**3GPP TSG-RAN WG4 Meeting #109 R4-231xxxx**

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

**Agenda item:** 8.27.3

**Source:** Moderator (China Telecom)

**Title:** Topic summary for [109][325] 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 8.27.2.

# Topic #1: Multiple PRACH transmission reuqirements

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318056 | Nokia, Nokia Shanghai Bell | Observation 1: To demonstrate the benefits of different beam patterns and sweeping approaches, RAN4 will require to introduce spatial channel models.  Proposal 1: RAN4 to define performance requirements for enhanced PRACH repetitions for coverage enhancements in Rel-18  Proposal 2: RAN4 shall use TDLC 300-100 Low and AWGN channels to define requirements for PRACH coverage enhancements.  Proposal 3: RAN4 shall use CDL-A to define requirements for PRACH coverage enhancements to capture spatial gains.  Proposal 4: RAN4 shall use 400 Hz (for TDLC 300-100) and 0 Hz (for AWNG) frequency offset to define requirements for PRACH coverage enhancements.  Proposal 5: RAN4 shall use 60 kHz SCS to define requirements for PRACH coverage enhancements.  Proposal 6: RAN4 shall use PRACH format B4 to define requirements for PRACH coverage enhancements. |
| R4-2318057 | Nokia, Nokia Shanghai Bell | This contribution provides initial results on our simulation campaign for PRACH repetitions on Coverage Enhancement and it’s impact on BS demodulation. |
| R4-2319310 | Ericsson | Proposal 1: Consider only FR2 for PRACH repetitions demodulation requirements.  Proposal 2: Consider format B4, A2 and C2 for PRACH repetition demodulation requirement.  Proposal 3: Define requirements for normal mode and sequence length 139.  Proposal 4: Consider 2 PRACH repetitions for the initial simulations.  Proposal 5: Consider TDLA30-300 Low and AWGN channel models for PRACH repetitions demodulation requirement.  Proposal 6: Take 4000 Hz frequency offset for fading channel in PRACH repetition demodulation requirements.  Proposal 7: Take 120 kHz sub-carrier spacing for PRACH repetition demodulation requirement.  Proposal 8: Take simulation assumptions in Table 2-2 for PRACH repetition demodulation requirement. |
| R4-2319311 | Ericsson | Simulation results for Rel-18 NR PRACH repetitions demodulation requirements |
| R4-2319391 | China Telecom | Proposal 1: Cover both FR1 and FR2 for PRACH repetition test.  Proposal 2: Fine to only define PRACH repetition requirements for normal mode and short length.  Proposal 3: Reuse the same test metric with the legacy PRACH normal mode tests, i.e., the probability of detection shall be equal to or exceed 99% under given SNR level.  Proposal 4: Cover PRACH format B4 as well as other PRACH formats with similar or larger CP length as B4, i.e., A3, C0 and C2.  Proposal 5: Test 8 times for multiple PRACH transmission if the SNR value could be testable  Proposal 6: Reuse the same configuration for the existing PRACH normal mode tests, i.e., 1x2, 1x4, 1x8 for FR1 and 1x2 for FR2-1.  Proposal 7: Reuse the same configuration for the existing PRACH normal mode tests, i.e., TDLC 300-100 Low and AWGN channels for FR1, and TDLA30-300 Low and AWGN channels for FR2-1.  Proposal 8: Reuse the same configuration for the existing PRACH normal mode tests, i.e., 0Hz for AWGN condition for both FR1 and FR2-1, 400Hz for fading channel for FR1 and 4000Hz for fading channel for FR2-1.  Proposal 9: Reuse the same configuration for the existing PRACH normal mode tests, i.e., cover 15kHz and 30kHz SCS for FR1 and cover 60kHz SCS and 120kHz SCS for FR2. |
| R4-2319533 | ZTE Corporation | Observation 1. Larger SCS is needed for FR2-2 due to the larger BW.  Observation 2. Performance gap from single PRACH to 2 repetition is larger than other cases.  Observation 3. No impact on specification is expected for MPR/PAPR reduction.  Proposal 1. To consider one of the value from [2, 4, 8] for multiple PRACH performance alignment and 2 is preferred.  Proposal 2. To consider TDL channel model for multiple PRACH performance requirements. |
| R4-2319843 | Samsung | Observation 1: No specific spectrum shaping was defined for Pi/2 BSPK with FDSS  Proposal 1: No PUSCH requirement need to be introduced with FDSS for PAR/MPA reduction  Proposal 2: RAN4 only consider PRACH format B4 requirements with multiple PRACH transmission.  Proposal 3: RAN4 should prioritize PRACH requirements with multiple PRACH transmission in FR2-1. FFS on PRACH requirements with multiple PRACH transmission in FR1  Proposal 4: RAN4 only define PRACH requirements for normal mode with sequence length as LRA=139.  Proposal 5: RAN4 consider to define PRACH requirements with 2 PRACH transmissions  Proposal 6: RAN4 consider to define PRACH requirements with the following antenna configuration  - FR1 (if introduced)  - 1T2R  - FR2  - 1T2R  Proposal 7: RAN4 consider the following channel model for PRACH requirements with multiple PRACH transmission  - FR1 (if introduced)  - TDLC300-100 Low and AWGN  - FR2  - TDLA30-300 Low and AWGN  Proposal 8: RAN4 consider the following frequency offset for PRACH requirements with multiple PRACH transmission  - AWGN  - 0Hz  - FR1 (if introduced)  - 400Hz  - FR2-1  - 4000Hz  Proposal 9: RAN4 consider the following SCS for PRACH requirements with multiple PRACH transmission  - FR1 (if introduced)  - 15KHz and 30KHz, 1.25KHz  - FR2-1  - 60KHz and 120KHz  Proposal 10: RAN4 reuse the existing test parameters for specifying the PRACH requirement with multiple PRACH transmission  - Test metric  - Missing detection: 1%  - False alarm probability: 0.1% |
| R4-2320223 | Huawei, HiSilicon | Proposal 1: Do not cover FR1 for multiple PRACH transmission requirements.  Proposal 2: Only define PRACH requirements for normal mode and sequence length 139.  Proposal 3: Only define PRACH requirements for 2 PRACH transmissions.  Proposal 4: Only use TDLA30-300 Low and AWGN channels for FR2-1 for multiple PRACH transmission requirements.  Proposal 5: Use 0 Hz for AWGN and 4000 Hz for fading channel for FR2-1.  Proposal 6: Do not consider 60kHz in FR2-1 for PRACH requirements.  Proposal 7: Only define PRACH requirements for PRACH format B4. |

## Open issues summary

Backgroud status on the test scope in the WF R4-2320223 in RAN4#108bis:

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| --- |
| *Whether to define BS performance requirements for Multiple PRACH transmission*   * + *RAN4 to define performance requirements for Multiple PRACH transmission with same preamble* |

**Issue 1-1: Coverage of frequency range (FR) for Multiple PRACH transmission**

* Status in the WF R4-2320223 in RAN4#108bis:

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| * + *Prioritize FR2-1.*   + *Further discuss whether to cover FR1* |

* Proposals:
  + Option 1: Consider PRACH repetition demodulation requirement for only FR2-1. (Ericsson, Huawei)
  + Option 2: Cover FR1 and FR2-1 (China Telecom)
  + Option 3: RAN4 should prioritize FR2-1 and FFS on FR1 (Samsung)
* Recommended WF
  + Need discussion on whether to cover FR1.
  + Keep the previous agreements if no consensus could be reached.

**Issue 1-2: Sequence length for BS performance requirements for Multiple PRACH transmission**

* Status in the WF R4-2320223 in RAN4#108bis:

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| --- |
| * + *Option 1: Only define PRACH requirements for normal mode and sequence length 139*   + *Other options are not precluded* |

* Proposals:
  + Option 1: Only define PRACH requirements for normal mode and sequence length 139 (China Telecom, Ericsson, Samsung, Huawei)
* Recommended WF
  + Option 1 can be agreed.

**Issue 1-3: PRACH preamble format for BS performance requirements for Multiple PRACH transmission**

* Status in the WF R4-2320223 in RAN4#108bis:

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| * + *Option 1: Use PRACH format B4*   + *Option 2: Cover PRACH preamble format A1, A2, A3, B4, C0 and C2* |

* Proposals:
  + Option 1: Use PRACH format B4 only (Nokia, Samsung, Huawei)
  + Option 2: Cover PRACH format B4 as well as other PRACH formats with similar or larger CP length as B4, i.e., A3, C0 and C2. (China Telecom)
  + Option 3: Consider format B4, A2 and C2 (Ericsson)
* Recommended WF
  + PRACH B4 can be included.
  + Need discussion on whether PRACH preamble formats in addition to B4 should be covered.

**Issue 1-4: PRACH repetition number for BS performance requirements for Multiple PRACH transmission**

* Status in the WF R4-2320223 in RAN4#108bis:

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| * + *Option 1: Test 8 times for PRACH repetition if the SNR value could be testable*   + *Option 2: Define PRACH requirements for 2 PRACH transmissions*   + *Other options are not precluded* |

* Proposals:
  + Option 1: Test 8 times for PRACH repetition if the SNR value could be testable (China Telecom)
  + Option 2: Define PRACH requirements for 2 PRACH transmissions (Ericsson, ZTE, Samsung, Huawei)
* Recommended WF
  + Need discussion.

**Issue 1-5: Antenna configuration for BS performance requirements for Multiple PRACH transmission**

* Status in the WF R4-2320223 in RAN4#108bis:

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| * + *FR1 (if introduced)*     - *Option 1: 1x2*     - *Option 2: 1x2, 1x4, 1x8*   + *FR2-1:*      - *Option 1: 1x2* |

* Proposals:
  + FR1 (if introduced)
    - Option 1: 1x2 (Samsung)
    - Option 2: 1x2, 1x4, 1x8 (China Telecom)
  + FR2-1:
    - Option 1: 1x2 (China Telecom, Ericsson, Samsung)
* Recommended WF
  + FFS on FR1.
  + Consider 1x2 for FR2-1?

**Issue 1-6: Channel model for BS performance requirements for Multiple PRACH transmission (if introduced)**

* Status in the WF R4-2320223 in RAN4#108bis:

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| * + *FR1 (if introduced)*     - *Option 1: TDLC 300-100 Low and AWGN channels*     - *Option 2: Use CDL-A to define requirements for PRACH coverage enhancements to capture spatial gains*   + *FR2-1*     - *Option 1: TDLA30-300 Low and AWGN channels*     - *Option 2: Use CDL-A to define requirements for PRACH coverage enhancements to capture spatial gains* |

* Proposals:
  + FR1 (if introduced)
    - Option 1: TDLC 300-100 Low and AWGN channels (China Telecom, Samsung)
  + FR2-1
    - Option 1: TDLA30-300 Low and AWGN channels (China Telecom, Ericsson, [ZTE], Samsung, Huawei)
* Ericsson: CDL and TDL show similar gain, no need to use CDL model especially
  + - Option 2: Cover TDLC 300-100 Low, AWGN and CDL-A ([Nokia])
* Nokia: CDL-A to reflect spatial domain gain.
* Recommended WF
  + FFS on FR1.
  + Need discussion whether CDL-A channel model should be covered.

**Issue 1-7: Frequency offset for BS performance requirements for Multiple PRACH transmission**

* Status in the WF R4-2320223 in RAN4#108bis:

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| * + *For AWGN for both FR1 (if introduced) and FR2-1:*     - *Option 1: 0 Hz*     - *Other options are not precluded*   + *For fading channel for FR1 (if introduced):*     - *Option 1: 400 Hz*     - *Other options are not precluded*   + *For fading channel for FR2-1:*     - *Option 1: 4000 Hz*     - *Other options are not precluded* |

* Proposals:
  + For AWGN for both FR1 (if introduced) and FR2-1:
    - Option 1: 0 Hz (China Telecom, Nokia, Ericsson, Samsung, Huawei)
  + For fading channel for FR1 (if introduced):
    - Option 1: 400 Hz (China Telecom, [Nokia], Samsung)
  + For fading channel for FR2-1:
    - Option 1: 4000 Hz (China Telecom, Ericsson, Samsung, Huawei)
    - Option 2: 400 Hz ([Nokia])
* Recommended WF
  + For AWGN for both FR1 (if introduced) and FR2-1: 0Hz
  + FFS on fading channel for FR1.
  + Can we agree to use 4000Hz for fading channel for FR2-1?

**Issue 1-8: Sub Carrier Spacing for BS performance requirements for PRACH repetitions**

* Status in the WF R4-2320223 in RAN4#108bis:

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| * + *FR1 (if introduced)*     - *Option 1: 15kHz and 30kHz*     - *Other options are not precluded*   + *FR2-1*     - *Option 1: Use 60kHz SCS*     - *Option 2: Cover 60kHz SCS and 120kHz SCS*     - *Option 3: 120kHz SCS* |

* Proposals:
  + FR1 (if introduced)
    - Option 1: 15kHz and 30kHz (China Telecom)
    - Option 2: 15KHz and 30KHz, 1.25KHz (Samsung)
  + FR2-1
    - Option 1: Use 60kHz SCS (Nokia)
* Nokia: In RAN1, the sub carrier spacing used for alignment on coverage enhancements is 60 kHz
  + - Option 2: Cover 60kHz SCS and 120kHz SCS (China Telecom, Samsung)
    - Option 3: 120kHz SCS (Ericsson, Huawei)
* E///, HW: only 120kHz SCS is deployed in real network.
* Recommended WF
  + FFS on FR1.
  + For FR2-1, can we at least cover 120kHz SCS and FFS whether to cover 60kHz SCS?

**Issue 1-9: Test metric for BS performance requirements for Multiple PRACH transmission**

* Proposals:
  + Option 1: Reuse the same test metric with the legacy PRACH normal mode tests, i.e., SNR with missing detection of 1%. (China Telecom)
  + Option 2: Cover requirements for both missing detection of 1% and false alarm probability 0.1% (Samsung)
* Recommended WF
  + Need discussion on whether false alarm probability requirements should be defined.

**Issue 1-10: Whether to cover BS conformance test for Multiple PRACH transmission with different Tx beams (enhanced PRACH repetitions)**

* Proposals:
  + Option 1: RAN4 to define performance requirements for enhanced PRACH repetitions in Rel-18 (Nokia)
* Moderator observation:
  + The following conclusion is made in the RAN1#113 chairman note:
    - *There is no consensus to support Multiple PRACH transmission with different Tx beams in Rel-18.*
* Recommended WF
  + TBA

# Topic #2: Power domain enhancements

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2319391 | China Telecom | Proposal 10: Not to cover FDSS BS requirements unless a clear transmitting and receiving process can be agreed for FDSS. |
| R4-2318056 | Nokia, Nokia Shanghai Bell | Observation 3: Power domain enhancements will not impact the required SINR at the base station.  Observation 4: Power domain enhancements implies the use of FDSS.  Observation 5: FDSS impaired performance requirements are not included in TS 38.104  Observation 6: FDSS has been demonstrated to cause an impact of performance between slight gains up to a loss 4.5dB in some extreme cases.  Observation 7: FDSS with 3-tap filter design provides significantly worse performance than 2-tap filter designs.  Proposal 7: If FDSS performance requirements are defined, RAN4 shall use 2-tap filter designs.  Observation 8: FDSS has been demonstrated to cause insignificant impact with a lower MCS choice.  Proposal 8: RAN4 shall define performance requirements for power domain enhancements with impact from FDSS.  Proposal 9: RAN4 shall use MCS 2 for PUSCH with FDSS impact performance requirements.  Proposal 10: RAN4 shall align results for FDSS impact, whereby companies shall state filter assumptions when presenting results. |
| R4-2318057 | Nokia, Nokia Shanghai Bell | This contribution provides initial results on our simulation campaign for PRACH repetitions on Coverage Enhancement and it’s impact on BS demodulation. |
| R4-2319310 | Ericsson | Proposal 9: Not to define BS performance requirements with FDSS. |
| R4-2319533 | ZTE Corporation | Proposal 3. To consider option 2 for BS performance requirements with FDSS. |
| R4-2319843 | Samsung | Proposal 1: No PUSCH requirement need to be introduced with FDSS for PAR/MPA reduction |
| R4-2320223 | Huawei, HiSilicon | Proposal 8: Do not define BS performance requirements with FDSS. |

## Open issues summary

Backgroud status on the test scope in the WF R4-2320223 in RAN4#108bis:

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| --- |
| *Whether to define BS performance requirements for increased UE Tx power*   * + *Do not define BS performance requirements for increased UE Tx power*   *Whether to define BS performance requirements with Frequency Domain Spectrum Shaping (FDSS)*   * + *Option 1: Define BS performance requirements with FDSS*   + *Option 2: Not to define BS performance requirements with FDSS* |

**Issue 2-1: Whether to define BS performance requirements with impairments from Frequency Domain Spectrum Shaping (FDSS)**

* Proposals:
  + Option 1: Define BS performance requirements with impairments from FDSS with MCS2 and with use 2-tap filter designs (Nokia)
    - Nokia: Companies shall state filter assumptions when presenting results
  + Option 2: Not to define BS performance requirements with impairments from FDSS (China Telecom, Ericsson, ZTE, Samsung, Huawei)
* Recommended WF
  + Discuss needed.