

[101-bis-e][319] NR_cov_enh_Demod_NWM - Version 0.0.3
RAN4

3GPP TSG-RAN WG4 Meeting # 101-bis-e R4-2202975

Electronic Meeting, Jan 17 - 25, 2022

Agenda item: 6.18.3

Source: Moderator (China Telecom)

Title: Email discussion summary for [101-bis-e][319] NR_cov_enh_Demod_NWM

Document for: Information

Introduction

This email thread discusses the demodulation part of the Rel-17 NR coverage enhancement WI in agenda 6.18.3.

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

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

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

1.1 Companies' contributions summary

Table 1:

T-doc number	Company	Proposals / Observations
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R4-2200025	China Telecom	<p>1) BS demodulation impact for PUSCH enhancements For Enhancements on PUSCH repetition type A: Observation 1: The required SNR is decreasing when the number of repetitions is increasing, and the required SNR is 3.1 dB lower for 32 repetitions supported in Rel-17 compared to 16 repetitions supported in Rel-16. Proposal 1: Define BS demodulation requirements for PUSCH repetition type A with 32 repetitions, using the following parameters:</p> <ol style="list-style-type: none"> 1. Counting based on physical slots and available slots (i.e., UL slots) for FDD and TDD respectively 2. QPSK 1/3 (MCS 4), 4PRB PUSCH allocation 3. Inter-slot frequency hopping enabled 4. DFT-S-OFDM and CP-OFDM 5. FR1 and FR2 <p>For TB processing over multi-slot PUSCH: Observation 2: The main difference of TBoMS compared to single-slot PUSCH transmission is that a single RV is used over the N slots, the payload size is scaled by N. Typically, TBoMS is used with small PUSCH PRB allocation. Proposal 2: Define BS demodulation requirements for PUSCH TBoMS, using the following parameters: 4 physical/available slots for a TBoMS for FDD/TDD 4 physical/available slots for a TBoMS for FDD/TDD 4 repetitions for the TBoMS QPSK 1/3 (MCS 4), single PRB PUSCH allocation Inter-slot frequency hopping enabled DFT-S-OFDM and CP-OFDM FR1 and FR2 For joint channel estimation for PUSCH: Observation 3: Around 2dB or</p>
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R4-2200408	Nokia, Nokia Shanghai Bell	<p>Enhancements on PUSCH repetition type A</p> <p>Observation 1:The increase from n16 to n32 impacts the BS demodulation performance in a very predictable way that is independent of implementation.</p> <p>Proposal 1:RAN4 to not specify new BS demodulation requirements only for the increased number of Type A repetitions.</p> <p>TB processing over multi-slot PUSCH</p> <p>Observation 2:By mapping a single TB across multiple slots, TBoMS feature decreases the effective coding rate</p> <p>Proposal 2:RAN4 to specify new BS demodulation requirements for TBoMS feature.</p> <p>Joint channel estimation for PUSCH</p> <p>Observation 3:JCE for PUSCH feature has clear impact on the BS receiver implementation and the demodulation performance, as disregarding the phase and power continuity leads to sub-optimal demodulation performance.</p> <p>Proposal 3:RAN4 BS demodulations to include requirements for joint channel estimation for PUSCH.</p> <p>PUCCH enhancements</p> <p>Observation 4:DM-RS bundling feature has clear impact on the BS receiver implementation and the demodulation performance, as disrespecting the phase and power continuity can have large negative implications.</p> <p>Proposal 4:RAN4 BS demodulation to include requirements for DM-RS bundling over PUCCH.</p> <p>Type A PUSCH repetition for msg3</p> <p>Observation 5:The implementation of PUSCH Msg3 repetition could simply reuse Rel-16 demodulation implementation of PUSCH up to 16 repetitions cycled over RV sequence.</p> <p>Proposal 5:RAN4 not to specify new BS demodulation requirements for the introduced PUSCH Msg3 repetitions.</p>
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R4-2200477	Ericsson	<p>Observation 1: There is no algorithm change comparing Rel-16 and Rel-17 PUSCH repetition type A features without joint channel estimation, and only the maximum repetition number is increased.</p> <p>Proposal 1: For increasing the number of repetitions and counting repetitions based on available slots for PUSCH repetition type A and type A repetition for Msg.3 PUSCH without joint channel estimation, no specific demodulation requirements are defined.</p> <p>Observation 2: Demodulation processing might be impacted by TBoMS due to specific TBS determination and rate matching operations.</p> <p>Proposal 2: For the dynamic indication of the number of repetitions for PUCCH, no specific demodulation requirement is defined.</p> <p>Observation 3: Demodulation algorithm could be impact by JCE.</p> <p>Observation 4: Demodulation performance of JCE depends on actual window length which UE can keep the power consistency and phase continuity. Further check on algorithm difference between different actual window length could be needed.</p> <p>Proposal 3: If it is agreed to introduce requirements for non-JCE enhanced features, define only one set of requirements to cover both FDD and TDD configurations.</p>
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R4-2200756	Samsung	<p>Observation 1: PUSCH slot repetition requirements have been verified in RAN4 for both FR1 and FR2</p> <p>Propose 1: FFS to specify the PUSCH repetition type A requirements with Rel-17 repetition value.</p> <p>Propose 2: PUSCH requirement with TB processing over multi-slot can be considered in RAN4</p> <p>Propose 3: UCI multiplexing on PUSCH requirement with TB processing over multi-slot can be considered in RAN4</p> <p>Propose 4: Further discuss whether to define PUSCH/PUCCH multiple transmission requirement with DMRS bundling when the core requirement is finalized in RAN1 and RAN4</p> <p>Propose 5: No PUCCH demodulation requirement for dynamic PUCCH repetition factor indication.</p> <p>Propose 6: Type A PUSCH repetition for Msg 3 with inter-slot frequency hopping requirement can be considered, FFS on Type A PUSCH repetition for Msg 3 requirement with intra-slot frequency hopping</p>
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R4-2201017	Huawei, HiSilicon	<p>Proposal 1: Do not define performance requirements enhancements on PUSCH repetition type A.</p> <p>Proposal 2: Define performance requirements for TBoMS, scheduling 2 slots for single TB to ensure consecutive slots allocation for the default TDD UL-DL pattern 7D1S2U for 30kHz SCS.</p> <p>Proposal 3: Define performance requirements for joint channel estimation for PUSCH only for Back-to-back PUSCH transmissions across consecutive slots for repetition type A, scheduling 2 slots for JCE processing to ensure consecutive slots allocation for the default TDD UL-DL pattern 7D1S2U for 30kHz SCS.</p> <p>Proposal 4: Do not define any performance requirements for type A PUSCH repetitions.</p> <p>Proposal 5: Do not define performance requirements for dynamic PUCCH repetition factor indication.</p> <p>Proposal 6: Do not define performance requirements for PUCCH DMRS bundling.</p>
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R4-2201604	Intel Corporation	<p>Proposal 1: Define Rel-17 PUSCH demodulation requirements to verify the following coverage enhancements functionality: TB processing over multi-slot PUSCH and Joint channel estimation.</p> <p>Proposal 2: Use configuration of existing Rel-16 PUSCH requirements with repetition Type A as the starting point to identify the test configuration for verification of Joint channel estimation</p> <p>Proposal 3: Define Rel-17 PUCCH demodulation requirements to verify DMRS bundling or Joint channel estimation functionality and use test configuration of existing multi-slot PUCCH requirements as the starting point for further discussion.</p>
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1.2 Open issues summary

1.2.1 Sub-topic 1-1: General

Issue 1-1-1: Test metric for BS PUSCH demodulation test cases

- Proposals:
 - Option 1: Test SNR at which the PUSCH achieves 70% of throughput (Nokia)
- **Recommended WF**
 - TBA

1.2.2 Sub-topic 1-2: PUSCH repetition type A with 32 repetitions

Issue 1-2-1: Whether to define BS demodulation requirements for PUSCH repetition type A with 32 repetitions

- Proposals:
 - Option 1: Yes (China Telecom)

- CTC: The required SNR is 3.1 dB lower for 32 repetitions supported in Rel-17 compared to 16 repetitions supported in Rel-16
 - Option 2: No (Nokia, E///, HW, Intel)
 - Nokia: New repetition factors can be included in the JCE feature.
 - E///, HW: There is no algorithm change comparing Rel-16 and Rel-17 PUSCH repetition type A features without joint channel estimation.
 - Option 3: FFS (Samsung)
 - Samsung: In Rel-16 URLLC WI, RAN4 has specified the PUSCH repetition type A requirement for both FDD and TDD targeting FR1 and FR2, where the number of repetition is configured 2 or 8 pending on TDD pattern.
- **Recommended WF**
- TBA

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

- 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

1.2.3 Sub-topic 1-3: PUSCH TB over Multi Slots (TBoMS)

Issue 1-3-1: Whether to define BS demodulation requirements for PUSCH TBoMS

– Proposals:

- Option 1: Yes (China Telecom, Nokia, E///, Samsung, HW, Intel)
 - CTC: The main difference of TBoMS compared to single-slot PUSCH transmission is that a single RV is used over the N slots, the payload size is scaled by N. Typically, TBoMS is used with small PUSCH PRB allocation.
 - Nokia: TBoMS feature decreases the effective coding rate and potentially requires demodulator implementation changes.

– **Recommended WF**

- Agree to define BS demodulation requirements for PUSCH TBoMS and further discuss the test parameters.

Issue 1-3-2: Physical/available slots for BS requirements for PUSCH TBoMS (if introduced)

– Proposals:

- Option 1: 4 physical/available slots for FDD, and 4 available slots for TDD (China Telecom)
- Option 2: 8 available slots (Nokia)
- Option 3: 2 available slots(HW)

– **Recommended WF**

- Further discuss

Issue 1-3-3: Repetition number for BS requirements for PUSCH TBoMS (if introduced)

– Proposals:

- Option 1: 4 (China Telecom)

– **Recommended WF**

- TBA

Issue 1-3-4: PRB number for BS requirements for PUSCH TBoMS (if introduced)

- Proposals:
 - Option 1: Single PRB PUSCH allocation (China Telecom)
 - Option 2: Full applicable test bandwidth (Nokia)
- **Recommended WF**
 - TBA

Issue 1-3-5: Inter-slot frequency hopping for BS requirements for PUSCH TBoMS (if introduced)

- Proposals:
 - Option 1: Enabled (China Telecom, Nokia)
- **Recommended WF**
 - TBA

Issue 1-3-6: TDD UL-DL pattern for BS requirements for PUSCH TBoMS (if introduced)

- Proposals:
 - Option 1: 7D1S2U, S=6D:4G:4U for 30kHz SCS (Nokia, HW)
- **Recommended WF**
 - TBA

Issue 1-3-7: Transform precoding for BS requirements for PUSCH TBoMS (if introduced)

- Proposals:
 - Option 1: Cover both DFT-S-OFDM and CP-OFDM (China Telecom)

- Option 2: CP-OFDM only (Nokia)
- **Recommended WF**

- TBA

Issue 1-3-8: Whether to consider UCI multiplexing on PUSCH for TBoMS transmission

– Proposals:

- Option 1: Yes (Samsung)
 - Samsung: UCI multiplexing is also applied for TB over multi-slot transmission. The related bit mapping and CB calculation method will has some impact baseband processing.

– **Recommended WF**

- Further discuss, and Proponent of option 1 to confirm whether the purpose is to test PUSCH data performance but not UCI decoding performance.

Issue 1-3-9: Other parameters for BS requirements for PUSCH TBoMS (if introduced)

– Proposals:

- Proposal 1: (China Telecom)
 - QPSK 1/3 (MCS 4)
 - FR1 and FR2
- Proposal 2: (Nokia)

Table 2:

Parameter		Value
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	$N_{ID}^0=0, n_{SCID}=0$
Time domain resource assignment	PUSCH mapping type	A, B
	Start symbol	0
	Allocation length	14
Code block group based PUSCH transmission		Disabled

– **Recommended WF**

- Encourage comments

1.2.4 Sub-topic 1-4: PUSCH demodulation with Joint Channel Estimation (JCE)

Issue 1-4-1: Whether to define BS PUSCH demodulation requirements with JCE

– Proposals:

- Option 1: Yes (China Telecom, Nokia, HW, Intel)
 - Nokia: JCE for PUSCH feature has clear impact on the BS receiver implementation and the demodulation performance, a new channel estimator needs to be implemented at receiver to process DM-RS across multiple repetitions.
- Option 2: FFS after the finalization of core requirements in RAN1 and RAN4 (E///, Samsung)
 - E///: The nominal window could be “broken” into several actual windows by system events, such as timing advance. The real channel estimation is based on the actual window length.
 - Samsung: The details mechanisms to enable joint channel estimation for both PUSCH and PUCCH multiple transmission are still under discussion.

- Moderator’s observation
 - All companies agree that JCE will have BE demodulation implementation impact.
- **Recommended WF**
 - Define BS PUSCH demodulation requirements with JCE, while the detailed parameters should be set following RAN1 and RAN4 RF agreements..

Issue 1-4-2: Slot number for JCE in BS PUSCH demod requirements (if introduced)

- Proposals:
 - For TDD
 - Option 1: 2 consecutive slots (China Telecom, HW, Intel)
 - Option 2: 4? (Nokia)
 - For FDD
 - Option 1: 2 consecutive slots (Intel, Huawei)
 - Option 2: more than 2 consecutive slots (China Telecom)
 - Option 3: 4 (Nokia)
- **Recommended WF**
 - TBA

Issue 1-4-3: PUSCH repetition type for BS PUSCH demod requirements with JCE (if introduced)

- Proposals:
 - Option 1: Back-to-back PUSCH transmissions with repetition type A (HW, [Intel])
- **Recommended WF**
 - TBA

Issue 1-4-4: PRB number for BS PUSCH demod requirements with JCE (if introduced)

- Proposals:
 - Option 1: 4 PRB (China Telecom)
 - Option 2: Full applicable test bandwidth (Nokia)

– **Recommended WF**

- TBA

Issue 1-4-5: Inter-slot frequency hopping for BS PUSCH demod requirements with JCE (if introduced)

- Proposals:
 - Option 1: Enabled (China Telecom, Nokia)

– **Recommended WF**

- TBA

Issue 1-4-6: TDD UL-DL pattern for BS PUSCH demod requirements with JCE (if introduced)

- Proposals:
 - Option 1: 7D1S2U, S=6D:4G:4U for 30kHz SCS (Nokia, HW)

– **Recommended WF**

- TBA

Issue 1-4-7: Transform precoding for BS PUSCH demod requirements with JCE (if introduced)

- Proposals:
 - Option 1: Cover both DFT-S-OFDM and CP-OFDM (China Telecom)
 - Option 2: CP-OFDM only (Nokia)

– **Recommended WF**

- TBA

Issue 1-4-8: Other parameters for BS PUSCH demod requirements with JCE (if introduced)

– Proposals:

- Option 1: (China Telecom)
 - QPSK 1/3 (MCS 4)
 - FR1 and FR2
- Option 2: (Nokia)

Table 3:

Parameter		Value
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	$N_{ID}^0=0, n_{SCID}=0$
Time domain resource assignment	PUSCH mapping type	A, B
	Start symbol	0
	Allocation length	14
	Rel-17 PUSCH aggregation factor (RAN1 name TBD)	n8

	AvailableSlotCounting (RAN1 name TBD)	enabled
Code block group based PUSCH transmission		Disabled

- Option 3: Use configuration of existing Rel-16 PUSCH requirements with repetition Type A as the starting point (Intel)

– **Recommended WF**

- TBA

1.2.5 Sub-topic 1-5: PUSCH Enhancements for Type A PUSCH repetitions for Msg3

Issue1-5-1: Whether to define PUSCH demodulation requirements for Msg3 repetition

- Option 1: Consider type A PUSCH repetition for Msg 3 with inter-slot frequency hopping requirement, FFS on requirement with intra-slot frequency hopping (Samsung)
 - Samsung: 1) In Rel-16 URLLC WI, there is no PUSCH requirement with considering frequency hopping. 2) There is no basic requirement for PUSCH without repetition transmission for intra-slot frequency hopping
- Option 2: No (China Telecom, Nokia, E///, HW)
 - CTC: From BS demodulation perspective, the main difference between Msg3 PUSCH repetition and non-Msg3 PUSCH repetition is on the payload size, while the difference on the payload size is not significant.
 - Nokia: The implementation of PUSCH Msg3 repetition could simply reuse Rel-16 demodulation implementation of PUSCH up to 16 repetitions cycled over RV sequence.
- Recommended WF
 - TBA

1.3 Companies views’ collection for 1st round

Sub-topic 1-1: General

- Issue 1-1-1: Test metric for BS PUSCH demodulation test cases

Feedback Form 1: Sub-topic 1-1: General

1 – Ericsson Inc.

Ericsson: OK with Option 1. 70% throughput as test metric could be OK to compared with legacy requirement.

2 – China Telecommunications

Issue 1-1-1: Test metric for BS PUSCH demodulation test cases

SNR @70% max TP is the metric we used for normal PUSCH demodulation tests.

We test BLER for URLLC and PUSCH repetition type A tests.

Therefore we think the test metric should be discussed for each feature independently.

3 – Intel Corporation SAS

We agree with China Telecom. Probably we first need to agree on test scope and test setup and, after that, decide on suitable test metric.

4 – Samsung Electronics Benelux BV

Samsung:

we should focus on the test scope discussion firstly, then, dicide whether to apply 70% TP as test metric or choose other test metric

5 – Nokia France

Nokia:

Issue 1-1-1: Test metric for BS PUSCH demodulation test cases

Option 1 : We remain with our proposal. The most meaningful KPI to be tested for coverage enhanced PUSCH is SNR at 70% TPUT. We don't see URLLC performance as priority in NR coverage enhancements WI.

6 – HiSilicon Technologies Co. Ltd

We are OK with Option 1.

7 – Qualcomm CDMA Technologies

Agree with Samsung. The test scope should be first agreed before discussing the 70% TP test metric.

Sub-topic 1-2: PUSCH repetition type A with 32 repetitions

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

Feedback Form 2: Sub-topic 1-2: PUSCH repetition type A with 32 repetitions

1 – Ericsson Inc.

Ericsson:

Issue 1-2-1: For non-JCE scenarios, although the SNR is lower, there is no new algorithm is introduced by increasing repetition time. The increased performance compared to Rel-16 requirements can be predicable by repetition time.

Issue 1-2-2: Pending the discussion until the conclusion of Issue 1-2-1 is agreed.

2 – China Telecommunications

We still prefer option 1.

The current spec only defines max 2 repetitions test. With 32 repetitions, the UE performance will be much better.

3 – Intel Corporation SAS

Issue 1-2-1: Support Option 2. In Rel-16 we have requirements only for one configuration and we don't have testing of all possible repetition settings. Based on our understanding, baseband processing is same for different repetition configuration. Therefore, we think that definition of additional requirements for Repetition Type A is redundant.

4 – Samsung Electronics Benelux BV

Samsung:

From baseband processing, we don't see the difference compared with Rel-15/16 repetition configuration, only large number of repetition as 32 can be supported for Rel-17 repetition type A Existing Rel-16 test case can fulfill the verification of multi-slot combination functionality. There is no necessary to specify PUSCH repetition type A with larger number repetition, such as 16, or 32.

5 – Nokia France

Issue 1-2-1: Option2: The increase of PUSCH number of repetitions will impact the BS demodulation performance in a very predictable way that is independent of implementation. Furthermore, n32 has very large resources utilization which makes it widespread usage in practice questionable. No need to specify new requirements for 32 repetitions.

Issue 1-2-2: Wait for issue 1-2-1 to be agreed.

6 – HiSilicon Technologies Co. Ltd

Issue 1-2-1: Whether to define BS demodulation requirements for PUSCH repetition type A with 32 repetitions

We prefer Option 2. Firstly, there is no algorithm change comparing Rel-16 and Rel-17 PUSCH repetition type A features without joint channel estimation. Secondly, only n2/n8 is considered for Rel-16 PUSCH repetition requirements even though the maximum number of configurable slots is 16. We think the performance for PUSCH repetition has been verified based on existing Rel-16 requirements.

7 – Qualcomm CDMA Technologies

We prefer option 1.

Sub-topic 1-3: PUSCH TB over Multi Slots (TBoMS)

- Issue 1-3-1: Whether to define BS demodulation requirements for PUSCH TBoMS
- Issue 1-3-2: Physical/available slots for BS requirements for PUSCH TBoMS (if introduced)
- Issue 1-3-3: Repetition number for BS requirements for PUSCH TBoMS (if introduced)
- Issue 1-3-4: PRB number for BS requirements for PUSCH TBoMS (if introduced)
- Issue 1-3-5: Inter-slot frequency hopping for BS requirements for PUSCH TBoMS (if introduced)
- Issue 1-3-6: TDD UL-DL pattern for BS requirements for PUSCH TBoMS (if introduced)
- Issue 1-3-7: Transform precoding for BS requirements for PUSCH TBoMS (if introduced)
- Issue 1-3-8: Whether to consider UCI multiplexing on PUSCH for TBoMS transmission (if introduced)
- Issue 1-3-9: Other parameters for BS requirements for PUSCH TBoMS (if introduced)

Feedback Form 3: Sub-topic 1-3: PUSCH TB over Multi Slots (TBoMS)

1 – Ericsson Inc.

Ericsson:

Issue 1-3-1: Agree with WF

Issue 1-3-2: Support Option 3. Two available slots could be enough to check the TBoMS processing in non-JCE scenarios and also can be used for both FDD and TDD frame structure. The simulation workload can be reduced.

Issue 1-3-3: Pending until 1-3-2 is agreed.

Issue 1-3-4: Support Option 2. To check the performance improvement by TBoMS, same PRB allocation could be used.

Issue 1-3-5: We support no frequency hopping to keep the same configuration as Rel-16 for checking the improvement. Frequency hopping is not relevant to TBoMS algorithm enhancement. DM-RS between different hopping can't be combined and the performance improvement can't be seen.

Issue 1-3-6: Option 1 is OK.

Issue 1-3-7: We support Option 2 since it's no performance and receiver decoding algorithm difference between two waveforms if the assumptions are similar as Rel-16.

Issue 1-3-8: We don't see the necessary to define requirement for UCI multiplexing on PUSCH over TBoMS. This issue could also depend on the conclusion of Issue 1-3-4. If Option 1 is agreed, then it would be an issue on scheduling UCI.

Issue 1-3-9: Proposal 1 and 2 could be the start point for further discussion. Companies could deliver some simulation results based on it to see if it is feasible.

2 – China Telecommunications

Issue 1-3-1: Whether to define BS demodulation requirements for PUSCH TBoMS

Support the recommended WF.

Issue 1-3-2: Physical/available slots for BS requirements for PUSCH TBoMS (if introduced)

Better performance is expected with more available slots. We are fine with 4 available slots for FDD and TDD.

For TDD especially, configuring more than 2 available slots will enable cross frame reception and better performance will be achieved due to time domain diversity.

Issue 1-3-3: Repetition number for BS requirements for PUSCH TBoMS (if introduced)

TBoMS also enable repetition to achieve better performance. Therefore, repetition number of 4 is proposed.

Issue 1-3-4: PRB number for BS requirements for PUSCH TBoMS (if introduced)

TBoMS is targeting coverage limited scenario in which small bandwidth transmission is more practical.

Moreover, inter-slot frequency hopping will not be enabled if we use full bandwidth transmission in the test.

Issue 1-3-5: Inter-slot frequency hopping for BS requirements for PUSCH TBoMS (if introduced)

Support to enable Inter-slot frequency hopping which is supported by TBoMS.

Issue 1-3-6: TDD UL-DL pattern for BS requirements for PUSCH TBoMS (if introduced)

Fine with option 1 for simulation. Existing test applicability for different TDD patterns should also apply.

Issue 1-3-7: Transform precoding for BS requirements for PUSCH TBoMS (if introduced)

DFT-s-OFDM is also likely to be used for coverage limited scenarios. Both should be covered.

3 – Intel Corporation SAS

Issue 1-3-1: Agree with WF

Issue 1-3-2: Option 1 and 3 are fine for us

Issue 1-3-3: This issue can be discussed after agreement on Issue 1-3-2.

Issue 1-3-4: Taking into account that we consider coverage limited use case, it is better to consider narrow PUSCH allocation. Probably, it is better to consider non single PRB allocation, for example, 5 or 10 PRBs. We are open to further discuss.

Issue 1-3-5: No strong view at current stage. We can check the performance for different options and decide later.

Issue 1-3-6: Support option 1 for scenario with 30 kHz. Probably we also need to consider TDD with 15 kHz scenario. DDDSU pattern can be used (i.e. similar as for existing requirements).

Issue 1-3-7: We suggest to focus on CP-OFDM waveform and consider DFT-S-OFDM if time allows.

Issue 1-3-8: We need more time to check whether introduction of such requirements will lead to verification of specific functionality.

Issue 1-3-9: We are fine to consider Option 1 and 2 as starting point. As for RV sequence, [0 3 0 3] is used for existing requirements with repetition type A. Probably we can also consider this option in case two repetitions will be considered.

4 – Nokia France

Issue 1-3-1: Option 1, Ok with WF.

Issue 1-3-2: We were not very clear in our contribution. We didn't propose specific number. We can remove option2. Both option1 and option3 are fine with us.

However, we caution that the current BS demod FRC framework might need to be adapted to capture the TB stretching over more than one slot for TBoMS.

Issue 1-3-3: Pending until Issue 1-3-2 is agreed.

Issue 1-3-4: Again, we excuse the confusing proposal, Nokia did not intent to propose full BW already in this meeting. However, both full CBW and single PRB have technical arguments to support them (e.g., comparability vs range focus). We should discuss this topic further in this meeting.

Issue 1-3-5: Another misunderstanding, please remove Nokia from Option 1 for now.

Issue 1-3-6: Option 1 is fine for us as it seems to be consensus.

Issue 1-3-7: We support Option 2 for consistency with Rel16 type A repetition requirements.

Issue 1-3-8: It is unclear to us how an equally sized payload should differ here between PUSCH and UCI over PUSCH. The performance should at least be comparable. Hence, we propose to not consider UCI multiplexing. Or is this issue intended to cover PUSCH vs UCI priority rules?

Issue 1-3-9: The table reproduced here was intended for PUSCH JCE, not TBoMS, so it can be removed. Option 1 seems fine to us.

5 – Samsung Electronics Benelux BV

Samsung

Issue 1-3-1: we are fine with option 1 and recommended WF

Issue 1-3-2: This meeting is the 1st meeting to discuss performance part of CE, we should focus on the test scope. Regarding the slots, we are open to further discuss, at current stage, option 3 is reasonable for both FDD and TDD, similar with Rel-16 URLLC with repetition requirement, With large number of slots, the simulation time is increasing, especially for TDD, since the typical TDD pattern, 2 continues UL slots is available

Issue 1-3-3: pending on issue 1-3-2. we prefer to further discussion, at least other options is not precluded

Issue 1-3-4: we are open to further discuss , pending whether frequency hopping should be enabled,

Issue 1-3-5: we are open to further discuss whether we should combine both two features together for requirement. For Rel-15/16, there is no frequency hopping considering, we can use as starting point.

Issue 1-3-6: This issue is pending on the Issue 1-3-2,

Issue 1-3-7: we are open to further discuss , at current stage, we think CP-OFDM should be considered firstly, which can compare with Rel-16 URLLC performance.

Issue 1-3-8: UCI multiplexing is also applied for TB over multi-slot transmission. The related bit mapping and CB calculation method will has some impact baseband processing. We are open to further discuss

Issue 1-3-9: This meeting is the 1st meeting to discuss performance part of CE, we should focus on the test scope. Option 1 and option 2 can be used as a starting point for further discussion

6 – HiSilicon Technologies Co. Ltd

Issue 1-3-1: Whether to define BS demodulation requirements for PUSCH TBoMS

We are OK with Option 1.

Issue 1-3-2: Physical/available slots for BS requirements for PUSCH TBoMS (if introduced)

We prefer Option 3. For TDD, we suggest to only consider consecutive slot configuration for default “7D1S2U” TDD pattern with 30kHz SCS so 2 consecutive slot is a reasonable value. For FDD, we are also OK with Option 1 or Option 2.

Issue 1-3-3: Repetition number for BS requirements for PUSCH TBoMS (if introduced)

We prefer to not consider repetition for TBoMS. We prefer to de-couple TBoMS testing and PUSCH repetition testing and consider TBoMS repetition can be covered by TBoMS testing and PUSCH repetition testing.

Issue 1-3-4: PRB number for BS requirements for PUSCH TBoMS (if introduced)

We prefer Option 2 to consider the same PRB allocation as the existing cases in the specification.

Issue 1-3-5: Inter-slot frequency hopping for BS requirements for PUSCH TBoMS (if introduced)

We prefer to not consider inter-slot frequency hopping since this feature is supported by legacy PUSCH transmission but we don't define any requirements for it.

Issue 1-3-6: TDD UL-DL pattern for BS requirements for PUSCH TBoMS (if introduced)

We prefer Option 1. Performance under 7D1S2U, S=6D:4G:4U for 30kHz SCS should be ensured.

Issue 1-3-7: Transform precoding for BS requirements for PUSCH TBoMS (if introduced)

We prefer Option 2. We prefer to focus on TBoMS feature for the testing and only one certain typical configuration can be selected, such as CP-OFDM like other WIs did.

Issue 1-3-8: Whether to consider UCI multiplexing on PUSCH for TBoMS transmission

We don't see any necessity to define addition performance requirements for UCI multiplexing on PUSCH for TBoMS transmission, considering there is just mapping formula changed.

Issue 1-3-9: Other parameters for BS requirements for PUSCH TBoMS (if introduced)

For the MCS, we prefer to select MCS 2 for evaluation that is same as the existing cases in the specification.

7 – Qualcomm CDMA Technologies

Issue 1-3-1: Support option 1.

Issue 1-3-2: Options 1 and 3 are fine with us.

Issue 1-3-3: This should be decided based on agreement in Issue 1-3-2.

Issue 1-3-4: Support option 2.

Issue 1-3-5: We do not see a strong need for Inter-slot frequency hopping at this stage. Can be investigated later.

Issue 1-3-6: Support option 1.

Issue 1-3-7: Support option 2.

Issue 1-3-8: No strong views here, TBD.

Issue 1-3-9: Ok with option 1 and RAN4 can further add other parameters.

Sub-topic 1-4: PUSCH demodulation with Joint Channel Estimation (JCE)

- Issue 1-4-1: Whether to define BS PUSCH demodulation requirements with JCE
- Issue 1-4-2: Slot number for JCE in BS PUSCH demod requirements (if introduced)
- Issue 1-4-3: PUSCH repetition type for BS PUSCH demod requirements with JCE (if introduced)

- Issue 1-4-4: PRB number for BS PUSCH demod requirements with JCE (if introduced)
- Issue 1-4-5: Inter-slot frequency hopping for BS PUSCH demod requirements with JCE (if introduced)
- Issue 1-4-6: TDD UL-DL pattern for BS PUSCH demod requirements with JCE (if introduced)
- Issue 1-4-7: Transform precoding for BS PUSCH demod requirements with JCE (if introduced)
- Issue 1-4-8: Other parameters for BS PUSCH demod requirements with JCE (if introduced)

**Feedback Form 4: Sub-topic 1-4: PUSCH demodulation with
Joint Channel Estimation (JCE)**

1 – Ericsson Inc.

Ericsson:

Issue 1-4-1: Support WF.

Issue 1-4-2: It might need more check for JCE performance with different consecutive slots. If it shows the different slot number will use different processing methods then we might need to think if one requirement is sufficient or not.

Issue 1-4-3: Option 1 could be OK.

Issue 1-4-4: We prefer Option 2 to aligned with Rel-15/16 applicability rule and see the performance improvement by using JCE if possible.

Issue 1-4-5: Similar view as Issue 1-3-5.

Issue 1-4-6: Depend on the conclusion of Issue 1-4-2.

Issue 1-4-7: Further check is needed. If no much performance difference then Option 2 could be preferred, otherwise Option 1 could be preferred.

Issue 1-4-8: Pending until RAN1/4 has agreement on UE coherent duration.

2 – China Telecommunications

Issue 1-4-1: Whether to define BS PUSCH demodulation requirements with JCE

Support the recommended WF.

Issue 1-4-2: Slot number for JCE in BS PUSCH demod requirements (if introduced)

For TDD, 2 consecutive slots configuration is practical considering the commonly used 7D1S2U and DDDSU+DDSUU TDD patterns. For FDD, more consecutive slots can be supported by the UE. 4 or 8 consecutive slots is fine for us.

Issue 1-4-3: PUSCH repetition type for BS PUSCH demod requirements with JCE (if introduced)

We are fine with using Back-to-back PUSCH transmission. But Type B should not be precluded at this stage.

Issue 1-4-4: PRB number for BS PUSCH demod requirements with JCE (if introduced)

JCE is targeting coverage limited scenario in which small bandwidth transmission is more practical.

Moreover, inter-slot frequency hopping will not be enabled if we use full bandwidth transmission in the test.

Issue 1-4-5: Inter-slot frequency hopping for BS PUSCH demod requirements with JCE (if introduced)

Support option 1.

Issue 1-4-6: TDD UL-DL pattern for BS PUSCH demod requirements with JCE (if introduced)

For 15k SCS, JCE cannot be applied in DDDSU pattern, we should consider other patterns. OK for 30k SCS

Issue 1-4-7: Transform precoding for BS PUSCH demod requirements with JCE (if introduced)

Option 1. Same with issue 1-3-7

Issue 1-4-8: Other parameters for BS PUSCH demod requirements with JCE (if introduced)

Whether to use DMRS 1+0 or 1+1 need further discussion. There is a potential difference in the performance gain of JCE.

3 – Intel Corporation SAS

Issue 1-4-1: Support recommended WF

Issue 1-4-2: We can consider 2 consecutive slots as starting point. Same time, we need to ensure that test setup is selected properly for verification of JCE processing and JCE provides performance benefits over single slot CE for selected assumptions.

Issue 1-4-3: Option 1 is fine for us.

Issue 1-4-4: Both options are fine for us. Option 1 is slightly preferred due to coverage limited scenarios.

Issue 1-4-5: Based on our understanding, JCE is only possible in scenarios without inter-slot hopping.

Issue 1-4-6: Same comment as for Issue 1-3-6.

Issue 1-4-7: Same comment as for Issue 1-3-7.

Issue 1-4-8: Further discussion is needed.

4 – Nokia France

Issue 1-4-1: Option 1. Agree with the WF.

Issue 1-4-2: We are unsure what "slot number for JCE" refers to in this issue.

Is it the number of consecutive UL slots in the TDD pattern, or the cTDW/L (PUSCH-TimeDomainWindowLength), or number of repetitions (Rel-16/17 PUSCH aggregation factor, i.e., numberOfRepetitions[-r17])?

Currently, we assume that it is the cTDW, hence Nokia's proposal was "4" for both TDD and FDD.

Issue 1-4-3: Option 1 is fine with us. The questions of repetition type, TDD pattern, and frequency hopping will need to be decided together. What we want to achieve is a configuration that has an aTDW of two consecutive slots, where DMRS can be shared (JCE).

The exact combination of configurations that enables such a scenario is of lower importance to us and can be discussed in the next meeting, but the goal (i.e., how many DMRS are actually usable for JCE) should be agreed in this meeting. Can we add such an issue?

Issue 1-4-4: We are open to compromise and are interested to hear proposals from other companies.

Issue 1-4-5: See response to 1-4-3

Issue 1-4-6: See response to 1-4-3.

Issue 1-4-7: CP-OFDM only to align with Rel16.

Issue 1-4-8: Option 1 might be fine for us. MCS4 can be used as baseline for cell edge cases / coverage challenges scenarios. Agreeing right now to option 2 in full might be a bit early this meeting.

5 – Samsung Electronics Benelux BV

Samsung

Issue 1-4-1: we are fine with recommended WF

Issue 1-4-2: Since current RAN1 and RAN4 has still dicuss the related requirement , such as UE coherent duration to keep power and phase continuous. At current stage, we prefer to use the same number slots for FDD and TDD as 2, we are open to further discuss

Issue 1-4-3: we are fine with option 1 at current stage

Issue 1-4-4: Both option 1 and option2 are fine with us,

Issue 1-4-5: Similar view as Iss

Issue 1-4-6: Pending on the number of slots

Issue 1-4-7: We are open to futher discuss, at current stage, we prefer CP-OFDM firstly.

Issue 1-4-8: This meeting is the 1st meeting to discuss performance part of CE, we should focus on the test scope. Option 1 and option 2 can be used as a staring point for further discussion

6 – HiSilicon Technologies Co. Ltd

Issue 1-4-1: Whether to define BS PUSCH demodulation requirements with JCE

We prefer Option 1. We are OK with the recommended WF.

Issue 1-4-2: Slot number for JCE in BS PUSCH demod requirements (if introduced)

We prefer Option 1. For TDD, performance under default “7D1S2U” TDD pattern with 30kHz SCS should be ensured, so 2 consecutive slots can be a reasonable value. For FDD, we are also OK with Option 3.

Issue 1-4-3: PUSCH repetition type for BS PUSCH demod requirements with JCE (if introduced)

We prefer Option 1.

Issue 1-4-4: PRB number for BS PUSCH demod requirements with JCE (if introduced)

We prefer Option 2 to consider the same PRB allocation as the existing cases in the specification.

Issue 1-4-5: Inter-slot frequency hopping for BS PUSCH demod requirements with JCE (if introduced)

We prefer to not consider inter-slot frequency hopping for BS PUSCH demod requirements with JCE. It is enough to verify BS implementation by configuring TDW in which there is no any event occurs that violates power consistency and phase continuity.

Issue 1-4-6: TDD UL-DL pattern for BS PUSCH demod requirements with JCE (if introduced)

We prefer Option 1.

Issue 1-4-7: Transform precoding for BS PUSCH demod requirements with JCE (if introduced)

We prefer Option 2. We prefer to focus on TBoMS feature for the testing and only one certain typical configuration can be selected, such as CP-OFDM like other WIs did.

Issue 1-4-8: Other parameters for BS PUSCH demod requirements with JCE (if introduced)

For the *numberOfRepetitions-r17*, the value discussed in Issue 1-4-2 should be applied. For the MCS, we prefer to select MCS 2 for evaluation that is same as the existing cases in the specification.

7 – Qualcomm CDMA Technologies

Issue 1-4-1: Support WF.

Issue 1-4-2: Aren't 8 slots utilized for the UE side? Why BS demod should not follow the same line?

Issue 1-4-3: Ok with option 1.

Issue 1-4-4: Support option 2.

Issue 1-4-5: We do not see a need for inter-slot frequency hopping at this stage.

Issue 1-4-6: Ok with option 1. RAN4 can modify in the future based on the discussion progression.

Issue 1-4-7: Support option 2.

Issue 1-4-8: No strong opinion here.

Sub-topic 1-5: PUSCH Enhancements for Type A PUSCH repetitions for Msg3

- Issue1-5-1: Whether to define PUSCH demodulation requirements for Msg3 repetition

Feedback Form 5: Sub-topic 1-5: PUSCH Enhancements for Type A PUSCH repetitions for Msg3

1 – Ericsson Inc.

Ericsson:

Issue 1-5-1: Support Option 2. No frequency hopping requirement is needed since it is not relevant to repetition itself.

2 – China Telecommunications

Issue1-5-1: Whether to define PUSCH demodulation requirements for Msg3 repetition

We are fine to not test PUSCH demodulation requirements for Msg3 repetition. Normal repetition test same with 32 repetition test. To Samsung, Inter-slot frequency hopping can be tested in the 32 repetition test.

3 – Intel Corporation SAS

Issue1-5-1: Support Option 2. Based on our understanding, there is no new baseband functionality for this feature.

4 – Nokia France

Issue 1-5-1: Support Option 2. No requirements needed for Msg3 as it can use the nominal PUSCH requirements.

5 – Samsung Electronics Benelux BV

Samsung

From the BS baseband processing perspective, there is no difference foresee between Msg3 PUSCH and PUSCH scheduled with UE in RRC_CONNECTED, only different is the payload and scheduled MCS.

Regarding frequency hopping, both intra-slot and inter-slot hopping can be supported for Msg3 PUSCH transmission to improve the reliability. In Rel-16 URLLC WI, there is no PUSCH requirement with considering frequency hopping. Define related Msg3 PUSCH with frequency hopping requirement to verify this functionality may be needed. we are open to further discuss it.

6 – HiSilicon Technologies Co. Ltd

We prefer Option 2.

7 – Qualcomm CDMA Technologies

Support option 2.

1.4 Summary for 1st round

Issue 1-1-1: Test metric for BS PUSCH demodulation test cases

– *Candidate options*

- Option 1: Test SNR at which the PUSCH achieves 70% of throughput (Nokia, E///, HW)
- Option 2: Discuss test metric for each feature independently after discuss the test scope and test setup (CTC, Intel, Samsung, QC)

– *Recommendation for the second round*

- Add separate issues for each feature.

Issue 1-2-1: Whether to define BS demodulation requirements for PUSCH repetition type A with 32 repetitions

– *Candidate options*

- Option 1: Yes (China Telecom, QC)
- Option 2: No (Nokia, E///, HW, Intel, Samsung)
- ~~Option 3: FFS (Samsung)~~

– *Recommendation for the second round*

- Further discuss in the next meeting.

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

- *Candidate options*
 - 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
- *Recommendation for the second round*
 - Further discuss

Issue 1-3-1: Whether to define BS demodulation requirements for PUSCH TBoMS

- *Tentative agreement*
 - *Agree to define BS demodulation requirements for PUSCH TBoMS and further discuss the test parameters. (E///, CTC, Intel, Nokia, Samsung, HW, QC)*

Issue 1-3-2: Physical/available slots for BS requirements for PUSCH TBoMS

- *Candidate options:*
 - For FDD:
 - Option 1: 4 physical/available slots (China Telecom, Intel, Nokia, HW, QC)
 - Option 2: 8 available slots (HW)
 - Option 3: 2 available slots (E///, Intel, Nokia, Samsung, QC)
 - For TDD:

- Option 1: 4 available slots (China Telecom, Intel, Nokia, QC)
 - Option 2: 2 available slots (HW, E///, Intel, Nokia, Samsung, QC)
- *Recommendation for the second round*
- Further discuss in the next meeting

Issue 1-3-3: Repetition number for BS requirements for PUSCH TBoMS

- *Candidate options:*
- Option 1: 4 (China Telecom)
 - Option 2: Not to consider repetition for TBoMS (HW)
 - HW: We can consider TBoMS repetition by TBoMS testing and PUSCH repetition testing separately.
 - Option 3: FFS after available slot number is agreed (E///, Intel, Nokia, Samsung, QC)
- *Recommendation for the second round*
- Further discuss in the next meeting

Issue 1-3-4: PRB number for BS requirements for PUSCH TBoMS

- *Candidate options:*
- Option 1: Narrow PUSCH allocation (China Telecom, Intel)
 - Option 1A: Single PRB PUSCH allocation (China Telecom)
 - Option 1B: Non-single PRB allocation, i.e., 5 or 10 PRBs (Intel)
 - CTC, Intel: TBoMS is targeting coverage limited scenario in which small bandwidth transmission is more practical.
 - Option 2: Full applicable test bandwidth (Nokia, E///, HW, QC)
 - HW: the same PRB allocation as the existing cases in the specification.
 - Option 3: FFS pending whether frequency hopping should be enabled (Samsung)

- *Recommendation for the second round*
 - Further discuss in the next meeting

Issue 1-3-5: Inter-slot frequency hopping for BS requirements for PUSCH TBoMS

- *Candidate options:*
 - Option 1: Enabled (China Telecom, ~~Nokia~~)
 - Option 2: Disabled (E///, HW)
 - E///: DM-RS between different hopping can't be combined and the performance improvement can't be seen.
 - Option 3: FFS (Intel, Samsung, QC)
 - Samsung: For Rel-15/16, there is no frequency hopping considering, we can use as starting point.
- *Recommendation for the second round*
 - Further discuss in the next meeting

Issue 1-3-6: TDD UL-DL pattern for BS requirements for PUSCH TBoMS

- *Candidate options:*
 - For 30kHz SCS:
 - Option 1: 7D1S2U, S=6D:4G:4U for 30kHz SCS (Nokia, HW, E///, CTC, Intel, HW)
 - CTC: Existing test applicability for different TDD patterns should also apply.
 - Samsung: Pending on the available slot number issue.
 - For 15kHz SCS:
 - Option 1: Reuse the pattern in the spec, i.e., 3D1S1U, S=10D:2G:2U (Intel)
- *Recommendation for the second round*
 - For 30kHz SCS, encourage companies to check whether 7D1S2U, S=6D:4G:4U is feasible with reusing the test applicability in the spec that '*The same requirements are applicable to FDD and TDD with different UL-DL pattern*'

- For 15kHz SCS, encourage companies' feedback on whether the proposed TDD pattern is feasible.

Issue 1-3-7: Transform precoding for BS requirements for PUSCH TBoMS

– *Candidate options:*

- Option 1: Cover both DFT-S-OFDM and CP-OFDM (China Telecom)
- Option 2: CP-OFDM only (Nokia, E///, HW, QC)
- Option 3: Prioritize CP-OFDM (Intel, Samsung)

– *Recommendation for the second round*

- Further discuss in the next meeting

Issue 1-3-8: Whether to consider UCI multiplexing on PUSCH for TBoMS transmission

– *Candidate options:*

- Option 1: Test PUSCH demodulation with UCI multiplexing for TBoMS transmission (Samsung)
 - Samsung: The related bit mapping and CB calculation method will have some impact on baseband processing.
- Option 2: Not to test PUSCH demodulation with UCI multiplexing for TBoMS transmission (E///, Nokia, HW)
 - E///: If single PRB transmission is agreed, then it would be an issue on scheduling UCI.
 - HW: There is just mapping formula changed.
- Option 3: FFS (Intel, QC)

– *Recommendation for the second round*

- Further discuss in the next meeting.

Issue 1-3-9: Other parameters for BS requirements for PUSCH TBoMS

– *Candidate options:*

- For MCS
 - Option 1: QPSK 1/3 MCS 4 (CTC, E///, Intel, Samsung, Nokia, QC)
 - Option 2: MCS 2 (HW)

- For RV sequence for HARQ transmission
 - Option 1: [0 2 3 1] (E///, Samsung)
 - Option 2: [0 3 0 3] in case two repetitions will be considered (Intel)
 - Other options are not precluded pending on the repetition number

- For other parameters:
 - Cover FR1 and FR2 (E///, Intel, Samsung, Nokia, QC)
 - Other parameters:

Table 4:

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	$N_{ID}^0=0, n_{SCID}=0$
Time domain resource assignment	PUSCH mapping type	A, B
	Start symbol	0
	Allocation length	14
Code block group based PUSCH transmission		Disabled

– *Recommendation for the second round*

- **Agree to cover both FR1 and FR2**
- For the other parameters, check in the second round whether we can use the parameters in the above table as starting point
- FFS on the MCS and RV sequence for HARQ transmission

Issue 1-4-1: Whether to define BS PUSCH demodulation requirements with JCE

– *Tentative agreement*

- **Define BS PUSCH demodulation requirements with JCE, while the detailed parameters should be set following RAN1 and RAN4 RF agreements. (E///, CTC, Intel, Nokia, Samsung, HW, QC)**

Issue 1-4-2: Slot number for JCE in BS PUSCH demod requirements

– *Candidate options:*

- For TDD
 - Option 1: 2 consecutive slots (China Telecom, HW, Intel, Samsung)
 - Option 2: 4 slots within configured TDW (Nokia)
 - Option 3: FFS (E///, Samsung)
- For FDD
 - Option 1: 2 consecutive slots (Intel, Huawei, Samsung, HW)
 - Option 2: more than 2 consecutive slots (China Telecom)
 - Option 3: 4 consecutive slots (Nokia, CTC, HW)
 - Option 4: 8 consecutive slots (CTC, [QC])
 - Option 5: FFS (E///, Samsung)

– *Recommendation for the second round*

- Further discuss in the next meeting

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

- *Tentative agreement*
 - *Back-to-back PUSCH transmissions (HW, Intel, E///, CTC, Nokia, Samsung, QC)*
 - Repetition Type will be further discussed

Issue 1-4-4: PRB number for BS PUSCH demod requirements with JCE

- *Candidate options:*
 - Option 1: 4 PRB (China Telecom, Intel slightly preferred, Samsung)
 - Option 2: Full applicable test bandwidth (Nokia, E///, Intel, Samsung, HW, QC)
- *Recommendation for the second round*
 - Further discuss in the next meeting

Issue 1-4-5: Inter-slot frequency hopping for BS PUSCH demod requirements with JCE

- *Candidate options:*
 - Option 1: Enabled (China Telecom, Nokia)
 - Nokia: Repetition type, TDD pattern, and frequency hopping will need to be decided together.
 - Option 2: Disabled (E///, Intel, HW, QC)
 - Intel: JCE is only possible in scenarios without inter-slot hopping.
- *Recommendation for the second round*
 - Further discuss in the next meeting

Issue 1-4-6: TDD UL-DL pattern for BS PUSCH demod requirements with JCE

- *Candidate options:*
 - For 30kHz SCS:
 - Option 1: 7D1S2U, S=6D:4G:4U (Nokia, HW, CTC, Intel, QC)
 - Option 2: Depend on the slot number for JCE (E///, Samsung)
 - For 15kHz SCS:
 - Option 1: Reuse the pattern in the spec, i.e., 3D1S1U, S=10D:2G:2U (Intel)
 - Option 2: Consider other TDD patterns (CTC)
 - Nokia: Repetition type, TDD pattern, and frequency hopping will need to be decided together.
- *Recommendation for the second round*
 - Further discuss in the next meeting

Issue 1-4-7: Transform precoding for BS PUSCH demod requirements with JCE

- *Candidate options:*
 - Option 1: Cover both DFT-S-OFDM and CP-OFDM (China Telecom)
 - Option 2: CP-OFDM only (Nokia, HW, QC)
 - Option 3: Prioritize CP-OFDM (Intel, Samsung)
 - Option 4: FFS whether DFT-S-OFDM should be included (E///)
- *Recommendation for the second round*
 - Further discuss in the next meeting

Issue 1-4-8: Other parameters for BS PUSCH demod requirements with JCE

- *Candidate options:*
 - Option 1: (China Telecom)
 - QPSK 1/3 (MCS 4)
 - FR1 and FR2
 - Option 2: (Nokia)

Table 5:

Parameter		Value
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	$N_{ID}^0=0, n_{SCID}=0$
Time domain resource assignment	PUSCH mapping type	A, B
	Start symbol	0
	Allocation length	14
	Rel-17 PUSCH aggregation factor (RAN1 name TBD)	n8
	AvailableSlotCounting (RAN1 name TBD)	enabled
Code block group based PUSCH transmission		Disabled

- Option 3: Use configuration of existing Rel-16 PUSCH requirements with repetition Type A as the starting point (Intel)
- Option 4 (HW): MCS2

– *Recommendation for the second round*

- Further discuss in the next meeting

Issue1-5-1: Whether to define PUSCH demodulation requirements for Msg3 repetition

– *Candidate options:*

- Option 1: Consider type A PUSCH repetition for Msg 3 with inter-slot frequency hopping requirement, FFS on requirement with intra-slot frequency hopping (Samsung)
 - Samsung: both intra-slot and inter-slot hopping can be supported for Msg3 PUSCH transmission to improve the reliability.
- Option 2: No (China Telecom, Nokia, E///, HW, Intel, QC)

– *Recommendation for the second round*

- Further discuss in the next meeting

1.5 Discussion on 2nd round

TBA

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

2.1 Companies' contributions summary

Captured in sub-clause 1.1.

2.2 Open issues summary

2.2.1 Sub-topic 2-1: General

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

– Proposals:

- Option 1: (Nokia)
 - Test UCI block error probability for PUCCH format 2/3/4

- Test NACK to ACK detection probability for PUCCH format 1

– **Recommended WF**

- FFS

2.2.2 Sub-topic 2-2: Dynamic indication of PUCCH repetition

Issue 2-2-1: Whether to define BS demodulation requirements for dynamic indication of PUCCH repetition

– Proposals:

- Option 1: No (China Telecom, E///, Samsung, HW, Intel)
 - CTC: Dynamic indication of PUCCH repetition factor is not changed in Rel-17.

– **Recommended WF**

- Agree not to define BS demodulation requirements for dynamic indication of PUCCH repetition

2.2.3 Sub-topic 2-3: PUCCH demodulation with Joint Channel Estimation (JCE)

Issue 2-3-1: Whether to define BS PUCCH demodulation requirements with JCE

– Proposals:

- Option 1: Yes (China Telecom, Nokia, Intel)
- Option 2: No (HW)
 - HW: PUCCH is not the weak point for the uplink transmission, good enough performance can be observed for legacy PUCCH repetition.
- Option 3: FFS after the finalization of core requirements in RAN1 and RAN4 (E///, Samsung)

– **Recommended WF**

- TBA

Issue 2-3-2: PUCCH format for BS PUCCH demodulation requirements with JCE (if introduced)

- Proposals:
 - Option 1: Format 3 (China Telecom)
 - Option 2: Format 1, 2, 3, 4 (Nokia)
 - Option 3: Format 1 (Intel)
- **Recommended WF**
 - TBA

Issue 2-3-3: Slot number for JCE in BS PUCCH demod requirements (if introduced)

- Proposals:
 - For TDD
 - Option 1: 2 consecutive slots (China Telecom, Intel)
 - Option 2: 4? (Nokia)
 - For FDD
 - Option 1: 2 consecutive slots (Intel)
 - Option 2: more than 2 consecutive slots (China Telecom)
 - Option 3: 4 (Nokia)
- **Recommended WF**
 - TBA

Issue 2-3-4: Other parameters for BS PUCCH demodulation requirements with JCE (if introduced)

- Proposals:
 - Option 1: (China Telecom)

- 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 (okia)

Table 6:

Parameter	Format 1	Format 2	Format 3	Format 4
Number of information bits	2			
Modulation order		QSPK		
First PRB prior to frequency hopping	0			
Intra-slot frequency hopping	Disabled	N/A	Disabled	
First PRB after frequency hopping	The largest PRB index – (Number of PRBs – 1)			
Number of PRBs	1	4	3	1
Number of symbols	14	1	4	14
The number of UCI information bits		4	16	22
First symbol		13	0	
DM-RS sequence generation		$N_{ID}^0=0$		
Group and sequence hopping	neither	-		neither
First symbol			-	0
Length of the orthogonal cover code			-	n2
Index of the orthogonal cover code			-	n0

PUCCH-nrofSlots-r17 (RAN1 name TBD, Rel-17 dynamic PUCCH repetition factor indication)	4			
PUCCH-TimeDomainWindowLength (in slots) (RAN1 name TBD)	4			

- *Note: Intra-slot frequency hopping was disabled to allow for DM-RS bundling.*

- Option 3: Consider test configuration of existing multi-slot PUCCH requirements as the starting point (Intel)

– **Recommended WF**

- FFS

2.3 Companies views’ collection for 1st round

Sub-topic 2-1: General

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

Feedback Form 6: Sub-topic 2-1: General

<p>1 – Ericsson Inc.</p> <p>Ericsson:</p> <p>Issue 2-1-1: Pending until the conclusion of Issue 2-3-2 is agreed.</p>
<p>2 – China Telecommunications</p> <p>Issue 2-1-1: Test metric for BS PUCCH demodulation test cases</p> <p>The existing test metric for different PUCCH formats can be reused as a baseline.</p>
<p>3 – Intel Corporation SAS</p> <p>Issue 2-1-1: Option 1 is fine for us.</p>
<p>4 – Nokia France</p> <p>Issue 2-1-1: We can continue with option 1 as baseline for now and come back after Issue 2-3-2 has been agreed.</p>

<p>5 – Samsung Electronics Benelux BV</p> <p>Samsung: In general, we are fine with option 1, while we should focus on the test scope firstly</p>
<p>6 – HiSilicon Technologies Co. Ltd</p> <p>This issue should be discussed after conclusion is made in Issue 2-2-1 and Issue 2-3-1.</p>
<p>7 – Qualcomm CDMA Technologies</p> <p>Ok to adopt option 1 as a starting point.</p>

Sub-topic 2-2: Dynamic indication of PUCCH repetition

- Issue 2-2-1: Whether to define BS demodulation requirements for dynamic indication of PUCCH repetition

Feedback Form 7: Sub-topic 2-1: Dynamic indication of PUCCH repetition

<p>1 – Ericsson Inc.</p> <p>Ericsson: Issue 2-2-1: Support WF.</p>
<p>2 – China Telecommunications</p> <p>Issue 2-2-1: Whether to define BS demodulation requirements for dynamic indication of PUCCH repetition Support the recommended WF.</p>
<p>3 – Intel Corporation SAS</p> <p>Issue 2-2-1: Support recommended WF.</p>
<p>4 – Nokia France</p> <p>Issue 2-2-1: Agree with WF.</p>
<p>5 – Samsung Electronics Benelux BV</p> <p>Samsung we are fine with recommended WF</p>
<p>6 – HiSilicon Technologies Co. Ltd</p> <p>We prefer Option 1.</p>

7 – Qualcomm CDMA Technologies

Support WF.

Sub-topic 2-3: PUCCH demodulation with Joint Channel Estimation (JCE)

- Issue 2-3-1: Whether to define BS PUCCH demodulation requirements with JCE
- Issue 2-3-2: PUCCH format for BS PUCCH demodulation requirements with JCE (if introduced)
- Issue 2-3-3: Slot number for JCE in BS PUCCH demod requirements (if introduced)
- Issue 2-3-4: Other parameters for BS PUCCH demodulation requirements with JCE (if introduced)

Feedback Form 8: Sub-topic 2-3: PUCCH demodulation with Joint Channel Estimation (JCE)

1 – Ericsson Inc.

Ericsson:

Issue 2-3-1: Option 3 at current stage. It would be better to wait until core requirement is finalized.

Issue 2-3-2: We think Option 3 Format 1 with NACK -> ACK and ACK miss detection could be start point.

Issue 2-3-3: Depend on the conclusion of Issue 1-4-2.

Issue 2-3-4: Depend on the conclusion of Issue 2-3-2.

2 – China Telecommunications

Issue 2-3-1: Whether to define BS PUCCH demodulation requirements with JCE

With JCE, BS demodulation and decoding implementation for PUCCH will be impacted.

To HW, JCE for PUCCH is introduced in the coverage enhancement in RAN1, we should not discuss the necessity of this feature in RAN4.

Similar to PUSCH JCE, we support defining BS PUSCH demodulation requirements with JCE, while the detailed parameters should be set following RAN1 and RAN4 RF agreements.

Issue 2-3-2: PUCCH format for BS PUCCH demodulation requirements with JCE (if introduced)

We proposed to select the typical PUCCH format 3 for JCE test.

Issue 2-3-3: Slot number for JCE in BS PUCCH demod requirements (if introduced)

Same with issue 1-4-2

Issue 2-3-4: Other parameters for BS PUCCH demodulation requirements with JCE (if introduced)

Further discuss when we have decided on the PUCCH format

3 – Intel Corporation SAS

Issue 2-3-1: Support introduction of this requirements. This feature was introduced by RAN1. Therefore, we assume that benefits and necessity of this feature was proven before introduction.

Issue 2-3-2: We are open to further discuss the list of tested PUCCH formats. At least, we think that Format 1 and Format 2 or 3 or 4 can be considered.

Issue 2-3-3: We can check JCE performance for different options and decide further.

Issue 2-3-4: Further discuss depending on agreed list of covered PUCCH formats.

4 – Nokia France

Issue 2-3-1: RAN1 has identified for PUCCH to be included in improvements and said improvements required changes in the receiver implementation, as such option 1 seems like the correct way forward.

Issue 2-3-2: We are also ready to down select to format 1 and 3. However, at least two formats should have requirements, otherwise the test might not be applicable a larger number of BSs.

Issue 2-3-3: Same comments as Issue 1-4-2.

Issue 2-3-4: Agreeing to all parameters in this meeting might be too early. However, we would like for the main directions to be discussed, e.g. how many PUCCH slots are to be usable for bundling and the activation of intraslot and interslot FH.

Option 3 can serve as a starting point for format 1.

5 – Samsung Electronics Benelux BV

Samsung

Issue 2-3-1: Similar with PUSCH, at current stage, the RAN1 and RAN4 have still discussed the core requirement, such as UE coherent duration, to keep the power and phase continuous, so we prefer to option 3.

Issue 2-3-2: We are open to further discuss whether all the formats requirement should be considered for JCE requirement

Issue 2-3-3: At current stage, we are fine with option 1 for both FDD and TDD, while we are open whether the benefit can be achieved for large number of slots

Issue 2-3-4: This is 1st meeting to discuss the performance part, we prefer to keep it open, both option 1 and option 2 can be considered as starting point for further discussion

6 – HiSilicon Technologies Co. Ltd

Issue 2-3-1: Whether to define BS PUCCH demodulation requirements with JCE

We prefer Option 2. For the JCE for PUCCH, we don't think necessity to define requirements since PUCCH is not the weak point for the uplink transmission, good enough performance can be observed for legacy PUCCH repetition. Also, even we have PUCCH repetition features in Rel-16, the corresponding requirement is not considered in Rel-16. Also, we have multi-slot requirements defined in Rel-15 to ensure PUCCH performance.

7 – Qualcomm CDMA Technologies

Issue 2-3-1: Ok with option 1.

Issue 2-3-2: We can start with option 3.

Issue 2-3-3: pending the discussion in 1-4-2.

Issue 2-3-4: Pending the discussion in 2-3-2.

2.4 Summary for the 1st round

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

– *Candidate options*

- Option 1: (Nokia, Intel, Samsung, QC)
 - 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 (CTC)
- Option 3: FFS (E///, HW)

– *Recommendation for the second round*

- Further discuss in the next meeting

Issue 2-2-1: Whether to define BS demodulation requirements for dynamic indication of PUCCH repetition

– *Tentative agreement*

- *Agree not to define BS demodulation requirements for dynamic indication of PUCCH repetition (E///, CTC, Intel, Nokia, Samsung, HW, QC)*

Issue 2-3-1: Whether to define BS PUCCH demodulation requirements with JCE

– *Candidate options:*

- Option 1: Yes (China Telecom, Nokia, Intel, QC)
- Option 2: No (HW)
- Option 3: FFS after the finalization of core requirements in RAN1 and RAN4 (E///, Samsung)

– *Recommendation for the second round*

- Further check whether we can agree to define BS demodulation requirements for PUCCH with JCE.

Issue 2-3-2: PUCCH format for BS PUCCH demodulation requirements with JCE (if introduced)

– *Candidate options:*

- Option 1: Format 3 (China Telecom)
- Option 2: Format 1, 2, 3, 4 (Nokia)
- Option 3: Format 1 (Intel, E///, QC)
- Option 4: Format 1 and Format 2 or 3 or 4 (Intel)
- Option 5: Format 1 and 3 (Nokia)

– *Recommendation for the second round*

- Check whether can include PUCCH format 1 and FFS on other formats

Issue 2-3-3: Slot number for JCE in BS PUCCH demod requirements (if introduced)

– Proposals:

- For TDD
 - Option 1: 2 consecutive slots (China Telecom, Intel, Samsung)
 - Option 2: 4 slots within the configured TDW (Nokia)
 - Option 3: Depending on the issue 1-4-2 (E///)
- For FDD
 - Option 1: 2 consecutive slots (Intel, Samsung)
 - Option 2: more than 2 consecutive slots (China Telecom)
 - Option 3: 4 (Nokia, CTC)
 - Option 4: 8 (CTC)
 - Option 4: Depending on the issue 1-4-2 (E///)

– *Recommendation for the second round*

- Further discuss in the next meeting

Issue 2-3-4: Other parameters for BS PUCCH demodulation requirements with JCE (if introduced)

– Candidate options:

- Option 1: (China Telecom)
 - 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 (Nokia)

Table 7:

Parameter	Format 1	Format 2	Format 3	Format 4
Number of information bits	2			
Modulation order		QSPK		
First PRB prior to frequency hopping	0			
Intra-slot frequency hopping	Disabled	N/A	Disabled	
First PRB after frequency hopping	The largest PRB index – (Number of PRBs – 1)			
Number of PRBs	1	4	3	1
Number of symbols	14	1	4	14
The number of UCI information bits		4	16	22
First symbol		13	0	
DM-RS sequence generation		$N_{ID}^0=0$		
Group and sequence hopping	neither	-		neither
First symbol			-	0

Length of the orthogonal cover code			-	n2
Index of the orthogonal cover code			-	n0
PUCCH-nrofSlots-r17 (RAN1 name TBD, Rel-17 dynamic PUCCH repetition factor indication)	4			
PUCCH-TimeDomainWindowLength (in slots) (RAN1 name TBD)	4			

- *Note: Intra-slot frequency hopping was disabled to allow for DM-RS bundling.*

- Option 3: Consider test configuration of existing multi-slot PUCCH requirements as the starting point (Intel)

– *Recommendation for the second round*

- Further discuss in the next meeting

2.5 Discussion on the 2nd round

TBA

3 Recommendations for Tdocs

3.1 1st round

New tdocs

Table 8:

Title	Source	Comments
WF on PUSCH demodulation performance of Rel-17 NR coverage enhancement	China Telecom	
WF on PUCCH demodulation performance of Rel-17 NR coverage enhancement	Nokia, Nokia Shanghai Bell	

Existing tdocs

Table 9:

Tdoc number	Title	Source	Recommendation	Comments
R4-2200025	BS demodulation requirements for NR coverage enhancements	China Telecom	Noted	
R4-2200408	BS demodulation requirements for NR coverage enhancements	Nokia, Nokia Shanghai Bell	Noted	
R4-2200477	Discussion on BS demodulation requirements for NR coverage enhancement	Ericsson	Noted	
R4-2200756	View on demodulation requirement for Rel-17 coverage enhancement	Samsung	Noted	
R4-2201017	Discussion on BS coverage enhancement demod	Huawei, HiSilicon	Noted	
R4-2201604	Discussion on scope of BS demodulation requirements for NR coverage enhancements WI	Intel Corporation	Noted	

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:
 - a) CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
 - b) 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

3.2 2nd round

Table 10:

Tdoc number	Title	Source	Recommendation	Comments

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:
 - a) CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
 - b) Other documents: Agreeable, Revised, Noted
3. Do not include hyperlinks in the documents

undefined