**3GPP TSG-RAN WG4 Meeting # 102-e R4-22xxxxx**

**Electronic Meeting, February 21st – March 3rd, 2022**

**Agenda item:** 10.18.3

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for [102-e][329] NR\_cov\_enh\_Demod

**Document for:** Information

# Introduction

This email thread discusses the demodulation part of the Rel-17 NR coverage enhancement WI: in agenda 10.18.3.

List of candidate target of email discussion for 1st round and 2nd round:

* 1st round: Invite companies to provide comments in section 1.3 and 2.3.
* 2nd round: TBA

# Topic #1: PUSCH Enhancements of Rel-17 NR Coverage Enhancement

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2203552 | Samsung | Observation 1: Compared with Rel-15/16, the range of slot repetition can be up to 32 from 16  Observation 2: PUSCH slot repetition requirements have been verified in RAN4 for both FR1 and FR2. No PUSCH requirement with 16 repetition.  Propose 1: No BS demodulation requirements for PUSCH repetition type A with 32 repetitions.  Propose 2: RAN4 applies 4 available slots in FDD and 2 available slots in TDD for PUSCH requirements with TBoMS  Propose 3: RAN4 do not apply repetition for PUSCH requirements with TBoMS  Propose 4: RAN4 applies narrow PUSCH allocation for PUSCH requirements with TBoMS.  Propose 5: RAN4 applies the following TDD UL-DL pattern for PUSCH requirement with TBoMS for 30KHz SCS.  - For 30KHz SCS  - 7D1S2U, S=6D:4G:4U as starting point  - Reuse the existing applicability rule for test requirement for different TDD UL-DL patterns  No PUCCH requirement with TBoMS for TDD UL-DL pattern as 3D1SU in 15 KHz SCS. If needed, the PUSCH requirement with TBoMS for TDD with 2 available slots can be applied for FDD with 2 available slots  Propose 6: RAN4 applies CP-OFDM waveform for PUSCH requirements with TBoMS  Propose 7: RAN4 not to test PUSCH demodulation with UCI multiplexing for TBoMS transmission  Propose 8: RAN4 applies the following parameters for PUSCH with TBoMS transmission  - Cover both FR1 and FR2, with test applicability rule  - For MCS: QPSK 1/3 MCS4  - For RV sequence for HARQ transmission: [0 2 3 1]  - For PUSCH mapping type: Cover PUSCH mapping type A and type B, with test applicability rule.  Propose 9: RAN4 applies the test metric of SNR@ 70% of Throughput for PUSCH requirements with TBoMS  Propose 10: RAN4 applied 2 slots in TDD and FDD for PUSCH requirement with Joint channel estimation  Propose 11: RAN4 applied configured TDW lengths as 2 for requirement with JCE  Propose 12: RAN4 applied repetition type A for requirement with JCE  Propose 13: RAN4 applies full applicable test bandwidth for PUSCH requirement with JCE  Propose 14: RAN4 applies inter-slot frequency hopping disable for PUSCH requirement with JCE.  Propose 15: RAN4 applies the following TDD UL-DL pattern for PUSCH requirement with JCE for 30KHz SCS.  - For 30KHz SCS  - 7D1S2U, S=6D:4G:4U as starting point  - Reuse the existing applicability rule for test requirement for different TDD UL-DL patterns  No PUCCH requirement with JCE for TDD UL-DL pattern as 3D1SU in 15 KHz SCS. If needed, the PUSCH requirement with JCE for TDD with 2 continuous slots can be applied for FDD with 2 available slots  Propose 16: RAN4 applies only CP-OFDM waveform only for PUSCH requirement with JCE  Propose 17: RAN4 applies the configuration of existing Rel-16 PUSCH requirement with repetition Type A as the starting point.  Propose 18: RAN4 applies the test metric as SNR @70%TP for PUSCH requirement with JCE |
| R4-2204033 | Ericsson | Proposal 1: For PUSCH repetition type A with 32 repetitions, regardless counting repetitions based on physical slot or available slot, no demodulation requirement is defined.  Observation 1: Frequency hopping impact depends on channel condition but not the implementation of BS.  Proposal 2: For type A repetitions for Msg.3, no demodulation requirement is defined.  Proposal 3-1: For PUSCH TBoMS requirement, only CP-OFDM is considered.  Proposal 3-2: For PUSCH TBoMS requirement, frequency hopping is disabled.  Proposal 3-3: For PUSCH TBoMS requirement, repetition is not considered.  Proposal 3-4: For PUSCH TBoMS requirement, following parameters are considered  • MCS#2 (193/1024) in 64QAM MCS table  • RV sequence of {0,2,3,1}  • PUSCH mapping type  o FR1: A and B  o FR2: B  Proposal 3-5: For PUSCH TBoMS requirement, UCI multiplexing is not considered.  Proposal 3-6: For PUSCH TBoMS requirement, following TDD patterns are used:  • 15kHz/120kHz SCS: 3D1S1U, S=10D:2G:2U  • 30kHz SCS: 7D1S2U, S=6D:4G:4U  • 60kHz SCS: DDSU, S=11D:3G:0U  Proposal 3-7: For PUSCH TBoMS requirement, following RB and slot assignments are used:  • 15kHz SCS: 25 RBs and 2 available slots for all channel bandwidths  • 30kHz SCS: 24 RBs and 2 available slots for all channel bandwidths  • 60kHz and 120kHz SCS: 32 RBs and 2 available slots for all channel bandwidths  Proposal 3-8: For PUSCH TBoMS requirement, 1 Tx antenna and 2 Rx antennas are considered.  Proposal 3-9: Take parameters in Table 2-3 and 2-4 for TBoMS requirement.  Proposal 4-1: For PUSCH JCE demodulation requirement, only CP-OFDM is considered.  Proposal 4-2: For PUSCH JCE demodulation requirement, frequency hopping is disabled.  Proposal 4-3: For PUSCH JCE demodulation requirement, only PUSCH repetition type A is considered.  Proposal 4-4: Define new TDD pattern with multiple contiguous UL slots for SCS 15kHz/60kHz/120kHz for PUSCH JCE test.  Proposal 4-5: Define PUSCH JCE requirement for TDD and FDD separately. Test the maximum aTDW length for FDD.  Proposal 4-6: cTDW = aTDW = 2 slots for TDD and cTDW = aTDW = [8] slots for FDD as the start point.  Proposal 4-7: For PUSCH JCE requirement, full bandwidth is used.  Proposal 4-8: For PUSCH JCE requirement, 1 Tx antenna and 2 Rx antennas are considered.  Proposal 4-9: Take parameters in Table 2-5 at least for the requirement PUSCH JCE with 30kHz SCS in FR1  Proposal 5-1: Do not define new demodulation requirement for Redcap UE. |
| R4-2205500 | China Telecom | Proposal 1: Define BS demodulation requirements for PUSCH repetition type A with 32 repetitions, using the following parameters:   Counting based on physical slots and available slots (i.e., UL slots) for FDD and TDD respectively   QPSK 1/3 (MCS 4), 4PRB PUSCH allocation   Inter-slot frequency hopping enabled   DFT-S-OFDM and CP-OFDM   FR1 and FR2  Proposal 2: For the test metric for PUSCH repetition type A with 32 repetitions, use the required SNR at 2% BLER, which is also used in RAN1 phase I verification in TR38.830.  Proposal 3: Use 4 physical/available slots for a TBoMS for FDD/TDD with repetition number of 4 with Inter-slot frequency hopping enabled for TBoMS PUSCH demodulation tests.  Proposal 4: Use narrow PUSCH allocation with either single or non-single PRB allocation.  Proposal 5: Cover 15kHz SCS for TBoMS tests for FR1, and the existing TDD UL-DL pattern, i.e., 3D1S1U, S=10D:2G:2U, can be used as a start point.  Proposal 6: Cover 60kHz and 120kHz SCS for TBoMS tests for FR2, and use TDD UL-DL pattern with more UL slots in the test, e.g., DSUUU.  Proposal 7: Cover both DFT-S-OFDM and CP-OFDM for BS requirements for PUSCH TboMS.  Proposal 8: Use the following parameters for PUSCH TboMS test:  – QPSK 1/3 MCS 4  – Use [0 2 3 1] as the effective RV sequence and further adjust the test parameter based on the repetition number  – Cover both PUSCH mapping type A and type B  Proposal 9: Include SNR point at 2% BLER as a candidate test metric and further decide based on simulation results.  Proposal 10: Use the following parameters for BS PUSCH demod requirements for JCE:   JCE over 2 slots for TDD with available slot based counting, and JCE over 16 slots for FDD   QPSK 1/3 (MCS 4), 4PRB PUSCH allocation   Inter-slot frequency hopping with DMRS bundling disabled for TDD, and enabled for FDD (16\*2=32 repetition for FDD)   Use PUSCH repetition type A   DFT-S-OFDM and CP-OFDM   Cover both FR1 and FR2  Proposal 11: Further decide whether to use 1+0 or 1+1 DMRS symbol based on companies’ simulation results, and select one that achieves larger PUSCH performance gain with JCE compared with PUSCH performance without JCE.  Proposal 12: Include SNR point at 2% BLER as a candidate test metric and further decide based on simulation results.  Proposal 13: Phase error needs also to be modeled in the BS demod test for JCE. Smaller number of phase offset compared to the UE RF requirements should be model in the BS demodulation requirements, and the exact number can be further discussed in the next meeting pending on the inputs from TE side.  Proposal 14: Do not model the power error when defining BS demod requirement. |
| R4-2205489 | Nokia, Nokia Shanghai Bell | Test metric for PUSCH  Proposal 1:Use as evaluation metric the SNR at which the PUSCH achieves 70% of throughput to test PUSCH TBoMS and PUSCH JCE performances.  TB processing over multi-slot PUSCH  Observation 1:The increase from n16 to n32 impacts the BS demodulation performance in a very predictable way that is independent of implementation. New repetition factors can be included in the JCE feature.  Proposal 2:RAN4 to not specify new BS demodulation requirements only for the increased number of Type A repetitions.  TB processing over multi-slot PUSCH  Observation 2:For both single-slot transmission and TBoMS, the number of slots of retransmission could be different from the initial transmission. However, this would not strongly impact the TPUT KPIs. Hence, we should not test this slot number change.  Observation 3:The same RV is used for all slots in the TBoMS scheme and is up counted for repetitions. New RV values can be chosen for HARQ re-transmissions, RAN1 does not give guidance concerning which RV cycling should be used.  Observation 4:In the common use cases for TBoMS, the 1st slot will contain the most systematic bits and the following slots will contain a large portion of the parity bits.  Observation 5:For re-transmissions it is advantageous to always use RV0, to be sure that systematic bits are contained.  Proposal 3:RAN4 to use HARQ re-transmission RV cycling with the pattern [0 0 0 0] and optionally [0 3 0 3].  Proposal 4:TBoMS demod requirements to be specified using 4PRB.  Proposal 5:RAN4 to include both FR1 and FR2 in demod requirements of TBoMS  Proposal 6:RAN4 to specify TBoMS requirements over 8 available slots in FDD and TDD (using the default 7D1S2U, S=6D:4G:4U pattern).  Proposal 7:RAN4 to test TBoMS performance without enabling repetitions.  Proposal 8:RAN4 to consider CP-OFDM only to test TBoMS performance  Observation 6:The UCI on PUSCH multiplexing feature on top of the TBoMS PUSCH feature has some non-trivial performance interactions between the two features. It can be discussed, but priority is lower with respect to other requirements.  Joint channel estimation for PUSCH  Observation 7:To test JCE PUSCH performance, the inter-slot frequency hopping interval and configured cTDW should be defined jointly to ensure an actual aTDW > 1.  Observation 8:In Rel-17 coverage enhancement it was agreed to have a new configuration to set a frequency hopping interval, i.e., it is no longer needed to hop at each slot, which enable aTDW>1 with FH enabled.  Proposal 9:To test PUSCH JCE, the aTDW/slot number should at least be equal to 2  Proposal 10:Use TDD UL/DL pattern 7DSUU.  Proposal 11:Use configured time domain window (cTDW) to be 32 slots.  Proposal 12:Use configured number of repetitions = 8.  Proposal 13:Activate inter-slot frequency hopping, with hopping interval length equal to 2 slots.  Observation 9:In FDD the phase continuity is not repeatedly broken by DL slots and similar JCE gains to TDD can be achieved with smaller cTDW/aTDW lengths.  Proposal 14:Use configured time domain window (cTDW) to be 8  Proposal 15:Use configured number of repetitions = 8.  Proposal 16:Activate inter-slot frequency hopping, with hopping interval 4.  Proposal 17:RAN4 to specify BS demod requirements for JCE PUSCH feature by using large TDRA, e.g., 14 slot PUSCH TDRA with full applicable test bandwidth.  Type A PUSCH repetition for msg3  Observation 10: The implementation of PUSCH Msg3 repetition could simply reuse Rel-16 demodulation implementation of PUSCH up to 16 repetitions cycled over RV sequence.  Proposal 18: RAN4 not to specify new BS demodulation requirements for the introduced PUSCH Msg3 repetitions. |
| R4-2205772 | Huawei, HiSilicon | Proposal 1: Do not define performance requirements enhancements on PUSCH repetition type A.  Proposal 2: For TDD, select 2 consecutive slots for BS requirements for PUSCH TBoMS.  Proposal 3: For FDD, select 4 or 8 consecutive slots for BS requirements for PUSCH TBoMS.  Proposal 4: Do not to consider repetition for TBoMS..  Proposal 5: Select 5 PRB for BS PUSCH demod requirements with JCE.  Proposal 6: Do not consider inter-slot frequency hopping for PUSCH TBoMS.  Proposal 7: Do not consider 15kHz SCS for BS requirements for PUSCH TBoMS.  Proposal 8: Select CP-OFDM only as transform precoding configuration for BS requirements for PUSCH TBoMS.  Proposal 9: Do not to test PUSCH demodulation with UCI multiplexing for TBoMS transmission.  Proposal 10: Select MCS2 for BS requirements for PUSCH TBoMS.  Proposal 11: Select the test SNR at which the PUSCH achieves 70% of throughput as the test metric for BS demodulation requirements for PUSCH TBoMS.  Proposal 12: For TDD, select 2 consecutive slots for BS PUSCH demod with JCE.  Proposal 13: For FDD, select 4 or 8 consecutive slots for BS PUSCH demod with JCE.  Proposal 14: Select configured TDW length same as actual TDW length for BS PUSCH demod with JCE.  Proposal 15: Only consider one typical configuration for BS PUSCH demod requirements with JCE.  Proposal 16: Select 4 PRB for BS PUSCH demod requirements with JCE.  Proposal 17: Do not consider inter-slot frequency hopping for BS PUSCH demod requirements with JCE.  Proposal 18: For 30kHz SCS, select 7D1S2U, S=6D:4G:4U for PUSCH demod requirements with JCE.  Proposal 19: For 15kHz SCS, do not consider BS PUSCH demod requirements with JCE for 15kHz SCS.  Proposal 20: Select CP-OFDM only as transform precoding configuration for BS PUSCH demod requirements with JCE.  Proposal 21: Use configuration of existing Rel-16 PUSCH requirements with repetition Type A as the starting point.  Proposal 22: Select the test SNR at which the PUSCH achieves 70% of throughput as the test metric for BS PUSCH demod requirements with JCE. |
| R4-2205817 | Intel Corporation | Proposal 1: Don’t define the requirements for PUSCH repetition type A with 32 repetitions.  Proposal 2: Consider the following PUSCH test design for verification of TB over Multi Slots:  • 2 physical slots  • No repetitions  • 5 PRBs PUSCH allocation  • Inter-slot frequency hopping is ON  • CP-OFDM only  • Without UCI multiplexing on PUSCH  • FRC: QPSK 1/3, MCS 4  • RV sequence: [0 2 3 1]  • PUSCH mapping type A and type B  • Other parameters are same as for Rel-15 PUSCH tests (Table: 8.2.1.1-1 in 38.104)  • Test metric: Test SNR at which the PUSCH achieves 70% of throughput  Proposal 3: Consider the following PUSCH test design for verification of Joint Channel Estimation:  • Number of slots for JCE: 2 and 4 slots as starting point with further down selection based on results  • PUSCH repetition type A  • 4 PRBs PUSCH allocation  • Inter-slot frequency hopping is OFF  • CP-OFDM only  • MCS 2 and 4 as starting point and make final decision based on simulation results  • PUSCH mapping type A and type B  • Other parameters (DMRS and time domain resource allocation) are same as for Rel-15 PUSCH tests (Table: 8.2.1.1-1 in 38.104)  • Test metric: SNR for 70% of maximum throughput and SNR for 1% BLER as starting point with further down selection based on results  Proposal 4: In case big misalignment will be observed for JCE simulations, consider the following reference receiver for definition of minimum requirements: DMRS symbols from previous (if available) and current slots are used for channel estimation on Data REs at current slot. |
| R4-2206132 | MediaTek Inc. | 1) Why are only up to 8 slots being considered for the BS demod testing, when some companies (including at least 1 BS vendor) have been pushing quite hard to specify up to 32 slots for the UE?  2) Why is a cTDW size not at least as large as the maximum consecutive slot size?  3) Why is non-back to back PUSCH not being considered, when a few companies (including 1 BS vendor) have been pushing very hard to define complex requirements on the UE for such a case?  4) Changing the UE RB allocations has been ruled out since RAN#98-e. So, what does “enabling” inter-slot frequency hopping for PUSCH mean in this context?  5) TDD patterns: Why is a maximum of 2ms of UL consecutive transmissions being considered when companies are asking the UE to support up to 32ms?  6) Given that the whole aim of this feature is to enhance “coverage”. Why is it being questioned as to whether demod requirements should be defined for DFT-s-OFDM?  Proposal 1: We would appreciate answers to the above questions raised on the status, as one would naturally expect the Base Station requirements to follow the UE potential capabilities that are being requested.  Proposal 2: Consider how to take into account the presence of frequency error in the UL signal for BS demodulation |

## Open issues summary

### Sub-topic 1-1: PUSCH repetition type A with 32 repetitions

**Issue 1-1-1: Whether to define BS demodulation requirements for PUSCH repetition type A with 32 repetitions**

* *Status in the last meeting WF (R4-2203030):*
  + *Whether to define BS demodulation requirements for PUSCH repetition type A with 32 repetitions*
    - *Option 1: Yes*
    - *Option 2: No*
* Proposals:
  + Option 1: Yes (China Telecom)
    - CTC: PUSCH repetition type A with 32 repetitions achieves about 10dB lower SNR point than that of 2 repetitions which is the only repetition test we have in RAN4.
  + Option 2: No (Samsung, E///, Nokia, HW, Intel)
* Recommended WF
  + TBA

**Issue 1-1-2: Parameters for BS requirements for PUSCH repetition type A with 32 repetitions (if introduced)**

* *Status in the last meeting WF (R4-2203030):*
  + *Whether to define BS demodulation requirements for PUSCH repetition type A with 32 repetitions*
    - *Option 1: Yes*
    - *Option 2: No*
  + *Parameters for BS requirements for PUSCH repetition type A with 32 repetitions (if introduced)*
    - *Option 1:*

*Counting based on physical slots and available slots (i.e., UL slots) for FDD and TDD respectively*

*QPSK 1/3 (MCS 4), 4PRB PUSCH allocation*

*Inter-slot frequency hopping enabled*

*DFT-S-OFDM and CP-OFDM*

*FR1 and FR2*

* + - *Other options are not precluded*
* Proposals:
  + Option 1: (China Telecom)
    - Counting based on physical slots and available slots (i.e., UL slots) for FDD and TDD respectively
    - QPSK 1/3 (MCS 4), 4PRB PUSCH allocation
    - Inter-slot frequency hopping enabled
    - DFT-S-OFDM and CP-OFDM
    - FR1 and FR2
* Recommended WF
  + Encourage comments

**Issue 1-1-3: Test metric for BS demodulation requirements for PUSCH repetition type A with 32 repetitions (if introduced)**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Test SNR at which the PUSCH achieves 70% of throughput*
  + *Other options are not precluded*
* Proposals:
  + Option 1: The required SNR at 2% BLER (China Telecom)
    - CTC: also used in RAN1 evaluation in TR 38.830, and it is also similar with the existing test metric for PUSCH repetition type A with 2 repetitions
* Recommended WF
  + Encourage comments

### Sub-topic 1-2: PUSCH TB over Multi Slots (TBoMS)

**Issue 1-2-1: Physical/available slots for BS requirements for PUSCH TBoMS**

* *Status in the last meeting WF (R4-2203030):*
  + *For FDD:*
    - *Option 1: 4 physical/available slots*
    - *Option 2: 8 available slots*
    - *Option 3: 2 available slots*
  + *For TDD:*
    - *Option 1: 4 available slots*
    - *Option 2: 2 available slots*
* Proposals:
  + For FDD:
    - Option 1: 4 available slots (Samsung, CTC, HW)
    - Option 2: 8 available slots (HW, Nokia)
    - Option 3: 2 available slots (E///, Intel)
    - ~~Option 4: Over 8 available slots (Nokia)~~
  + For TDD:
    - Option 1: 4 available slots (CTC)
    - Option 2: 2 available slots (Samsung, E///, HW, Intel)

Samsung: the PUSCH requirement with TBoMS for TDD with 2 available slots can be applied for FDD with 2 available slots.

* + - Option 3: ~~Over~~ 8 available slots (Nokia)
* Recommended WF
  + To have unified test setup for FDD and TDD, can we agree to use 2 available slots for FDD and TDD.

**Issue 1-2-2: Repetition number for BS requirements for PUSCH TBoMS**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: 4*
  + *Option 2: Not to consider repetition for TBoMS*
  + *Option 3: FFS after available slot number is agreed*
* Proposals:
  + Option 1: 4 (CTC)
  + Option 2: Not to consider repetition for TBoMS (Samsung, Nokia, HW, Intel)
* Recommended WF
  + Agree option 2?

**Issue 1-2-3: PRB number for BS requirements for PUSCH TBoMS**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Narrow PUSCH allocation*
    - *Option 1A: Single PRB PUSCH allocation*
    - *Option 1B: Non-single PRB allocation, i.e., 5 or 10 PRBs*
  + *Option 2: Full applicable test bandwidth*
  + *Option 3: FFS pending whether frequency hopping should be enabled*
* Proposals:
  + Option 1: Narrow PUSCH allocation (Samsung, Nokia, CTC, HW, Intel)
    - Option 1A: Single PRB PUSCH allocation (CTC)

CTC: Small PRB with high PSD is main use case for TBoMS

Samsung: With single PRB, if multiple slots is configured, the effective coding rate will be very low, which can be comparable with NB-IoT

* + - Option 1B: 4 PRBs (Nokia, CTC)
    - Option 1C: 5 PRBs (HW, CTC, Intel)
  + Option 2: (E///)
    - 15kHz SCS: 25 RBs for all channel bandwidths
    - 30kHz SCS: 24 RBs for all channel bandwidths
    - 60kHz and 120kHz SCS: 32 RBs for all channel bandwidths
* Recommended WF
  + Can we agree using 5 PRBs for BS requirements for PUSCH TBoMS?

**Issue 1-2-4: Inter-slot frequency hopping for BS requirements for PUSCH TBoMS**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Enabled*
  + *Option 2: Disabled*
  + *Option 3: FFS*
* Proposals:
  + Option 1: Enabled (CTC, Intel)
  + Option 2: Disabled (E///, HW)
* Recommended WF
  + TBA

**Issue 1-2-5: TDD UL-DL pattern and test applicability for BS requirements for PUSCH TBoMS**

* *Status in the last meeting WF (R4-2203030):*
  + *For 30kHz SCS:*
    - *7D1S2U, S=6D:4G:4U as starting point*
    - *As baseline, reuse the existing applicability for test requirement for different TDD UL-DL patterns.*
    - *The above sub-bullets can be further updated if technical issues are found*
  + *For 15kHz SCS:*
    - *FFS whether 15kHz SCS will be included*
* Proposals:
  + For FR1 15kHz SCS:
    - Option 1: 3D1S1U, S=10D:2G:2U (E///, CTC)
    - Option 2: No PUSCH requirement with TBoMS for TDD UL-DL pattern as 3D1SU in 15 kHz SCS. (Samsung, HW)
  + For FR1 30kHz SCS:
  + Option 1: 7D1S2U, S=6D:4G:4U (Samsung, E///, Nokia) For FR2 60kHz SCS:
    - Option 1: DDSU, S=11D:3G:0U (E///)
    - Option 2: Use TDD UL-DL pattern with more UL slots in the test, e.g., DSUUU (CTC)
  + For FR2 120kHz SCS:
    - Option 1: 3D1S1U, S=10D:2G:2U (E///)
    - Option 2: Use TDD UL-DL pattern with more UL slots in the test, e.g., DSUUU (CTC)
    - Option3: Use the default 7D1S2U, S=6D:4G:4U pattern (Nokia)
* Recommended WF
  + For FR1 30 kHz SCS, agree on option 1.
  + For other SCSs, encourage more discussion.

**Issue 1-2-6: Transform precoding for BS requirements for PUSCH TBoMS**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Cover both DFT-S-OFDM and CP-OFDM*
  + *Option 2: CP-OFDM only*
  + *Option 3: Prioritize CP-OFDM*
* Proposals:
  + Option 1: Cover both DFT-S-OFDM and CP-OFDM (CTC)
  + Option 2: CP-OFDM only (Samsung, E///, Nokia, HW, Intel)
* Recommended WF
  + Cover CP-OFDM, FFS DFT-S-OFDM

**Issue 1-2-7: Whether to consider UCI multiplexing on PUSCH for TBoMS transmission**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Test PUSCH demodulation with UCI multiplexing for TBoMS transmission*
  + *Option 2: Not to test PUSCH demodulation with UCI multiplexing for TBoMS transmission*
  + *Option 3: FFS*
* Proposals:
  + Option 1: Not to test PUSCH demodulation with UCI multiplexing for TBoMS transmission (Samsung, E///, HW, Intel)
    - Nokia: The UCI on PUSCH multiplexing feature on top of the TBoMS PUSCH feature has some non-trivial performance interactions between the two features. It can be discussed, but priority is lower with respect to other requirements.
* Recommended WF
  + Agree not to test PUSCH demodulation with UCI multiplexing for TBoMS transmission

**Issue 1-2-8: Test requirement for FR1 and FR2 on PUSCH for TBoMS transmission**

* *Agreement in the last meeting WF (R4-2203030):*
  + *Cover both FR1 and FR2*
* Proposals:
  + Option 1: Cover both FR1 and FR2, with applying the existing test applicability rule (Samsung, Nokia)
* Recommended WF
  + Keep the previous agreement on covering both FR1 and FR2, and proponent of option 1 is encourage to further clarify what existing test applicability rule is proposed.

**Issue 1-2-9: MCS for TBoMS PUSCH demod test**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: QPSK 1/3 MCS4*
  + *Option 2: MCS2*
* Proposals:
  + Option 1: MCS4 (QPSK 1/3) in 64QAM MCS table (Table 1) (Samsung, CTC, Intel)
    - Samsung: With TB processing over multi-slot, then effective coding rate is very low.
  + Option 2: MCS2 (QPSK 193/1024) in 64QAM MCS table (Table 1) (E///, HW)
* Recommended WF
  + Agree Option 1 with majority support?

**Issue 1-2-10: RV sequence for TBoMS PUSCH demod test**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: [0 2 3 1]*
  + *Option 2: [0 3 0 3] in case two repetitions will be considered*
  + *Other options are not precluded pending on repetition number*
* Proposals:
  + Option 1: [0 2 3 1] in case no repetition is used (Samsung, E///, CTC, Intel)
    - CTC: RV sequence to be further adjust to ensure the effective sequence is also [0 2 3 1] in case repetition is enabled
  + Option 2: [0 0 0 0] and optionally [0 3 0 3] when no repetition is used (Nokia)
    - Nokia: New RV values can be chosen for HARQ re-transmissions, for re-transmissions it is advantageous to always use RV0, to be sure that systematic bits are contained
* Recommended WF
  + Agree option 1 with majority’s support?

**Issue 1-2-11: PUSCH mapping type for TBoMS PUSCH demod test**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Cover PUSCH mapping type A and type B*
  + *Option 2: Other options are not precluded*
* Proposals:
  + For FR1:
    - Option 1: Cover PUSCH mapping type A and type B (Samsung, E///, CTC, Intel)

Option 1A: Cover PUSCH mapping type A and type B with test applicability rule (Samsung)

* + For FR2:
    - Option 1: Cover PUSCH mapping type A and type B (CTC, Intel)
    - Option 2: Only cover PUSCH mapping type B (E///)
* Recommended WF
  + Check if we can we have the following agreements:
    - Cover PUSCH mapping type A and type B for both FR1 and FR2
    - Reuse the existing applicability rule for different configurations defined in 8.1.2.1.3 in TS 38.141-1 and TS 38.141-2 for FR1 and FR2, respectively.

**Issue 1-2-12: Antenna configuration for TBoMS PUSCH demod test**

* Proposals:
  + Option 1: 1T2R (E///)
* Recommended WF
  + Encourage feedback.

**Issue 1-2-13: Propagation condition for TBoMS PUSCH demod test**

* Proposals:
  + Option 1: TDLB100-400 Low for FR1 and TDLA30-300 Low for FR2 (E///)
* Recommended WF
  + Encourage feedback.

**Issue 1-2-14: Test metric for TBoMS PUSCH demod test**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Test SNR at which the PUSCH achieves 70% of throughput*
  + *Other options are not precluded*
* Proposals:
  + Option 1: Test SNR at which the PUSCH achieves 70% of throughput (Samsung, E///, Nokia, HW, Intel)
    - Samsung: For TBoMS feature, the design purpose is not to achieve high reliable probability.
  + Option 2: Include SNR point at 2% BLER as a candidate test metric and further decide based on simulation results (CTC)
* Recommended WF
  + TBA

**Issue 1-2-15: Other parameters for BS requirements for PUSCH TBoMS**

* *Status in the last meeting WF (R4-2203030):*
  + *Cover both FR1 and FR2*
  + *For other parameters, use the parameters in the following table as starting point*

|  |  |  |
| --- | --- | --- |
| *Parameter* | | *Value* |
| *HARQ* | *Maximum number of HARQ transmissions* | *4* |
| *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* |  |  |
| *Start symbol* | *0* |
| *Allocation length* | *14* |
| *Code block group based PUSCH transmission* | | *Disabled* |

* Proposals:
  + Proposal 1: (E///)
    - Test parameters for TBoMS in FR1: Same with the agreed start point parameters listed above
    - Test parameters for TBoMS in FR2:

|  |  |  |
| --- | --- | --- |
| Parameter | | Value |
| HARQ | Maximum number of HARQ transmissions | 4 |
| DM-RS | DM-RS configuration type | 1 |
|  | DM-RS duration | single-symbol DM-RS |
|  | Additional DM-RS symbols | pos0, pos1 |
|  | Number of DM-RS CDM group(s) without data | 2 |
|  | Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB |
|  | DM-RS port(s) | {0} |
|  | DM-RS sequence generation | NID=0, nSCID =0 |
| Time domain | PUSCH mapping type | B |
| resource | Start symbol index | 0 |
| Allocation length | 10 |
| PT-RS | Frequency density (*KPT-RS*) | 2, Disabled |
| configuration | Time density (*LPT-RS*) | 1, Disabled |

* + Proposal 2 (Intel): Other parameters are same as for Rel-15 PUSCH tests (Table: 8.2.1.1-1 in 38.104)
* Recommended WF
  + Encourage feedback on the test parameter proposal for FR2.

### Sub-topic 1-3: PUSCH demodulation with Joint Channel Estimation (JCE)

**Issue 1-3-1: Actual TDW length for JCE in BS PUSCH demod requirements**

* *Status in the last meeting WF (R4-2203030):*
  + *For TDD* 
    - *Option 1: 2 consecutive slots*
    - *Other options are not precluded*
  + *For FDD*
    - *Option 1: 2 consecutive slots*
    - *Option 2: more than 2 consecutive slots*
    - *Option 3: 4 consecutive slots*
    - *Option 4: 8 consecutive slots*
    - *Other options are not precluded*
  + *Note: Slot number refers to the actual TDW number*
* Proposals:
  + For TDD
    - Option 1: 2 consecutive slots (Samsung, E///, Nokia, CTC, HW)

Samsung: the PUSCH requirement with JCE for TDD with 2 available slots can be applied for FDD with 2 available slots

* + - Option 2: 2 and 4 slots as starting point with further down selection based on results (Intel)
  + For FDD
    - Option 1: 2 consecutive slots (Samsung)
    - Option 2: 4 consecutive slots (Samsung, Nokia, HW)
    - Option 3: Test the maximum aTDW length, i.e., 8 slots (E///, HW)
    - Option 4: 16 consecutive slots (CTC, [MTK])

MTK: Some companies (including at least 1 BS vendor) have been pushing quite hard to specify up to 32 slots for the UE?

* + - Option 5: 2 and 4 slots as starting point with further down selection based on results (Intel)
* Recommended WF
  + Can we agree using aTDW length of 2 slots for TDD?
  + Further discussion is needed for FDD case.

**Issue 1-3-2: Configured TDW number for JCE in BS PUSCH demod requirements**

* *Status in the last meeting WF (R4-2203030):*
  + *For TDD* 
    - *Option 1: 4 slots*
    - *Other options are not precluded*
  + *For FDD*
    - *Option 1: 4 slots*
    - *Other options are not precluded*
* Proposals:
  + For TDD
    - Option 1: cTDW length is configured same as the aTDW length (Samsung, E///, HW)

Moderator’s note: based on available slot counting?

* + - Option 2: Use configured time domain window (cTDW) to be 32 slots (Nokia)

MTK: Why is a cTDW size not at least as large as the maximum consecutive slot size

* + For FDD
    - Option 1: cTDW length is configured same as the aTDW length (Samsung, E///, HW)
    - Option 2: Use configured time domain window (cTDW) to be 8 slots (Nokia)
* Recommended WF
  + TBA

**Issue 1-3-3: PUSCH repetition type for BS PUSCH demod requirements with JCE**

* *Status in the last meeting WF (R4-2203030):*
  + *Agree to use Back-to-back PUSCH transmissions*
  + *Repetition Type will be further discussed*
* Proposals:
  + Option 1: RAN4 apply repetition type A for requirement with JCE (Samsung, E///, CTC, Intel, [HW])
    - HW: Only consider one typical repetition type
    - MTK: Why is non-back to back PUSCH not being considered, when a few companies (including 1 BS vendor) have been pushing very hard to define complex requirements on the UE for such a case?
* Recommended WF
  + Can we agree RAN4 only apply repetition type A for requirement with JCE?

**Issue 1-3-4: PUSCH repetition number for BS PUSCH demod requirements with JCE**

* Proposals:
  + Option 1: the same as aTDW length for JCE (CTC, E///)
  + Option 2: 8 for TDD and 8 for FDD (Nokia)
* Recommended WF
  + TBA

**Issue 1-3-5: PRB number for BS PUSCH demod requirements with JCE**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: 4 PRB*
  + *Option 2: Full applicable test bandwidth*
* Proposals:
  + Option 1: 4 PRB (CTC, HW, Intel)
  + Option 2: Full applicable test bandwidth (Samsung, E///, Nokia)
    - Samsung: With large number of PRB, the channel estimation performance can be improved
    - E///: Align with the existing PUSCH related tests.
* Recommended WF
  + TBA

**Issue 1-3-6: Inter-slot frequency hopping for BS PUSCH demod requirements with JCE**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Enabled*
  + *Option 2: Disabled*
* Proposals:
  + Option 1: Enabled with hopping with interval length equal to 2 slots for TDD and 4 for FDD (Nokia)
    - Nokia: RAN1 agreed to have a new configuration to set a frequency hopping interval, i.e., it is no longer needed to hop at each slot, which enable aTDW>1 with FH enabled
  + Option 2: Disabled for TDD and FDD (Samsung, E///, HW, Intel)
    - E///: Frequency hopping is an event of violating power consistency and phase continuity
  + Option 3: Disabled for TDD, and enabled for FDD (CTC)
* Recommended WF
  + Can we agree option 2 with majority’s support?

**Issue 1-3-7: TDD UL-DL pattern for BS PUSCH demod requirements with JCE**

* *Status in the last meeting WF (R4-2203030):*
  + *For 30KHz SCS*
    - *Option 1: 7D1S2U, S=6D:4G:4U*
    - *Option 2: Depend on the slot number for JCE*
  + *For 15KHz SCS*
    - *Option 1: Reuse the pattern in the spec, i.e., 3D1S1U, S=10D:2G:2U*
    - *Option 2: Consider other TDD patterns*
* Proposals:
  + For FR1 15KHz SCS
    - Option 1: Define new TDD pattern with multiple contiguous UL slots (E///)
    - Option 2: No PUCCH requirement with JCE for TDD UL-DL pattern as 3D1SU in 15 KHz SCS. (Samsung, HW)

Samsung: For TDD pattern 3D1S1U in 15 KHz SCS, DMRS bundling is not feasible.

* + For FR1 30kHz SCS:
    - Option 1: 7D1S2U, S=6D:4G:4U (Samsung, E///, Nokia, HW)
  + MTK: Why is a maximum of 2ms of UL consecutive transmissions being considered when companies are asking the UE to support up to 32ms?For FR2 60/120 kHz SCS:
    - Option 1: Define new TDD pattern with multiple contiguous UL slots (E///)
* Recommended WF
  + For FR1 15 kHz SCS: further discuss
  + For FR1 30 kHz SCS: agree option 1?
  + For FR2 60/120 kHz SCS: agree option 1, and inputs on the candidate new TDD patterns are encouraged.

**Issue 1-3-8: Transform precoding for BS PUSCH demod requirements with JCE**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Cover both DFT-s-OFDM and CP-OFDM*
  + *Option 2: CP-OFDM only*
  + *Option 3: Prioritize CP-OFDM*
  + *Option 4: FFS whether DFT-s-OFDM should be included*
* Proposals:
  + Option 1: Cover both DFT-S-OFDM and CP-OFDM (CTC, [MTK])
  + Option 2: CP-OFDM only (Samsung, E///, Nokia, HW, Intel)
* Recommended WF
  + Include CP-OFDM, FFS on DFT-S-OFDM

**Issue 1-3-9: MCS for BS PUSCH demod requirements with JCE**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: QPSK 1/3 MCS 4*
  + *Option 2: MCS2*
  + *Option 3: Use configuration of existing Rel-16 PUSCH requirements with repetition Type A as the starting point*
* Proposals:
  + Option 1: QPSK 1/3 MCS 4 (CTC, Intel)
  + Option 2: MCS2 (Intel)
  + Option 3: Use configuration of existing Rel-16 PUSCH requirements with repetition Type A as the starting point, i.e., QPSK 99/1024 MCS 5 in MCS Table 3 (Samsung, HW)
* Recommended WF
  + TBA

**Issue 1-3-10: Propagation condition for BS PUSCH demod requirements with JCE**

* Proposals:
  + Option 1: TDLB100-400 Low for FR1 (E///)
* Recommended WF
  + Encourage feedback

**Issue 1-3-11: Antenna configuration for BS PUSCH demod requirements with JCE**

* Proposals:
  + Option 1: 1T2R for FR1 (E///)
* Recommended WF
  + Encourage feedback

**Issue 1-3-12: Frequency range coverage for BS PUSCH demod requirements with JCE**

* Proposals:
  + Option 1: Cover both FR1 and FR2 (CTC)
* Recommended WF
  + Encourage feedback

**Issue 1-3-13: PUSCH mapping type for BS PUSCH demod requirements with JCE**

* Proposals:
  + Option 1: Cover PUSCH mapping type A and type B for FR1 (Intel, E///, Samsung, HW)
* Recommended WF
  + Cover PUSCH mapping type A and type B for FR1
  + Further discuss for FR2

**Issue 1-3-14: Additional DM-RS position for BS PUSCH demod requirements with JCE**

* Proposals:
  + Option 1: DMRS 1+1 (E///)
  + Option 2: Decide whether to use 1+0 or 1+1 DMRS symbol based on companies’ simulation results, and select one that achieves larger PUSCH performance gain with JCE compared with PUSCH performance without JCE. (CTC)
* Recommended WF
  + Can we agree option 2 for initial simulation purpose?

**Issue 1-3-15: Phase and power offset modelling for BS PUSCH demod requirements with JCE**

* Proposals:
  + Phase offset model:
    - Proposal 1: Model smaller number of phase offset compared to the UE RF requirements in the BS demodulation requirements, and the exact number can be further discussed in the next meeting pending on the inputs from TE side (CTC)
    - Proposal 2: Consider how to take into account the presence of frequency error in the UL signal for BS demodulation, as part of the channel estimation (MTK)
  + Power offset model
    - Option 1: Do not model the power error when defining BS demod requirement. (CTC)

CTC: Power offset has marginal impact on the link simulation results

* Recommended WF
  + Encourage feedback

**Issue 1-3-16: Receiver implementation for BS PUSCH demod requirements with JCE**

* Proposals:
  + Option 1: In case big misalignment will be observed for JCE simulations, consider the following reference receiver for definition of minimum requirements: DMRS symbols from previous (if available) and current slots are used for channel estimation on Data REs at current slot. (Intel)
* Recommended WF
  + Encourage feedback

**Issue 1-3-17: Test metric for BS PUSCH demod requirements with JCE**

* *Status in the last meeting WF (R4-2203030):*
  + *Option 1: Test SNR at which the PUSCH achieves 70% of throughput*
  + *Other options are not precluded*
* Proposals:
  + Option 1: Test SNR at which the PUSCH achieves 70% of throughput (Samsung, E///, Nokia, HW)
  + Option 2: Include SNR point at a certain BLER as a candidate test metric and further decide based on simulation results (CTC, Intel)
    - Option 2A: SNR point at 2% BLER (CTC)
    - Option 2B: SNR point at 1% BLER (Intel)
* Recommended WF
  + Can we agree to use both option 1 and 2B for initial simulation purpose, and make decision on the test metric in the next meeting?

**Issue 1-3-18: Other parameters for BS PUSCH demod requirements with JCE**

* Proposals:
  + Proposal 1: Use configuration of existing Rel-16 PUSCH requirements with repetition Type A as the starting point (Samsung, HW)
  + Proposal 2: Other parameters (DMRS and time domain resource allocation) are same as for Rel-15 PUSCH tests (Intel)
  + Proposal 3: (E///)

|  |  |  |
| --- | --- | --- |
| Parameter | | Value |
| HARQ | Maximum number of HARQ transmissions | 4 |
| RV sequence | 0, 3, 0, 3 for TDD  0, 0, 0, 0 for FDD |
| DM-RS | DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| 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 | Start symbol | 0 |
| Resource allocation | Allocation length | 14 |
| Code block group based PUSCH transmission | | Disabled |

* + Proposal 4: Use large TDRA, e.g., 14 slot PUSCH TDRA (Nokia)
* Recommended WF
  + Check whether parameters in Proposal 2 can be agreed as a start point.

### Sub-topic 1-4: PUSCH Enhancements for Type A PUSCH repetitions for Msg3

**Issue 1-4-1: Whether to define PUSCH demodulation requirements for Msg3 repetition**

* *Status in the last meeting discussion summary (R4-2203117):*
  + Option 1: Consider type A PUSCH repetition for Msg 3 with inter-slot frequency hopping requirement, FFS on requirement with intra-slot frequency hopping
  + Option 2: No
* Proposals:
  + Option 1: Not to consider type A PUSCH repetition for Msg 3 with inter-slot frequency hopping requirement, FFS on requirement with intra-slot frequency hopping (E///, Nokia)
* Recommended WF
  + Not to consider type A PUSCH repetition for Msg 3 with inter-slot frequency hopping requirement
  + Discuss further to consider requirement with intra-slot frequency hopping

### Sub-topic 1-5: Redcap BS demodulation for NR coverage enhancement demodulation

**Issue 1-5-1: Whether to new BS demodulation requirement for Redcap UE**

* Proposals:
  + Option 1: Do not define new BS demodulation requirement for Redcap UE (E///)
* Recommended WF
  + Encourage feedback.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | Sub-topic 1-1: PUSCH repetition type A with 32 repetitions  **Issue 1-1-1: Whether to define BS demodulation requirements for PUSCH repetition type A with 32 repetitions**  **Issue 1-1-2: Parameters for BS requirements for PUSCH repetition type A with 32 repetitions (if introduced)**  **Issue 1-1-3: Test metric for BS demodulation requirements for PUSCH repetition type A with 32 repetitions (if introduced)**  Sub-topic 1-2: PUSCH TB over Multi Slots (TBoMS)  **Issue 1-2-1: Physical/available slots for BS requirements for PUSCH TboMS**  **Issue 1-2-2: Repetition number for BS requirements for PUSCH TBoMS**  **Issue 1-2-3: PRB number for BS requirements for PUSCH TBoMS**  **Issue 1-2-4: Inter-slot frequency hopping for BS requirements for PUSCH TBoMS**  **Issue 1-2-5: TDD UL-DL pattern and test applicability for BS requirements for PUSCH TBoMS**  **Issue 1-2-6: Transform precoding for BS requirements for PUSCH TBoMS**  **Issue 1-2-7: Whether to consider UCI multiplexing on PUSCH for TBoMS transmission**  **Issue 1-2-8: Test requirement for FR1 and FR2 on PUSCH for TBoMS transmission**  **Issue 1-2-9: MCS for TBoMS PUSCH demod test**  **Issue 1-2-10: RV sequence for TBoMS PUSCH demod test**  **Issue 1-2-11: PUSCH mapping type for TBoMS PUSCH demod test**  **Issue 1-2-12: Antenna configuration for TBoMS PUSCH demod test**  **Issue 1-2-13: Propagation condition for TBoMS PUSCH demod test**  **Issue 1-2-14: Test metric for TBoMS PUSCH demod test**  **Issue 1-2-15: Other parameters for BS requirements for PUSCH TBoMS** Sub-topic 1-3: PUSCH demodulation with Joint Channel Estimation (JCE) **Issue 1-3-1: Actual TDW length for JCE in BS PUSCH demod requirements**  **Issue 1-3-2: Configured TDW number for JCE in BS PUSCH demod requirements**  **Issue 1-3-3: PUSCH repetition type for BS PUSCH demod requirements with JCE**  **Issue 1-3-4: PUSCH repetition number for BS PUSCH demod requirements with JCE**  **Issue 1-3-5: PRB number for BS PUSCH demod requirements with JCE**  **Issue 1-3-6: Inter-slot frequency hopping for BS PUSCH demod requirements with JCE**  **Issue 1-3-7: TDD UL-DL pattern for BS PUSCH demod requirements with JCE**  **Issue 1-3-8: Transform precoding for BS PUSCH demod requirements with JCE**  **Issue 1-3-9: MCS for BS PUSCH demod requirements with JCE**  **Issue 1-3-10: Propagation condition for BS PUSCH demod requirements with JCE**  **Issue 1-3-11: Antenna configuration for BS PUSCH demod requirements with JCE**  **Issue 1-3-12: Frequency range coverage for BS PUSCH demod requirements with JCE**  **Issue 1-3-13: PUSCH mapping type for BS PUSCH demod requirements with JCE**  **Issue 1-3-14: Additional DM-RS position for BS PUSCH demod requirements with JCE**  **Issue 1-3-15: Phase and power offset modelling for BS PUSCH demod requirements with JCE**  **Issue 1-3-16: Receiver implementation for BS PUSCH demod requirements with JCE**  **Issue 1-3-17: Test metric for BS PUSCH demod requirements with JCE**  **Issue 1-3-18: Other parameters for BS PUSCH demod requirements with JCE**  Sub-topic 1-4: PUSCH Enhancements for Type A PUSCH repetitions for Msg3  **Issue 1-4-1: Whether to define PUSCH demodulation requirements for Msg3 repetition**  Sub-topic 1-5: Redcap BS demodulation for NR coverage enhancement demodulation  **Issue 1-5-1: Whether to new BS demodulation requirement for Redcap UE** |
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## Summary for 1st round

### Open issues

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| --- | --- |
|  | **Status summary** |
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## Discussion on 2nd round

# Topic #2: PUCCH Enhancements of Rel-17 NR Coverage Enhancement

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2203553 | Samsung | Propose 1: RAN4 apply the existing test metric for PUCCH requirement with joint channel estimation, if agreed to introduce.  Propose 2: Further discuss the necessity of requirement of PUCCH with JCE  Propose 3: if RAN4 agreed to introduce PUCCH requirement with joint channel estimation, format 1 or format 3 can be considered  Propose 4: if RAN4 agreed to introduce PUCCH requirement with joint channel estimation, 2 consecutive slots for TDD and FDD can be considered.  Propose 5: if RAN4 agreed to introduce PUCCH requirement with joint channel estimation, apply existing test parameters specified in Rel-15 for PUCCH requirement with JCE as starting point. The details can be further discussed pending on the agreed PUCCH format. Disable inter-slot and intra-slot hopping with DMRS bundling. |
| R4-2204034 | Ericsson | Proposal 1: The demodulation requirement for multi-slot PUCCH with JCE should be defined.  Observation 1: FR2 PUCCH is performance bottleneck only in O2I scenario according to TR38.830.  Observation 2: There is no available FR2 TDD pattern for PUCCH JCE.  Proposal 2: Only define FR1 PUCCH JCE demodulation requirement.  Proposal 3: For PUCCH JCE demodulation requirement, frequency hopping is disabled.  Proposal 4: For defining the demodulation requirement for PUCCH JCE, PUCCH format 1 and 3 can be considered.  Proposal 5: For PUCCH JCE demodulation requirement, use the same cTDW and aTDW configuration as PUSCH JCE requirement.  Proposal 6: Take following parameters for PUCCH JCE requirement. |
| R4-2205490 | Nokia, Nokia Shanghai Bell | PUCCH formats  Proposal 1:RAN4 to specify BS demod requirements for PUCCH DMRS bundling for formats 1 and 3.  Test metric  Proposal 2:Use as evaluation metric for PUCCH format 3 requirements UCI block error probability. Format 1 shall use NACK to ACK detection probability and ACK missed detection probability  Test parameters for TDD  Observation 1:For PUCCH DMRS bundling, FH is commonly configured, and cTDW needs to be chosen rather larger than the repetition factor due to the different slot counting methods.  Proposal 3:Use TDD UL/DL pattern 7DSUU.  Proposal 4:Use configured time domain window (cTDW) to be 32 slots.  Proposal 5:Use configured number of repetitions = 8.  Proposal 6:Activate inter-slot frequency hopping, with hopping interval length equal to 2 slots.  Test parameters for FDD  Observation 2:In FDD the phase continuity is not repeatedly broken by DL slots and similar JCE gains to TDD can be achieved with smaller cTDW/aTDW lengths.  Proposal 7: Use configured time domain window (cTDW) to be 8  Proposal 8:Use configured number of repetitions = 8.  Proposal 9:Activate inter-slot frequency hopping, with hopping interval 4.  Other test parameters  Proposal 10:For PUCCH format 3, use 1 PRB allocation, 14 OFDM symbols, and [16] bits payload. Intra-slot FH shall be disabled. Requirements shall be applicable to both FR1 and FR2.  Proposal 12:For PUCCH format 1, use 14 OFDM symbols, and 2 bits payload. Intra-slot FH shall be disabled. Requirements shall be applicable to both FR1 and FR2. |
| R4-2205501 | China Telecom | Proposal 1: Define BS PUCCH demodulation requirements with JCE.  Proposal 2: Use the following parameters for PUCCH demodulation requirements for JCE:   JCE over 2 slots for TDD, and JCE over 8 slots for FDD   11 or 22 bits for PUCCH format 3, 2 bits for PUCCH format 1   1 PRB allocation and 14 OFDM symbols for PUCCH format 1 and format 3   Inter-slot frequency hopping with DMRS bundling disabled for TDD and FDD   FR1 and FR2  Proposal 3: Use the same phase and power offset model as defined in PUSCH demodulation test with JCE. |
| R4-2205773 | Huawei, HiSilicon | Proposal 1: Do not define BS PUCCH demodulation requirements with JCE. |
| R4-2205818 | Intel Corporation | Proposal 1: Define BS PUCCH demodulation requirements with Joint Channel Estimation.  Proposal 2: Consider the following PUCCH test design for verification of Joint Channel Estimation:  • Format 1 and 3  • Number of slots for JCE: 2 and 4 slots as starting point with further down selection based on results  • Test parameters  o Format 1: Payload 2 bits, 14 symbols  o Format 3: Payload 16 bits, 14 symbols, 1 PRB, With additional DMRS  • Test metric  o Format 1: NACK to ACK and ACK missed detection  o Format 3: UCI block error probability |

## Open issues summary

### Sub-topic 2-1: General

**Issue 2-1-1: Test metric for BS PUCCH demodulation test cases**

* *Status in the last meeting WF (R4-2203031):*
  + *Option 1*
    - *Test UCI block error probability for PUCCH format 2/3/4*
    - *Test NACK to ACK detection probability for PUCCH format 1*
  + *Option 2: Reusing the existing test metric for different PUCCH formats can be reused as a baseline*
  + *Option 3: FFS*
* Proposals:
  + Option 1: For PUCCH format 1 and format 3, reuse the existing test metric for different PUCCH formats can be reused as a baseline (Samsung, ~~Nokia,~~ Intel)
    - Test UCI block error probability for PUCCH format 3
    - Test NACK to ACK detection probability for PUCCH format 1
  + Option 2: For PUCCH format 1 and format 3, reuse the existing test metric for different PUCCH formats can be reused as a baseline (Nokia)
    - Test UCI block error probability for PUCCH format 3
    - Test NACK to ACK detection probability and ACK missed detection probability for PUCCH format 1
* Recommended WF
  + Check if we can use option 1?

### Sub-topic 2-2: PUCCH demodulation with Joint Channel Estimation (JCE)

**Issue 2-2-1: Whether to define BS PUCCH demodulation requirements with JCE**

* *Status in the last meeting WF (R4-2203031):*
  + *Option 1: Yes*
  + *Option 2: No*
  + *Option 3: FFS after the finalization of core requirements in RAN1 and RAN4*
* Proposals:
  + Option 1: Yes (E///, Nokia, CTC, Intel)
  + Option 2: No (HW)
  + Option 3: FFS the necessity of requirement of PUCCH with JCE (Samsung)
* Recommended WF
  + TBA

**Issue 2-2-2: PUCCH format for BS PUCCH demodulation requirements with JCE (if introduced)**

* *Status in the last meeting WF (R4-2203031):*
  + *Option 1: Format 3*
  + *Option 2: Format 1, 2,3,4*
  + *Option 3: Format 1*
  + *Option 4: Format 1 and Format 2 or 3 or 4*
  + *Option 5: Format 1 and 3*
* Proposals:
  + Option 1: Format 1 or format 3 (Samsung)
    - Samsung, ~~Nokia,~~ Intel: As per RAN1 agreement, PUCCH DMRS bundling is not supported for PUCCH format 0/2.
  + Option 2: Format 1 and format 3 (E///, Nokia, CTC, Intel)
* Recommended WF
  + In case BS PUCCH demodulation requirements with JCE is introduced, can we cover both format 1 and format 3 based on majorities’ view?

**Issue 2-2-3: Actual TDW length for JCE in BS PUCCH demod requirements (if introduced)**

* *Status in the last meeting WF (R4-2203031):*
  + *For TDD*
    - *Option 1: 2 consecutive slots*
    - *Option 2: 4 slots within the configured TDW*
    - *Option 3: Depending on the Slot number for JCE in BS PUSCH*
  + *For FDD*
    - *Option 1: 2 consecutive slots*
    - *Option 2: more than 2 consecutive slots*
    - *Option 3: 4*
    - *Option 4: 8*
    - *Option 5: Depending on the Slot number for JCE in BS PUSCH*
  + *Note: slot number refers to the actual TDW length*
* Proposals:
  + For TDD
    - Option 1: 2 consecutive slots (Samsung, Nokia, CTC, [E///])
    - Option 2: Follow the Slot number for JCE in BS PUSCH (E///)
    - Option 3: 2 and 4 slots as starting point with further down selection based on results (Intel)
  + For FDD
    - Option 1: 2 consecutive slots (Samsung)
    - Option 2: Follow the Slot number for JCE in BS PUSCH (E///)
    - Option 3: 4 consecutive slots (Nokia, Intel)
    - Option 4: 8 slots (CTC)

MTK: some companies (including at least 1 BS vendor) have been pushing quite hard to specify up to 32 slots for the UE

* + - Option 5: 2 and 4 slots as starting point with further down selection based on results (Intel)
* Recommended WF
  + In case BS PUCCH demodulation requirements with JCE is introduced
    - Can we agree using aTDW length of 2 for TDD?
    - Further discussion is needed for FDD case.

**Issue 2-2-4: Configured TDW length for JCE in BS PUCCH demod requirements (if introduced)**

* Proposals:
  + For TDD
    - Option 1: 32 slots (Nokia)
  + For FDD
    - Option 1: 8 slots (Nokia)
* Recommended WF
  + TBA

**Issue 2-2-5: Number of repetitions for BS PUCCH demodulation requirements with JCE (if introduced)**

* Proposals:
  + Option 1: 8 for FDD and TDD (Nokia)
  + Option 2: 2 (E///)
* Recommended WF
  + TBA

**Issue 2-2-6: Frequency hopping for BS PUCCH demodulation requirements with JCE (if introduced)**

* Proposals:
  + Intra-slot frequency hopping:
    - Option 1: Disabled (Samsung. E///, Nokia)
  + Inter-slot frequency hopping:
    - Option 1: Disabled (Samsung. E///, CTC)
    - Option 2: Activate inter-slot frequency hopping, with inter-slot hopping interval length 2 for TDD and 4 for FDD (Nokia)
* Recommended WF
  + Intra-slot frequency hopping: Disabled
  + Inter-slot frequency hopping: Disabled?

**Issue 2-2-7: TDD UL-DL pattern for BS PUCCH demodulation requirements with JCE (if introduced)**

* Proposals:
  + Option 1: Use 7DSUU (Nokia)
* Recommended WF
  + Same as PUSCH JCE demod requirements?

**Issue 2-2-8: Frequency range coverage for BS PUCCH demodulation requirements with JCE (if introduced)**

* Proposals:
  + Option 1: Only cover FR1 (E///)
    - E///: 1) FR2 PUCCH is performance bottleneck only in O2I scenario according to TR38.830. 2) here is no available FR2 TDD pattern for PUCCH JCE.
  + Option 2: Cover both FR1 and FR2 (Nokia, CTC)
* Recommended WF
  + Encourage feedback

**Issue 2-2-9: Phase and power offset modelling for BS PUCCH demod requirements with JCE (if introduced)**

* Proposals:
  + Phase offset model:
    - Proposal 1: Aligned with the JCE test modelling for PUSCH (CTC)
  + Power offset model
    - Proposal 1: Aligned with the JCE test modelling for PUSCH (CTC)
* Recommended WF
  + Encourage feedback

**Issue 2-2-10: Bit payload for BS PUCCH demodulation requirements with JCE (if introduced)**

* Proposals:
  + PUCCH format 1:
    - Option 1: 2 bits (CTC, E///, Nokia, Intel, Samsung)
  + PUCCH format 3:
    - Option 1: 11 or 22 bits (CTC)
    - Option 2: 22 bits (E///, CTC)
    - Option 3: 16 bits (Nokia, Intel, Samsung)
* Recommended WF
  + In case BS PUCCH demodulation requirements with JCE is introduced:
    - Can we agree with using 2 bits for PUCCH format 1?
    - For PUCCH format 3, can we agree to use option 3 of 16 bits, which is in the middle of option 1 and 2, and supported by majority companies

**Issue 2-2-11: Resource allocation for BS PUCCH demodulation requirements with JCE (if introduced)**

* Proposals:
  + PUCCH format 1:
    - Option 1: 14 symbols, 1 PRB (Intel, ~~[~~Nokia~~]~~, E///, CTC, Samsung)
  + PUCCH format 3:
    - Option 1: 14 symbols, 1 PRB (Intel, E///, Nokia, CTC)
* Recommended WF
  + In case BS PUCCH demodulation requirements with JCE is introduced:
    - Can we agree with using 14 symbols, 1 PRB for both PUCCH format 1 and format 3?

**Issue 2-2-12: Other parameters for BS PUCCH demodulation requirements with JCE (if introduced)**

* *Status in the last meeting WF (R4-2203031):*
  + *Option 1:* 
    - *11 or 22 bits for PUCCH format 3*
    - *1 PRB allocation and 14 OFDM symbols*
    - *Inter-slot frequency hopping with DMRS bundling*
    - *FR1 and FR2*
  + *Option 2: Use legacy configuration as starting point but disable intra-slot frequency hopping to allow for DM-RS bundling.*
  + *Option 3: Consider test configuration of existing multi-slot PUCCH requirements as the starting point*
* Proposals:
  + Proposal 1: Apply existing test parameters specified in Rel-15 for PUCCH requirement with JCE as starting point (Samsung)
  + Proposal 2: (E///)

Table 2-1: Test Parameters for PUCCH JCE format 1

|  |  |
| --- | --- |
| Parameter | Test |
| First PRB prior to frequency hopping | 0 |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 0 |
| Index of orthogonal cover code (*timeDomainOCC*) | 0 |

Table 2-2: Test Parameters for FR1 PUCCH JCE format 3

|  |  |
| --- | --- |
| Parameter | Test |
| Modulation order | QPSK |
| First PRB prior to frequency hopping | 0 |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| First symbol | 0 |

* + Proposal 3: (Nokia)
    - Use Rel-15 PUCCH format 3 SCS, CBW, tx/rx antenna numbers, number of DM-RS per slot, and channel model, as starting point for further discussion.
    - Use Rel-15 PUCCH format 1 SCS, CBW, tx/rx antenna numbers, and channel model, as starting point for further discussion.
* Recommended WF
  + Encourage feedback.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | Sub-topic 2-1: General  **Issue 2-1-1: Test metric for BS PUCCH demodulation test cases**  Sub-topic 2-2: PUCCH demodulation with Joint Channel Estimation (JCE)  **Issue 2-2-1: Whether to define BS PUCCH demodulation requirements with JCE**  **Issue 2-2-2: PUCCH format for BS PUCCH demodulation requirements with JCE (if introduced)**  **Issue 2-2-3: Actual TDW length for JCE in BS PUCCH demod requirements (if introduced)**  **Issue 2-2-4: Configured TDW length for JCE in BS PUCCH demod requirements (if introduced)**  **Issue 2-2-5: Number of repetitions for BS PUCCH demodulation requirements with JCE (if introduced)**  **Issue 2-2-6: Frequency hopping for BS PUCCH demodulation requirements with JCE (if introduced)**  **Issue 2-2-7: TDD UL-DL pattern for BS PUCCH demodulation requirements with JCE (if introduced)**  **Issue 2-2-8: Frequency range coverage for BS PUCCH demodulation requirements with JCE (if introduced)**  **Issue 2-2-9: Phase and power offset modelling for BS PUCCH demod requirements with JCE (if introduced)**  **Issue 2-2-10: Bit payload for BS PUCCH demodulation requirements with JCE (if introduced)**  **Issue 2-2-11: Resource allocation for BS PUCCH demodulation requirements with JCE (if introduced)**  **Issue 2-2-12: Other parameters for BS PUCCH demodulation requirements with JCE (if introduced)** |
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## Summary for 1st round

### Open issues

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|  | **Status summary** |
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## Discussion on 2nd round

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
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| **Title** | **Source** | **Comments** |
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**Existing tdocs**

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| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
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Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tdoc number | Title | Source | Recommendation | Comments |
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Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)