**3GPP TSG-RAN WG4 Meeting # 109 R4-2318222**

**Chicago, USA, November 13 – November 17, 2023**

**Agenda item:** 8.34.5

**Source:** Huawei, HiSilicon

**Title:** Topic summary for [109][330] Netw\_Energy\_NR\_demod

**Document for:** Information

# Introduction

This contribution summarizes the open issues for demodulation and CSI requirements for Rel-18 Network energy saving.

# Topic #1: Demodulation and CSI requirements

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318353 | Nokia, Nokia Shanghai Bell | 1. The demodulator implementation to conform to Rel-15 CA can be built on SSB and DM-RS TOE/TOC, while the Rel-18 SSB-less Scell CA demodulator implementation needs to implementation TRS based TOE/TOC to achieve comparable performance (assuming the TRS TOE is correct, which is not necessarily correct).
2. Using Rel-15 compliant demodulator implementations, based on Pcell SSB TOE/TOC results, for Rel-18 SSB-less Scells results in poor performance, much below acceptable operating points for deployment of the feature.
3. A practical Rel-15 compliant TRS based TOE algorithm has a realistic initial TO tolerance on the order of magnitude of RTD\_max=TO\_max = +/- 1.1\*CP.
4. RAN4 shall evaluate the performance of SSB-less SCells CA performance with Rel-15 compliant demodulator implementation (without TRS based TOE) and decide, if the observed performance constitutes a practical operating point of the feature, or if new requirements capturing improved demodulator implementations are needed, or if SSB-less SCell compliant UE shall be tested with normal CA requirements.
5. RAN4 shall not introduce CSI requirements for spatial and power domain techniques.
6. RAN4 shall not introduce CSI requirements for spatial and power domain techniques.
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| R4-2318354 | Nokia, Nokia Shanghai Bell | Provide the simulation results |
| R4-2318678 | Apple Inc | Proposal 1: Do not define additional requirements for the scenario of SSB-less CA operation.Proposal 2: Do not introduce new CSI requirements for NES.Proposal 3: Do not specify new tests intended to new power offset values an adaptation, since this does not meaningfully impact UE internal signal processing. |
| R4-2319337 | Samsung | Proposal 1: Do not to define new PDSCH demodulation requirements for SSB-less SCell operation.Proposal 2: Do not to define new CSI requirements for spatial domain techniques and power domain techniques. |
| R4-2319552 | ZTE Corporation | Observation 1. Timing difference between different Rx chains could be considered, which should be also part of contribution for timing difference reached at baseband.Proposal 1. RAN4 shall define demodulation minimum performance requirements for SSB-less SCell operation for inter-band CA for FR1 and co-located cells. |
| R4-2319748 | Ericsson | Proposal 1: Define PDSCH CA demodulation requirements for UE supporting SSB-less SCell operation, by reusing the existing minimum PDSCH CA demodulation requirements.* Apply the same requirements as the minimum CA demodulation requirements, TS38.101-4 5.2A.2.1 for 2Rx UE and 5.2A.3.1 for 4Rx UE.
* Add a new test parameter table for SCell where SSB is not configured.
* Applicable only for inter-band CA in FR1.

Proposal 2: Introduce a test applicability if UE supporting SSB-less SCell operation passes the PDSCH CA demodulation requirements with SSB-less SCell configuration, UE can skip to test for the existing PDSCH CA demodulation requirement with SSB configuration in SCell.Proposal 3: Not define CSI reporting requirements for spatial and power domain adaptation.  |
| R4-2320196 | Huawei, HiSilicon | Observation 1: When N=2 (N refer to number of CSIs to be reported in one CSI report occasion) is configured, 2 CPUs are occupied, resulting in higher CPU capacity is required compared to legacy CQI test with only one CPU occupied.Observation 2: The potential new UE behaviour is that UE can calculate CQI for first power offset and derive the CQI for the second power offset directly by mapping the changed SINR to CQI.Proposal 2: Define CQI test under AWGN for power domain adaptation to check CQI performance with multiple CPUs and if UE can calculate CQI for each power offset correctly. Observation 3: When N=2 (N refer to number of CSIs to be reported in one CSI report occasion) is configured, 2 CPUs are occupied, resulting in higher CPU capacity is required compared to legacy PMI test with only one CPU occupied and one CSI-RS configured.Observation 4: The potential new UE behaviour is that UE can utilize the character that PMIs between different spatial domain patterns are highly correlated to simplify the PMI derivation for all spatial domain patterns.Proposal 3: Define PMI test for spatial domain adaptation to check PMI performance with multiple CPUs and if UE can calculate PMI for each spatial pattern correctly. Proposal 4: Use following test setup for power domain adaptation test as start point.

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| Set two CSI-RS to PDSCH power offsets, each of which corresponds to one sub-configuration (denoted as offset1 and offset2).For case with N=1, use A-CSI reporting, TE triggers two sub-configurations alternatively and collects reported CQI (denoted as CQI1 and CQI2) and calculates median CQI for each sub-configuration respectively.(denoted as median CQI1 and median CQI2)\_For case with N=2, use P-CSI reporting or A-CSI reporting. TE triggers two sub-configurations simultaneously and collects reported CQI (denoted as CQI1 and CQI2) and calculate median CQI respectively for sub-configuration. (denoted as median CQI1 and median CQI2)\_TE transmits PDSCH with two different power, each of which is derived by CSI-RS to PDSCH power offset specified in sub-configuration with assumption of fixed power of CSI-RS and following test metrics are defined:

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| a) The reported CQI1 value according to the reference channel shall be in the range of ±1 of the reported median CQI1 more than 90% of the time.b) If the PDSCH BLER using the transport format indicated by median CQI1 is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI1+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI1 is greater than 0.1, then the BLER using transport format indicated by (median CQI1-1) shall be less than or equal to 0.1.c) The reported CQI2 value according to the reference channel shall be in the range of ±1 of the reported median CQI2 more than 90% of the time.d) If the PDSCH BLER using the transport format indicated by median CQI2 is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI2+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI2 is greater than 0.1, then the BLER using transport format indicated by (median CQI2-1) shall be less than or equal to 0.1. |

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Proposal 5: Use following test setup for spatial domain adaptation test as start point.

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| For test setup of follow PMI case:For case with N=1, use A-CSI reporting, TE triggers two CSI report sub-configurations and apply the reported CSI alternatively. For case with N=2, use P-CSI reporting or A-CSI reporting, TE triggers two CSI report two sub-configurations simultaneously and apply the reported CSI alternatively. For test setup of random PMI case:Type 1 spatial domain pattern: TE selects PMI randomly from the union of two codebook corresponding to two spatial patterns. Type 2 spatial domain pattern: TE selects PMI randomly from the codebook per slot per PRG.Then legacy test metric can be reused: $γ=\frac{TP\_{follow}}{TP\_{random}}$ |

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| R4-2320798 | Qualcomm Inc. | Observation 1: PDSCH Demodulation requirements assume TRS is present and UE is processing TRS as source for tracking loops updates;Proposal 1: SSB-less SCell doesn’t have an impact on UE baseband processing algorithms, and RAN4 should not consider introducing a dedicated PDSCH requirement;Proposal 2: There is no impact to UE baseband processing algorithms when using Spatial or Power domain techniques, and RAN4 should not consider introducing a dedicated CSI requirement; |

## 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 1-1: SSB less Scell requirements for inter-band CA

**Issue 1-1-1: Whether to introduce SSB less Scell requirements for inter-band CA**

* Proposals
	+ Option 1: RAN4 shall evaluate the performance of SSB-less SCells CA performance with Rel-15 compliant demodulator implementation (without TRS based TOE) and decide, if the observed performance constitutes a practical operating point of the feature, or if new requirements capturing improved demodulator implementations are needed, or if SSB-less SCell compliant UE shall be tested with normal CA requirements. (Nokia)
	+ Option 2: Define the SSB less Scell requirements for inter-band CA by reusing the existing minimum PDSCH CA demodulation requirements (Ericsson)
		- Apply the same requirements as the minimum CA demodulation requirements, TS38.101-4 5.2A.2.1 for 2Rx UE and 5.2A.3.1 for 4Rx UE.
		- Add a new test parameter table for SCell where SSB is not configured:

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| Table 5.2A.x.y-1: Additional test parameters for SCell

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| Parameter | Unit | Value |
| Common serving cell parameters | Physical Cell ID |  | Same as PSell |
| SSB position in burst |  | Not configured |
| SSB periodicity | ms | N/A |

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* + - Applicable only for inter-band CA in FR1**.**
	+ Option 3: RAN4 shall define demodulation requirements for SSB-less Scell operation for inter-band CA for FR1 and co-located cells. (ZTE)
	+ Option 4: Not to introduce the requirements(Samsung, Huawei, Qualcomm, Apple)
* Recommended WF
	+ TBA

**Issue 1-1-2: Test applicability rules (If agreed to introduce the requirements)**

* Proposals
	+ Option 1: Introduce a test applicability if UE supporting SSB-less SCell operation passes the PDSCH CA demodulation requirements with SSB-less SCell configuration, UE can skip to test for the existing PDSCH CA demodulation requirement with SSB configuration in SCell. (Ericsson)
* Recommended WF
	+ Postpone the discussion until issue 1-1-1 is finalized.

### Sub-topic 1-2: CSI requirements

**Issue 1-2-1: Whether to introduce CSI requirements for power/spatial domain adaption**

* Proposals
	+ Option 1: Yes, RAN4 to introduce: (Huawei)
		- CQI requirements under AWGN channel for power domain adaption to check CQI performance with multiple CPUs and if UE can calculate CQI for each power offset correctly.
		- PMI requirements for type1 and type2 spatial domain adaption to check PMI performance with multiple CPUs and if UE can calculate PMI for each spatial pattern correctly.
	+ Option 2: Not to introduce CSI requirements for power/domain adaption. (Ericsson, Nokia, Samsung, Qualcomm, Apple)
* Recommended WF
	+ TBA

**Issue 1-2-2: Test setup for power domain adaption (If it’s agreed to introduce the requirements)**

* Proposals
	+ Option 1: (Huawei)

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| Set two CSI-RS to PDSCH power offsets, each of which corresponds to one sub-configuration (denoted as offset1 and offset2).For case with N=1, use A-CSI reporting, TE triggers two sub-configurations alternatively and collects reported CQI (denoted as CQI1 and CQI2) and calculates median CQI for each sub-configuration respectively.(denoted as median CQI1 and median CQI2)\_For case with N=2, use P-CSI reporting or A-CSI reporting. TE triggers two sub-configurations simultaneously and collects reported CQI (denoted as CQI1 and CQI2) and calculate median CQI respectively for sub-configuration. (denoted as median CQI1 and median CQI2)\_TE transmits PDSCH with two different power, each of which is derived by CSI-RS to PDSCH power offset specified in sub-configuration with assumption of fixed power of CSI-RS and following test metrics are defined:

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| a) The reported CQI1 value according to the reference channel shall be in the range of ±1 of the reported median CQI1 more than 90% of the time.b) If the PDSCH BLER using the transport format indicated by median CQI1 is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI1+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI1 is greater than 0.1, then the BLER using transport format indicated by (median CQI1-1) shall be less than or equal to 0.1.c) The reported CQI2 value according to the reference channel shall be in the range of ±1 of the reported median CQI2 more than 90% of the time.d) If the PDSCH BLER using the transport format indicated by median CQI2 is less than or equal to 0.1, then the BLER using the transport format indicated by the (median CQI2+1) shall be greater than 0.1. If the PDSCH BLER using the transport format indicated by the median CQI2 is greater than 0.1, then the BLER using transport format indicated by (median CQI2-1) shall be less than or equal to 0.1. |

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* Recommended WF
	+ Postpone the discussion until issue 1-2-1 is finalized.

**Issue 1-2-3: Test setup for spatial domain adaption (If it’s agreed to introduce the requirements)**

* Proposals
	+ Option 1: Use following test setup for spatial domain adaptation test as start point. (Huawei)

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| For test setup of follow PMI case:For case with N=1, use A-CSI reporting, TE triggers two CSI report sub-configurations and apply the reported CSI alternatively. For case with N=2, use P-CSI reporting or A-CSI reporting, TE triggers two CSI report two sub-configurations simultaneously and apply the reported CSI alternatively. For test setup of random PMI case:Type 1 spatial domain pattern: TE selects PMI randomly from the union of two codebook corresponding to two spatial patterns. Type 2 spatial domain pattern: TE selects PMI randomly from the codebook per slot per PRG.Then legacy test metric can be reused: $γ=\frac{TP\_{follow}}{TP\_{random}}$ |

* Recommended WF
	+ Postpone the discussion until issue 1-2-1 is finalized.