**3GPP TSG-RAN WG4 Meeting # 97-e R4-200XXXX**

**Electronic Meeting, 2-13 Nov., 2020**

**Agenda item:** 7.1.8.1, 7.1.8.4

**Source:** Moderator (Huawei, HiSilicon)

**Title:** Email discussion summary for [97e][316] NR\_unlic\_Demod\_BS

**Document for:** Information

# Introduction

The email discussion is for Rel-16 NR-U BS demodulation performance in Agenda 7.1.8.1 and 7.1.8.4. This email discussion focuses on the test scenarios and specific test configurations for PUSCH, PUCCH and PRACH. In 2nd round discussion, work split for draft CR will be discussed based on agreed test cases.

List of topics of email discussion for 1st round and 2nd round are as follows:

* 1st round:
* Topic#1: Test scopes
  + Sub-topic 1-1: Test scenarios
  + Sub-topic 1-2: Wideband operation mode
  + Sub-topic 1-3: Guard band configuration
* Topic#2: PUSCH requirements
  + Sub-topic 2-1 Test configurations
  + Sub-topic 2-2 CG-UCI multiplexed on PUSCH requirements
* Topic#3: PUCCH requirements
  + Sub-topic 3-1: Test configurations
  + Sub-topic 3-2 :PUCCH format 0
  + Sub-topic 3-3: PUCCH format 1
  + Sub-topic 3-2: PUCCH format 2
  + Sub-topic 3-2: PUCCH format 3
* Topic#4: PRACH requirements
  + Sub-topic 4-1: Test configurations
* 2nd round:
  + Remaining open issues for each topic left from 1st round discussion (Topic#1,#2, #3 and #4) will be discussed.
  + Work split for draft CR will be discussed.

# Topic #1: Test Scope

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014940 | Nokia, Nokia Shanghai Bell | Proposal 1: RAN4 to define PUSCH, PRACH, and PUCCH requirements that apply to all scenarios A, B, and C  Proposal 2: RAN4 to define BS demodulation wideband requirements that are agnostic to the wideband operation modes 1 and 2.  Proposal 3:RAN4 to define wideband performance requirements for 20, 40, 60, and 80 MHz.  Proposal 4: Similar to Rel-15, depending on vendor declaration, define an applicability rule that a BS only has to perform tests for 20 MHz and the largest supported bandwidth.  Observation 1: RAN4 has already agreed to define NR-U performance requirements for PUSCH, PUCCH, and PRACH.  Observation 2: The BS demodulation tests including PUSCH, PUCCH, and PRACH are already enough to cover the test scenarios A, B, and C.  Observation 3: During RAN4#96-e, it was decided that BS demodulation would not include LBT model.  Observation 4: The distinction between wideband operation modes 1 and 2 is closely related to the type of LBT behaviour in the subbands. |
| R4-2015117 | Samsung | Proposal 1: Define demodulation requirements only for Scenario A (LAA), but these requirements can be applied for other scenarios. Meanwhile, only define requirements for single carrier and don’t define requirements for intra-band CA.  Proposal 2: Define the demodulation requirement with 20 MHz CBW with TDD 15 KHz and 30 KHz, only one SCS can be tested.  Proposal 3: Do not define requirements for wideband operation 1.  Proposal 4: Do not define requirements for GC-UCI multiplexing on PUSCH |
| R4-2015637 | Huawei, HiSilicon | Proposal 1: Define the BS requirements only for scenario A. i.e. Carrier aggregation between licensed band NR and unlicensed band NR-U.  Proposal 2: Define the performance requirements per CC only for scenario A. For the performance requirement of PCell, reuse it from NR Rel-15. For the performance requirement of SCell, define the case with bandwidth of 20MHz, 40MHz, 60MHz and 80MHz.  Proposal 3: No need to define the BS requirement for wideband operation 1  Proposal 4: Set intra cell guard size to 0 for PUSCH requirements.  Proposal 5: Introduce the performance requirements for CG-UCI when it is multiplexing on PUSCH with interlaced resource allocation and no HARQ-ACK, CSI part 1, CSI part 2 are existed.  Proposal 6: Use Table 1 as simulation assumptions  **Table 1: Simulation assumptions for PRB-Interlaced PUSCH performance**   |  |  |  | | --- | --- | --- | | Parameter | | Value | | Transform precoding | | Disabled | | SCS | | 30kHz | | Default TDD UL-DL pattern (Note 1) | | 7D1S2U, S=6D:4G:4U | | Bandwidth | | 20MHz,40MHz,60MHz,80MHz | | Propagation conditions | | TDLA30-10 | | Antenna configuration | | 1T4R | | MCS | | 11 | | HARQ | Maximum number of HARQ transmissions | 4 | | RV sequence | 0, 2, 3, 1 | | DM-RS | DM-RS configuration type | 1 | | DM-RS duration | single-symbol DM-RS | | Additional DM-RS position | pos1 | | Number of DM-RS CDM group(s) without data | 2 | | Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB | | DM-RS port | {0} | | DM-RS sequence generation | NID0=0, nSCID =0 | | Time domain resource assignment | PUSCH mapping type | A | | Start symbol | 0 | | Allocation length | 14 | | Frequency domain resource assignment | RB assignment | Only first interlace is allocated | | Frequency hopping | Disabled | | TPMI index for 2Tx two-layer spatial multiplexing transmission | | 0 | | Code block group based PUSCH transmission | | Disabled | | Note 1: The same requirements are applicable to FDD and TDD with different UL-DL pattern. | | | |
| R4-2015851 | Ericsson | Proposal 1: Consider a minimum subset of Rel-15 test cases for NR-U scenario and define proper applicability rules for these requirements  Proposal 2: Define demodulation requirements for the corresponding scenarios, but these requirements can be applied for other scenarios. Meanwhile, only define requirements for single carrier and don’t define requirements for intra-band CA.  Proposal 3: Do not consider mode 2 transmission of Wideband operation 2 during the NR-U BS demodulation discussion.  Proposal 4: Do not define requirements for Wideband Operation 1 specially. The requirement for 20MHz can be used for either Wideband Operation 1 or 2.  Proposal 5: Reuse Rel-15 demodulation assumptions as much as possible for NR-U demodulation.  Proposal 6: Define requirements for TDLA30-10 channel model. FFS for TDLB100 and TDLC300.  Proposal 7: Define low Doppler shift for TDLB100 and TDLC300 if we agree to define requirements for them. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1: Test scenarios

**Issue 1-1-1: Performance requirements definition**

* Proposals
  + Option 1: Only define the performance requirements for Scenario A based on per CC including the requirements for licensed CC (reuse existing requirements) and unlicensed CC (Samsung, Huawei, Ericsson)
  + Option 2: Define demodulation requirements for Scenario C and make them applicable for other NR-U scenarios (Intel)
  + Option 3: RAN4 to define PUSCH, PRACH, and PUCCH requirements that apply to all scenarios A, B, and C (Nokia)
* Recommended WF
  + Only define the BS performance requirements for single carrier, including the requirements for licensed CC (reuse existing requirements) and unlicensed CC

**Issue 1-1-2: Test scenarios**

* Proposals
  + Option 1: Only test Scenario A (Huawei)
  + Option 2: Scenarios A and C with test applicability, the test is based on BS declaration of supporting scenario A and/or scenario C, if BS passed the requirements for Scenario A, it does not need to execute the tests for Scenario C.
* Recommended WF
  + Follow the agreements made for NR Rel-15 (R4-1813755), no specific requirements and tests are needed for Scenario B.

**Issue 1-1-3: How to handle Rel-15 test requirements for NR-U BS?**

* Proposals
  + Option 1: Consider a minimum subset of Rel-15 test cases for NR-U scenario and define proper applicability rules for these requirements. (Ericsson)
* Recommended WF

### Sub-topic 1-2: Wideband operation mode

**Issue 1-2-1: Wideband operation mode for PUSCH requirements**

* Proposals
  + Option 1: Define BS demodulation requirements only for wideband operation 2 with 20MHz (Samsung)
  + Option 2: Define BS demodulation requirements only for wideband operation 2 with 20MHz, 40MHz, 60MHz and 80MHz (Huawei)
  + Option 3: Define BS demodulation requirements with 20MHz that are agnostic to wideband operation 1 and 2 (Ericsson)
  + Option 4: Define BS demodulation requirements with 20MHz, 40MHz, 60MHz and 80MHz that are agnostic to wideband operation 1 and 2, with test applicability rule that a BS only has to perform tests for 20 MHz and the largest supported bandwidth based on BS vendor’s declaration (Nokia)
  + Option 5: Define BS demodulation requirements with 80MHz for wideband operation which are agnostic to the mode of wideband operation (Intel)
* Recommended WF

**Issue 1-2-2: LBT mode for wideband operation 2**

* Proposals
  + Option 1: Don’t consider mode 2 transmission of wideband operation 2 during the NR-U BS demodulation discussion (Ericsson)
* Recommended WF
  + As it was agreed in the last meeting R4-2012611 not to consider sub-band LBT failure, no need to discuss LBT mode for mode 1 or mode 2 for wideband operation 2.

### Sub-topic 1-3: Guard band configuration

**Issue 1-3-1: Whether to configure guard band for PUSCH requirements**

* Proposals
  + Option 1: Don’t consider guard band. (Huawei, HiSilicon)
* Recommended WF
  + Not consider guard band.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Sub-topic 1-1: Test scenarios**  **Issue 1-1-1: Performance requirements definition**  Agree with recommended WF to only define requirements for single carrier including licensed and unlicensed CC. But we need to consider how to reuse licensed requirements.  **Issue 1-1-2: Test scenarios**  Since enhanced features in NR-U are supported by different scenarios, it is hard to only consider one scenario. Option 2 mentioned scenario A and C but test cases in scenario A seems can’t fully cover scenario C. Then we might need different test case sets for different scenarios to optimize test effort.  Also agree with recommended WF that no requirements are needed for scenario B.  **Issue 1-1-3: How to handle Rel-15 test cases for NR-U BS?**  We tend to reuse some Rel-15 requirements for NR-U BS. But we need to answer the question that which test cases should be used for NR-U scenarios, otherwise all Rel-15 requirements which is not overlapping new NR-U requirements should be tested. And we also need to consider different scenario might lead to different test cases and effort. How to get a reasonable and limited test case sets is essential to further discussion.  **Sub-topic 1-2: Wideband operation mode**  **Issue 1-2-1: Wideband operation mode for PUSCH requirements**  For wideband operation 1 which use CA method with 20MHz carrier, the interlacing structure is also can be used. In that case, it would be no difference from wideband operation 2 which use RB sets methods with 20MHz carrier from the demodulation perspective. That’s why we propose Option 3.  But for wideband operation 2 uplink transmission which doesn’t consider LBT failure, the applicability rule mentioned in Option 4 can be accepted to use 20MHz requirements for other wideband carrier just like discussion for HST.  **Sub-topic 1-3: Guard band configuration**  **Issue 1-3-1: Whether to configure guard band for PUSCH requirements**  We agree with Option 1 that don’t consider guard band for demodulation requirements. |
| Samsung | **Issue 1-1-1: Performance requirements definition**  We agree with recommend WF.  **Issue 1-1-2: Test scenarios**  From the demodulation performance perspective, the performance for each carrier should be similar.  We are ok with option 2,  **Issue 1-1-3: How to handle Rel-15 test requirements for NR-U BS?**  We are ok with option 1, while the detail sub-set should be further discussion to apply the NR-U scenario.  **Issue 1-2-1: Wideband operation mode for PUSCH requirements**  We are also ok with option 3.  For wideband operation 1, the bandwidth for each CC is only 20MHz. For wideband operation 2, up to 80 MHz can be supported. From the performance perspective, the difference for different CBW is minor. To reduce the test, we don't think all the possible CBW requirement should be defined. Meanwhile, two modes can be supported for wideband operation 2. Only LBT channel successfully can be used for transmission. The LBT bandwith is 20MHz. In that sense, 20MHz should be the typical one.  **Issue 1-2-2: LBT mode for wideband operation 2**  We agree with recommend WF.  **Issue 1-3-1: Whether to configure guard band for PUSCH requirements**  We are ok with recommend WF. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: PUSCH requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **R4-2014941** | Nokia, Nokia Shanghai Bell | Proposal 1: RAN4 to consider only 1 interlace allocation for PUSCH performance requirements.  Proposal 2: RAN4 to define wideband performance requirements for 20, 40, 60, and 80 MHz.  Proposal 3: Depending on vendor declaration, define that a BS is only required to perform tests for 20 MHz and the largest supported bandwidth.  Proposal 4: RAN4 to define BS demodulation requirements for CG-UCI multiplexed on PUSCH, if demodulation impact is identified.  Proposal 5: RAN4 to consider the following parameters as baseline the definition of PUSCH BS demodulation requirements  Table 1 Proposed parameters for PUSCH BS demodulation performance requirements   |  |  | | --- | --- | | Parameter | Value | | Waveform | CP-OFDM | | MCS | QPSK, R=193/1024  16QAM, R= 658/1024 | | Subcarrier spacing | 15 kHz and 30 kHz | | Number of interlaces | 1 interlace | | Number of symbols | 14 | | PUSCH mapping type | Type A+B | | DMRS | 1+1 | | BW | 20 MHz, 40 MHz, 60 MHz, and 80 MHz | | Test metric | SNR at 70% throughput |   Observation 1: Performance differences from interlaced allocation in comparison to contiguous allocation is larger with a small number of interlaces.  Observation 2: A new type of UCI on PUSCH is defined for NR-U with for operation with configured grants, the CG-UCI. |
| R4-2015117 | Samsung | Proposal 1: Define demodulation requirements only for Scenario A (LAA), but these requirements can be applied for other scenarios. Meanwhile, only define requirements for single carrier and don’t define requirements for intra-band CA.  Proposal 2: Define the demodulation requirement with 20 MHz CBW with TDD 15 KHz and 30 KHz, only one SCS can be tested.  Proposal 3: Do not define requirements for wideband operation 1.  Proposal 4: Do not define requirements for GC-UCI multiplexing on PUSCH |
| R4-2015637 | Huawei, HiSilicon | Proposal 1: Define the BS requirements only for scenario A. i.e. Carrier aggregation between licensed band NR and unlicensed band NR-U.  Proposal 2: Define the performance requirements per CC only for scenario A. For the performance requirement of PCell, reuse it from NR Rel-15. For the performance requirement of SCell, define the case with bandwidth of 20MHz, 40MHz, 60MHz and 80MHz.  Proposal 3: No need to define the BS requirement for wideband operation 1  Proposal 4: Set intra cell guard size to 0 for PUSCH requirements.  Proposal 5: Introduce the performance requirements for CG-UCI when it is multiplexing on PUSCH with interlaced resource allocation and no HARQ-ACK, CSI part 1, CSI part 2 are existed.  Proposal 6: Use Table 1 as simulation assumptions  **Table 1: Simulation assumptions for PRB-Interlaced PUSCH performance**   |  |  |  | | --- | --- | --- | | Parameter | | Value | | Transform precoding | | Disabled | | SCS | | 30kHz | | Default TDD UL-DL pattern (Note 1) | | 7D1S2U, S=6D:4G:4U | | Bandwidth | | 20MHz,40MHz,60MHz,80MHz | | Propagation conditions | | TDLA30-10 | | Antenna configuration | | 1T4R | | MCS | | 11 | | HARQ | Maximum number of HARQ transmissions | 4 | | RV sequence | 0, 2, 3, 1 | | DM-RS | DM-RS configuration type | 1 | | DM-RS duration | single-symbol DM-RS | | Additional DM-RS position | pos1 | | Number of DM-RS CDM group(s) without data | 2 | | Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB | | DM-RS port | {0} | | DM-RS sequence generation | NID0=0, nSCID =0 | | Time domain resource assignment | PUSCH mapping type | A | | Start symbol | 0 | | Allocation length | 14 | | Frequency domain resource assignment | RB assignment | Only first interlace is allocated | | Frequency hopping | Disabled | | TPMI index for 2Tx two-layer spatial multiplexing transmission | | 0 | | Code block group based PUSCH transmission | | Disabled | | Note 1: The same requirements are applicable to FDD and TDD with different UL-DL pattern. | | | |
| R4-2015852 | Ericsson | Proposal 1: Only consider 20MHz bandwidth for NR-U PUSCH requirement.  Proposal 2: Using single interlace with 10 PRBs for NR-U PUSCH demodulation simulation.  Proposal 3: Consider following assumptions for NR-U PUSCH demodulation simulation.   * Bandwidth: 20MHz * SCS: 15kHz and 30kHz * Waveform: CP-OFDM * TDD pattern:   + 15kHz SCS: 3D1S1U, S=10D:2G:2U   + 30kHz SCS: 7D1S2U, S=6D:4G:4U * Channel model and MCS   + TDLA30-10 and MCS20   + FFS for TDLC300,Doppler shift and MCS16   + FFS for TDLB100, Doppler shift and MCS 2 * PUSCH mapping type: Type B * Antenna configuration: 1Tx2Rx, FFS for other configurations * DM-RS: 1+1 * Frequency domain PRB allocation: single interlace with 10 PRBs in each slot N   + 15kHz SCS: N, N+10, N+20, …, N+90, where N=0, 1, 2, …, 9   + 30kHz SCS: N, N+5, N+10, …, N+45, where N=0, 1, 2, …, 5   Proposal 4: Consider introduce a Rel-15 requirement for HARQ-ACK multiplexing on PUSCH with more than 2 HARQ-ACK information bits and using it to cover CG-UCI multiplexing on CG-PUSCH in NR-U scenario with proper applicability rule.  Observation 1: When CG-UCI is multiplexing on CG-PUSCH without HARQ-ACK, CG-UCI will use similar encoding procedure as CG-UCI with HARQ-ACK. The only difference is the payload length.  Observation 2: When HARQ-ACK and CG-UCI are multiplexing on CG-PUSCH, the jointly encoded HARQ-ACK and CG-UCI are treated as an HARQ-ACK with more than 2 information bits. |
| R4-2015986 | Intel Corporation | Proposal 5: RAN4 to define PUSCH requirements for bandwidth equal to 80MHz. |
| R4-2015988 | Intel Corporation | Proposal 1: RAN4 to define demodulation requirements for PRB-Interlaced PUSCH Resource Allocation considering single interlace.  Proposal 2: Do not define requirements for UCI multiplexed on PUSCH |

## Open issues summary

### Sub-topic 2-1 Test configurations

**Issue 2-1-1: Waveform**

* Proposals
  + Option 1: CP-OFDM (Nokia, Ericsson)
  + Option 2: Other options
* Recommended WF

**Issue 2-1-2: Number of interlaces**

* Proposals
  + Option 1: Single interlace that is same for all slots (Nokia, Huawei, Intel)
  + Option 2: Single interlace with 10 PRBs that is different per slot. (Ericsson).
    - Take following method as an example:
      * Frequency domain PRB allocation: single interlace with 10 PRBs in each slot N
      * 15kHz SCS: N, N+10, N+20, …, N+90, where N=0, 1, 2, …, 9
      * 30kHz SCS: N, N+5, N+10, …, N+45, where N=0, 1, 2, …, 5
* Recommended WF

**Issue 2-1-3: Number of symbols**

* Proposals
  + Option 1: 14 symbols (Nokia, Huawei)
  + Option 2: Other options
* Recommended WF

**Issue 2-1-4: SCS**

* Proposals
  + Option 1: Both 15kHz and 30kHz (Nokia, Samsung, Ericsson)
  + Option 2: Only 30kHz (Huawei)
* Recommended WF

**Issue 2-1-4a: Test applicability for different SCS**

* Proposals
  + Option 1: Only test performance requirements for 15kHz or 30kHz SCS based on BS declaration if agreed to define requirements for both SCS (Samsung)
  + Option 2:
* Recommended WF

Based on the discussion on Issue 2-1-2.

**Issue 2-1-5: TDD pattern**

* Proposals
  + Option 1: 3D1S1U, S=10D:2G:2U for 15kHz and 7D2S1U, S=6D:4G:4U for 30kHz (Ericsson)
  + Option 2: 7D2S1U for 30kHz (Huawei)
* Recommended WF
  + 7D2S1U for 30 kHz SCS
  + FFS for 15 kHz SCS

**Issue 2-1-6: PUSCH mapping type**

* Proposals
  + Option 1: Only Type A (Huawei)
  + Option 2: Only Type B (Ericsson)
  + Option 3: Both Type A and Type B (Nokia)
* Recommended WF

**Issue 2-1-7: MCS**

* Proposals
  + Option 1: MCS 11(16QAM, R=378/1024) (Huawei)
  + Option 2: MCS 2 (QPSK, R=193/1024) and MCS 16 (16QAM, R= 658/1024) (Nokia)
  + Option 3: MCS 20 for TDLA30-10. FFS:16 for TDLC300 and 2 for TDLB100 (Ericsson)
* Recommended WF

**Issue 2-1-8: Antenna configuration**

* Proposals
  + Option 1: 1x2 (Ericsson)
  + Option 2: 1x4 (Huawei)
* Recommended WF

**Issue 2-1-9: DM-RS configuration**

* Proposals
  + DM-RS configure type 1 with single-symbol and *dmrs-AdditionalPosition* ‘pos1’ (Huawei, Nokia, Ericsson)
* Recommended WF

Use DM-RS configuration type 1 with single-symbol DM-RS and *dmrs-AdditionalPosition* ‘pos1’

**Issue 2-1-10: Propagation conditions**

* Proposals
  + Option 1: TDLA30-10 (Huawei)
  + Option 2: TDLA30-10 as baseline and FFS for TDLB100 and TDLC300, Doppler shift can be further discussed. (Ericsson)
* Recommended WF

**Issue 2-1-11: Test metric**

* Proposals
  + Option 1: SNR@70% max throughput (Nokia)
  + Option 2: Other options
* Recommended WF

### Sub-topic 2-2 CG-UCI multiplexed on PUSCH requirements

**Issue 2-2-1: Whether to introduce requirements for CG-UCI multiplexed on PUSCH with interlaced allocation**

* Proposals
  + Option 1: No (Intel, Samsung)
  + Option 2: Introduce performance requirements for CG-UCI multiplexed on PUSCH with interlaced resource allocation and without HARQ-ACK, CSI part 1 and CSI part 2 (Huawei)
  + Option 3: Consider introduce a Rel-15 requirement for HARQ-ACK multiplexing on PUSCH with more than 2 HARQ-ACK information bits and using it to cover CG-UCI multiplexing on CG-PUSCH in NR-U scenario with proper applicability rule. (Ericsson)
* Recommended WF

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Sub-topic 2-1: Test configurations**  **Issue 2-1-1: Waveform**  We agree with Option 1. For NR-U typical deployment, coverage might not be an issue, then DFT-s-OFDM wave form is not necessary to be considered.  **Issue 2-1-2: Number of interlaces**  We prefer Option 2. Single interlace includes 10 or 11 PRBs for 15kHz and 30kHz. Considering to simplify the FRC definition, the similar method used in RF discussion can be reused which only define 10 PRBs in single interlace and ignore several edge PRBs.  **Issue 2-1-3: Number of symbols**  We can agree with Option 1 to consider 14 symbols.  **Issue 2-1-4: SCS**  Not quite sure if there is only 30kHz used for NR-U. If yes, then we are OK for Option 2.  **Issue 2-1-5: TDD pattern**  Agree with recommended WF and wait for other companies’ feedback.  **Issue 2-1-6: PUSCH mapping type**  We just thought type B might be more useful in NR-U scenario, but we can accept define requirements only for type A since there would be no much difference if we use same FRC table.  **Issue 2-1-7: MCS**  We think the MCS might need to be considered with fading channel together. In Rel-15, MCS20 and TDLA30-10 are applied together. We propose reuse it to check if the simulation results are feasible or not and then decide further modification.  **Issue 2-1-8: Antenna configuration**  We prefer start from low combinations cases at first. Option 1.  **Issue 2-1-10: Propagation conditions**  We think TDLA30-10 could be a better choice for start. For other channel models, we are open for further discussion since they are defined for whole FR1 at the beginning. Maybe we can directly reuse them without special consideration on NR-U deployment. This discussion will also impact on PUCCH and PRACH discussion.  **Issue 2-1-11: Test metric**  We are OK with Option 1.  **Sub-topic 2-2: CG-UCI multiplexed on PUSCH requirements**  **Issue 2-2-1: Whether to introduce requirements for CG-UCI multiplexed on PUSCH with interlaced allocation**  There is no new encoding procedure is introduced for CG-UCI. The encoding procedure for CG-UCI is the same as the encoding procedure for HARQ-ACK with more than 2 information bits. Then it would be strange that only define this requirement for CG-UCI in unlicensed band but no requirement for HARQ-ACK for licensed band. We actually tend to reuse licensed requirements to cover unlicensed requirements if possible, not reversely. That is the motivation we propose Option 3 here to keep the requirements more consistency. |
| Samsung | **Issue 2-1-1: Waveform** We are ok with only CP-OFDM **Issue 2-1-2: Number of interlaces** We are ok with option 1, similar with eLAA. The performance with different interlace location should be minor different. **Issue 2-1-3: Number of symbols** For NR-U scenario, the data transmission should be based on LBT successfully, 14 symbols cannot be guaranteed for all the transmission slots. Similar as eLAA, we think less than 14 is more appropriable. We are also ok with 14 symbols **Issue 2-1-4: SCS** Considering the interlace structure for 15KHz and 30KHz is different, we think it is natural to define requirement with two SCS. **Issue 2-1-5: TDD pattern** We are ok with recommend WF **Issue 2-1-6: PUSCH mapping type** We prefer option 2  For NR-U scenario, the data transmission should be based on LBT successfully, Type B is more typical **Issue 2-1-7: MCS** We are fine with option2 with aligned Rel-15 BS PUSCH requirement. **Issue 2-1-8: Antenna configuration** We are ok with option 1, only 2Rx can be proceed for OTA test. **Issue 2-1-9: DM-RS configuration** We are ok with recommend WF **Issue 2-1-10: Propagation conditions** We are not sure whether NR-U is only applied for low mobility scenario. If not, we are ok with option 2. **Issue 2-1-11: Test metric** We are ok with option 1  **Issue 2-2-1: Whether to introduce requirements for CG-UCI multiplexed on PUSCH with interlaced allocation**  We still prefer option 1  In Rel-15, RAN4 has defined UCI multiplexed on PUSCH performance requirement, where CSI part1 and CSI part2 are included. For the mapping rule, CSI part 1information is mapped starting on the first available non-DMRS symbols regardless of number of DMRS symbols in PUSCH transmission  CG-UCI is transmitted on each CG-PUSCH. Payload is mapped to the first non DMRS symbols with the highest priority. In that sense, the encoded procedure of CG-UCI is same with CSI part 1. Compared with CSI part1, only the content of payload is different. From BS receiver perspective, we don't think there is any different behaviour. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: PUCCH requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014942 | Nokia, Nokia Shanghai Bell | Proposal 1: RAN4 to define demodulation requirements to all interlaced PUCCH formats (i.e. formats 0, 1, 2, and 3), with NR-U specific applicability rule for the new formats.  Proposal 2: RAN4 to define performance requirements only for 1 interlace PUCCH.  Proposal 3: RAN4 to consider NR-U PUCCH performance requirements without frequency hopping.  Proposal 4: RAN4 to consider QPSK modulation order tor NR-U PUCCH formats 2 and 3.  Proposal 5: RAN4 to consider Rel.15 PUCCH requirements as a baseline for the discussion of the NR-U PUCCH test scenarios as in the table below:  Table 3 Proposed parameters for PUCCH testing   |  |  |  |  | | --- | --- | --- | --- | | PUCCH format | Number Interlaces | Number symbols | Information bits | | 0 | 1 | 1 | 1 | |  | 1 | 2 | 1 | | 1 | 1 | 14 | 2 | | 2 | 1 | 1 | 4 | |  | 1 | 2 | 22 | | 3 | 1 | 14 | 16 | |  | 1 | 4 | 16 |   Observation 1: Demodulation requirements for Rel. 15 PUCCH formats are applicable depending on manufacturer declaration D.102.  Observation 2: The maximum number of PRBs used on Rel. 15 PUCCH performance requirements is 9 for PUCCH format 2.  Observation 3: When using interlaced PUCCH in NR-U, the minimum allocation of 1 interlace consists of 10/11 PRBs.  Observation 4: When considering interlaced PUCCH in NR-U, the minimum allocation of 1 interlace includes more PRBs than any of the Rel. 15 PUCCH performance requirements in 38.104. |
| R4-2015638 | Huawei, HiSilicon | Proposal 1: Define the requirements for PRB-interlaced PUCCH resource allocation with following simulation setups:   * PF0/1/2/3 * Both 15 kHz and 30 kHz * Test applicability rules: * Unless otherwise stated, PUCCH requirement tests shall apply only for each PUCCH format declared to be supported * Unless otherwise stated, PUCCH requirement tests shall apply only for each subcarrier spacing declared to be supported   Proposal 2: Only test one interlace and use interlace index 0 for PF0/1/2/3.  Proposal 3: Not configure frequency hopping for all cases.  Proposal 4: Use 1T4R for all cases.  Proposal 5: Use Table 2~Table 5 as simulation assumptions for performance requirements for NR-U PF0/1/2/3 respectively  **Table 2: Test Parameters for PF0**   |  |  | | --- | --- | | Parameter | Test | | Number of UCI information bits | 1 | | Intra-slot frequency hopping | N/A | | Group and sequence hopping | neither | | Hopping ID | 0 | | Initial cyclic shift | 0 | | First symbol | 13 | | Antenna configuration | 1T4R | | Channel bandwidth | 20MHz | | SCS | 15kHz; 30kHz | | Number of interlaces | 1 | | Interlace index | 0 Note1 | | Propagation conditions | TDLC300-100 low | | Test metric | SNR@  SNR@ | | Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz and RBs 0,5,10,…,50 are allocated for 30kHz. | |   **Table 3: Test Parameters for PF1:**   |  |  | | --- | --- | | Parameter | Test | | Number of information bits | 2 | | Number of symbols | 14 | | Intra-slot frequency hopping | N/A | | Group and sequence hopping | neither | | Hopping ID | 0 | | Initial cyclic shift | 0 | | First symbol | 0 | | Index of orthogonal cover code (*timeDomainOCC*) | 0 | | Antenna configuration | 1T4R | | Channel bandwidth | 20MHz | | SCS | 15kHz; 30kHz | | Number of interlaces | 1 | | Interlace index | 0 Note1 | | Propagation conditions | TDLC300-100 low | | Test metric | SNR@  SNR@ | | Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz and RBs 0,5,10,…,50 are allocated for 30kHz. | |   **Table 4: Test Parameters for PF2:**   |  |  | | --- | --- | | Parameter | Value | | Modulation order | QSPK | | Intra-slot frequency hopping | N/A | | Number of symbols | 2 | | The number of UCI information bits | 22 | | First symbol | 12 | | DM-RS sequence generation | *NID0=0* | | Antenna configuration | 1T4R | | Channel bandwidth | 20MHz | | SCS | 15kHz; 30kHz | | Number of interlaces | 1 | | Interlace index | 0 Note 1 | | Propagation conditions | TDLC300-100 low | | OCC-Length-r16 | Not configured | | Test metric |  | | Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz and RBs 0,5,10,…,50 are allocated for 30kHz. | |   **Table 5:** **Test Parameters for PF3:**   |  |  | | --- | --- | | Parameter | Test 1 | | Modulation order | QPSK | | Intra-slot frequency hopping | N/A | | Group and sequence hopping | neither | | Hopping ID | 0 | | Additional DM-RS configuration | No additional DM-RS | | Number of symbols | 4 | | The number of UCI information bits | 16 | | Channel bandwidth | 20MHz | | SCS | 15kHz; 30kHz | | Antenna configuration | 1T4R | | Number of interlaces | 1 | | Interlace index | 0Note 1 | | Propagation conditions | TDLC300-100 low | |  | 1 | | Cyclic shift index for DMRS | 0 | | Test metric |  | | Note 1: RBs 0, 10, 20,…,90 are allocated for 15kHz and RBs 0,5,10,…,45 are allocated for 30kHz.  Note 2: The UCI information does not contain CSI part 2. | | |
| R4-2015853 | Ericsson | Proposal 1: Introduce requirements for PUCCH enhanced format 0/1/2/3.  Proposal 2: Introduce NR-U PUCCH requirements with single interlace for enhanced format 0/1/2/3.  Proposal 3: Introduce NR-U PUCCH requirements with 2 discontinuous interlaces for enhanced format 2/3.  Proposal 4: Consider following simulation assumptions for enhanced PUCCH requirements.   * SCS: 15kHz and 30kHz * Channel model: TDLA30-10 * Antenna Configuration: 1Tx2Rx, FFS on other configurations * Only using interlacing structure  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Enhanced PUCCH | Format 0 | Format 1 | Format 2 | | | Format 3 | | | | Modulation order | \ | \ | QPSK | | | QPSK | | | | Number of UCI bits | [1] | [2] | [4 and/or 16] | | | [16] | | | | First PRB | 0 | 0 | 0 | 15kHz SCS: 0 and 9, 30kHz SCS: 0 and 4 | | 0 | | 15kHz SCS: 0 and 9, 30kHz SCS: 0 and 4 | | Number of PRBs | 11 | 11 | 11 | 15kHz SCS: 22, 30kHz SCS: 21 | | 10 | | 20 for both 15kHz and 30kHz SCS | | Initial cyclic shift | 0 | 0 | \ | | | \ | | | | First OFDM symbol | 13 | 0 | 13 | | | 0 | | | | Number of OFDM symbols | 1 | 14 | 1 | | | 14 | | | | Index of OCC | \ | 0 | n0 | | \ | n0 | \ | | | Length of OCC | \ | \ | n2 | | \ | n2 | \ | | |
| R4-2015989 | Intel Corporation | Proposal 1: RAN4 to define demodulation requirements for PRB-Interlaced PUCCH Resource Allocation considering single interlace.  Proposal 2: RAN4 to define demodulation requirements for PDCCH enhanced formats 0/1/2/3  Proposal 3: For EPF 0/1/2/3 performance requirements RAN4 to reuse test configurations of Rel-15 PF 0/1/2/3 keeping only BW = 20MHz |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 3-1: Test configurations

**Issue 3-1-1: PUCCH formats**

* Proposals
  + Option 1: PF0/1/2/3 (Nokia, Huawei, Ericsson, Intel)
* Recommended WF
  + Define the performance requirements for Rel-16 PF 0/1/2/3 with interlace resource allocation

**Issue 3-1-2: Number of interlaces**

* Proposals
  + Option 1: 1 interlace for PF 0/1/2/3 (Nokia, Huawei, Intel)
  + Option 2: 1 interlace for PF 0/1/2/3 and 2 discontinuous interlaces for enhanced format 2/3. (Ericsson)
* Recommended WF

**Issue 3-1-3: Antenna configuration**

* Proposals
  + Option 1: 1x2 (Ericsson).
  + Option 2: 1x4 (Huawei)
* Recommended WF

**Issue 3-1-4: SCS**

* Proposals
  + Option 1: 30 kHz (Huawei)
  + Option 2: 15 kHz and 30 kHz (Ericsson)
* Recommended WF

**Issue 3-1-5: Propagation conditions**

* Proposals
  + Option 1: TDLA30-10 (Ericsson)
  + Option 2: TDLC300-100 (Huawei)
* Recommended WF

**Issue 3-1-6: Bandwidth**

* Proposals
  + Option 1: 20MHz (Nokia, Intel, Huawei, Ericsson)
* Recommended WF
  + Use 20MHz for all PUCCH test cases

**Issue 3-1-7: Frequency hopping**

* Proposals
  + Option 1: Not configure frequency hopping for all PUCCH cases (Nokia, Huawei, Ericsson)
* Recommended WF
  + Define PUCCH performance requirements without frequency hopping.

### Sub-topic 3-2 PUCCH format 0

**Issue 3-2-1 Number of symbols**

* Proposals :
  + Option 1: 1 (Huawei, Ericsson)
  + Option 2: 1 and 2 (Nokia)
* Recommended WF

**Issue 3-2-2 Simulation assumptions**

* Proposals:
  + Option 1: (Nokia)

|  |  |  |  |
| --- | --- | --- | --- |
| **PUCCH format** | **Number Interlaces** | **Number symbols** | **Information bits** |
| 0 | 1 | 1 | 1 |
|  | 1 | 2 | 1 |

* + Option 2: (Huawei)

|  |  |
| --- | --- |
| Parameter | Test |
| Number of UCI information bits | 1 |
| Number of symbol | 1 |
| Intra-slot frequency hopping | N/A |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 13 |
| Antenna configuration | 1T4R |
| Channel bandwidth | 20MHz |
| SCS | 15kHz; 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note1 |
| Propagation conditions | TDLC300-100 low |
| Test metric | SNR@  SNR@ |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz and RBs 0,5,10,…,50 are allocated for 30kHz. | |

* + Option 3: (Ericsson)

|  |  |
| --- | --- |
| Enhanced PUCCH | Format 0 |
| Modulation order | \ |
| Number of UCI bits | [1] |
| First PRB | 0 |
| Number of PRBs | 11 |
| Initial cyclic shift | 0 |
| First OFDM symbol | 13 |
| Number of OFDM symbols | 1 |
| Index of OCC | \ |
| Length of OCC | \ |

* Recommended WF

Based on the simulation assumptions proposed by companies, the following simulation assumptions are recommended:

|  |  |
| --- | --- |
| Parameter | Test |
| Number of UCI information bits | 1 |
| Intra-slot frequency hopping | N/A |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| Number of symbols | Option 1: 1  Option 2: 1 and 2 |
| First symbol | 13 for 1 symbol  [12 for 2 symbols] |
| Antenna configuration | Option 1: 1x2  Option 2: 1x4 |
| Channel bandwidth | 20MHz |
| SCS | Option 1: 30kHz  Option 2: 15kHz and 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note1 |
| Propagation conditions | Option 1: TDLA30-10 Low  Option 2: TDLC300-100 Low |
| Test metric | SNR@  SNR@ |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz SCS (if agreed) and RBs 0,5,10,…,50 are allocated for 30kHz SCS. | |

### Sub-topic 3-3 PUCCH format 1

**Issue 3-3-1 Simulation assumptions**

* Proposals:
  + Option 1: (Nokia)

|  |  |  |  |
| --- | --- | --- | --- |
| **PUCCH format** | **Number Interlaces** | **Number symbols** | **Information bits** |
| 1 | 1 | 14 | 2 |

* + Option 2: (Huawei)

|  |  |
| --- | --- |
| Parameter | Test |
| Number of information bits | 2 |
| Number of symbols | 14 |
| Intra-slot frequency hopping | N/A |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 0 |
| Index of orthogonal cover code (*timeDomainOCC*) | 0 |
| Antenna configuration | 1x4 |
| Channel bandwidth | 20MHz |
| SCS | 15kHz; 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note1 |
| Propagation conditions | TDLC300-100 Low |
| Test metric | SNR@  SNR@ |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz and RBs 0,5,10,…,50 are allocated for 30kHz. | |

* + Option 3: (Ericsson)

|  |  |
| --- | --- |
| **Enhanced PUCCH** | **Format 1** |
| Modulation order | \ |
| Number of UCI bits | [2] |
| First PRB | 0 |
| Number of PRBs | 11 |
| Initial cyclic shift | 0 |
| First OFDM symbol | 0 |
| Number of OFDM symbols | 14 |
| Index of OCC | 0 |
| Length of OCC | \ |

* Recommended WF

Based on the simulation assumptions proposed by companies, the following simulation assumptions are recommended:

|  |  |
| --- | --- |
| Parameter | Test |
| Number of information bits | 2 |
| Number of symbols | 14 |
| Intra-slot frequency hopping | N/A |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 0 |
| Index of orthogonal cover code (*timeDomainOCC*) | 0 |
| Antenna configuration | Option 1:1x4  Option 2:1x2 |
| Channel bandwidth | 20MHz |
| SCS | Option 1: 30kHz  Option 2: 15kHz and 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note1 |
| Propagation conditions | Option 1:TDLC300-100 Low  Option 2: TDLA30-10 Low |
| Test metric | SNR@  SNR@ |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz (if agreed) and RBs 0,5,10,…,50 are allocated for 30kHz. | |

### Sub-topic 3-4 PUCCH format 2

**Issue 3-4-1: Information bits**

* Proposals:
  + Option 1: 4 bits for 1 OFDM symbol and 22 bits for 2 OFDM symbols (Nokia)
  + Option 2: 22 bits (Huawei)
  + Option 3: 4 bits and/or 16 bits (Ericsson)
* Recommended WF

**Issue 3-4-2: Number of interlaces**

* Proposals:
  + Option 1: 1 (Huawei, Nokia, Intel)
  + Option 2: 1 and 2 (Ericsson)
* Recommended WF

**Issue 3-4-2: Number of OFDM symbols**

* Proposals
  + Option 1: 1 and 2 (Nokia)
  + Option 2: 1 (Huawei, Ericsson)
* Recommended WF

**Issue 3-4-3: OCC configuration**

* Proposals:
  + Option 1: Not configure (Huawei)
  + Option 2: For 1 interlace, OCC length n2, OCC index n0; For 2 interlace, OCC is not configured. (Ericsson)
* Recommended WF

**Issue 3-4-4: Simulation assumptions**

* Proposals:
  + Option 1: (Ericsson)

|  |  |  |
| --- | --- | --- |
| **Enhanced PUCCH** | **Format 2** | |
| Modulation order | QPSK | |
| Number of UCI bits | [4 and/or 16] | |
| First PRB | 0 | 15kHz SCS: 0 and 9, 30kHz SCS: 0 and 4 |
| Number of PRBs | 11 | 15kHz SCS: 22, 30kHz SCS: 21 |
| Initial cyclic shift | \ | |
| First OFDM symbol | 13 | |
| Number of OFDM symbols | 1 | |
| Index of OCC | n0 | \ |
| Length of OCC | n2 | \ |

* + Option 2: (Huawei)

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Modulation order | QSPK |
| Intra-slot frequency hopping | N/A |
| Number of symbols | 2 |
| The number of UCI information bits | 22 |
| First symbol | 12 |
| DM-RS sequence generation | *NID0=0* |
| Antenna configuration | 1x4 |
| Channel bandwidth | 20MHz |
| SCS | 15kHz; 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note 1 |
| Propagation conditions | TDLC300-100 low |
| OCC-Length-r16 | Not configured |
| Test metric |  |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz and RBs 0,5,10,…,50 are allocated for 30kHz. | |

* + ~~Option 3: Ericsson~~

|  |  |  |  |
| --- | --- | --- | --- |
| ~~Enhanced PUCCH~~ | ~~Format 3~~ | | |
| ~~Modulation order~~ | ~~QPSK~~ | | |
| ~~Number of UCI bits~~ | ~~[16]~~ | | |
| ~~First PRB~~ | ~~0~~ | | ~~15kHz SCS: 0 and 9, 30kHz SCS: 0 and 4~~ |
| ~~Number of PRBs~~ | ~~10~~ | | ~~20 for both 15kHz and 30kHz SCS~~ |
| ~~Initial cyclic shift~~ | ~~\~~ | | |
| ~~First OFDM symbol~~ | ~~0~~ | | |
| ~~Number of OFDM symbols~~ | ~~14~~ | | |
| ~~Index of OCC~~ | ~~n0~~ | ~~\~~ | |
| ~~Length of OCC~~ | ~~n2~~ | ~~\~~ | |

* Recommended WF

### Sub-topic 3-5 PUCCH format 3

**Issue 3-5-1: OFDM symbols**

* Proposals:
  + Option 1: 4 and 14 (Nokia)
  + Option 2: 4 (Huawei)
  + Option 3: 14 (Ericsson)
* Recommended WF

**Issue 3-5-2: Number of interlaces**

* Proposals:
  + Option 1: Only 1 (Huawei, Nokia, Intel)
  + Option 2: 1 and 2 (Ericsson)
* Recommended WF

**Issue 3-5-3: OCC length**

* Proposals
  + Option 1: n1 (Huawei)
  + Option 2: n2 (Ericsson)
* Recommended WF

**Issue 3-5-4: Simulation assumptions**

* Proposals:
  + Option 1:(Nokia)

|  |  |  |  |
| --- | --- | --- | --- |
| **PUCCH format** | **Number Interlaces** | **Number symbols** | **Information bits** |
| 3 | 1 | 14 | 16 |
|  | 1 | 4 | 16 |

* + Option 2: (Huawei)

|  |  |
| --- | --- |
| Parameter | Test 1 |
| Modulation order | QPSK |
| Intra-slot frequency hopping | N/A |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Additional DM-RS configuration | No additional DM-RS |
| Number of symbols | 4 |
| The number of UCI information bits | 16 |
| Channel bandwidth | 20MHz |
| SCS | 15kHz; 30kHz |
| Antenna configuration | 1T4R |
| Number of interlaces | 1 |
| Interlace index | 0Note 1 |
| Propagation conditions | TDLC300-100 low |
|  | 1 |
| Cyclic shift index for DMRS | 0 |
| Test metric |  |
| Note 1: RBs 0, 10, 20,…,90 are allocated for 15kHz and RBs 0,5,10,…,45 are allocated for 30kHz.  Note 2: The UCI information does not contain CSI part 2. | |

* + Option 3: (Ericsson)

|  |  |  |
| --- | --- | --- |
| **Enhanced PUCCH** | **Format 3** | |
| Modulation order | QPSK | |
| Number of UCI bits | [4 and/or 16] | |
| First PRB | 0 | 15kHz SCS: 0 and 9, 30kHz SCS: 0 and 4 |
| Number of PRBs | 10 | 20 for both 15kHz and 30kHz SCS |
| Initial cyclic shift | \ | |
| First OFDM symbol | 0 | |
| Number of OFDM symbols | 14 | |
| Index of OCC | n0 | \ |
| Length of OCC | n2 | \ |

* Recommended WF

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Sub-topic 3-1: Test configurations** **Issue 3-1-1: PUCCH formats**  We agree with Option 1  **Issue 3-1-2: Number of interlaces**  We are open for further discussion on 2 interlaces mentioned in Option 2.  **Issue 3-1-3: Antenna configuration**  If there is no strong opinion, we prefer start from 1x2.  **Issue 3-1-4: SCS**  Similar view as in PUSCH discussion. If only 30kHz will be used in NR-U band, then Option 1 can be agreed.  **Issue 3-1-5: Propagation conditions**  We propose Option 1 but we are open for further discussion.  **Issue 3-1-6: Bandwidth**  Option1.  **Issue 3-1-7: Frequency hopping**  Option 1. **Sub-topic 3-2 PUCCH format 0** **Issue 3-2-1 Number of symbols**  Option 1. We propose reuse Rel-15 assumptions and also think no need to test 2 symbols here because no frequency hopping is used. Furthermore, the symbol number would be better to align with PF2.  **Issue 3-2-2 Simulation assumptions**  For test metric, we think it could follow Rel-15 to define requirements for ACK missed detection. **Sub-topic 3-3 PUCCH format 1** **Issue 3-3-1 Simulation assumptions** **Sub-topic 3-4 PUCCH format 2** **Issue 3-4-1: Information bits**  In Rel-15, 22 bits is used for 2 OFDM symbols with frequency hopping. Since there is no frequency hopping used, then it might need more consideration.  We propose 16 bits UCI is because PF2 can also used for multi-user multiplexing like PF3. So we take some PF3 assumptions here to test it. Companies opinions are welcome.  **Issue 3-4-2: Number of interlaces**  We can accept Option 1 for now if 2 interlace is confirmed as no clear benefit.  **Issue 3-4-2: Number of OFDM symbols:**  Only 1 symbol are enough since 2 symbols is used for frequency hopping test in Rel-15.  **Issue 3-4-3: OCC configuration**  We think it is worthy to test the multi-user multiplexing feature on PF2.  **Issue 3-4-4: Simulation assumptions**  Option 3 is for PF3 and should be removed here. **Sub-topic 3-5 PUCCH format 3** **Issue 3-5-1: OFDM symbols:**  Option 3. We think it would be better to align the number of OFDM symbol of PF3 with PF1 if we don’t have strong preference.  **Issue 3-5-2: Number of interlaces**  We can accept Option 1 for now if 2 interlace is confirmed as no clear benefit.  **Issue 3-5-3: OCC length**  We proposed the same OCC parameters as PF4 in Rel-15 since the same way is used for NR-U PF3.  **Issue 3-5-4: Simulation assumptions**  For information bits, we also think it might be good to include 4 bits for 14 os cases to cover RM encoding. |
| Samsung | **Issue 3-1-1: PUCCH formats** We are ok with option 1, for testing of different PUCCH formats, it should be based on the BS declartion reule with test applicability **Issue 3-1-2: Number of interlaces** Ok with option 1 **Issue 3-1-3: Antenna configuration** Ok with option 1, consideirng only 2Rx can be tested for OTA  **Issue 3-1-4: SCS**  Considering the interlace structure for 15KHz and 30KHz is different, we think it is natural to define requirement with two SCS.  **Issue 3-1-5: Propagation conditions**  We are not sure whether NR-U is only applied for low mobility scenario. If not, either option1 and option 2 are fine for us  **Issue 3-1-6: Bandwidth**  Ok with option 1  **Issue 3-1-7: Frequency hopping**  Ok with option 1  **Sub-topic 3-2 PUCCH format 0**  **Issue 3-2-1 Number of symbols**  Ok with option 1, considering there is no frequency hopping,  **Issue 3-2-2 Simulation assumptions** Sub-topic 3-3 PUCCH format 1 **Issue 3-3-1 Simulation assumptions** Sub-topic 3-4 PUCCH format 2 **Issue 3-4-1: Information bits**  We prefer to down select with one of 4 bits or 22bit, since the purpose is to verify the interlace design, no need to repeat the test defined in Rel-15  **Issue 3-4-2: Number of interlaces**  We prefer only 1 interlace  **Issue 3-4-2: Number of OFDM symbols**  Ok with option 2  **Issue 3-4-3: OCC configuration**  Ok with option 1  **Issue 3-4-4: Simulation assumptions** Sub-topic 3-5 PUCCH format 3 **Issue 3-5-1: OFDM symbols**  We prefer to down select with one of 4 symbols or 14 symbols, since the purpose is to verify the interlace design, no need to repeat the test defined in Rel-15  **Issue 3-5-2: Number of interlaces**  Prefer with only 1 interlace  **Issue 3-5-3: OCC length**  This value depends on the symbols length. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
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|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #4: PRACH requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014943 | Nokia, Nokia Shanghai Bell | Proposal 1: RAN 4 to define NR-U BS demodulation performance requirements for 15 kHz and 30 kHz and formats A2, B4, and C2.  Proposal 2: RAN4 to consider Rel. 15 PRACH for Normal Mode testing parameters as a baseline for the discussion on the parameters for NR-U performance requirements as in the table below:  Table 1 Proposed parameters for PRACH BS demodulation performance requirements   |  |  | | --- | --- | | Parameter | Value | | Subcarrier spacing | 15 kHz and 30 kHz | | Antenna configuration | 1x2, 1x4, 1x8 | | Propagation channel | AWGN and TDLC300-100 | | Frequency Offset | 0 (AWGN) and 400 (TDLC300-100) | | Test metric | SNR at Pfa < 0.1 % and Pd > 99% |   Observation 1: In addition to all Rel-15 PRACH sequences, longer Zadoff-Chu sequences were introduced in NR-U for 15 kHz and 30 kHz SCS.  Observation 2: New PRACH sequences for operation on unlicensed bands were designed for PRACH formats A1, A2, A3, B1, B2, B3, B4, C0, and C2 with 15 kHz and 30 kHz SCS.  Observation 3: NR-U is applicable to both LA BS and MR BS.  Observation 4: RAN4 has Rel-15 BS demodulation performance requirements for short PRACH formats A1, A2, A3, B4, C0 and C2 with 15 kHz and 30 kHz SCS in FR1.  Observation 5: RAN4 has Rel-16 HST BS demodulation performance requirements for short PRACH formats A2, B4, and C2 with 15 kHz and 30 kHz SCS in FR1. |
| R4-2015639 | Huawei, HiSilicon | Proposal 1: Define the performance requirements for wideband PRACH with following assumptions:   * Sequence length: LRA=1151 for 15kHz and LRA=571 for 30kHz * Format: B4, C2 * Ncs: 164 for LRA=1151 and 190 for LRA=571 * Logic root sequence index: 0 * v: 0 * Propagation conditions and CFO: AWGN and TDLA 30-10 with 600Hz CFO * Antenna configuration: 1T4R * Time error tolerance and test metric are reused from Rel-15 NR PRACH. |
| R4-2015990 | Intel Corporation | Proposal 1: RAN4 to define the performance requirements for both LRA = 1151 and LRA = 571 preamble length.  Proposal 2: RAN4 to define new test preambles as listed in Table 1  **Table 1: Test preambles for wideband PRACH**   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Burst format | LRA | SCS (kHz) | Ncs | Logical sequence index | v | | A1, A2, A3, | 1151 | 15 | 127 | 0 | 0 | | B4, C0, C2 | 571 | 30 | 63 | 0 | 0 |   Proposal 3: For NR-U PRACH performance requirements RAN4 to reuse the test configuration parameters used for Rel-15 LRA = 139 preamble as listed in Table 2.  **Table 2: Wideband PRACH performance test configuration**   |  |  | | --- | --- | | **Number of TX Antennas** | **1** | | **Number of RX Antennas** | **2, 4, 8** | | **Channel model** | **AWGN**  **TDL-C fading channel, frequency offset 400 Hz** | | **PRACH formats** | **A1, A2, A3, B4, C0, C2** |   Proposal 4: For NR-U PRACH performance requirements RAN4 to keep using existing test metrics: the false alarm probability shall be less than or equal to 0.1%, the probability of detection shall be equal to or exceed 99% and time error tolerance requirements given in Table 8.4.2.1-1 of TS38.104 |
| R4-2015854 | Ericsson | Proposal 1: Simulation assumptions for enhanced PRACH format   * Sequence format: A2, B4, C2 * SCS: 15kHz and 30kHz for n46 band * Channel model: AWGN and TDLA30-10 * Timing error tolerance:  |  |  |  |  | | --- | --- | --- | --- | | PRACH preamble | PRACH SCS (kHz) | Time error tolerance | | | AWGN | TDLA30-10 | | **A2, B4, C2** | **15** | [0.065us] | **FFS** | | **30** | **FFS** |  * Frequency offset: 0Hz for AWGN and FFS for TDLA30-10 |

## Open issues summary

### Sub-topic 4-1: Test configurations

**Issue 4-1-1: PRACH formats**

* Proposals
  + Option 1: A2, B4, C2 (Nokia, Ericsson)
  + Option 2: B4, C2 (Huawei)
  + Option 3: A1, A2, A3, B4, C0, C2 (Intel)
* Recommended WF

**Issue 4-1-2: Antenna configuration**

* Proposals
  + Option 1: 1x2, 1x4, 1x8. (Nokia, Intel)
  + Option 2: 1x4 (Huawei)
  + Option 3: 1x2 (Ericsson)
* Recommended WF

**Issue 4-1-3: Propagation conditions**

* Proposals
  + Option 1: AWGN and TDLC300-100 (Nokia, Intel)
  + Option 2: AWGN and TDLA30-10 (Huawei, Ericsson)
* Recommended WF

**Issue 4-1-4: Frequency offset**

* Proposals
  + Option 1: 400Hz (Nokia, Intel)
  + Option 2: 600Hz (Huawei)
* Recommended WF

**Issue 4-1-5: Ncs**

* Proposals
  + Option 1:127 for *LRA*=1151 and 63 for *LRA*=571 (Intel)
  + Option 2:164 for *LRA*=1151 and 190 for *LRA*=571 (Huawei)
* Recommended WF

**Issue 4-1-6: Time error estimation tolerance**

* Proposals
  + Option 1: Reuse the values in Table 8.4.2.1-1 of TS 38.104 (Intel)

|  |  |  |  |
| --- | --- | --- | --- |
| PRACH preamble | PRACH SCS (kHz) | Time error tolerance | |
| AWGN | TDLC300-100 |
| 0 | 1.25 | 1.04 us | 2.55 us |
| A1, A2, A3, B4, C0, C2 | 15 | 0.52 us | 2.03 us |
| 30 | 0.26 us | 1.77 us |

* + Option 2: New value (Ericsson)

|  |  |  |  |
| --- | --- | --- | --- |
| PRACH preamble | PRACH SCS (kHz) | Time error tolerance | |
| AWGN | TDLA30-10 |
| **A2, B4, C2** | **15** | [0.065us] | FFS |
| **30** | FFS |

* Recommended WF

**Issue 4-1-7: Test metric**

* Proposals
  + Option 1: Reuse existing test metrics: the false alarm probability shall be less than or equal to 0.1%, the probability of detection shall be equal to or exceed 99% and time error tolerance requirements FFS
* Recommended WF

Reuse the existing test metric for NR Rel-15 PRACH performance requirements, with the agreed time error tolerance based on the discussion of Issue 4-1-6.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | **Sub topic 4-1: Test configurations**  **Issue 4-1-1: PRACH formats**  Prefer Option 1 as HST discussion. This option consider typical NR-U deployment.  **Issue 4-1-2: Antenna configuration**  We prefer start from 1x2. More antenna cases can be considered if necessary.  **Issue 4-1-3: Propagation conditions**  No strong opinions. Option 2 considers typical NR-U deployment, but Option 1 keep the consistency between licensed band and unlicensed band.  **Issue 4-1-4: Frequency offset**  This should be discussed after the decision of channel model and carrier frequency.  **Issue 4-1-5: *Ncs:***  No strong opinions and need more check.  **Issue 4-1-6: Time error estimation tolerance**  We propose consider time error estimation tolerance based on the extended bandwidth for NR-U PRACH. The bandwidth is increased 8 times compared to normal PRACH, then the tolerance can be scaled 8 times down accordingly.  The time error tolerance for fading channel should be discussed after decision of fading channel.  **Issue 4-1-7: Test metric**  We can accept that reusing Rel-15 test metric. |
| Samsung | **Issue 4-1-1: PRACH formats**  We prefer to option1 with the minimum set of PRACH format. Meanwhile, the Rel-15 test applicability ruler can be applied.  **Issue 4-1-2: Antenna configuration**  We prefer to option 3. Only test one of antenna configuration to reduce the test effort. Considering only 2Rx is supported for OTA testing.  **Issue 4-1-3: Propagation conditions**  We prefer to option 1, which is same with existing Rel-15 PRACH requirement  **Issue 4-1-4: Frequency offset**  We are ok with option 2, considering the NR-U is targeting with 6Hz, with 0.01ppm, the FO is about 600Hz  **Issue 4-1-5: Ncs**  We have no strong view and add other options are not precluded.  **Issue 4-1-6: Time error estimation tolerance**  We are ok with option 2, the test tolerance should be scaled with PRACH sequence length.  **Issue 4-1-7: Test metric**  We are ok with recommended WF. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |