**3GPP TSG-RAN WG4 Meeting #111 R4-2408977**

**Fukuoka, Japan, 20th – 24th, 2024**

**Title:** Simulation assumption on demodulation requirements for NR NTN enhancements

**Source:** Huawei, HiSilicon

**Agenda item:** 7.16.8

**Document for:** Approval

# Background

In this contribution, the simulation assumption on demodulation requirements for NR NTN enhancements is captured for simulation results alignment.

# Simulation assumptions

## UE demodulation performance requirements

### PDSCH

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | | **Unit** | **Value** |
| Duplex mode | |  | FDD |
| Active DL BWP index | |  | 1 |
| PDSCH configuration | Mapping type |  | Type A |
| k0 |  | 0 |
| Starting symbol (S) |  | 1 |
| Length (L) |  | 13 |
| PDSCH aggregation factor |  | 1 |
| PRB bundling type |  | Static |
| PRB bundling size |  | 2 |
| Resource allocation type |  | Type 0 |
| RBG size |  | Config2 |
| VRB-to-PRB mapping type |  | Non-interleaved |
| VRB-to-PRB mapping interleaver bundle size |  | N/A |
| PDSCH DMRS configuration | DMRS Type |  | Type 1 |
| Number of additional DMRS |  | 1 |
| Maximum number of OFDM symbols for DL front loaded DMRS |  | 1 |
| CSI-RS for tracking | CSI-RS periodicity | Slots | 160 for CSI-RS resource 1,2,3,4. |
| CSI-RS offset | Slots | 80 for CSI-RS resource 1 and 2  81 for CSI-RS resource 3 and 4 |
| PT-RS configuration | |  | Not configured |
| Number of HARQ Processes | |  | 16 for Test 1-1, Test 1-2  32 for Test 1-3  For Test 1-4: 4 with feedback disabled, 12 with feedback enabled in 16 HARQ processes with re-Tx disable for all HARQ processes and only transmit initial transmissions with NDI toggling. Throughput shall be measured on processes with HARQ enabled. Which 4 processes to disable are randomly select at test configuration. |
| Maximum number of HARQ transmission | |  | 4 for Test 1-1, Test 1-2, Test 1-3  Disabled for all HARQ processes for Test 1-4 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **Propagation condition** | **Correlation matrix and antenna configuration** | **Test metric** |
| 1-1 | 200 / 120 | QPSK, 0.30(MCS4 in Table1) | NTN-TDLC5-1200 | 1x1 Low | 70% of maximum throughput |
| 1-2 | 200 / 120 | 16QAM, 0.48 (MCS13 in Table 1) | NTN-TDLC5-1200 | 1x1 Low | 70% of maximum throughput |
| 1-3 | 200 / 120 | QPSK, 0.30 | NTN-TDLC5-1200 | 1x1 Low | 70% of maximum throughput |
| 1-4 | 200 / 120 | QPSK, 0.30 | NTN-TDLC5-1200 | 1x1 Low | 70% of maximum throughput |

### PDCCH

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bandwidth (MHz) | SCS (kHz) | CORESET RB | CORESET duration | Aggregation level | CCE to REG mapping type | REG bundle size | Interleave size | Shift index | DCI format | Payload (without CRC) | Propagation Condition | Antenna configuration and correlation Matrix | Test metric |
| 200 | 120 | 132 | 1 | 8 | Interleaved | 2 | 3 | 0 | 1\_0 | 42 | NTN-TDLC5-1200 | 1x1 Low | 1% of Pm-dsg |
| 200 | 120 | 132 | 2 | 16 | Interleaved | 2 | 3 | 0 | 1\_1 | 56 | NTN-TDLC5-1200 | 1x1 Low | 1% of Pm-dsg |

## SAN demodulation performance requirements

### Above 10GHz bands

#### PUSCH

##### Normal PUSCH with CP-OFDM

|  |  |  |
| --- | --- | --- |
| **Parameter** | | **Value** |
| Transform precoding | | Disabled |
| 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 symbols | 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 resource | PUSCH mapping type | B |
| Start symbol index | 0 |
| Allocation length | 10 |
| Frequency domain resource | RB assignment | Full applicable test bandwidth |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | | Disabled |
| PT-RS configuration | Frequency density (*KPT-RS*) | Disabled |
| Time density (*LPT-RS*) | Disabled |
| Antenna configuration | | 1x1, 1x2 |
| Propagation condition | | NTN-TDLC5-1200 Low |
| MCS | | MCS 2 and MCS12 in Table 1 |
| SCS | | 120kHz |
| Channel bandwidth | | 50MHz |
| Test metric | | 70% of maximum throughput |

##### Normal PUSCH with DFT-s-OFDM

|  |  |  |
| --- | --- | --- |
| **Parameter** | | **Value** |
| Transform precoding | | Enabled |
| 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 symbols | 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 resource | PUSCH mapping type | B |
| Start symbol index | 0 |
| Allocation length | 10 |
| Frequency domain resource | RB assignment | 30 PRBs in the middle of the test bandwidth |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | | Disabled |
| PT-RS configuration | Frequency density (*KPT-RS*) | Disabled |
| Time density (*LPT-RS*) | Disabled |
| Antenna configuration | | 1x1, 1x2 |
| Propagation condition | | NTN-TDLC5-1200 Low |
| MCS | | MCS 2 in Table 1 |
| SCS | | 120kHz |
| Channel bandwidth | | 50MHz |
| Test metric | | 70% of maximum throughput |

##### PUSCH repetition Type A

|  |  |  |
| --- | --- | --- |
| **Parameter** | | **Value** |
| Transform precoding | | Disabled |
| HARQ | Maximum number of HARQ transmissions | 4 |
| RV sequence | 0, 3, 0, 3 [Note 1] |
| DM-RS | DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| Additional DM-RS symbols | 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 resource | PUSCH mapping type | B |
| Start symbol index | 0 |
| Allocation length | 10 |
| PUSCH aggregation factor | n2 |
| Frequency domain resource | RB assignment | Full applicable test bandwidth |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | | Disabled |
| PT-RS configuration | Frequency density (*KPT-RS*) | Disabled |
| Time density (*LPT-RS*) | Disabled |
| Antenna configuration | | 1x1, 1x2 |
| Propagation condition | | NTN-TDLC5-1200 Low |
| MCS | | MCS 5 in Table 3 |
| SCS | | 120kHz |
| Channel bandwidth | | 50MHz |
| Test metric [NOTE 2] | | 1% BLER |
| NOTE 1: The effective RV sequence is {0,2,3,1} with slot aggregation  NOTE 2: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks,  independently of the number HARQ transmission(s) for each transport block. | | |

#### PUCCH

##### PUCCH format 0

|  |  |
| --- | --- |
| **Parameter** | **Test** |
| Number of UCI information bits | 1 |
| Number of PRBs | 1 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | N/A for 1 symbol Enabled for 2 symbols |
| First PRB after frequency hopping | The largest PRB index – (Number of PRBs - 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 13 for 1 symbol  12 for 2 symbols |
| Antenna configuration | 1x1, 1x2 |
| Propagation condition | NTN-TDLC5-1200 Low |
| SCS | 120kHz |
| Channel bandwidth | 50MHz |
| Test metric | 1% of DTX to ACK probability  1% of ACK missed detection probability |

##### PUCCH format 1

|  |  |
| --- | --- |
| **Parameter** | **Test** |
| Number of information bits | 2 |
| Number of PRBs | 1 |
| Number of symbols | 14 |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index – (nrofPRBs – 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Initial cyclic shift | 0 |
| First symbol | 0 |
| Index of orthogonal cover code (*timeDomainOCC*) | 0 |
| Antenna configuration | 1x1, 1x2 |
| Propagation condition | NTN-TDLC5-1200 Low |
| SCS | 120kHz |
| Channel bandwidth | 50MHz |
| Test metric | 1% of DTX to ACK probability  0.1% of NACK to ACK probability  1% of ACK missed detection probability |

##### PUCCH format 2 (ACK missed detection)

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Modulation order | QSPK |
| Starting RB location | 0 |
| Intra-slot frequency hopping | N/A |
| Number of PRBs | 4 |
| Number of symbols | 1 |
| The number of UCI information bits | 4 |
| First symbol | 13 |
| DM-RS sequence generation | *NID*0=0 |
| Antenna configuration | 1x1, 1x2 |
| Propagation condition | NTN-TDLC5-1200 Low |
| SCS | 120kHz |
| Channel bandwidth | 50MHz |
| Test metric | 1% of DTX to ACK probability  1% of ACK missed detection probability |

##### PUCCH format 2 (UCI BLER)

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Modulation order | QSPK |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | enabled |
| Frist PRB after frequency hopping | The largest PRB index – (Number of PRBs – 1) |
| Number of PRBs | 9 |
| Number of symbols | 2 |
| The number of UCI information bits | 22 |
| First symbol | 12 |
| DM-RS sequence generation | *NID*0=0 |
| Antenna configuration | 1x1, 1x2 |
| Propagation condition | NTN-TDLC5-1200 Low |
| SCS | 120kHz |
| Channel bandwidth | 50MHz |
| Test metric | 1% of BLER |

##### PUCCH format 3

|  |  |
| --- | --- |
| **Parameter** | **Test 1** |
| Modulation order | QPSK |
| First PRB prior to frequency hopping | 0 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index – (Number of PRBs – 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Number of PRBs | 1 |
| Number of symbols | 14 |
| The number of UCI information bits | 16 |
| First symbol | 0 |
| DM-RS configuration | With and without additional DM-RS |
| Antenna configuration | 1x1, 1x2 |
| Propagation condition | NTN-TDLC5-1200 Low |
| SCS | 120kHz |
| Channel bandwidth | 50MHz |
| Test metric | 1% of BLER |

##### PUCCH format 4

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Modulation order | QPSK |
| First PRB prior to frequency hopping | 0 |
| Number of PRBs | 1 |
| Intra-slot frequency hopping | enabled |
| First PRB after frequency hopping | The largest PRB index – (Number of PRBs – 1) |
| Group and sequence hopping | neither |
| Hopping ID | 0 |
| Number of symbols | 14 |
| The number of UCI information bits | 22 |
| First symbol | 0 |
| DM-RS configuration | With and without additional DM-RS |
| Length of the orthogonal cover code | n2 |
| Index of the orthogonal cover code | n0 |
| Antenna configuration | 1x1, 1x2 |
| Propagation condition | NTN-TDLC5-1200 Low |
| SCS | 120kHz |
| Channel bandwidth | 50MHz |
| Test metric | 1% of BLER |

#### PRACH

|  |  |
| --- | --- |
| Parameter | Test |
| Burst format | B4, C2 |
| Time error tolerance | 0.13us |
| Ncs | 69 |
| Logical sequence index | 0 |
| v | 0 |
| Antenna configuration | 1x1, 1x2 |
| Propagation condition | NTN-TDLC5-1200 Low |
| Frequency offset | 3000Hz |
| SCS | 120kHz |
| Channel bandwidth | 50MHz |
| Test metric | 0.1% of DTX to ACK probability  1% of ACK missed detection probability |

### PUSCH with DMRS bundling for FR1

#### Normal PUSCH with CP-OFDM

|  |  |  |
| --- | --- | --- |
| **Parameter** | | **Value** |
| Transform precoding | | Disabled |
| HARQ | Maximum number of HARQ transmissions | 4 |
| RV sequence [Note 1] | 0, 0, 0, 0 [Note1] |
| 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 |
| PUSCH aggregation factor | n4 for 15kHz SCS  n8 for 30kHz SCS |
| pusch-TimeDomainWindowLength | | 8 for n8, 4 for n4 |
| Frequency domain resource assignment | RB assignment | 6 RBs in the middle of test bandwidth |
| Frequency hopping | Disabled |
| Code block group based PUSCH transmission | | Disabled |
| Antenna configuration | | 1x1, 1x2 |
| Propagation condition | | NTN-TDLA100-200 Low |
| MCS | | MCS 4 in Table 1 |
| SCS | | 15kHz, 30kHz |
| Channel bandwidth | | 5MHz for 15kHz SCS  10MHz for 30kHz SCS |
| Test metric | | 1% BLER [Note 2] |
| Note 1: The effective RV sequence is {0, 2, 3, 1} with slot aggregation.  Note 2: BLER is defined as residual BLER; i.e. ratio of incorrectly received transport blocks / sent transport blocks, independently of the number HARQ transmission(s) for each transport block. | | |

# Proposals

In this contribution, the simulation assumption on demodulation requirements for NR NTN enhancements is captured for simulation results alignment.

# Reference

1. R4-2406024, WF on NR\_NTN\_enh\_SAN\_UE\_demod, RAN4#110bis, Huawei, HiSilicon
2. R4-2402660, Topic summary for [110][320] NR\_NTN\_enh\_SAN\_UE\_demod, RAN4#110, Huawei, HiSilicon
3. R4-2402865, WF on NR\_NTN\_enh\_SAN\_UE\_demod, RAN4#110, Huawei, HiSilicon
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5. R4-2316921, WF on NR\_NTN\_enh\_SAN\_UE\_demod, RAN4#108-bis, Huawei, HiSilicon