**3GPP TSG-RAN WG4 Meeting # 101-bis-e R4-22xxxxx**

**Electronic Meeting, Jan 17 - 25, 2022**

**Agenda item:** **6.18.3**

**Source: China Telecom**

**Title: WF on PUSCH demodulation performance of Rel-17 NR coverage enhancement**

**Document for:** **Approval**

# Introduction

This document provides the way forward on PUSCH demodulation performance of Rel-17 NR coverage enhancement.

# PUSCH repetition type A with 32 repetitions

## Whether to define BS demodulation requirements for PUSCH repetition type A with 32 repetitions

* + Option 1: Yes (China Telecom, QC)
  + Option 2: No (Nokia, E///, HW, Intel, Samsung)

## Parameters for BS requirements for PUSCH repetition type A with 32 repetitions (if introduced)

* + 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
  + Other options are not precluded

## Test metric for BS PUSCH demodulation test cases (if introduced)

* + Option 1: Test SNR at which the PUSCH achieves 70% of throughput
  + Other options are not precluded

# PUSCH TB over Multi Slots (TBoMS)

## Whether to define BS demodulation requirements for PUSCH TBoMS

* + Define BS demodulation requirements for PUSCH TBoMS and further discuss the test parameters. (E///, CTC, Intel, Nokia, Samsung, HW, QC)

## Physical/available slots for BS requirements for PUSCH TBoMS

* + 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)

## Repetition number for BS requirements for PUSCH TBoMS

* + Option 1: 4 (China Telecom)
  + Option 2: Not to consider repetition for TBoMS (HW)
  + Option 3: FFS after available slot number is agreed (E///, Intel, Nokia, Samsung, QC)

## PRB number for BS requirements for PUSCH TBoMS

* + 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)
  + Option 2: Full applicable test bandwidth (E///, HW, QC)
  + Option 3: FFS pending whether frequency hopping should be enabled (Samsung)

## Inter-slot frequency hopping for BS requirements for PUSCH TBoMS

* + Option 1: Enabled (China Telecom~~, Nokia~~)
  + Option 2: Disabled (E///, HW)
  + Option 3: FFS (Intel, Samsung, QC)

## TDD UL-DL pattern for BS requirements for PUSCH TBoMS

* + For 30kHz SCS:
    - 7D1S2U, S=6D:4G:4U for 30kHz SCS (Nokia, HW, E///, CTC, Intel, HW)
  + For 15kHz SCS:
    - Reuse the pattern in the spec, i.e., 3D1S1U, S=10D:2G:2U (Intel)
  + The same requirements are applicable to TDD with different UL-DL pattern.

## Transform precoding for BS requirements for PUSCH TboMS

* + 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)

## Whether to consider UCI multiplexing on PUSCH for TBoMS transmission

* + Option 1: Test PUSCH demodulation with UCI multiplexing for TBoMS transmission (Samsung)
  + Option 2: Not to test PUSCH demodulation with UCI multiplexing for TBoMS transmission (E///, Nokia, HW)
  + Option 3: FFS (Intel, QC)

## Other parameters for BS requirements for PUSCH TboMS

* + Cover both FR1 and FR2
  + 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, 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 | PUSCH mapping type | A, B |
| Start symbol | 0 |
| Allocation length | 14 |
| Code block group based PUSCH transmission | | Disabled |

## Test metric for BS demodulation requirements for PUSCH TBoMS

* + Option 1: Test SNR at which the PUSCH achieves 70% of throughput
  + Other options are not precluded

# PUSCH demodulation with Joint Channel Estimation (JCE)

## Whether to define BS PUSCH demodulation requirements with JCE

* + 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)

## Slot number for JCE in BS PUSCH demod requirements

* + 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)

## PUSCH repetition type for BS PUSCH demod requirements with JCE

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

## PRB number for BS PUSCH demod requirements with JCE

* + Option 1: 4 PRB (China Telecom, Intel slightly preferred, Samsung)
  + Option 2: Full applicable test bandwidth (Nokia, E///, Intel, Samsung, HW, QC)

## Inter-slot frequency hopping for BS PUSCH demod requirements with JCE

* + Option 1: Enabled (China Telecom, Nokia)
  + Option 2: Disabled (E///, Intel, HW, QC)

## TDD UL-DL pattern for BS PUSCH demod requirements with JCE

* + 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)

## Transform precoding for BS PUSCH demod requirements with JCE

* + 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///)

## Other parameters for BS PUSCH demod requirements with JCE

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

|  |  |  |
| --- | --- | --- |
| 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 | NID0=0, nSCID =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

## Test metric for BS PUSCH demod requirements with JCE

* + Option 1: Test SNR at which the PUSCH achieves 70% of throughput
  + Other options are not precluded

# References