**3GPP TSG-RAN WG4 Meeting #110bis R4-240xxxx**

**Fukuoka City, JP, May 20-24, 2024**

**Agenda item:** 7.17.3

**Source:** Moderator (China Telecom)

**Title:** Topic summary for [111][326] NR\_cov\_enh2\_demod

**Document for:** Information

# Introduction

This contribution summarizes the open issues, candidate options as well as the recommended WF for the performance part for the Rel-18 further coverage enhancement WI under agenda 7.17.2.

# Topic #1: Multiple PRACH transmission reuqirements (Open Issues)

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407108 | China Telecom | Proposal 1: Use the shortest interval (i.e., consecutive slots) for all PRACH repletion requirement definition as minimum requirement.  Proposal 2: Add note in the spec that the requirements are applicable for all BS that support this feature regardless of PRACH configuration index or TDD pattern.  Proposal 3: Prefer not to introduce additional manufacturer declarations for supported SCS(s) for PRACH repetition. Also fine with option 1 if there are BS vendors prefer to decouple PRACH repetition and Rel-15 basic PRACH.  Proposal 4: Reuse the SNR requirement value deriving rule for Rel-15 BS demodulation SNR requirement derivation procedure as agreed in [3]:  Procedure to derive the performance requirements:  – Only inputs that consist of a pair of ideal and impaired results can be taken into account.  – If the ideal span <= [2]dB:  • The AVERAGE impairment results can be used for the performance requirement with [] in the draftCRs/CRs;  – Else if the ideal span is larger than [2]dB:  • The results farthest from the AVERAGE value is taken out for the AVERAGE and SPAN re-calculation until the ideal span is <=2dB but still with at least 3 companies’ results available:  – The ultimate AVERAGE impairment results with corresponding ideal span <=2dB can be used for performance requirement with [] in the draftCRs/CRs.  • Otherwise put TBD for the related performance requirements.  – If the span of the impairment results after removal the outliers (if any) are larger than 4dB, then the procedure cannot be applied, related performance requirement remain TBD. |
| R4-2407138 | Nokia | Observation 1: In a coverage enhancement scenario, it is likely that PRACH would wish to be in consecutive slots.  Proposal 1: RAN4 shall use DDDSUDDDSU for 15kHz and 120kHz SCS for the TDD pattern on PRACH |
| R4-2407140 | Nokia | Simulations for Coverage Enhancement BS Demodulation |
| R4-2408345 | Ericsson | Observation 1 The performance gets stable when interval is 10ms for FR1 and 5ms for FR2-1.  Observation 2 The performance difference between 1 slot interval and 10ms (FR1) /5ms (FR2-1) interval is around 1~2dB.  Observation 3 The performance difference between 5ms interval and 10ms for FR1 is less than 0.6dB. The performance difference between 2.5ms interval and 5ms interval for FR2-1 is less than 0.2dB.  Observation 4 By option 1, BS under test would have low risk can’t pass requirements no matter what repetition interval is supported, and the specification could be simple.  Observation 5 The disadvantage of Option 1 is that it will lead to that the tested BS could 1~2dB margin at the beginning on 15kHz and 120kHz SCS tests.  Observation 6 One possible solution for Option 1 might be adding AWGN channel requirement to reduce the impact by relaxed requirement for fading channel.  Observation 7 By option 2, good product performance could be secured for all tests.  Observation 8 The disadvantages of Option 2 include the risk that BS under test can’t support large repetition interval and fail the test, and the detailed configurations should be captured in specifications.  Observation 9 It is very hard to have large repetition interval for some PRACH Configuration Index with 2 repetitions especially when number of available RO is high but the maximum SSB number is small.  Observation 10 One possible solution for Option 2 might be using higher repetition factor under fading channel to reduce the performance difference between Configuration Indexes. More simulations are needed to check the final difference.  Observation 11 The necessary of new applicability rule depends on the agreement on requirement definition method.  Based on the discussion in the previous sections we propose the following:  Proposal 1 If the requirement under fading channel is defined by simulation result with small repetition interval (<=1 slot), adding AWGN requirements to reduce the impact of fading channel.  Proposal 2 If the requirement under fading channel is defined by simulation result with large repetition interval, consider higher repetition factor (i.e., n4 or n8) to reduce the impact of fading channel.  Proposal 3 Take Option 1 to have supported SCS declaration for PRACH repetition. |
| R4-2408346 | Ericsson | Simulation results for Rel-18 NR PRACH repetitions demodulation requirements |
| R4-2408956 | Huawei, HiSilicon | Proposal 1: The detailed SSB and PRACH configurations is up to BS implementation and should not be mandated.  Proposal 2: The worst case should be considered, that means the detailed SSB and PRACH configurations resulting to higher SNR should be selected among all candidate options.  Proposal 3: Define one set of requirements for both FDD and TDD.  Proposal 4: Confirm that PRACH repetition can be within 1 slot for PRACH format A2 and C2.  Proposal 5: Confirm that PRACH B4 can be configured in FDD 15kHz SCS based on available PRACH Configuration Index.  Proposal 6: Use PRACH repetition interval = 4 symbols for A2 for 15/30/120kHz, 1 slot for B4 for 15/30kHz, 10 slots for B4 for 120kHz, 6 symbols for C2 for 15/30/120kHz for multiple PRACH transmission demodulation requirements.  Proposal 7: Introduce additional manufacturer declarations for supported SCS(s) for PRACH repetition, with the additional limitation that the new declared SCS shall be subset of the legacy declared SCS.  Proposal 8: Do not define additional applicability for different TDD patterns. |
| R4-2408957 | Huawei, HiSilicon | Simulation results on BS demodulation requirements for further coverage enhancements |
| R4-2409081 | ZTE Corporation, Sanechips | Observation 1. The configuration index not applicable to B4 for FDD 15kHz SCS.  Proposal 1. The following cases can be considered.  FR1 FDD 30 kHz with 1 slot repetition interval  FR1 TDD 15 kHz with 5 slot repetition interval  FR2-1 TDD 120kHz with 10 slot repetition interval  Proposal 2. The following configuration index can be considered if 10 slots repetition interval is considered.  [104, 162, 205] for FR1 TDD15kHz SCS,  [133, 210, 252] for FR1 FDD 30kHz SCS,  [58, 143, 201] for FR2-1 TDD 120kHz SCS.  Proposal 3. Not to introduce additional manufacturer declarations for supported SCS(s) for PRACH repetition. |
| R4-2409082 | ZTE Corporation, Sanechips | Simulation results for multiple PRACH |
| R4-2409475 | Samsung | Proposal 1: No need to introduce additional manufacturer declarations for supported SCS(s) for PRACH repetition, The Manufacturer declarations of PRACH format for multiple PRACH transmission can be considered as following  Observation 1: It is feasible to consider the format B4 in 15KHz SCS FDD with repetition transmission, where the interval between 2 ROs is 10ms  Proposal 2: Not consider the PRACH repetition within 1 slot for PRACH format A2 and C2  Proposal 3: Applying the interval between two repetition ROs as 10ms for requirement derivation of PRACH with repetition transmission.  Proposal 4: Applying the interval between two repetition ROs as 10ms for requirement derivation of PRACH with repetition transmission in FR1, and applying the interval between two repetition ROs as 5ms for requirement derivation of PRACH with repetition transmission in FR2  Proposal 5: The following PRACH configuration index can be considered as starting point  - 15KHz SCS  - Format A2  - PRACH configuration index, 127, number of RO within 10ms =3, number of SSB within 10ms=3  - Format B4  - PRACH configuration index, 210, number of RO within 10ms =1, number of SSB within 10ms=1  - Format C2  - PRACH configuration index, 246, number of RO within 10ms =2, number of SSB within 10ms=2  - 30KHz SCS  - Format A2  - PRACH configuration index 96, number of RO within 10ms =3, number of SSB within 10ms=3  - Format B4  - PRACH configuration index, 156, number of RO within 10ms =1, number of SSB within 10ms=1  - Format C2  - PRACH configuration index, 201, number of RO within 10ms =2, number of SSB within 10ms=2  - 120KHz SCS  - Format A2  - PRACH configuration index 41, number of RO within 10ms=4, number of SSB within 10ms =4  - Format B4  - PRACH configuration index, 124, number of RO within 10ms=4, number of SSB within 10ms =4  - Format C2  - PRACH configuration index, 185, number of RO within 10ms =4, number of SSB within 10ms=4 |

## Open issues summary

**Issue 1-1: PRACH repetition interval and TDD pattern for Multiple PRACH transmission**

* Status in the WF R4-2406137 in RAN4#110-bis:

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| *Agreements on detailed network configurations:*   * + *Msg1-FDM =1*   + *TDD pattern: 3D1S1U for 15KHz, and 120kHz, 7D1S2U for 30kHz*   + *msgA-SSB-PerRACH-Occasion:*   *msgA-SSB-PerRACH-OccasionAndCB-PreamblesPerSSB-r16 CHOICE {*  ***one*** *ENUMERATED {n4,n8,n12,n16,n20,n24,n28,n32,n36,n40,n44,n48,n52,n56,n60,n64},*  *On PRACH interval based on the above configurations:*   * + *Option 1: Simulation assumption based on the following PRACH repetition interval.*     - *For FDD and TDD with 7D1S2U 30kHz SCS: Consecutive slots.* * *FFS whether PRACH repetition can be within 1 slot for PRACH format A2 and C2.*   + - *For TDD with DDDSU:* * *Option 1A: Consecutive slots* * *Option 1B: DDDSUDDDSU for 15kHz and 120kHz SCS* * *Option 1C: DDDSUDDDSUDDDSUDDDSU for 120kHz SCS only*   + *Option 2: fixed PRACH interval for all the SCSs, i.e., 10ms.*   + *Companies are encouraged to bring simulation results for all options in the next meeting.*   *Companies are encouraged to bring detailed PRACH configuration for the above options in the next meeting.*   * + *Companies to check if PRACH B4 can be configured in FDD 15kHz SCS based on available PRACH Configuration Index* |

* Whether PRACH B4 can be configured in FDD 15kHz SCS:
  + Option 1: PRACH B4 can be configured in FDD 15kHz SCS (Huawei, Samsung)
    - HW, Samsung: PRACH configuration index FDD 211/210
  + Option 2: The configuration index not applicable to B4 for FDD 15kHz SCS (ZTE)
    - ZTE: the number of PRACH slots within a subframe is always set to 2
* FFS whether PRACH repetition can be within 1 slot for PRACH format A2 and C2
  + Option 1: Not consider the PRACH repetition within 1 slot for PRACH format A2 and C2 (Samsung)
* Proposals on PRACH repetition interval:
  + Option 1: Define PRACH repetition requirements based on shortest PRACH repetition interval as min requirements (China Telecom, Nokia, Ericsson, Huawei, [ZTE])
    - For PRACH format A2 and C2 for FDD and TDD:
* Option 1: Consecutive slots (China Telecom)
* Option 2: PRACH repetition within 1 slot (Huawei)
* Samsung: it is too dense considering multiple ROs transmission within 10ms
* Option 3: FDD 30 kHz with 1 slot repetition interval, TDD 15 kHz with 5 slot repetition interval, TDD 120kHz with 10 slot repetition interval (ZTE)
  + - For PRACH format B4:
* For FDD and TDD with 7D1S2U 30kHz SCS: Consecutive slots (China Telecom, Huawei, ZTE)
* For TDD with DDDSU
* 15kHz SCS: DDDSUDDDSU, i.e., 5 slots (Nokia, [Huawei], ZTE)
* 120kHz SCS:
* Option 1: DDDSUDDDSU, i.e., 5 slots (Nokia)
* Option 2: DDDSUDDDSUDDDSUDDDSU, i.e.,10 slots (Huawei, ZTE)
  + Option 2: fixed PRACH interval for all the SCSs, i.e., 10ms (Samsung)
  + Option 3: Applying the interval between two repetition ROs as 10ms for requirement derivation of PRACH with repetition transmission in FR1, and applying the interval between two repetition ROs as 5ms for requirement derivation of PRACH with repetition transmission in FR2 (Samsung)
* Proposals on additional requirements if shortest PRACH repetition interval is used:
  + Proposal 1: Adding AWGN requirements to reduce the impact of fading channel (Ericsson)
  + Proposal 2: Do not define additional applicability for different TDD patterns (Huawei)
  + Proposal 3: Add note in the spec that the requirements are applicable for all BS that support this feature regardless of PRACH configuration index or TDD pattern (CTC)
* Proposals on additional requirements if longer PRACH repetition interval is used:
  + Proposal 1: Consider larger repetition number n4 or n8 (Ericsson)
  + Proposal 2: The following PRACH configuration index (Samsung)

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| * 15KHz SCS   + Format A2     - PRACH configuration index, 127, number of RO within 10ms =3, number of SSB within 10ms=3   + Format B4     - PRACH configuration index, 210, number of RO within 10ms =1, number of SSB within 10ms=1   + Format C2     - PRACH configuration index, 246, number of RO within 10ms =2, number of SSB within 10ms=2 * 30KHz SCS   + Format A2     - PRACH configuration index 96, number of RO within 10ms =3, number of SSB within 10ms=3   + Format B4     - PRACH configuration index, 156, number of RO within 10ms =1, number of SSB within 10ms=1   + Format C2     - PRACH configuration index, 201, number of RO within 10ms =2, number of SSB within 10ms=2 * 120KHz SCS   + Format A2     - PRACH configuration index 41, number of RO within 10ms=4, number of SSB within 10ms =4   + Format B4     - PRACH configuration index, 124, number of RO within 10ms=4, number of SSB within 10ms =4   + Format C2   + PRACH configuration index, 185, number of RO within 10ms =4, number of SSB within 10ms=4 |

* Recommended WF
  + Discussion needed.

**Issue 1-2: Manufacturer declarations for PRACH repetition test requirements**

* Status in the WF R4-2406137 in RAN4#110-bis:

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| * + *Option 1: Introduce additional manufacturer declarations for supported SCS(s) for PRACH repetition*   + *Option 2: No need to introduce additional manufacturer declarations for supported SCS(s) for PRACH repetition* |

* Proposals:
  + Option 1: Introduce additional manufacturer declarations for supported SCS(s) for PRACH repetition (China Telecom, Ericsson, Huawei, [Samsung])
  + Option 2: No need to introduce additional manufacturer declarations for supported SCS(s) for PRACH repetition (China Telecom, ZTE, Samsung)
* Recommended WF
  + Can we agree with option 1 considering it give BS more flexibility?

**Issue 1-3: SNR requirement value deriving rule for both PUSCH and PUCCH BE demod requirements**

* Proposals:
  + Proposal 1 (China Telecom)
    - Reuse the SNR requirement value deriving rule for Rel-15 BS demodulation SNR requirement derivation procedure as agreed in R4-1904713:

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| Procedure to derive the performance requirements:  – Only inputs that consist of a pair of ideal and impaired results can be taken into account.  – If the ideal span <= [2]dB:  • The AVERAGE impairment results can be used for the performance requirement with [] in the draftCRs/CRs;  – Else if the ideal span is larger than [2]dB:  • The results farthest from the AVERAGE value is taken out for the AVERAGE and SPAN re-calculation until the ideal span is <=2dB but still with at least 3 companies’ results available:  – The ultimate AVERAGE impairment results with corresponding ideal span <=2dB can be used for performance requirement with [] in the draftCRs/CRs.  • Otherwise put TBD for the related performance requirements.  – If the span of the impairment results after removal the outliers (if any) are larger than 4dB, then the procedure cannot be applied, related performance requirement remain TBD. |

* Recommended WF
  + It is recommended to use the above proposal for requirement definition in this meeting.
  + The requirement value will be in [] and companies can still update results in the next meeting as a maintenance part.

# Topic #2: Multiple PRACH transmission reuqirements (Draft CRs)

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Draft CR on** |
| R4-2407110 | China Telecom | Draft CR on multiple PRACH transmission BS performance requirements for FR1 |
| R4-2407111 | China Telecom | Big CR for further coverage enhancements requirements for TS38.141-2 |
| R4-2407139 | Nokia | [NR\_cov\_enh2-Perf] BigCR for TS 38.104 on coverage enhancement demodulation |
| R4-2408347 | Ericsson | (NR\_cov\_enh2-Perf) Draft CR for 38.104 on FR2-1 PRACH repetition demodulaiton requirements |
| R4-2408348 | Ericsson | (NR\_cov\_enh2-Perf) Draft CR for 38.141-1 on FR1 PRACH repetition demodulation requirements |
| R4-2408958 | Huawei,HiSilicon | Draft CR on manufacturer declarations and applicability of PRACH performance requirements for Multiple PRACH transmission (TS38.141-1, Rel-18) |
| R4-2408959 | Huawei,HiSilicon | Draft CR on manufacturer declarations and applicability of PRACH performance requirements for Multiple PRACH transmission (TS38.141-2, Rel-18) |
| R4-2409473 | Samsung | Draft CR on test requirements for multiple PRACH transmission in TS 38.141-2 |
| R4-2409474 | Samsung | Big CR on test requirements for multiple PRACH transmission in TS 38.141-1 |

## Open issues

**Issue 2-1: Draft CR review**

* Big CRs should be revised for post meeting e-mail approval.
* Companies to provide comments and response under e-mail thread [110bis][326] NR\_cov\_enh2\_demod – draft CR review.