**3GPP TSG-RAN WG4 Meeting # 97-e R4-2017611**

**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 CProposal 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 1Proposal 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 requirementsProposal 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. |
| Nokia | **Issue 1-1-1: Performance requirements definition**We agree with the recommended WF. **Issue 1-1-2: Test scenarios**We think Option 2 reflects more our understanding, however, we don’t believe if a BS passes the Scenario A test it would be implicitly passing a Scenario C set of tests. Therefore, we propose a new Option 3If the BS passes a given test for Scenario A is does not need to repeat the test for same requirement on Scenario C. **Option 3 (new):** Tests should be defined independently of the scenario. If gNB supports more than one scenario, a given requirement only has to be tested once. **Issue 1-1-3: How to handle Rel-15 test requirements for NR-U BS?** We propose a new Option 2**Option 2 (new):** Consider all the mandatory Rel. 15 test cases for NR-U scenario, and define proper applicability rules The reason for that is even if a BS is designed to work only on unlicensed bands, the interlaced PUSCH/PUCCH and wideband PRACH is not mandatory in all regions. Additionally, RAN1 is still discussing if it a mandatory UE feature for NR-U capable devices. Therefore, there might be situations where the gNB operating in unlicensed bands will receive non-interlaced signals in UL, even in the Scenario C (standalone NR-U). **Issue 1-2-1: Wideband operation mode for PUSCH requirements** We agree with **Option 4**. Concerning Option 2, we would like to clarify that we probably have the same intention here. The intention of this proposal is to have requirements for a single wideband component carrier, with BW 20, 40, 60, or 80 MHz. If that makes it clearer, we would propose to change the text of Options 2 and 4 as:**Option 6 (new):** Define BS demodulation requirements for a single component carrier with 20MHz, 40MHz, 60MHz and 80MHz, 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.**Issue 1-2-2: LBT mode for wideband operation 2**We agree with the WF. **Issue 1-3-1: Whether to configure guard band for PUSCH requirements**During the last meeting we had agreements on this topic:

|  |
| --- |
| * Whether to consider intra-cell guard band in wideband operation 2 (if agreed to define requirements for wideband operation 2)
	+ Don’t consider intra-cell guard band in wideband operation 2.
	+ Define requirements for the test cases scheduling intra-cell guard band PRBs which are between continual successful CCA LBT bands for UL transmission.
 |

Please clarify Option 1. Does it mean that the PRBs between two contiguous CCA LBT bands are scheduled for transmission? If that is the case, we agree with that option, if the clarification is done. One suggestion for the clarification is:**Option 1a (new):** In the demodulation tests always consider that PRBs between 2 contiguous LBT sub**-**bands are scheduled. |
| Intel | **Issue 1-1-1: Performance requirements definition**Ok with recommended WF**Issue 1-1-2: Test scenarios**Ok with Option 2Ok with recommended WF**Issue 1-2-1: Wideband operation mode for PUSCH requirements** Ok with option 4**Issue 1-2-2: LBT mode for wideband operation 2**Agree with recommended WF**Issue 1-3-1: Whether to configure guard band for PUSCH requirements**Agree with recommended WF |
| Huawei | **Sub-topic 1-1: Test scenarios****Issue 1-1-1: Performance requirements definition**OK with recommended WF.**Issue 1-1-2: Test scenarios**We still prefer option 1. Since CA scenario is commonly used in real deployment.**Issue 1-1-3: How to handle Rel-15 test cases for NR-U BS?** As per the previous discussions on other WIs, it can only be discussed case by case if some test applicability rules can be defined, otherwise all existing requirements need to be tested by following general rules. **Sub-topic 1-2: Wideband operation mode****Issue 1-2-1: Wideband operation mode for PUSCH requirements**We share same views with Nokia. Since no LBT sub-band failure is considered, so there is no difference between two wideband operations. We propose to define the requirements with 20MHz, 40MHz, 60MHz and 80MHz as wideband operation agnostic way. To Samsung and Ericsson. More simulation with different bandwidth are needed to determine if we can define the requirements as band agnostic way. One question for clarification, how to correctly understand the wideband operation 1 and operation 2 without consideration of LBT failure model? we cannot find the official definition in the core specifications in both RAN1 and RAN4 RF. From our understanding, only CA method with different bandwidth combination defined in TS 38.101-1 and single carrier with different bandwidth per SCS (10/20/40MHz for 15kHz SCS; 20/40/60/80MHz for 30kHz SCS) defined in Table 5.3.5-1 of TS 38.101-1.**Issue 1-2-2: LBT mode for wideband operation 2**OK with recommended WF.**Sub-topic 1-3: Guard band configuration****Issue 1-3-1: Whether to configure guard band for PUSCH requirements**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 |
|  |

## 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#1-1：Test Scope** | **Issue 1-1-1: Performance requirements definition** Tentative agreements: Only define BS performance requirements for single carrier for both licensed CC (reuse the existing NR Rel-15 requirements) and unlicensed CCCandidate options: NoneRecommendations for 2nd round:If time allowed, can discuss how to reuse the existing NR Rel-15 requirements for Scenario A:- Option 1: Reuse all applicable requirements during the selection of the largest aggregated bandwidth for testing.- Option 2: Just choose one specific bandwidth for testing, such as 20MHz**Issue 1-1-2: Test scenarios** Tentative agreements: No specific requirements and tests will be defined for Scenario B.Candidate options:* Option 1: Only test scenario A(Huawei)
* Option 2: Test 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. (Samsung, Intel)
* Option 3: Test scenarios A and C. Define different test case sets for scenario A and scenario C and test them separately.(Ericsson)
* Option 4: Test scenarios A and C. Test should be defined independently of the scenario. If gNB supports more than one scenario, a given requirement only has to be tested once.(Nokia)

Recommendations for 2nd round: Moderator’s observation:* Scenario A: Licensed CC(s) + Unlicensed CC(s);
	+ Option 1: BS needs to test the performance requirements for both licensed CC(s) and unlicensed CC(s)
	+ Option 2: BS only needs to test the performance requirements for unlicensed CC(s)
* Scenario C: Unlicensed CC(s): BS only needs to test the performance requirements for unlicensed CC(s)
* Minor performance difference for different CBW based on further simulations

Is it feasible to discuss as per the following open issues listed:* Test applicability rule
	+ The tests should apply based on BS declaration of supporting Scenario A and/or Scenario C
* Option 1: If s a BS supports both Scenario A and Scenario C, and define one set of performance requirements
	+ - * Option 1a: BS only needs to pass the requirements for Scenario A that include performance requirements for both licensed CC(s) and unlicensed CC(s)
			* Option 1b: BS only tests performance requirements for unlicensed CC(s) considering the performance requirements for licensed CC has been verified in NR Rel-15
			* Option 1c: A given requirement only has to be tested once. If a BS passing a given test for Scenario A does not need to repeat the test for same requirements for Scenario C
* Option 2: If a BS supports both Scenario A and Scenario C, and two set of performance requirements for Scenario A and C:
	+ - * Option 2a: BS should test both set of requirements
			* Option 2b: other options

**Issue 1-1-3: How to handle Rel-15 test requirements for NR-U BS?**Tentative agreements: Candidate options:* Option 1: Consider a minimum subset of Rel-15 test cases for NR-U scenario and define proper applicability rules for these requirements. (Ericsson, Samsung, Huawei)
* Option 2: Consider all the mandatory Rel-15 test cases for NR-U scenario, and define proper applicability rules (Nokia)

Recommendations for 2nd round: * Focus on the discussion on NR-U specific performance requirements definition in this meeting
* Further discuss which Rel-15 test cases can be applied to NR-U scenario in next meetings.
 |
| **Sub-topic#1-2：Wide operation mode**  | **Issue 1-2-1: Wideband operation mode for PUSCH requirements** Tentative agreements: Define requirements that are agnostic to wideband operation 1 and 2Candidate options:* Option 1:Only define the requirements for single carrier with 20MHz (Ericsson, Samsung)
* Option 2: Define the requirements for single carrier with 20MHz,40MHz,60MHz and 80MHz, with the test applicability rule that a BS only has to perform tests for 20MHz and the largest supported bandwidth based on BS vendor’s declaration (Nokia, Intel)

Recommendations for 2nd round: Further discuss the above two options.**Issue 1-2-2: LBT mode for wideband operation 2**Tentative agreements: Not consider LBT model NR-U BS performance requirements definition.Candidate options:Recommendations for 2nd round: |
| **Sub-topic#1-3-1：Wide operation mode** | **Issue 1-3-1: Whether to configure guard band for PUSCH requirements**Tentative agreements: In the demodulation tests always consider the PRBs between 2 contiguous LBT sub**-**bands are scheduled.Candidate options:Recommendations for 2nd round: |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| R4-2017466 | Way forward on NR-U BS demodulation requirements for general part and PUSCH | Huawei, HiSilicon |

### 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

### Sub-topic 1-5-1: Test scenarios

**Issue 1-5-1-1: How to reuse NR Rel-15 performance requirements for licensed CC for Scenario A**

* Proposals
	+ Option 1: Reuse all applicable requirements during the selection of the largest aggregated bandwidth for testing.
	+ Option 2: Reuse one applicable requirement defined for one specific bandwidth for testing, such as 20MHz
* Recommended WF
	+ Updated the wording as per the GTW discussion. The listed options are to discuss whether consider CA or single carrier for licensed CC during the test.

**Issue 1-5-1-2: Bandwidth for performance requirements definition for unlicensed carrier**

* Proposals
	+ Option 1: Define the requirements for single carrier with 20MHz only with the test applicability rule that a BS only has to perform tests for the largest supported bandwidth based on BS vendor’s declaration. (Ericsson, Samsung)
	+ Option 2: Define the requirements for single carrier with 20MHz,40MHz,60MHz and 80MHz, with the test applicability rule that a BS only has to perform tests for the largest supported bandwidth based on BS vendor’s declaration (Nokia, Huawei)
* Recommended WF
	+ For Option 1, the applicability rule defined in NR Rel-15 for different channel bandwidths needs to applied: the tests shall be done only for the widest supported channel bandwidth. If performance requirement is not specified for this widest supported channel bandwidth, the tests shall be done by using performance requirement for the closest channel bandwidth lower than this widest supported bandwidth; the tested PRBs shall then be centered in this widest supported channel bandwidth.

**Issue 1-5-1-3: Test cases definition for Scenario A and Scenario C**

* Proposals
	+ Option 1: Only define test cases for scenario A
	+ Option 2: Define different test cases for Scenario A and C, i.e. different requirements for unlicensed CC for Scenario A and C
	+ Option 3: Define one set of test cases for Scenarios A and C, i.e. one set of requirements for unlicensed CC for Scenario A and C.
* Recommended WF
* GTW Agreement:
	+ RAN4 will introduce Test cases/requirements for both scenario A and scenario C ~~with below candidate options~~:
		-  Define one set of test cases for Scenarios A and C, i.e. one set of requirements for unlicensed CC for Scenario A and C. (Huawei, Samsung, Nokia, E/// ,Intel)

**Issue 1-5-1-4: Test applicability**

* Proposals
	+ The tests should apply based on BS declaration of supporting Scenario A and/or Scenario C
* Option 1: If a BS supports both Scenario A and Scenario C, and define one set of performance requirements for unlicensed CC
	+ - * Option 1a: BS only needs to pass the requirements for Scenario A that include performance requirements for both licensed CC(s) and unlicensed CC(s)
			* Option 1b: BS only tests performance requirements for unlicensed CC(s)
			* Other options not precluded
			* ~~Option 1c: A given requirement only has to be tested once. If a BS passing a given test for Scenario A does not need to repeat the test for same requirements for Scenario C~~
* Recommended WF
	+ Based on the GTW discussion and agreement reached for Issue 1-5-1-3, Option 1a, Option 1b and other possible options for further discussion

**Issue 1-5-1-5: 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
	+ Recommend to discuss this open issues in next meeting after we agree the specific test cases for NR-U

### Companies’ views collection for 2nd round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | **Issue 1-5-1-1: How to reuse NR Rel-15 performance requirements for licensed CC for Scenario A****Issue 1-5-1-2: Bandwidth for performance requirements definition****Issue 1-5-1-4: Test applicability****Issue 1-5-1-5: How to handle Rel-15 test requirements for NR-U BS?** |
|  |  |

## 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 requirementsTable 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 1Proposal 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 2For 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 1In 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 transmissionCG-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. |
| Nokia | **Sub-topic 2-1: Test configurations** **Issue 2-1-1: Waveform**We agree with **Option 1**. **Issue 2-1-2: Number of interlaces**We agree with **Option 1**. We could keep **Option 2** open if it shows a performance difference.**Issue 2-1-3: Number of symbols**We agree with **Option 1**.**Issue 2-1-4: SCS**We agree with **Option 1**.**Issue 2-1-4a: Test applicability for different SCS**We agree with **Option 1**.**Issue 2-1-5: TDD pattern**We agree with **Option 1**. **Issue 2-1-6: PUSCH mapping type**We agree with **Option 3**.Current FR1 requirements in NR cover both Type A and Type B. We propose to follow the same for NR-U. **Issue 2-1-7: MCS**We prefer **Option 2**. Prefer to use the MCSs used in Rel 15 PUSCH tests. **Issue 2-1-8: Antenna configuration**We agree with **Option 1**. 1x2 configuration**Issue 2-1-9: DM-RS configuration**We agree with the proposed WF. **Issue 2-1-10: Propagation conditions**We are ok with **Option 2**. **Issue 2-1-11: Test metric**We agree 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**We are open to consider Options 2 and 3, but further evaluation is needed. For Option 3, payload from 7 to 18 bits would have to be considered.  |
| Intel | **Issue 2-1-1: Waveform**Ok with Option 2**Issue 2-1-2: Number of interlaces**Prefer Option 1**Issue 2-1-3: Number of symbols**Agree with Option 1**Issue 2-1-4: SCS**Agree with Option 1**Issue 2-1-4a: Test applicability for different SCS**Ok with Option 1**Issue 2-1-5: TDD pattern**Ok with recommended WF**Issue 2-1-6: PUSCH mapping type**Ok with Option 2 as the flexibility of Type B mapping better fits to NR-U**Issue 2-1-7: MCS**Ok with Option 2. But prefer to limit to 1 value.**Issue 2-1-8: Antenna configuration**Ok with Option 1**Issue 2-1-9: DM-RS configuration**Ok with recommended WF**Issue 2-1-10: Propagation conditions**Prefer Option 1. Prefer to limit to 1 channel model. **Issue 2-1-11: Test metric**Agree with Option 1 |
| Huawei | **Issue 2-1-1: Waveform**Option 1.**Issue 2-1-2: Number of interlaces**Option 1. For option 2, performance gain can be acquired if HARQ repetition is configured because of the frequency selective gain. (Similar to frequency hopping). Considering minimal requirement, we support option 1.**Issue 2-1-3: Number of symbols**Option 1 **Issue 2-1-4: SCS**Option 2. 30kHz is typical for TDD.**Issue 2-1-5: TDD pattern**Option 2**Issue 2-1-6: PUSCH mapping type**Option 1.**Issue 2-1-7: MCS**Option 1, we prefer choose one MCS for performance requirements definition and open to the specific MCS value.**Issue 2-1-8: Antenna configuration**Option 2.**Issue 2-1-9: DM-RS configuration**OK with proposals**Issue 2-1-10: Propagation conditions**Option 1.**Issue 2-1-11: Test metric**Option 1.**Issue 2-2-1: Whether to introduce requirements for CG-UCI multiplexed on PUSCH with interlaced allocation**Option 2. To Ericsson, we should focus on NR-U part. Interlaced allocation is specified for PUSCH, we shouldn’t cover CG-UCI multiplexing on PUSCH by Rel-15 UCI multiplexing case considering different channel structure. |

### 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.*

|  |  |
| --- | --- |
| **Sub-topic#2-1: Test configuration**  | **Issue 2-1-1: Waveform***Tentative agreements:* Use CP-OFDM waveform*Candidate options:**Recommendations for 2nd round:***Issue 2-1-2: Number of interlaces***Tentative agreements:* Define the PUSCH requirements with 1 interlace*Candidate options:** Option 1: Single interlace that is same for all slots (Huawei, Samsung, Nokia, Intel)
* Option 2: Single interlace with 10 PRBs that is different per slot. (Ericsson, Nokia).

*Recommendations for 2nd round:* Further discuss the interlace allocation per slot.**Issue 2-1-3: Number of symbols***Tentative agreements:* Use 14 symbols for PUSCH transmission per slot*Candidate options:**Recommendations for 2nd round:***Issue 2-1-4: SCS***Tentative agreements:* *Candidate options** Option 1: Both 15kHz and 30kHz (Samsung, Nokia, Intel)
* Option 2: Only 30kHz (Huawei)

*Recommendations for 2nd round:* Further discuss if it is necessary to define requirements for 15kHz SCS**Issue 2-1-4a: Test applicability for different SCS***Tentative agreements:* *Candidate options** Option 1: Only test performance requirements for 15kHz or 30kHz SCS based on BS declaration if agreed to define requirements for both SCS (Samsung, Intel)

*Recommendations for 2nd round:* Based on the further discussion on Issue 2-1-4.**Issue 2-1-5: TDD pattern***Tentative agreements:* 7D2S1U S=6D:4G:4U for 30kHz SCS*Candidate options:** Option 1:3D1S1U for 15kHz (Nokia)

*Recommendations for 2nd round:* Based on the further discussion on Issue 2-1-4.**Issue 2-1-6: PUSCH mapping type***Tentative agreements:**Candidate options:** + Option 1: Only Type A (Ericsson, Huawei)
	+ Option 2: Only Type B (Ericsson, Samsung, Intel)
	+ Option 3: Both Type A and Type B (Nokia)

*Recommendations for 2nd round:* Further discuss in the 2nd round.**Issue 2-1-7: MCS***Tentative agreements:**Candidate options:* * + 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, Samsung, Intel)
	+ Option 3: MCS 20 for TDLA30-10. FFS:16 for TDLC300 and 2 for TDLB100 (Ericsson)

*Recommendations for 2nd round:* Further discuss in the 2nd round**Issue 2-1-8: Antenna configuration***Tentative agreements:* 1x2*Candidate options:**Recommendations for 2nd round:* **Issue 2-1-9: DM-RS configuration***Tentative agreements:* DM-RS configure type 1 with single-symbol and *dmrs-AdditionalPosition* ‘pos1’*Candidate options:**Recommendations for 2nd round:***Issue 2-1-10: Propagation conditions***Tentative agreements:* TDLA30-10 as baseline*Candidate options:** + FFS for TDLB100 and TDLC300

*Recommendations for 2nd round:*Further discuss whether consider additional propagation conditions of TDLB100 and TDLC300.**Issue 2-1-11: Test metric***Tentative agreements:* SNR@70% max throughput *Candidate options:**Recommendations for 2nd round:***Issue 2-1-12: Maximum number of HARQ transmissions***Tentative agreements:* *Candidate options:** Option 1: 4
* Option 2: others

*Recommendations for 2nd round:*This is a new open issue, collect comments in the 2nd round discussion.**Issue 2-1-13: RV sequence***Tentative agreements:* *Candidate options:** Option 1: {0,2,0,2}
* Option 2: others

*Recommendations for 2nd round:*This is a new open issue, collect comments in the 2nd round discussion. |
| **Sub-topic#2-1: CG-UCI multiplexing on PUSCH requirements** | **Issue 2-2-1: Whether to introduce requirements for CG-UCI multiplexed on PUSCH with interlaced allocation***Tentative agreements:* *Candidate options:** + 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, Nokia)
	+ 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, Nokia)

*Recommendations for 2nd round:* Further discuss whether to introduce the CG-UCI multiplexing on PUSCH with interlaced allocation requirements |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF included in section 1.4.1 |  |

### 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

### Sub-topic 2-5-1 Test configurations

**Issue 2-5-1-1: Single interlace allocation per slot**

* 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 2-5-1-2: SCS**

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

**Issue 2-5-2-2a: Test applicability for different SCS**

* Proposals
	+ Option 1: Only test performance requirements for subcarrier spacing that BS declares to support. If BS declares to support both 15kHz and 30kHz SCS, the tests shall be done for either 15kHz or 30kHz SCS
	+ Option 2: Only test performance requirements for subcarrier spacing that BS declares to support. If BS declares to support both 15kHz and 30kHz SCS, the tests shall be done for both 15kHz and 30kHz SCS
* Recommended WF

Based on the discussion on Issue 2-5-2.

**Issue 2-5-2-2b: TDD pattern for 15 kHz SCS**

* Proposals
	+ Option 1: 3D1S1U, S=10D:2G:2U for 15kHz
* Recommended WF
	+ 3D1S1U, S=10D:2G:2U for 15kHz SCS if performance requirements for 15kHz SCS agreed to be defined based on the discussion on Issue 2-5-2.

**Issue 2-5-1-3: PUSCH mapping type**

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

**Issue 2-5-1-4: 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, Samsung, Intel)
	+ Option 3: MCS 20 for TDLA30-10. FFS:16 for TDLC300 and 2 for TDLB100 (Ericsson)
* Recommended WF

**Issue 2-5-1-5: Propagation conditions**

* Proposals
	+ Option 1: Further consider TDLB100 and TDLC300 besides TDLA30-10
	+ Option 2: Not consider other propagation conditions except TDLA30-10
* Recommended WF

TDLA30-10 has been agreed as baseline in the 1st round discussion, further discussion if addition TDLB100 and TDLC300 need to be considered.

**Issue 2-5-1-6: Maximum number of HARQ transmission**

* Proposals
	+ Option 1: 4
	+ Other options
* Recommended WF

**Issue 2-5-1-7: RV sequence**

* Proposals
	+ Option 1: {0,2,0,2}
	+ Other options
* Recommended WF

### Sub-topic 2-5-2 CG-UCI multiplexed on PUSCH requirements

**Issue 2-5-2-1: 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, Nokia)
	+ 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, Nokia)
* Recommended WF

### Companies’ views collection for 2nd round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | **Issue 2-5-1-1: Single interlace allocation per slot****Issue 2-5-1-2: SCS****Issue 2-5-2-2a: Test applicability for different SCS****Issue 2-5-2-2b: TDD pattern for 15 kHz SCS****Issue 2-5-1-3: PUSCH mapping type****Issue 2-5-1-4: MCS****Issue 2-5-1-5: Propagation conditions]****Issue 2-5-1-6: Maximum number of HARQ transmission****Issue 2-5-1-7: RV sequence****Issue 2-5-2-1: Whether to introduce requirements for CG-UCI multiplexed on PUSCH with interlaced allocation** |
|  |  |

## 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  | $$Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)=10^{-2}$ SNR@$Prob\left(NACK\rightarrow ACK\right)=10^{-3}$ |
| 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 | $$Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)=10^{-2}$SNR@$Prob\left(NACK\rightarrow ACK\right)=10^{-3}$ |
| 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 | $$SNR @ Prob\left(UCI block BLER\right)=10^{-2}$$ |
| 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 |
| $$N\_{SF}^{PUCCH,3}$$ | 1 |
| Cyclic shift index for DMRS | 0 |
| Test metric  | $$SNR @ \left(UCI block BLER\right)=10^{-2}$$ |
| 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 0/1/2/3Proposal 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  | $$Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)=10^{-2}$ SNR@$Prob\left(NACK\rightarrow ACK\right)=10^{-3}$ |
| 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: 1Option 2: 1 and 2 |
| First symbol | 13 for 1 symbol [12 for 2 symbols] |
| Antenna configuration  | Option 1: 1x2Option 2: 1x4 |
| Channel bandwidth  | 20MHz |
| SCS | Option 1: 30kHzOption 2: 15kHz and 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note1 |
| Propagation conditions  | Option 1: TDLA30-10 LowOption 2: TDLC300-100 Low |
| Test metric  | $$Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)=10^{-2}$ SNR@$Prob\left(NACK\rightarrow ACK\right)=10^{-3}$ |
| 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 | $$Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)=10^{-2}$SNR@$Prob\left(NACK\rightarrow ACK\right)=10^{-3}$ |
| 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 1:1x4Option 2:1x2 |
| Channel bandwidth | 20MHz |
| SCS | Option 1: 30kHzOption 2: 15kHz and 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note1 |
| Propagation conditions | Option 1:TDLC300-100 LowOption 2: TDLA30-10 Low |
| Test metric | $$Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)=10^{-2}$SNR@$Prob\left(NACK\rightarrow ACK\right)=10^{-3}$ |
| 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 | $$SNR @ Prob\left(UCI block BLER\right)=10^{-2}$$ |
| 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 |
| $$N\_{SF}^{PUCCH,3}$$ | 1 |
| Cyclic shift index for DMRS | 0 |
| Test metric  | $$SNR @ \left(UCI block BLER\right)=10^{-2}$$ |
| 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. |
| Nokia | **Sub-topic 3-1: Test configurations****Issue 3-1-1: PUCCH formats**We agree with the WF: **Option 1**:PF0/1/2/3.**Issue 3-1-2: Number of interlaces**We prefer **Option 1** with 1 interlace. 2 interlaces could be FFS if impact is identified. **Issue 3-1-3: Antenna configuration**We prefer **Option 1**. **Issue 3-1-4: SCS**We agree with **Option 2**, 15 and 30 kHz. **Issue 3-1-5: Propagation conditions**We prefer **Option 1**.**Issue 3-1-6: Bandwidth** We agree with **Option 1**, 20 MHz.**Issue 3-1-7: Frequency hopping** We agree with **Option 1**, no frequency hopping.**Sub-topic 3-2 PUCCH format 0****Issue 3-2-1 Number of symbols** We are fine with **Option 1**. **Issue 3-2-2 Simulation assumptions**We agree on using the proposed table as baseline for the PUCCH format 0 parameter discussion. For the test metric, we agree with Ericsson on reusing Rel. 15 test metric or keeping “SNR@$Prob\left(NACK\rightarrow ACK\right)=10^{-3}$” open for the moment. **Sub-topic 3-3 PUCCH format 1****Issue 3-3-1 Simulation assumptions**We agree on using the recommended table as baseline. **Sub-topic 3-4 PUCCH format 2****Issue 3-4-1: Information bits**If we consider that channel coding implementation is already tested in the Rel 15 requirements, we can the only 1 payload size. This will also depend on the outcome of Issue 1-1-3. If Rel 15 requirements are also tested, our favourite option would be 4 bits, otherwise it is Option 2 which follows Rel 15 PUCCH requirements. **Issue 3-4-2: Number of interlaces** We prefer **Option 1**, with 1 interlace. **Issue 3-4-2: Number of OFDM symbols:** If we decide for 4 bits payload in Issue 3-4-1, we prefer **Option 2**. If we have 2 payload sizes we prefer **Option 1**. **Issue 3-4-3: OCC configuration** We prefer to follow Rel. 15 requirements and not configure, **Option 1.****Issue 3-4-4: Simulation assumptions** **Sub-topic 3-5 PUCCH format 3****Issue 3-5-1: OFDM symbols:**We proposed **Option 1**, but we agree to compromise to **Option 2** or **Option 3**. **Issue 3-5-2: Number of interlaces**We prefer 1 interlace **Option 1**.**Issue 3-5-3: OCC length**To be verified. **Issue 3-5-4: Simulation assumptions**Decision depending on the agreements on the previous issues.  |
| Intel | **Issue 3-1-1: PUCCH formats**Agree with recommended WF**Issue 3-1-2: Number of interlaces**Agree with Option 1. Interlace design can be verified with single interlace.**Issue 3-1-3: Antenna configuration**Ok with Option 1**Issue 3-1-4: SCS**Ok with Option 2**Issue 3-1-5: Propagation conditions**Ok with Option 1**Issue 3-1-6: Bandwidth** Agree with Option 1**Issue 3-1-7: Frequency hopping** Agree with recommended WF |
| Huawei | **Sub-topic 3-1: Test configurations****Issue 3-1-1: PUCCH formats**Ok with option 1, **Issue 3-1-2: Number of interlaces**Ok with option 1. Our preference is to set one interlace for all cases.**Issue 3-1-3: Antenna configuration**Option 2**Issue 3-1-4: SCS**Option 1.**Issue 3-1-5: Propagation conditions**No strong views**Issue 3-1-6: Bandwidth**OK with the recommended WF**Issue 3-1-7: Frequency hopping**OK with the recommended WF**Sub-topic 3-2 PUCCH format 0****Issue 3-2-1 Number of symbols**Option 1.Sub-topic 3-4 PUCCH format 2**Issue 3-4-1: Information bits**Option 2. Option 3 is also OK for us, but we propose to define only one case to reduce the test number.**Issue 3-4-2: Number of interlaces**Option 1**Issue 3-4-2: Number of OFDM symbols**Option 2. One case is enough **Issue 3-4-3: OCC configuration**Option 1Sub-topic 3-5 PUCCH format 3**Issue 3-5-1: OFDM symbols**Option 2. One case is preferred.**Issue 3-5-2: Number of interlaces**Option 1.**Issue 3-5-3: OCC length**Option 1 but option 2 is fine to us. |

### 3.3.2 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#3-1: Test configurations** | **Issue 3-1-1: PUCCH formats***Tentative agreements:*Define the performance requirements for PF0/1/2/3 *Candidate options:**Recommendations for 2nd round:***Issue 3-1-2: Number of interlaces***Tentative agreements:* 1 interlace for PF 0/1/2/3*Candidate options:* *Recommendations for 2nd round:***Issue 3-1-3: Antenna configuration***Tentative agreements:* 1x2*Candidate options:* *Recommendations for 2nd round:* **Issue 3-1-4: SCS***Tentative agreements:* *Candidate options:* * + Option 1: 30 kHz (Huawei, Ericsson)
	+ Option 2: 15 kHz and 30 kHz (Ericsson, Samsung, Nokia, Intel)

*Recommendations for 2nd round:* Further discuss in the 2nd round.**Issue 3-1-5 Propagation conditions** Tentative agreements: Candidate options: * + Option 1: TDLA30-10 (Ericsson, Samsung, Nokia, Intel)
	+ Option 2: TDLC300-100 (Huawei, Samsung)

Recommendations for 2nd round: Further discuss in the 2nd round.**Issue 3-1-6 Bandwidth**Tentative agreements: Define the NR-U PUCCH requirements with 20MHz bandwidthCandidate options: Recommendations for 2nd round: **Issue 3-1-7 Frequency hopping**Tentative agreements: Not configure frequency hoppingCandidate options: Recommendations for 2nd round:  |
| **Sub-topic#3-2: PUCCH format 0** | **Issue 3-2-1 Number of symbols**Tentative agreements: Only test 1 OFDM symbol for PF0Candidate options: Recommendations for 2nd round:**Issue 3-2-1 Simulation assumptions**Tentative agreements: Candidate options: * + Option 1:

|  |  |
| --- | --- |
| 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  | 1T2R |
| Channel bandwidth  | 20MHz |
| SCS | [15kHz]; 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note1 |
| Propagation conditions  | Option 1: TDLC300-100 lowOption 2: TDLA30-10 |
| Test metric  | $$SNR @Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)\leq 10^{-2}$ SNR@$Prob\left(NACK\rightarrow ACK\right)\leq 10^{-3}$ |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz if agreed and RBs 0,5,10,…,50 are allocated for 30kHz. |

Recommendations for 2nd round: Companies are invited to double check the listed simulation assumptions.  |
| **Sub-topic#3-3: PUCCH format 1** | **Issue 3-3-1 Simulation assumptions**Tentative agreements: Candidate options: * + Option 1:

|  |  |
| --- | --- |
| 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 | Option 1: TDLC300-100 lowOption 2: TDLA30-10 |
| Test metric | $$Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)\leq 10^{-2}$SNR@$Prob\left(NACK\rightarrow ACK\right)\leq 10^{-3}$ |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz if agreed and RBs 0,5,10,…,50 are allocated for 30kHz. |

Recommendations for 2nd round: Companies are invited to double check the listed simulation assumptions. |
| **Sub-topic#3-4: PUCCH format 2** | **Issue 3-4-1 Information bits**Tentative agreements: Candidate options: * Option 1: 4 bits or 22 bits (Samsung, Nokia)
* Option 2: 22 bits (Huawei)
* Option 3: 16 bits (Ericsson)

Recommendations for 2nd round:Further discuss in the 2nd round.**Issue 3-4-2 Number of interlaces**Tentative agreements: One interlaceCandidate options: Recommendations for 2nd round:**Issue 3-4-3 Number of OFDM symbols**Tentative agreements: One OFDM symbol Candidate options: Recommendations for 2nd round:**Issue 3-4-4 OCC configuration** Tentative agreements: Candidate options: * + Option 1: Not configure (Huawei, Samsung, Nokia)
	+ Option 2: OCC length n2 (Ericsson)

Recommendations for 2nd round: Further discuss whether to configure OCC for PF2 in the 2nd round. |
| **Sub-topic#3-5: PUCCH format 3** | **Issue 3-5-1: OFDM symbols**Tentative agreements: Candidate options: * + Option 1: Both 4 and 14 (Nokia)
	+ Option 2: 4 (Huawei, Samsung)
	+ Option 3: 14 (Ericsson, Samsung)

Recommendations for 2nd round: Further discuss in the 2nd round.**Issue 3-5-2: Number of interlaces**Tentative agreements: One interlaceCandidate options: Recommendations for 2nd round: **Issue 3-5-3: OCC length**Tentative agreements: Candidate options: * + Option 1: n1 (Huawei)
	+ Option 2: n2 (Ericsson)
	+ Other values are not precluded.

Recommendations for 2nd round: Further discuss the OCC configuration in the 2nd round. |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| R4-2017467 | Way forward on PUCCH demodulation requirements | Ericsson |

### 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

### Sub-topic 3-5-1: General test configurations

**Issue 3-5-1-1: SCS**

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

**Issue 3-5-1-2: Propagation conditions**

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

### Sub-topic 3-5-2 PUCCH format 0

**Issue 3-5-2-1 Simulation assumptions**

* Proposals:
	+ Option 1:

|  |  |
| --- | --- |
| 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  | 1T2R |
| Channel bandwidth  | 20MHz |
| SCS | [15kHz]; 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note1 |
| Propagation conditions  | Option 1: TDLC300-100 lowOption 2: TDLA30-10 |
| Test metric  | $$SNR @Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)\leq 10^{-2}$ SNR@$Prob\left(NACK\rightarrow ACK\right)\leq 10^{-3}$ |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz if agreed and RBs 0,5,10,…,50 are allocated for 30kHz. |

* Recommended WF

Companies are welcome to check the simulation assumptions if any other test parameters are missing. The open options will be updated based on the latest discussion

### Sub-topic 3-5-3 PUCCH format 1

**Issue 3-5-3-1 Simulation assumptions**

* Proposals:
	+ Option 1:

|  |  |
| --- | --- |
| 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 | Option 1: TDLC300-100 lowOption 2: TDLA30-10 |
| Test metric | $$Prob\left(PUCCH DTX\rightarrow Ack bits\right) \leq 10^{-2}$$SNR@$Prob\left(ACK miss\right)\leq 10^{-2}$SNR@$Prob\left(NACK\rightarrow ACK\right)\leq 10^{-3}$ |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz if agreed and RBs 0,5,10,…,50 are allocated for 30kHz. |

* Recommended WF

Companies are welcome to check the simulation assumptions if any other test parameters are missing. The open options will be updated based on the latest discussion

### Sub-topic 3-5-4 PUCCH format 2

**Issue 3-5-4-1: Information bits**

* Proposals:
	+ Option 1: 4 bits or 22 bits (Samsung, Nokia)
	+ Option 2: 22 bits (Huawei)
	+ Option 3: 16 bits (Ericsson)
* Recommended WF

Check if option of 4 bits can removed?

**Issue 3-5-4-2: OCC configuration**

* Proposals:
	+ Option 1: Not configure (Huawei, Samsung, Nokia)
	+ Option 2: OCC length n2 (Ericsson)
* Recommended WF

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

* Proposals:
	+ Option 1:

|  |  |
| --- | --- |
| **Parameter** | **Value**  |
| Modulation order | QSPK |
| Intra-slot frequency hopping | N/A |
| Number of symbols | 1 |
| The number of UCI information bits | Option 1: 4 bits or 22 bitsOption 2: 22 bitsOption 3: 16 bits |
| First symbol | 13 |
| DM-RS sequence generation | *NID0=0* |
| Antenna configuration | 1x2 |
| Channel bandwidth | 20MHz |
| SCS | [15kHz]; 30kHz |
| Number of interlaces | 1 |
| Interlace index | 0 Note 1 |
| Propagation conditions | Option 1: TDLC300-100 lowOption 2: TDLA30-10 |
| OCC-Length-r16 | Option 1: Not configuredOption 2: n2 |
| Test metric | $$SNR @ Prob\left(UCI block BLER\right)=10^{-2}$$ |
| Note 1: RBs 0, 10, 20,…,100 are allocated for 15kHz and RBs 0,5,10,…,50 are allocated for 30kHz. |

* Recommended WF

Companies are welcome to check the simulation assumptions if any other test parameters are missing. The open options will be updated based on the latest discussion.

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

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

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

**Issue 3-5-5-2: OCC length**

* Proposals
	+ Option 1: n1 (Huawei)
	+ Option 2: n2 (Ericsson)
	+ Other values are not precluded.
* Recommended WF

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

* Proposals:
	+ Option 1:

|  |  |
| --- | --- |
| 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 | Option 1: both 4 and 14Option 2: 4Option 3: 14 |
| The number of UCI information bits | 16 |
| Channel bandwidth | 20MHz |
| SCS | [15kHz]; 30kHz |
| Antenna configuration | 1x2 |
| Number of interlaces | 1 |
| Interlace index | 0Note 1 |
| Propagation conditions | Option 1: TDLC300-100 lowOption 2: TDLA30-10 |
| Index of OCC | n0 |
| Length of OCC | Option 1: n1Option 2: n2 |
| Cyclic shift index for DMRS | 0 |
| Test metric  | $$SNR @ \left(UCI block BLER\right)=10^{-2}$$ |
| 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. |

* Recommended WF

Companies are welcome to check the simulation assumptions if any other test parameters are missing. The open options will be updated based on the latest discussion.

### Companies’ views collection for 2nd round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | **Sub-topic 3-5-1: General test configurations****Issue 3-5-1-1: SCS****Issue 3-5-1-2: Propagation conditions****Sub-topic 3-5-2 PUCCH format 0****Issue 3-5-2-1 Simulation assumptions****Sub-topic 3-5-3 PUCCH format 1****Issue 3-5-3-1 Simulation assumptions****Sub-topic 3-5-4 PUCCH format 2****Issue 3-5-4-1: Information bits****Issue 3-5-4-2: OCC configuration****Issue 3-5-4-3: Simulation assumptions****Sub-topic 3-5-5 PUCCH format 3****Issue 3-5-5-1: Number of OFDM symbols****Issue 3-5-5-2: OCC length****Issue 3-5-5-3: Simulation assumptions** |
|  |  |

## 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 #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
* $L\_{RA}=\left\{\begin{matrix}1151&for 15kHz SCS\\571&for 30kHz SCS\end{matrix}\right.$
* 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. |
| Nokia | **Sub topic 4-1: Test configurations****Issue 4-1-1: PRACH formats**We prefer **Option 1**. **Issue 4-1-2: Antenna configuration**In order to reduce effort, we agree with **Option 3**. **Issue 4-1-3: Propagation conditions** We prefer **Option 1**. This is in line with Rel 15 requirements. We don’t have a strong view. **Issue 4-1-4: Frequency offset**We prefer **Option 1**. This is in line with Rel 15 requirements. We are open to evaluate it further. **Issue 4-1-5: *Ncs:***Needs further verification. **Issue 4-1-6: Time error estimation tolerance**We propose Option 3 (new)**Option 3 (new)**: Reuse the Table 8.4.2.1-1 of TS 38.104 for the moment, and encourage companies to bring analysis on the scaled tolerance for the next meeting. **Issue 4-1-7: Test metric**We agree with **Option 1**.  |
| Intel | **Issue 4-1-1: PRACH formats**Ok with Option 1**Issue 4-1-2: Antenna configuration**Ok with Option 3**Issue 4-1-3: Propagation conditions** Agree with Option 1 to align with Rel-15 requirements**Issue 4-1-4: Frequency offset**Prefer Option 1 to align with Rel-15 requirements**Issue 4-1-5: Ncs**We are Ok with both options**Issue 4-1-6: Time error estimation tolerance**Ok with Option 2**Issue 4-1-7: Test metric**Agree with recommended WF |
| Huawei | **Issue 4-1-1: PRACH formats**We support option 2. **Issue 4-1-2: Antenna configuration**Option 2**Issue 4-1-3: Propagation conditions**Option 2**Issue 4-1-4: Frequency offset**Option 2.**Issue 4-1-5: Ncs** Option 2 since it has the same cell size as Rel-15 PRACH requirements**Issue 4-1-6: Time error estimation tolerance**Option 2 can be used as baseline,**Issue 4-1-7: Test metric**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 |
|  |

## 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#4-1 Test configurations** | **Issue 4-1-1: PRACH formats**Tentative agreements:Candidate options:* + Option 1: A2, B4, C2 (Nokia, Ericsson, Samsung, Intel)
	+ Option 2: B4, C2 (Huawei)

Recommendations for 2nd round: Further discuss whether to test PRACH format A2**Issue 4-1-2: Antenna configuration**Tentative agreements: 1x2Candidate options:Recommendations for 2nd round:**Issue 4-1-3: Propagation conditions** Tentative agreements:Candidate options:* + Option 1: AWGN and TDLC300-100 (Ericsson, Samsung, Nokia, Intel)
	+ Option 2: AWGN and TDLA30-10 (Huawei, Ericsson)

Recommendations for 2nd round: Further discuss which fading channel mode to be used**Issue 4-1-4: Frequency offset**Tentative agreements:Candidate options:* + Option 1: 400Hz (Nokia, Intel)
	+ Option 2: 600Hz (Huawei, Samsung)
	+ Option 3: Should be further discussed after decision of channel mode and carrier frequency (Ericsson)

Recommendations for 2nd round:Further discuss in the 2nd round.**Issue 4-1-5: Ncs**Tentative agreements:Candidate options:* + Option 1:127 for *LRA*=1151 and 63 for *LRA*=571 (Intel)
	+ Option 2:164 for *LRA*=1151 and 190 for *LRA*=571 (Huawei, Intel)
	+ Other options are not

Recommendations for 2nd round: Further discuss the value of Ncs in the 2nd round.**Issue 4-1-6: Time error estimation tolerance**Tentative agreements:Candidate options:* + Option 1 New value (Ericsson, Samsung, Intel, Huawei)

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

* + Option 2: Reuse the Table 8.4.2.1-1 of TS 38.104 for the moment, and encourage companies to bring analysis on the scaled tolerance for the next meeting. (Nokia)

Recommendations for 2nd round: Further discuss the time error estimation tolerance after decision of TDLA30-10 or TDLC 300-100 in Issue 4-1-3.**Issue 4-1-7: Test metric**Tentative agreements: 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 FFSCandidate options:Recommendations for 2nd round: |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| R4-2017468 | Way forward on PRACH demodulation requirements | Nokia, Nokia Shanghai Bell |

### 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

### Sub-topic 4-5-1: Test configurations

**Issue 4-5-1-1: PRACH formats**

* Proposals
	+ Option 1: A2, B4, C2 (Nokia, Ericsson, Samsung, Intel)
	+ Option 2: B4, C2 (Huawei)
* Recommended WF

**Issue 4-5-1-2: Propagation conditions**

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

**Issue 4-5-1-3: Frequency offset**

* Proposals
	+ Option 1: 400Hz (Nokia, Intel)
	+ Option 2: 600Hz (Huawei, Samsung)
	+ Option 3: Should be further discussed after decision of channel mode and carrier frequency (Ericsson)
* Recommended WF

**Issue 4-5-1-4: 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, Intel)
	+ Other options are not
* Recommended WF

**Issue 4-5-1-5: Time error estimation tolerance**

* Proposals
	+ Option 1: New value (Ericsson, Samsung, Intel, Huawei)

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

* + Option 2: Reuse the Table 8.4.2.1-1 of TS 38.104 for the moment, and encourage companies to bring analysis on the scaled tolerance for the next meeting. (Nokia)Recommended WF
* Recommended WF

Discuss the issues after decision on propagation condition of Issue 4-5-1-2.

### Companies’ views collection for 2nd round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | **Sub-topic 4-5-1: Test configurations****Issue 4-5-1-1: PRACH formats****Issue 4-5-1-2: Propagation conditions****Issue 4-5-1-3: Frequency offset****Issue 4-5-1-4: Ncs****Issue 4-5-1-5: Time error estimation tolerance** |
|  |  |

## 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”* |