. As mentioned in the WID, the Rel-18 network energy saving techniques should be considered as baseline in the system level study. The cell DTX/DRX liked enhancements to the common control signaling for UEs in idle or inactive mode may be needed. When the SSB periodicity extension is introduced, the transmission of broadcast information including SIB1 and other system information may be extended accordingly.**

The proposal is drafted based on the inputs and the latest progress before RAN1#118 meeting. If agreements related to the common control channels are achieved during this meeting, the proposal will be updated accordingly. Companies are encouraged to provide your views in the table below.

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| Company | Do you support the proposal or can you live with the proposal ?(Yes/No) | If not, please provide views and the updates |
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**2.3 Discussion on Question 3**

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| **Question 3 :** Can RAN1 provide the feedback on whether UL beam hopping is also being studied in RAN1 (and whether this is separate from DL beam hopping)? |

**Proposal 3:**

**Answer to Q3:**

**The solutions of beam hopping are still under RAN1’s discussion. RAN1 has not discussed beam hopping for downlink and uplink separately.**

The proposal is drafted based on the inputs and the latest progress before RAN1#118 meeting. If agreements related to UL beam hopping are achieved during this meeting, the proposal will be updated accordingly. Companies are encouraged to provide your views in the table below.

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| Company | Do you support the proposal or can you live with the proposal ?(Yes/No) | If not, please provide views and the updates |
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**2.4 Discussion on Question 4**

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| **Question 4 :** RAN2 would like to remind RAN1 that satellite beams are currently not visible to UEs and any decision about different beam status (i.e. "off", "common messages only" and "active traffic") will likely have to relate to beams visible to the UE (e.g. SSB beams). RAN2 would also like to know whether RAN1 intends to define beam status for beams not visible to the UE or to define new beam status for beams visible to the UE. |

**Proposal 4:**

**Answer to Q4:**

**RAN1 confirms the RAN2 understanding that satellite beams are currently not visible to UEs. Beam footprint status in terms of "off", "common messages only" and "active traffic” in one of the RAN1 agreements is primarily defined for the sake of system-level evaluation methodology. Currently there is no intention to define beam status for beams not visible to the UE or to define new beam status for beams visible to the UE.**

**If the cell DTX/DRX operation is introduced, UEs may be aware that no DL transmission is expected during a period of time. The details are still open.**

The proposal is drafted based on the inputs and the latest progress before RAN1#118 meeting. If agreements related to beam status (i.e. "off", "common messages only" and "active traffic") are achieved during this meeting, the proposal will be updated accordingly. Companies are encouraged to provide your views in the table below.

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| Company | Do you support the proposal or can you live with the proposal ?(Yes/No) | If not, please provide views and the updates |
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**2.4 Discussion on Question 5**

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| **Question 5 :** Can RAN1 provide the feedback on whether the beam status in different beams (visible to the UE) of one cell are the same or can be different in any given time, i.e.. the beam status is cell specific or beam specific? |

**Proposal 5:**

**Answer to Q5:**

**Currently there is no intention to define new beam status for beams visible to the UE.**

**If the cell DTX/DRX operation is introduced, UEs may be aware that no DL transmission is expected during a period of time. The details are still open.**

The proposal is drafted based on the inputs and the latest progress before RAN1#118 meeting. If agreements related to beam status (i.e. "off", "common messages only" and "active traffic") are achieved during this meeting, the proposal will be updated accordingly.

Based on the contributions from companies, the beam status mentioned in the questions can be interpreted as on-off state of the cell DTX/DRX operation. With the consideration of this, “**If the cell DTX/DRX operation is introduced, UEs may be aware that no DL transmission is expected during a period of time. The details are still open.** ” is added.

Companies are encouraged to provide your views in the table below.

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| Company | Do you support the proposal or can you live with the proposal ?(Yes/No) | If not, please provide views and the updates |
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# Conclusions

# References

1. R1-2405785, LS on DL coverage enhancements, 3GPP TSG-RAN WG1 Meeting #118
2. Draft\_Minutes\_report\_RAN1#117\_v010, 3GPP TSG RAN WG1 Meeting #118, Maastricht, The Netherlands, August 19th – 23rd, 2024
3. RP-241667, Revised WID: Non-Terrestrial Networks (NTN) for NR Phase 3, 3GPP TSG RAN Meeting #104, Shanghai, China, June 17-20, 2024
4. R1-2405841 Discussion on the reply of LS on DL coverage enhancement Huawei, HiSilicon
5. R1-2405897 Discussion on LS on DL coverage enhancements Spreadtrum Communications
6. R1-2405971 Discussion on LS on DL coverage enhancements CMCC
7. R1-2405972 Draft Reply LS on DL coverage enhancements CMCC
8. R1-2406126 Discussion on LS on DL coverage enhancements ZTE Corporation, Sanechips
9. R1-2406146 Discussion on LS on DL coverage enhancements vivo
10. R1-2406147 Draft reply LS on DL coverage enhancements vivo
11. R1-2406235 Discussion on DL coverage enhancements OPPO
12. R1-2406236 Draft reply LS on DL coverage enhancements OPPO
13. R1-2406320 Discussion on LS reply on DL coverage enhancements CATT
14. R1-2406551 Discussion on RAN2 LS on DL coverage enhancements NEC
15. R1-2406616 Discussion on RAN2 LS for DL coverage enhancements Samsung
16. R1-2406816 Discussion on RAN2 LS on DL Coverage Enhancements Apple
17. R1-2406817 Draft Reply LS to RAN2 on DL Coverage Enhancements Apple
18. R1-2406753 Discussion of LS response related to DL coverage enhancements for NR over NTN operation Nokia
19. R1-2406876 [Draft] Reply LS on DL coverage enhancements Ericsson
20. R1-2406877 Discussion on RAN2 LS on DL coverage enhancements Ericsson
21. R1-2406446, Discussion on NR-NTN downlink coverage enhancement, LG Electronics
22. R1-2406949, Discussion on DL coverage enhancement for NR-NTN, NTT DOCOMO
23. R1-2407078, Downlink Coverage Enhancements for NR NTN, CEWiT, IITKGP

# Annex (WID RP-241667 for reference)

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| The objectives of the work item are the following: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
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