**3GPP TSG-RAN WG4 Meeting #94-e R4-200xxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.9.1.2 & 8.9.1.3

**Source:** Moderator (Huawei, HiSilicon)

**Title:** Email discussion summary for RAN4#94e\_#91\_NR\_L1enh\_URLLC\_Demod\_Requirements (2nd round)

**Document for:** Information

# Introduction

The discussions in this thread include URLLC UE and BS demodulation requirements for high reliability but with higher BLER and/or lower confidence level and low latency and UE CQI reporting requirements for high reliability. The discussion about UE and BS demodulation requirements for high reliability with BLER 10^-5 and confidence level 99.999% will happen in another thread RAN4#94e\_#90\_NR\_L1enh\_URLLC\_Demod\_Test:

* Topic #1: UE demodulation requirements for high reliability with higher BLER and/or lower confidence level.
* Topic #2: UE PDSCH demodulation requirements for low latency.
* Topic #3: UE CQI reporting requirements for support of CQI table 3.

*Note: As per the discussion about the test feasibility and methodology in thread RAN4#94e\_#90\_NR\_L1enh\_URLLC\_Demod\_Test for ultra-low BLER CQI requirement is concluded, RAN4 can discuss whether other high BLER CQI reporting test is needed or not if possible.*

* Topic #4: BS demodulation requirements for high reliability with higher BLER and/or lower confidence level.
* Topic #5: BS demodulation requirements for low latency.
* Topic #6: PUCCH demodulation requirements for high reliability.

**Background:**

As per the approved WF R4-1915913, the following open issues will be discussed in this email thread:

|  |
| --- |
| UE demodulation requirements for high reliability   * Other test cases will be defined with higher BLER and/or lower confidence level   + Other parameter combinations of HARQ, aggregation, channel etc. and further requirements will be considered.   + When further requirements are specified, it will be decided case by case whether to test them at 10^-5 BLER and CL 99.999% or other conditions   + These test cases will include PDSCH aggregation     - FFS PDSCH aggregation level   UE CQI reporting requirements for high reliability   * Introduce CQI reporting requirements to verify the support of CQI Table 3   + Option 1: CQI test in AWGN   + Option 2: CQI test in fading channel   + FFS:     - Target BLER     - Test metrics   UE demodulation requirements for low latency   * Introduce PDSCH demodulation performance requirements to verify PDSCH processing capability 2   + UL-DL configuration     - FFS on TDD pattern     - FFS on which slots will be scheduled * Introduce performance requirements to verify PDSCH mapping Type B with non-slot configured with fewer symbols than Rel-15 demod   + Option 1: define the additional PDSCH demodulation performance requirements   + Option 2: no specific requirement and verify it in the other introduced performance requirements * Introduce PDSCH demodulation performance requirements for pre-emption   + Verify the performance of UE flushing the URLLC PDSCH REs which is scheduled by DCI transmitted after that URLLC PDSCH   + FFS whether to define the demodulation requirements to verify decoding performance of PDSCH transmitted ahead of corresponding DCI   BS demodulation requirements for high reliability   * Other test cases will be defined with higher BLER and/or lower confidence level   + Other parameter combinations of HARQ, aggregation, channel etc. and further requirements will be considered.   + When further requirements are specified, it will be decided case by case whether to test them at 10^-5 BLER and CL 99.999% or other conditions   + Other test cases will include PUSCH aggregation     - FFS PUSCH aggregation level   BS demodulation requirements for high reliability   * FFS on introduction of PUCCH demodulation performance requirements   BS demodulation requirements for low latency   * Introduce PUSCH demodulation requirements to verify the support of PUSCH mapping Type B with non-slot configured with fewer symbols than Rel-15 * FFS requirements for UL transmission with grant free/UL configured grant |

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

* 1st round:
  + UE demodulation requirements:
* Key parameters for test cases to be defined for higher BLER and/or lower confidence level
* Conclude whether to define CQI reporting test with higher BLER
* Low latency
  + PDSCH processing capability 2
    - Initial agreements about some key parameters
  + PDSCH mapping Type B
    - Conclude how to verify the PDSCH mapping type B with non-slot configured with fewer symbols than Rel-15 demod features, i.e. individual test or combine with other requirements
      * If no individual test needed, verify with processing capability 2 or pre-emption
  + Pre-emption
    - Key parameters for eMBB demodulation requirements
    - Whether to define demodulation requirements for URLLC service
  + BS demodulation requirements:
* Cases with higher BLER and/or lower confidence level
* Key parameters
* PUCCH demodulation requirements
* Whether to define
* Low latency
* PUSCH mapping Type B
* Key parameters
* UL transmission grant free
  + - Whether to define
* 2nd round:
  + Agree on the initial simulation assumptions for those agreed test cases to facilitate further investigations or alignments.

# Topic #1: UE performance requirements for high reliability

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000371**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000371.zip) | Intel Corporation | Proposal #3: Introduce PDSCH demodulation test cases PDSCH slot aggregation with [1]% BLER requirement. |
| [**R4-2000944**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000944.zip) | NTT DOCOMO, INC. | Proposal 1: Following TDD configs should be supported for URLLC in order to avoid CLI.   * 1st priority   + 30kHz SCS: DDDSUUDDDD, S=6D:4G:4U   + 120kHz SCS: DDDSU, S=10D:2G:2U * 2nd priority   + 30kHz SCS: DSUU, S=12D:2G |
| [**R4-2001484**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001484.zip) | Huawei, HiSilicon | Proposal 4: We propose to test fading channel TDLA30-10.  Proposal 5: We propose to use lower BLER target of 10-3 when define other test cases.  Proposal 6: For test case TDLA30-10, we propose PDSCH aggregation level is 4. |
| [**R4-2001738**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001738.zip) | Ericsson | Proposal: Evaluate performance simulations for slot aggregation feature before setting BLER test point. |
| [**R4-2002142**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002142.zip) | Qualcomm Incorporated | Proposal 5: Only consider aggregation factor of 1 for low BLER high confidence level test. Define a separate test case for testing aggregation factor. |

## Open issues summary

In this section, the test parameters, such as target BLER, aggregation level and HARQ etc., for the cases of fading channels are discussed.

### Sub-topic 1-1: UE demodulation requirements with higher BLER and/or lower confidence level

*From the approved WF R4-1915913 in RAN4#93 meeting, following were agreed:*

* *Other test cases will be defined with higher BLER and/or lower confidence level* 
  + *Other parameter combinations of HARQ, aggregation, channel etc. and further requirements will be considered.*
  + *When further requirements are specified, it will be decided case by case whether to test them at 10^-5 BLER and CL 99.999% or other conditions*
  + *These test cases will include PDSCH aggregation if that is not included in the low BLER/high reliability testing.*

*FFS PDSCH aggregation level*

*Open issues and candidate options before e-meeting:*

**Issue 1-1-1: Target BLER**

* Proposals
  + Option 1: 1% BLER requirement (Intel, Ericsson)
  + Option 2: 10% (Ericsson)
  + Option 3: 0.1% (Ericsson, Huawei)
* Recommended WF
  + Align with UL, Option 1 is acceptable for all companies?

**Issue 1-1-1a: How to calculate the target BLER if HARQ activated**

* Proposals
  + Option 1: 1st transmission BLER (Ericsson)
  + Option 2: BLER after all transmission if HARQ activated (Ericsson, Huawei)
* Recommended WF
  + If agree to use 1% BLER, Option 2 is acceptable for all companies?

**Issue 1-1-2: PDSCH aggregation level**

*Note: This also depends on if the aggregation level is included in the low BLER/high reliability testing under discussion in email thread of URLLC testing.*

* Proposals
  + Option 1: 2, 4, 8 for FR1 FDD. (Ericsson)
  + Option 2: 4 and/or 7 for FR1 TDD (Ericsson)
  + Option 3: 2 and/or 3 for FR2 TDD (Ericsson)
  + Option 4: 4 (Huawei)
  + Option 5: 8 (Ericsson)
* Recommended WF
  + As per TS 38.331: *pdsch-AggregationFactor ENUMERATED { n2, n4, n8 }* , default value n1, so only aggregation level 2, 4 or 8 is applicable.
  + Continue discussion for FDD and TDD separately

**Issue 1-1-3: TDD pattern**

* Proposals
  + FR1 30 kHz SCS:
    - Option 1: 7D1S2U, S=6D:4G:4U (Huawei, Ericsson, Qualcomm)
    - Option 2: DDDSUUDDDD, S=6D:4G:4U (DoCoMo)
  + FR2 120 kHz SCS:
    - Option 1: DDDSU, S=10D:2G:2U (Ericsson, DoCoMo)
* Recommended WF
  + Aggregation level and TDD pattern need to be discussed together, as per TS 38.214 section 5.1.2.1: *if the UE is configured with pdsch-AggregationFactor, the same symbol allocation is applied across the pdsch-AggregationFactor consecutive slots. The UE may expect that the TB is repeated within each symbol allocation among each of the pdsch-AggregationFactor consecutive slots and the PDSCH is limited to a single transmission layer. The configured PDSCH aggregation factor should be distinguished from the real transmission number.*
  + Agree Option 1 for FR 1 30 kHz SCS.
  + Postpone discussion FR2 parameters until decision made on FR2 requirements.

**Issue 1-1-4: Number of HARQ transmission**

* Proposals
  + Option 1: 1 (Ericsson, Intel)
  + Option 2: 4 (Huawei, Qualcomm)
* Recommended WF
  + Continue to discuss

**Issue 1-1-5: MCS**

* Proposals
  + Option 1: MCS 4 in table 3 (Ericsson)
  + Option 2: MCS 5 in table 3 (Huawei, Ericsson, Intel)
* Recommended WF
  + Agree option 2

Moderator’s observation: except the above test parameters, RAN4 can reuse all other test parameters from the existing requirements for PDSCH mapping Type A or B, FDD with 10MHz/15kHz SCS, TDD of FR1 with 40MHz/30kHz SCS, FR2 with 100MHz/120kHz SCS, 2Rx and 4Rx?

**Issue 1-1-6: Propagation condition**

* Proposals
  + FR1
    - Option 1: TDLC300-100 (Ericsson)
    - Option 2: TDLA30-10 (Huawei, Ericsson, Qualcomm, Intel)
  + FR2
    - Option 1: TDLC60-300 (Ericsson)
    - Option 2: TDLA30-300 (Ericsson, Intel)
* Recommended WF
  + Agree option 2 for FR1.
  + Postpone discussion FR2 parameters until decision made on FR2 requirements.

**Issue 1-1-7: SCS &CBW**

* Proposals
  + FDD
    - Option 1: 15 kHz & 10MHz (Huawei, Ericsson, Qualcomm)
  + TDD
    - FR1: 30 kHz & 40MHz (Huawei, DoCoMo, Ericsson, Qualcomm)
    - FR2: 120 kHz & 100MHz SCS (DoCoMo, Ericsson, Huawei)
* Recommended WF
  + Agree 15 kHz & 10 MHz for FDD, 30 kHz & 40 MHz for FR1 TDD.
  + Postpone discussion FR2 parameters until decision made on FR2 requirements.

**Issue 1-1-8: PDSCH Mapping type**

* Proposals
  + Option 1: Type A (Ericsson, DoCoMo, Huawei, Qualcomm, Intel)
  + Option 2: Type B (Huawei, DoCoMo)
* Recommended WF
  + Agree option 1

**Issue 1-1-9: Starting symbol (S)**

* Proposals
  + Option 1: 2 (Huawei, Ericsson, Qualcomm)
* Recommended WF
  + Agree option 1

**Issue 1-1-10: Length (L)**

* Proposals
  + Option 1: 12 (Ericsson, DoCoMo, Huawei, Qualcomm)
  + Option 2: 4 (Huawei)
* Recommended WF
  + Agree option 1.

**Issue 1-1-11: Antenna configuration**

* Proposals
  + FR1
    - Option 1: 2x2, ULA low (Intel)
    - Option 2: 2x2 and 2x4, ULA low (Ericsson, DoCoMo, Huawei, Qualcomm)
  + FR2
    - Option 1: 2x2, ULA low (Ericsson, Huawei, Intel)
* Recommended WF
  + Agree option 2 for FR1.
  + Postpone discussion FR2 parameters until decision made on FR2 requirements.

### Sub-topic 1-2: Others

**Issue 1-2-1: Whether to define URLLC high reliability requirements for FR2**

* Proposals
  + Option 1: Down-prioritized it for later (Qualcomm)
  + Option 2:
* Recommended WF
  + Discussion for 2nd round to collect more companies’ view

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Sub topic 1-1:  Issue 1-1-1: We think it is better to wait with setting a strict BLER value until we have performance curves. Given different aggregation factors, and MCSs we need to set BLER requirements at not too low SNR values. Therefore, we are ok to leave BLER target metric open until we have simulated with a common set of simulation assumptions.  Issue 1-1-2: Our proposal with 3, and 7 is the practical values when configuring aggregation factor 4, and 8. For TDD patterns which are shorter than the aggregation factor will truncate the number of consecutive slots aggregated to 3, and 7 given DDDSU, and 7D1S2U respectively.  Issue 1-1-4: What’s the motivation behind having both HARQ and PDSCH aggregation factor configured together?  Issue 1-1-5: We are ok with either MCS4 or MCS5 but we think that we should not test with too high MCS given that PDSCH aggregation factor feature is intended for high reliability, not high throughput.  Issue 1-1-7: We are fine with using 10MHz/15kHz FDD, 40MHz/30kHz TDD FR1, 100MHz/120kHz TDD FR2  Issue 1-1-8: I don’t follow why we would allocate fewer than the maximum number of symbols and then do slot aggregation? If aggregation is needed to achieve sufficient SINR, why not use all slots?  ….  Update 2020-02-25:  Issue 1-1-4: To Huawei: If we consider HARQ, then similarly to the uplink we need to consider whether the BLER is the per transmission BLER or BLER after all transmissions. We see there could be some sense to consider HARQ with aggregation. For the latency we will comment below; it is not clear whether HARQ is useful if short slots are used to meet a strict latency target. |
| NTT DOCOMO | **Issue 1-1-2: PDSCH aggregation level**  We prefer to have at least 8, since it can guarantee the maximum performance benefit for PDSCH aggregation.  **Issue 1-1-3: TDD pattern**  We are generally fine to have 7D1S2U but we’d like to shifted it as DDDSUUDDDD (S=6d4g4u). For FR2, DDDSU (S=10d2g2u) is preferred.  **Issue 1-1-7: SCS &CBW**  FR1: 30 kHz & 40 MHz; FR2: 120 kHz & 100 MHz  **Issue 1-1-8: PDSCH Mapping type**  Option 1: Type A. But we are also fine to have type B, if type A is used for the test on high reliability with BLER 10^-5 and confidence level 99.999%.  **Issue 1-1-10: Length (L)**  Option 1: 12  **Issue 1-1-11: Antenna configuration**  Option 2: 2x2 and 2x4, ULA low |
| Huawei | Sub topic 1-1:  Issue 1-1-2: There is no necessary to test all the possible slot aggregation for one TDD pattern, this is just functionality test. As per the specification, only n2, n4 and n8 can be configured, it is true that PDSCH can transmit 3 or 7 repetition based on the configured TDD pattern, but the configured value should be just n2, n4 and n8.  Issue 1-1-4: Based on the core specification from RAN1, HARQ and repetition can be all configured. The motivation of using repetition is to improve the success rate of the first transmission of HARQ. The number of 4 HARQ process is just the maximum number of HARQ transmission, if the initial transmission is successful, it is not mandated to transmit 4 times.  For the ultra-low BLER target (10^-5), RAN4 has agreed to consider aggregation factor will be configured to 1 or 2, and no HARQ will be configured in the case to reduce the test time. So for other test cases with high BLER and/or low confidence level, we prefer to configure both repetition and HARQ.  Issue 1-1-8: From the RAN1 definition, the motivation of using mapping type B is to support very low latency transmissions, and the mini-slot is a key feature for URLLC. Although we are only considering the high reliability in this case, the mini-slot configuration will be configured in most URLLC scenarios. But if RAN4 would like to only test slot aggregation and reuse other parameters from Rel-15 for eMBB. We are ok to mapping type A.  Issue 1-1-10: If RAN4 agrees to use mapping type A, we are ok with L=12.  Issue 1-1-11: FR1 Option 2 and FR2 Option 1 are ok for us.  Update 2020-02-26:  Issue 1-1-4: To Ericsson: In this case, we are only consider the high reliability for DL, features relate to low latency will be considered in Sub-topic #2. For the high reliability of UL, we comment on Sub-topic #4. |
| Qualcomm | Issue 1-1-1/2/5: We prefer to choose Target BLER, PDSCH aggregation level and MCS based on the simulations to make sure that required SNR is not too low. So, we should agree on some simulation assumptions first with possible options for these parameters and then decide.  Issue 1-1-3:For FR1 30kHz SCS, we prefer to use the default TDD config, i.e., 7D1S2U.  Issue 1-1-4: As these tests will not be long tests, it should be ok to use 4 HARQ processes.  Issue 1-1-6: For FR1, we prefer to use TDLA30-10 channel model.  Issue 1-1-7: We are ok with FR1 options.  Issue 1-1-8: We prefer Option 1 since we are only testing high reliability here and not low latency.  Issue 1-1-9: Option 1 is ok.Issue 1-1-10: Option 1 is ok.  Issue 1-1-11: We prefer Option 2 for FR1 similar to other test cases so that UE could be tested for bands with mandatory 4Rx.  Others: We should first discuss whether to define URLLC requirements for FR2 or not before agreeing to parameters because many UEs may not support it in the beginning. So, it may be down-prioritized for later. |
| Intel | Sub-topic 1-1: UE demodulation requirements with higher BLER and/or lower confidence level  Issue 1-1-1: Ericsson’s proposal above is reasonable. We proposed [1%] BLER in our paper  Issue 1-1-2, 1-1-3: Recommend choosing a AL that is feasible in the TDD config chosen  Issue 1-1-4: We propose to disable HARQ re-transmission with slot aggregation enabled. Given that we are testing at a low BLER < 10% (from proposals so far) the gain from HARQ re-TX should be marginal  Issue 1-1-5: Option 2  Issue 1-1-6: Option 2  Issue 1-1-7: Reuse Rel-15 assumptions  Issue 1-1-8: Option 1: Type A mapping.  Issue 1-1-11: 2x2 ULA Low |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1-1** | Tentative agreements:  **Test parameters for UE FR1 URLLC demodulation requirement with high BLER**   * TDD pattern: 7D1S2U, S=6D: 4G: 4U for 30 kHz SCS. * MCS: MCS 5 in table 3. * Propagation condition: TDLA30-10 * SCS & CBW:   + FDD: 15 kHz & 10 MHz   + TDD: 30 kHz & 40 MHz * PDSCH configuration: Mapping type A, symbol length 12, starting symbol 2. * Antenna configuration: 2x2 and 2x4, ULA low   Candidate options:  Recommendations for 2nd round:   * Whether to introduce UE FR2 URLLC performance requirements * Remaining parameters still kept open are further 2nd round discussion, which are captured in section 1.5. |

*Recommendations on WF/LS assignment*

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

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *No CRs/TPs.* |

## Discussion on 2nd round

### Open issues

**Issue 1-5-1: Whether to define UE FR2 URLLC requirements for high reliability**

* Proposals
  + Option 1: Define requirements for FR2.
  + Option 2: Do not define requirements for FR2. (Qualcomm)
* Recommended WF
  + TBA

**Issue 1-5-2: Target BLER**

* Proposals
  + Option 1: 1% BLER requirement (Intel, Ericsson)
  + Option 2: 10% (Ericsson)
  + Option 3: 0.1% (Ericsson, Huawei)
* Recommended WF
  + Align with UL, Option 1 is acceptable for all companies?

**Issue 1-5-3: How to calculate the target BLER if HARQ activated**

* Proposals
  + Option 1: 1st transmission BLER (Ericsson)
  + Option 2: BLER after all transmission if HARQ activated (Ericsson, Huawei)
* Recommended WF
  + If agree to use 1% BLER, Option 2 is acceptable for all companies?

**Issue 1-5-4: Target confidence level**

* Proposals
  + Option 1: 99%
  + Option 2: 95%
* Recommended WF
  + TBA

**Issue 1-5-5: PDSCH aggregation level**

* Proposals
  + Option 1: 2, 4, 8 for FR1 FDD. (Ericsson)
  + Option 2: 4 and/or 7 for FR1 TDD (Ericsson)
  + Option 3: 2 and/or 3 for FR2 TDD (Ericsson)
  + Option 4: 4 (Huawei)
  + Option 5: 8 (Ericsson)
* Recommended WF
  + As per TS 38.331: *pdsch-AggregationFactor ENUMERATED { n2, n4, n8 }* , default value n1, so only aggregation level 2, 4 or 8 is applicable.
  + Continue to discuss for FDD and TDD separately, propose:
    - FDD: 2 or 4
    - TDD: 2

**Issue 1-5-6: Number of HARQ transmission**

* Proposals
  + Option 1: 1 (Ericsson, Intel)
  + Option 2: 4 (Huawei, Qualcomm)
* Recommended WF

### Companies’ views collection for 2nd round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Issue 1-5-1: Our understanding is that in FR2, there are some applications that can benefit from slot aggregation or type B mapping with fewer symbols but do not need ultra-low BLER. These may be URLLC but also for eMBB. So in our view it is useful to create some FR2 demod requirements with high BLER. Ultra-low BLER tests for FR2 are not needed.  Issue 1-5-2/3: Maybe good to use the same approach as PUSCH here.  Issue 1-5-4: We should use the same confidence level as agreed for PUSCH; i.e. 99%  Issue 1-5-5: We think that for TDD, configuring 4 for TDD pattern DDDSU would be more efficient. It would lead to 3 slots repetition (as only 3 slots are available; the 4th would not be used for repetition.), but otherwise the third DL slot could be unused.  Issue 1-5-6: We are OK to compromise to option 2  …. |
| Intel | Issue 1-5-1: Option1. It is useful to introduce requirements in FR2 for verifying features related to URLLC for high reliability and low latency  Issue 1-5-2: Option 1: 1% BLER; Align with UL  Issue 1-5-3: Option 2  Issue 1-5-4: Option 1: Align with UL  Issue 1-5-5: AL of 4 for FR1 for TDD pattern 7D1S2U; AL of 4 for FR2 with TDD pattern DDDSU |
| NTT DOCOMO | Issue 1-5-1: We prefer Option 1  Issue 1-5-5: We prefer 8 for FDD and 4 for TDD pattern DDDSUUDDDD since it can guarantee the maximum performance benefit for PDSCH aggregation.  Issue 1-5-6: We prefer Option 2 |
| Huawei | Issue 1-5-1: We prefer option 2. From current deployment request, we do not observe there is any request for FR2 URLLC deployment, it is better to focus on FR1 firstly and deprioritize FR2.  @Ericsson, we agree with you that aggregation and Type B are used not only for URLLC, but also for eMBB, but here we are discussing the performance requirements for URLLC, it is better to focus on URLLC scenario.  Issue 1-5-2/4: We are ok option 1. i.e. Align with UL.  Issue 1-5-5: Considering that we agreed “TDD pattern: 7D1S2U, S=6D: 4G: 4U for 30 kHz SC” in the first round discussion (unless company has strong concern about this tentative agreement), so we should share our proposal on aggregation level based on this TDD pattern. We still prefer 4. |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: UE demodulation requirements for low latency

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000371**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000371.zip) | Intel Corporation | Proposal #6: Use PDSCH mapping Type B with 2 symbols in PDSCH processing capability 2 test case  Proposal #7: Introduce test case with PDSCH processing capability 2 with the following parameters:  PDSCH Mapping Type B with 2 symbols For TDD mode – TDD pattern: SU; S=12D+2G  Number of HARQ processes: 2  Proposal #8: Introduce requirement to test DL preemption indication on eMBB UE |
| [**R4-2000944**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000944.zip) | NTT DOCOMO, INC. | Proposal 1: Following TDD configs should be supported for URLLC in order to avoid CLI.   * 1st priority   + 30kHz SCS: DDDSUUDDDD, S=6D:4G:4U   + 120kHz SCS: DDDSU, S=10D:2G:2U * 2nd priority   + 30kHz SCS: DSUU, S=12D:2G   Proposal 2: For non-slot based transmission, L= 2 and 4 should be supported. |
| [**R4-2001485**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001485.zip) | Huawei, HiSilicon | Observation 1: PDSCH mapping Type B of 2-symbol and 4-symbol can be supported by the special slot of ‘DDDSU’ pattern.  Observation 2: PDSCH mapping Type B of 2-symbol and 4-symbol can be supported by the special slot of ‘7D1S2U’ pattern.  Proposal 1: No specific requirement is needed for PDSCH mapping Type B, it can be verified with UE processing capability 2 requirements.  Proposal 2: To define UE processing capability 2, we propose to use ‘DDDSU’ pattern and use the PDSCH mapping Type B with 2-symbol configuration on the special slot to verify the performance requirements.  Proposal 3: we propose to use combination of {14, 1} for PI and periodicity T­INT =1.  Proposal 4: Define the RAN5 test to verify URLLC performance for pre-emption. |
| [**R4-2001739**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001739.zip) | Ericsson | Observation 1: URLLC UEs using pre-emption to transmit data do not need new demodulation requirements to ensure pre-emption functionality.  Observation 2: eMBB UEs which are affected by DL pre-emption need new demodulation requirements to support URLLC data pre-emption indication from DCI format 2\_1.  Observation 3: Rel-15 eMBB UE requirements do not have any performance requirements for DL data pre-emption. Therefore, if this feature is introduced, legacy Rel-15 eMBB demodulation performance cannot be guaranteed in a Release heterogenous network including pre-emption capable gNBs and UEs.  Proposal 1: Introduce a selected number of test cases for eMBB scheduled UEs with REs punctured for the URLLC pre-empted UE.  Proposal 2: Capture eMBB demodulation requirements for DL pre-emption by reusing three Rel-15 test cases (FR1 FDD, FR1 TDD, and FR2 TDD) and applying additional configurations from Table 1, and Table 2.  Proposal 3: Capture new demodulation requirements for Type B non-slot transmission based on the parameters found in Table 3, and Table 4.  Proposal 4: Introduce UE demodulation test case with k1 HARQ timing value which corresponds to PDSCH processing Capability 2. Base demodulation test cases off tests from Table 6. This is applicable for both FDD and TDD and for TDD, RAN4 reuse the existing TDD UL/DL configuration. |
| [**R4-2002142**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002142.zip) | Qualcomm Incorporated | Proposal 6: Use 2 symbol PDSCH Type B grant and set HARQ parameter k1 = 0 for testing URLLC low latency feature.  Proposal 7: Use FR1.30-2 (DDDSU, S = 10D+2G+2U) slot pattern and schedule grant only on S slot for testing URLLC low latency feature for TDD. |

## Open issues summary

In this section, views about the features related to low latency are summarised that include PDSCH mapping Type B, PDSCH processing capabiltiy 2 and pre-emption. How to verify these three features, devise individual test case or verify two features in one test cases need to be discussed firstly before the dicussion for the detailed test parameters.

### Sub-topic 2-1: PDSCH processing capability 2

*From the approved WF R4-1915913 in RAN4#93 meeting, following were agreed:*

*UE demodulation requirements for low latency*

* *Introduce PDSCH demodulation performance requirements to verify PDSCH processing capability 2*
  + *UL-DL configuration* 
    - *FFS on TDD pattern*
    - *FFS on which slots will be scheduled*

*Open issues and candidate options before e-meeting:*

**Issue 2-1-1: How to verify PDSCH processing capability 2**

* Proposals
  + Option 1: Verify it with PDSCH mapping Type B (Intel, Huawei, Qualcomm, DoCoMo)
  + Option 2: Individual test by reusing the Rel-15 eMBB test cases with change of the HARQ timing K1 values (Ericsson)

|  |  |  |  |
| --- | --- | --- | --- |
| **Test cases** | **FR1 FDD** | **FR1 TDD** | **FR2 TDD** |
| 38-101-4 v.15.4.0 Table | 5.2.2.1.1-4 | 5.2.2.2.1-4 | 7.2.2.2.1-4 |
| Test number | 2-1 | 2-1 | 2-2 |
| TDD UL-DL pattern | N/A | FR1.30-1 (7D1S2U) | FR2.120-1 (DDDSU) |
| FRC | R.PDSCH.1-3.1 FDD | R.PDSCH.2-3.1 TDD | R.PDSCH.5-2.2 TDD |

* Recommended WF
  + TBA

***Note：If verify PDSCH processing capability 2 with mapping Type B, proposals from companies are captured below:***

**Issue 2-1-2: Slots to be scheduled**

* Proposals
  + Option 1: S slot (Intel, Huawei, Qualcomm, DoCoMo)
  + Option 2: Every slot (Ericsson)
* Recommended WF
  + Agree Option 1: S slot

**Issue 2-1-3: TDD pattern**

* Proposals
  + FR1 TDD 30kHz SCS:
    - Option 1: 7D1S2U, S=6D:4G:4U (Ericsson)
    - Option 2: DDDSUUDDDD, S=6D:4G:4U (1st priority), DSUU, S=12D:2G (2nd priority) (DoCoMo)
    - Option 3: DDDSU, S=10D+2G+2U (Huawei, Qualcomm)
    - Option 4: SU, S=12D+2G (Intel)
  + FR2 120 kHz SCS:
    - Option 1: DDDSU, S=10D:2G:2U (Ericsson, DoCoMo)
* Recommended WF
  + Focus on FR1 TDD first

**Issue 2-1-4: Number of HARQ processes**

* Proposals
  + Option 1: 2 (Intel, DoCoMo)
* Recommended WF
  + More inputs are needed after decision on TDD patterns

**Issue 2-1-5: Parameter K1**

* Proposals
  + Option 1: 0 (Qualcomm)
  + Option 2: Change K1 HARQ timing based off existing eMBB tests (Ericsson)
* Recommended WF
  + Agree Option 1: 0

### Sub-topic 2-2: PDSCH mapping Type B

*From the approved WF R4-1915913 in RAN4#93 meeting, following were agreed:*

* *Introduce performance requirements to verify PDSCH mapping Type B with non-slot configured with fewer symbols than Rel-15 demod*
  + *Option 1: define the additional PDSCH demodulation performance requirements*
  + *Option 2: no specific requirement and verify it in the other introduced performance requirements*

Note: this open issue is captured in Issue 2-1-1, here discuss the specific test parameters related to mapping Type B.

*Open issues and candidate options before e-meeting:*

**Issue 2-2-1: Slots scheduled with data**

* Proposals
  + Option 1: All available DL slots/symbols, i.e. same as the existing Rel-15 Type B requirements (DoCoMo)
  + Option 2: Verify it every 10th with agreed parameter set (Ericsson)
  + Option 3: S slots for TDD and all DL slots for FDD (Qualcomm)
* Recommended WF
  + Agree option 3 based on recommend WF for Issue 2-1-1 and Issue 2-1-2 of verifying PDSCH processing capability 2 with mapping Type B

**Issue 2-2-2: Symbol length (L)**

* Proposals
  + Option 1: 2 and 7os (Ericsson)
  + Option 2: 2os (Huawei, Intel, Qualcomm)
  + Option 3: 2 and 4os (DoCoMo)
* Recommended WF
  + All companies are ok with 2os

**Issue 2-2-3: Starting symbol (S)**

* Proposals
  + Option 1: 3 (Ericsson)
  + Option 2: 2 (Huawei, Intel, Qualcomm)
* Recommended WF
  + Agree option 2

**Issue 2-2-4: Other test parameters**

* Proposals
  + Option 1: (Ericsson)

|  |  |  |  |
| --- | --- | --- | --- |
| **Test cases** | **FR1 FDD** | **FR1 TDD** | **FR2 TDD** |
| Channel model | TDLC300-100 | TDLC300-100 | TDLA30-300 |
| Antenna configuration | 2x2, ULA low | 2x2, ULA low | 2x2, ULA low |
| MCS | 4 | 4 | 4 |
| Scheduling type | Type B 2 and 7os | Type B 2 and 7os | Type B 2 and 7os |
| Starting symbol (S) | 3 | 3 | 3 |
| Slots allocated with data | 1 slot per 10 slots | 1 slot per 10 slots | 1 slot per 10 slots |
| Number of contiguous PRB | Maximum transmission bandwidth and smaller allocation | Maximum transmission bandwidth and smaller allocation | Maximum transmission bandwidth and smaller allocation |
| FRC | TBD | TBD | TBD |

* + Option 2: Reuse other test parameters from the existing Rel-15 PDSCH Type B requirements for FR1.(Huawei)

|  |  |  |
| --- | --- | --- |
| **Test cases** | **FR1 FDD** | **FR1 TDD** |
| Channel model | TDLA30-10 | TDLA30-10 |
| Antenna configuration | 2x2 and 2x4, ULA Low | 2x2 and 2x4, ULA Low |
| MCS | MCS 4 in Table 1 | MCS 4 in Table 1 |
| Number of contiguous PRB | 10MHz / 15kHz with full bandwidth | 40MHz / 30kHz with full bandwidth |
| FRC | R.PDSCH.1-1.4 FDD | R.PDSCH.2-1.3 TDD if 7D1S2U |

Note 1: Only one Type B case is defined for FR1 FDD, FR1 TDD with channel model TDLA30-10

* Recommended WF
  + TBA

### Sub-topic 2-3: Pre-emption indication

*From the approved WF R4-1915913 in RAN4#93 meeting, following were agreed:*

* *Introduce PDSCH demodulation performance requirements for pre-emption*
  + *Verify the performance of UE flushing the URLLC PDSCH REs which is scheduled by DCI transmitted after that URLLC PDSCH*
  + *FFS whether to define the demodulation requirements to verify decoding performance of PDSCH transmitted ahead of corresponding DCI*

*Open issues and candidate options before e-meeting:*

**Issue 2-3-1: Test parameters to verify DL pre-emption indication for eMBB UE**

1. Pre-emption periodicity
   * + Proposals
       - Option 1: 10% probability with non-fixed scheduling within 1 radio frame (Ericsson, Qualcomm)
       - Option 2: 1 slot (Huawei)
     + Recommended WF
       - Continue to discuss
2. Time frequency set
   * + Proposals
       - Option 1: 14x1 (Huawei, Ericsson, Qualcomm)
       - Option 2: 7x2
     + Recommended WF
       - Agree option 1.
3. Number of symbols to be pre-empted
   * + Proposals
       - Option 1: 2 and 7 (Ericsson)
       - Option 2: 2 (Qualcomm)
       - Option 3: 2 and 4 (Intel)
     + Recommended WF
       - 2os is acceptable to all companies.
4. Starting symbol to be pre-empted
   * + Proposals
       - Option 1: 3 (Ericsson, Qualcomm)
     + Recommended WF
       - Agree Option 1: 3
5. (Void)
   * + - Note: Considering the different views, split the other parameters to following individual parameters
6. Channel Model
   * + Proposals
       - FR1
         * Option 1: TDLC300-100 (Ericsson)
         * Option 2: TDLA30-10 (Qualcomm)
       - FR2
         * Option 1: TDLA30-300 (Ericsson)
         * Option 2: TDLA30-75 (Qualcomm)
     + Recommended WF
       - Focus on FR1 only
7. Antenna configuration
   * + Proposals
       - Option 1: 2x2, ULA low (Ericsson)
       - Option 2: 2x2 and 2x4, ULA low
     + Recommended WF
8. FRC
   * + Proposals
       - Option 1: 16QAM (Ericsson)

|  |  |  |  |
| --- | --- | --- | --- |
| **Test cases** | **FR1 FDD** | **FR1 TDD** | **FR2 TDD** |
| FRC (modified for every 10th slot) | R.PDSCH.1-2.1 FDD | R.PDSCH.2-2.1 TDD | R.PDSCH.5-2.1 TDD |

* + - * Option 2: QPSK (Qualcomm, Huawei)

|  |  |  |  |
| --- | --- | --- | --- |
| **Test cases** | **FR1 FDD** | **FR1 TDD** | **FR2 TDD** |
| FRC | R.PDSCH.1-1.1 FDD | R.PDSCH.2-1.1 TDD | R.PDSCH.5-1.1 TDD |

* + - * Option 3: New FRC with 64QAM (Intel)
    - Recommended WF
      * Continue to discuss

**Issue 2-3-2: Impact on legacy Rel-15 eMBB UE by this Rel-16 eMBB UE requirements for PI**

* Observations
* Observation 3: Rel-15 eMBB UE requirements do not have any performance requirements for DL data pre-emption. Therefore, if this feature is introduced, legacy Rel-15 eMBB demodulation performance cannot be guaranteed in a Release heterogenous network including pre-emption capable gNBs and UEs. (Ericsson)
* Recommended WF
  + PI is a feature of optional with UE capability signalling, test applicability should be defined for eMBB UE performance requirements.

**Issue 2-3-3: Whether to define URLLC demodulation requirements for PI**

* Proposals
  + Option 1: No. (Ericsson, Huawei, Qualcomm)
* Recommended WF
  + Agree option 1.

### Sub-topic 2-4: Others

**Issue 2-4-1: Whether to define URLLC low latency requirements for FR2**

* Proposals
  + Option 1: Down-prioritized it for later (Qualcomm)
  + Option 2:
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Sub-topic 2-1:  Issue 2-1-1: We think that pre-emption indication and Type B non-slot scheduling tests should be tested separately but with similar parameters. Pre-emption flushing data in certain eMBB UE REs, Type B non-slot URLLC UEs instead being scheduled in the eMBB flushed REs. In both cases the UE is not expected to be scheduled continuously. So for pre-emption and non-slots we propose to pre-empt 10% of slots. For PDSCH processing capability 2, we propose to test every slot as this is more realistic. In summary:  • Pre-emption test with 2os, and 7os pre-empted at symbol 3 (10% of slots; i.e. 1 in every 10)  • Type B non-slot test with 2os, and 7os starting at symbol 3 (10% of slots; i.e. 1 in every 10)  • PDSCH capability 2 test case design by changing K1 HARQ timing values based off existing eMBB tests  We see that other companies propose to combine the non-slot and PDSCH processing capability 2 test; we will further consider this. We welcome other companies views on these tests.  Sub-topic 2-2:  Issue 2-2-3: If we start at symbol 2, the first DMRS symbol for eMBB will not be scheduled making demodulation performance for eMBB suffer.  Issue 2-2-4:  ….  Others: |
| NTT DOCOMO | **Issue 2-1-1: How to verify PDSCH processing capability 2**  Option 1: Verify it with PDSCH mapping Type B  **Issue 2-1-2: Slots to be scheduled**  Option 1: S slot  **Issue 2-1-3: TDD pattern**  For FR1, we prefer DDDSUUDDDD, S=6D:4G:4U. However we are open to have different TDD patterns between high reliability and low latency. In addition, we prefer to have DSUU. For FR2, we prefer Option 1: DDDSU, S=10D:2G:2U.  **Issue 2-1-4: Number of HARQ processes**  We understand that # of necessary processes can be 2 in the test, since DL packet is scheduled in S slot only. However in the real low latency system, we need larger # of HARQ processes, since DL data is multiplexed also for D slot. If number of HARQ processes can be guaranteed with eMBB test cases, we can allow small number of HARQ processes.  **Issue 2-2-1: Slots scheduled with data**  Option 1: All available DL slots/symbols  **Issue 2-2-2: Symbol length (L)**  Option 3: 2 and 4os. Because 7 os is supported in eMBB test. |
| Huawei | Sub-topic 2-2:  Issue 2-2-1: Huawei prefer option 1. Option 2 is mixing the configuration of Type B and PI, it complicated the test setup.  Issue 2-2-2: It is not necessary to test all the possible symbol length for mapping type B. If companies agree that the mapping type B is verified with processing capability 2, the symbol length should be considered with feature of processing capability 2, L=7 is covered in the existing test cases. We can select one of from 2 and 4.  Issue 2-2-3: From RAN1 definition for the mapping type B, the first DM-RS is located in the first symbol of the data allocation. So when we configure the start symbol is 2, it has already included the location of the first DM-RS. It is not needed to multiplex eMBB and URLLC during the test.  Sub-topic 2-3:  Issue 2-3-1:  Pre-emption periodicity: Option 1 is too complex for real testing, it is DCI based scheduling, to unify the real test setup, a fixed scheduling pattern is preferred.  Number of symbols to be pre-empted: to reduce the number of test cases we can choose one from 2, 4 and 7.  Update 2020-02-26:  Issue 2-2-4: We prefer option 2. For the test defined for capability 2 and mapping type B, parameters in Rel-15 can be reused except the parameters has already been listed in Sub-topic 2-1 and Sub-topic 2-2.  There is no requirements for FR2 mapping type B in Rel-15.  Issue 2-3-1: We prefer to reuse the test cases R.PDSCH.1-1.1 FDD, R.PDSCH.2-1.1 TDD and R.PDSCH.5-1.1 TDD. |
| Qualcomm | Sub topic 2-1:  Issue 2-1-1: We prefer Option 1 because Option 2 will have UL availability too far from the end of PDSCH and that will make it difficult to test processing capability 2.  Issue 2-1-3: One comment on option 4 is that it will not let us configure 2-slot TRS.  Issue 2-1-4: It should be decided after we finalize TDD pattern.  Sub topic 2-2:  Issue 2-2-1: We prefer to verify it along with PDSCH processing capability 2. In that case, we should only schedule data on S slots for TDD and all DL slots on FDD.  Issue 2-2-3: We support Option 2.  Issue 2-2-4: We prefer to reuse the channel model as in the existing PDSCH Type B tests. Option 2 needs to be clarified on which parameters it is talking about as some of the parameters are already discussed in previous issues.  Sub topic 2-3:  Issue 2-3-1:   1. We prefer option 1 so that RAN5 could verify the eMBB performance for remaining slots. 2. 2. We are ok with Option 1. 3. We are ok with 2 symbols to be pre-empted. 4. We are ok with Option 1. 5. We prefer R.PDSCH.1-1.1 FDD, R.PDSCH.2-1.1 TDD, R.PDSCH.5-1.1 TDD and channel model of TDLA30-10 for FR1 and TDLA30-75 for FR2.   Issue 2-3-2: Ok with WF.  Issue 2-3-3: Ok with Option 1.  Others: We should discuss if we can down-prioritize FR2 requirements. |
| Intel | Sub-topic 2-2:  Discuss simulation assumptions along with processing capability 2 if agreeable to have single test for both  Sub-topic 2-3: Pre-emption indication  Issue 2-3-1   1. (1-4) The number of symbols preempted should be based on simulation and analysis – Options: 2,4. Also the number of PRBs and frequency of preemption should be based on simulation. It’s difficult to agree on parameters first. 2. For PDSCH we might need to consider higher order modulation at least 64QAM so that we see impact of preemption or effect of UE not flushing the buffer correctly |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Topic#2** | *Tentative agreements:*  **UE FR1 demodulation requirements for URLLC low latency**   * Verify PDSCH mapping Type B with PDSCH processing capability 2   + Slots to be scheduled:     - FDD: All DL slots     - TDD: S slots with K1=0   + Starting symbol: 2   + Symbol length: 2, FFS on additional symbol length 4, 7   + Slot aggregation level: 1 * Pre-emption indication   + Time frequency set: 14x1   + Number of symbols to be pre-emptied: 2, FFS on additional symbol length 4, 7   + Starting symbol to be pre-emptied: 3   + Test applicability for eMBB UE PI requirements: optional with UE capability signalling   + No URLLC PI performance requirements   Candidate options:  Recommendations for 2nd round:   * Whether to introduce UE FR2 URLLC performance requirements * Remaining parameters still kept open are further 2nd round discussion, which are captured in section 2.5. |

*Suggestion on WF/LS assignment*

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

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX |  |

## Discussion for 2nd round

### Sub-topic 2-5-0: Whether to define UE FR2 URLLC requirements for low latency

**Issue 2-5: Whether to define UE FR2 URLLC requirements for low latency**

* Proposals
  + Option 1: Define requirements for FR2.
  + Option 2: Do not define requirements for FR2.
* Recommended WF
  + TBA

### Sub-topic 2-5-1: Verify PDSCH mapping Type B with PDSCH processing capability 2 for FR1

**Issue 2-5-1-1: TDD pattern**

* Proposals
  + TDD 30kHz SCS:
    - Option 1: 7D1S2U, S=6D:4G:4U (Ericsson)
    - Option 2: DDDSUUDDDD, S=6D:4G:4U (1st priority), DSUU, S=12D:2G (2nd priority) (DoCoMo)
    - Option 3: DDDSU, S=10D+2G+2U (Huawei, Qualcomm)
    - Option 4: SU, S=12D+2G (Intel)
* Recommended WF
  + TBA

**Issue 2-5-1-2: Number of HARQ processes**

* Proposals
  + Option 1: 2 (Intel, DoCoMo)
* Recommended WF
  + More inputs are needed after decision on TDD patterns

**Issue 2-5-1-3: Maximum number of HARQ transmissions**

* Proposals
  + Option 1: 1
  + Option 2: >1 TBC
* Recommended WF

**Issue 2-5-1-4: How to verify PDSCH processing capability 2 and type B mapping**

* Proposals
  + Option 1: Test together
  + Option 2: Test separately
* Recommended WF
  + Decision needs review after discussing number of HARQ transmissions and latency

**Issue 2-5-1-5: Symbol length (L)**

* Proposals (note: 2os already agreed)
  + Option 1: Also include 4os
  + Option 2: Also include 7os
  + Option 3: Only 2os
* Recommended WF

**Issue 2-5-1-6: Other test parameters**

* Proposals
  + Option 1: (Ericsson)

|  |  |  |  |
| --- | --- | --- | --- |
| **Test cases** | **FR1 FDD** | **FR1 TDD** | **FR2 TDD** |
| Channel model | TDLC300-100 | TDLC300-100 | TDLA30-300 |
| Antenna configuration | 2x2, ULA low | 2x2, ULA low | 2x2, ULA low |
| MCS | 4 | 4 | 4 |
| Scheduling type | Type B 2 and 7os | Type B 2 and 7os | Type B 2 and 7os |
| Starting symbol (S) | 3 | 3 | 3 |
| Slots allocated with data | 1 slot per 10 slots | 1 slot per 10 slots | 1 slot per 10 slots |
| Number of contiguous PRB | Maximum transmission bandwidth and smaller allocation | Maximum transmission bandwidth and smaller allocation | Maximum transmission bandwidth and smaller allocation |
| FRC | TBD | TBD | TBD |

* + Option 2: Reuse other test parameters from the existing Rel-15 PDSCH Type B requirements for FR1.(Huawei)

|  |  |  |
| --- | --- | --- |
| **Test cases** | **FR1 FDD** | **FR1 TDD** |
| Channel model | TDLA30-10 | TDLA30-10 |
| Antenna configuration | 2x2 and 2x4, ULA Low | 2x2 and 2x4, ULA Low |
| MCS | MCS 4 in Table 1 | MCS 4 in Table 1 |
| Number of contiguous PRB | 10MHz / 15kHz with full bandwidth | 40MHz / 30kHz with full bandwidth |
| FRC | R.PDSCH.1-1.4 FDD | R.PDSCH.2-1.3 TDD if 7D1S2U |

Note 1: Only one Type B case is defined for FR1 FDD, FR1 TDD with channel model TDLA30-10

* Recommended WF
  + TBA

### Sub-topic 2-5-2: Pre-emption indication for FR1

**Issue 2-5-2-1: Pre-emption periodicity**

* Proposals
  + Option 1: 10% probability with non-fixed scheduling within 1 radio frame (Ericsson, Qualcomm)
  + Option 2: 1 slot (Huawei)
* Recommended WF
  + TBA

**Issue 2-5-2-2: Channel Model**

* Proposals
  + Option 1: TDLC300-100 (Ericsson)
  + Option 2: TDLA30-10 (Qualcomm)
* Recommended WF
  + TBA

**Issue 2-5-2-3: Antenna configuration**

* Proposals
  + Option 1: 2x2, ULA low (Ericsson)
  + Option 2: 2x2 and 2x4, ULA low
* Recommended WF
  + TBA

**Issue 2-5-2-4: FRC**

* Proposals
  + Option 1: 16QAM (Ericsson)

|  |  |  |  |
| --- | --- | --- | --- |
| **Test cases** | **FR1 FDD** | **FR1 TDD** | **FR2 TDD** |
| FRC (modified for every 10th slot) | R.PDSCH.1-2.1 FDD | R.PDSCH.2-2.1 TDD | R.PDSCH.5-2.1 TDD |

* + Option 2: QPSK (Qualcomm, Huawei)

|  |  |  |  |
| --- | --- | --- | --- |
| **Test cases** | **FR1 FDD** | **FR1 TDD** | **FR2 TDD** |
| FRC | R.PDSCH.1-1.1 FDD | R.PDSCH.2-1.1 TDD | R.PDSCH.5-1.1 TDD |

* + Option 3: New FRC with 64QAM (Intel)
* Recommended WF
  + TBA

**Issue 2-5-2-5: Number of symbols to be pre-empted**

* Proposals (note: 2os already agreed)
  + Option 1: Also include 4os
  + Option 2: Also include 7os
  + Option 3: Only 2os
* Recommended WF

### Companies’ views collection for 2nd round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Sub topic 2-5-0: See comments on issue 1-5-1.  Sub topic 2-5-1  Issue 2-5-1-3: We believe that for low latency, a single transmission should be considered, as retransmissions would arrive too late (and remove the need for short slots).  Issue 2-5-1-4: We are OK to test these together. After further checking, we believe is possible to test processing capability 2 together with PDSCH mapping type B with no retransmissions because even with no retransmissions, the UE can generate ACK/NACK and so processing capability 2 can be verified.  Issue 2-5-1-5: We propose option 2. This tests different situations (i.e. different DM-RS, processing length etc.)  Issue 2-5-2-1: To clarify our proposal, “10% probability” would be implemented practically as preemption once per 10 slots; i.e. testing setup is not complex.  Issue 2-5-2-3: We do not have a strong opinion option 1 or option 2.  …. |
| Intel | Issue 2-5: Option1. It is useful to introduce requirements in FR2 for verifying features related to URLLC for high reliability and low latency  Issue 2-5-1-3: Option 1: For low latency requirements, it would be preferred to test with no HARQ re-transmission  Issue 2-5-1-4: Option 1  Issue 2-5-2-1: Option 1  Issue 2-5-2-5: Option 3 |
| NTT DOCOMO | Issue 2-5: Option 1  Issue 2-5-1-1: We prefer Option 2. Our intention of Option 2 is to ensure the performance with the TDD pattern of DDDSUUDDDD in URLLC UEs. If normal demodulation requirements including tests with TDD pattern of DDDSUUDDDD are applied to URLLC UEs, we can compromise Option 1. We need to clarify this applicability first, otherwise Option 1 is not acceptable.  Issue 2-5-1-2: Our proposal is not Option 1. Please remove DoCoMo from Opton1. We prefer 4 or 8.  Issue 2-5-1-4: We need more discussion.  Issue 2-5-1-5: We prefer Option 1  Issue 2-5-1-6: We prefer to discuss these test parameters separately in the next meeting. |
| Huawei | Sub topic 2-5-0:  Issue 2-5: We prefer option2. Same view as Issue 1-5-1.  Sub topic 2-5-1  Issue 2-5-1-3: We prefer option 1. For low latency test, no need to configure HARQ.  Issue 2-5-1-4: We prefer to test together. Option 1.  Issue 2-5-1-5: We prefer option3. E.g. if we agree include other symbol length besides 2os, and based on scheduling on S slot and at least 4.5 symbols for processing capability 2:   * Such as 7os and DDDSU, S=10:2:2: if 2 symbols for PDCCH, then 9 allocated, only 3 symbols gap for HARQ ACK feedback that is less than processing capability 2; * Such as 7os and 7D1S2U, S=6:4:4: it is impossible for S slot. * Such as 4os and DDDSU, S=10:2:2: it is feasible * Such as 4os and 7D1S2U, S=6:4:4: 2os for PDCCH and only 4os gap for HARQ ACK feedback that is less than processing capability 2.   In summary, 2os is feasible for both TDD patterns.  Issue 2-5-1-6: We propose to reuse the existing test parameters for type B cases as much as possible  Sub topic 2-5-2  Issue 2-5-2-1: If company has strong view on Option 1, as a compromise and simplify and unify the test setup for all UEs verification, we propose to test the pre-emption with 10% probability but with fixed scheduling within 1 radio frame.  Issue 2-5-2-2: Prefer Option 2.  Issue 2-5-2-3: We prefer option 2.  Issue 2-5-2-5: We prefer option 3 |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: CQI reporting requirements for support of CQI table 3

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000371**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000371.zip) | Intel Corporation | Proposal #5: Introduce CQI reporting test case with CQI table 3 for fading channel conditions |
| [**R4-2001486**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001486.zip) | Huawei, HiSilicon | Proposal 1: Introduce CQI reporting requirements to verify the support of CQI Table 3 in AWGN.  Proposal 2: Consider a higher BLER target, e.g. 1-10-3.  Proposal 3: The BLER criteria test metrics presented in TS38.101-4 Section 6 can be reused.  Proposal 4: Define CQI reporting tests for 2Rx with FDD and TDD modes. |
| [**R4-2001739**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001739.zip) | Ericsson | Observation 4: the eMBB designed CQI tests does not satisfy the criteria needed for UEs supporting CQI table 3.  Proposal 5: New CQI should be designed with either lower BLER target metric (e.g. 1%, or 1‰ BLER) or using a different metric e.g. percentage based of the maximum theoretical throughput (per MCS). |
| [**R4-2002142**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002142.zip) | Qualcomm Incorporated | Proposal 1: Define CQI reporting tests for testing 99.999% reliability under AWGN condition.  Proposal 2: Define a lower bound for median reported CQI in the CQI reporting tests for 99.999% reliability.  Observation 1: Only one long test needs to be run for testing CQI reporting under AWGN condition for 1e-5 BLER with 99.999% confidence level.  Proposal 3: Define CQI reporting test under AWGN condition with 99.999% confidence level.  Observation 2: It is possible to have an applicability rule between CQI reporting test and FMCS test under AWGN.  Proposal 4: Consider evaluating the UE performance with and without HARQ. If they are similar, we can have an applicability rule between CQI reporting test and FMCS test under AWGN to reduce the number of tests. |

## Open issues summary

*From the approved WF R4-1915913 in RAN4 #93 meeting, following were agreed:*

* *Introduce CQI reporting requirements to verify the support of CQI Table 3*
  + *Option 1: CQI test in AWGN*
  + *Option 2: CQI test in fading channel*
  + *FFS:*
    - *Target BLER*
    - *Test metrics*

*Open issues and candidate options before e-meeting:*

### Sub-topic 3-1: Propagation channel

**Issue 3-1: Propagation channel for CQI reporting**

* Proposals
  + Option 1: AWGN (Qualcomm, Huawei)
  + Option 2: Fading channel (Intel)
* Recommended WF
  + TBA

### Sub-topic 3-2: Target BLER and test metric

**Issue 3-2-1: Target BLER**

* Proposals
  + Option 1: 10^-3 (Huawei, Ericsson)
  + Option 2: 10^-2 (Ericsson)
  + Option 3: 10^-5 (Qualcomm, Intel?)
* Recommended WF
  + TBA

**Issue 3-2-2: Test metric**

* Proposals
  + Option 1: Reuse existing BLER criteria test metrics (Huawei, Ericsson)
  + Option 2: Percentage based of the maximum theoretical throughput (per MCS) (Ericsson)
  + Option 3: Reuse existing BLER criteria test metrics with a minimum median CQI (Qualcomm)
  + Option 4: TP ratio with follow CQI vs median CQI (Intel)
* Recommended WF
  + TBA

### Sub-topic 3-3: Test applicability for CQI reporting and FMCS

**Issue 3-3-1: Feasibility to define CQI reporting test case and FMCS case at the same SNR**

* Proposals
  + Option 1: Consider evaluating the UE performance with and without HARQ. If they are similar, we can have an applicability rule between CQI reporting test and FMCS test under AWGN to reduce the number of tests. (Qualcomm)
  + Option 2:
* Recommended WF
  + This can be discussed later, because it depends on whether FMCS long test with 10^-5 BLER will be defined with on HARQ under AWGN, whether CQI reporting test will be defined with test metric of 10^-5 BLER under AWGN that is under discussion in anther email thread.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Sub topic 3-1: We prefer AWGN because it will be more stable channel to get proper CQI reporting for 1e-5 BLER.  Sub topic 3-2:  Issue 3-2-1: As mentioned in our paper R4-2002142, we can have an applicability rule with FMCS test to reduce the number of long tests, but we think that we should define CQI reporting test with 1e-5 BLER to test the new CQI table properly.  Issue 3-2-2: In our opinion, we should reuse the existing BLER criteria for AWGN CQI reporting tests. However, we should add another metric of minimum median CQI, so that UE doesn’t cheat the test by always reporting CQI 0.  Issue 3-3-1: We don’t need to evaluate this if we agree to define FMCS long test with no HARQ. In that case, both FMCS and CQI reporting long tests will be without HARQ and we can easily define them at the same SNR point and then add an applicability rule. It makes sense to define FMCS long test with no HARQ to reduce the test time anyway.  ….  Others: |
| Intel | Sub-topic 3-1: Propagation channel  We prefer test in fading channel to verify CQI reporting with table 3. The test metrics can be modified to not have to test very low BLER.  Sub-topic 3-2: Target BLER and test metric  Issue 3-2-1  The BLER target for CQI reporting test should be 1e-5 and not higher. We are not suggesting that we measure low BLER as part of the test requirement.  Issue 3-2-2  Test metric for CQI reporting in fading channel would be TP ratio with follow CQI vs median CQI. We can remove BLER based test metric to avoid running long test to meet low BLER target.  Sub-topic 3-3: Test applicability for CQI reporting and FMCS  We can have FMCS test for low BLER and CQI reporting in fading channel to avoid having a test applicability |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | Tentative agreements:  No agreements in the 1st round.  Candidate options:  Recommendations for 2nd round:  Continue to discuss all open issues. Details are captured in section 3.5 |

*Suggestion on WF/LS assignment*

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

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX |  |

## Discussion on 2nd round

### Open issues

**Issue 3-5-1-1: Propagation channel for CQI reporting**

* Proposals
  + Option 1: AWGN (Qualcomm, Huawei)
  + Option 2: Fading channel (Intel)
* Recommended WF
  + TBA

**Issue 3-5-1-2: Target BLER**

* Proposals
  + Option 1: 10^-3 (Huawei, Ericsson)
  + Option 2: 10^-2 (Ericsson)
  + Option 3: 10^-5 (Qualcomm, Intel?)
* Recommended WF
  + TBA

**Issue 3-5-1-3: Test metric**

* Proposals
  + Option 1: Reuse existing BLER criteria test metrics (Huawei, Ericsson)
  + Option 2: Percentage based of the maximum theoretical throughput (per MCS) (Ericsson)
  + Option 3: Reuse existing BLER criteria test metrics with a minimum median CQI (Qualcomm)
  + Option 4: TP ratio with follow CQI vs median CQI (Intel)
* Recommended WF
  + TBA

**Issue 3-5-1-4: Feasibility to define CQI reporting test case and FMCS case at the same SNR**

* Proposals
  + Option 1: Consider evaluating the UE performance with and without HARQ. If they are similar, we can have an applicability rule between CQI reporting test and FMCS test under AWGN to reduce the number of tests. (Qualcomm)
  + Option 2:
* Recommended WF
  + This can be discussed later, because it depends on whether FMCS long test with 10^-5 BLER will be defined with on HARQ under AWGN, whether CQI reporting test will be defined with test metric of 10^-5 BLER under AWGN that is under discussion in anther email thread.

### Companies’ views collection for 2nd round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Issue 3-5-1-1: Option 2 – testing in fading channel eliminates the need to run a long test to measure 1e-5 BLER which would be required in AWGN channel.  Issue 3-5-1-2: There will not be a target BLER we would be testing for in fading channel if test metric is TP ratio. In case CQI reporting is introduced in AWGN channel, the target BLER should be 1e-5, it cannot be higher as the CQI table is designed for 1e-5 BLER target  Issue 3-5-1-3: Option 4: Our preference is to use the metrics (a) CQI index not in set, (b) TP ratio used in testcases for CQI reporting under fading conditions. |
|  |  |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #4: BS demodulation requirements for high reliability

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000371**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000371.zip) | Intel Corporation | Proposal #4: Introduce PUSCH demodulation test cases for PUSCH slot aggregation with [1]% BLER requirement. |
| [**R4-2000313**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000313.zip) | Samsung | Proposal 3: The following test parameters for PUSCH with high BLER requirement could be considered:  PUSCH aggregation Factor: 2  SCS &BW: 15 KHz, 10 MHz; 30 KHz, 40 MHz;  HARQ: 4  Antenna configuration: 1x2  Mapping type: type A  DMRS symbol: 1+1  Channel condition: TDLB100-400  Symbol length: 14  Waveform: CP-OFDM  MCS: 5 |
| [**R4-2001179**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001179.zip) | Ericsson | *Parameters are listed in tables, please see the documents for details.* |
| [**R4-2001197**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001197.zip) | NTT DOCOMO, INC. | Proposal 1: For URLLC requirements, consider the following SCS:   * 15/30/60(FR2)/120kHz SCS   NOTE: For FR1, the same requirements are applicable to both TDD and FDD.  Proposal 2: For URLLC requirements, the following TDD UL-DL patterns are used as simulation assumptions:   * 15kHz SCS: 3D1S1U, S=10D:2G:2U * 30kHz SCS: 7D1S2U, S=6D:4G:4U * 60kHz SCS: 3D1S1U, S=10D:2G:2U * 120kHz SCS: 3D1S1U, S=10D:2G:2U   Proposal 3: If no performance difference among different TDD UL-DL patterns is observed, the same requirements are applicable to any TDD UL-DL patterns. Otherwise, RAN4 to study how to support other TDD UL-DL patterns.  NOTE: From our perspective, at least the following TDD UL-DL patterns need to be supported.   * 1st priority   + 30kHz SCS: DDDSUUDDDD, S=6D:4G:4U   + 120kHz SCS: DDDSU, S=10D:2G:2U * 2nd priority   + 30kHz SCS: DSUU, S=12D:2G |
| [**R4-2001487**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001487.zip) | Huawei, HiSilicon | Proposal 4: We propose to test TDLB100-400 and TDLC300-100.  Proposal 5: We propose to use lower BLER target of 10-3 when define other test cases.  Proposal 6: For test case TDLB100-400 and TDLC300-100, we propose PUSCH aggregation level is 4. |
| [**R4-2001696**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001696.zip) | Nokia, Nokia Shanghai Bell | PUSCH relaxed high reliability requirements  Proposal 2: For any relaxed high reliability requirements defined for PUSCH, the confidence level and BLER target need to be on the same order of magnitude (CL ~= 1-BLER) or better.  Proposal 3: RAN4 to introduce relaxed high reliability requirements for PUSCH slot aggregation factor n4, with HARQ activated at the same time.  Proposal 4: RAN4 to introduce relaxed high reliability requirements using the low spectral efficiency table with an MCS having a lower coding rate than what would be possible without the low SE table, i.e., MCS 5 or lower.  Proposal 5: RAN4 to agree on relaxed high reliability requirements being not more test time intensive than BLER = 1e-2 with CL = 1-1e-2.  MCS table to be used  **Observation 2:** It is not clear from the adhoc minutes of RAN4#93, if PUSCH MCS was agreed to be chosen from the low SE table or not. The captured discussion and agreements seem to not align.  Proposal 6: RAN4 to clarify that the low spectral efficiency MCS tables are to be used for feasibility evaluation and eventual requirement definition.  Choice of static channel  **Observation 3:** Choosing the propagation condition of static channel (AWGN) eliminates the need for larger bandwidths to protect against systematic deep fading effects in fading channel models via frequency diversity.  Proposal 7: RAN4 to consider stat channel (AWGN) propagation conditions only, for all requirements with BLER <= 1e-3.  Proposal 11: If high reliability will be tested with BLER metric, add the following note to the test specification: “Note that this test procedure will only provide an indication to a certain confidence level that the target reliability requirements are likely to be satisfied, and it is assumed that for critical applications further testing would be done to ensure suitability of the equipment for the intended application.” |

## Open issues summary

In this section, the target BLER and confidence level for cases of fading channels with slot aggregation, HARQ, etc. are discussed. The views of slot aggregation factor are provided. After the 1st round, we should decide how many cases will be defined and the key parameters should be decided for each case.

### Sub-topic 4-1: PUSCH performance requirements with higher BLER and/or lower confidence level

*From the approved WF R4-1915913 in RAN4#93 meeting, following were agreed:*

* *Other test cases will be defined with higher BLER and/or lower confidence level* 
  + *Other parameter combinations of HARQ, aggregation, channel etc. and further requirements will be considered.*
  + *When further requirements are specified, it will be decided case by case whether to test them at 10^-5 BLER and CL 99.999% or other conditions*
  + *Other test cases will include PUSCH aggregation* 
    - *FFS PUSCH aggregation level*

*Open issues and candidate options before e-meeting:*

**Issue 4-1-1: Target BLER**

* Proposals
  + Option 1: 1% (Intel, Samsung, Nokia, Huawei, Ericsson)
  + Option 2: 10% (Ericsson, Samsung with 1st BLER)
* Recommended WF
  + Agree option 1

**Issue 4-1-1a: How to calculate the target BLER**

* Proposals
  + Option 1: 1st transmission BLER (Ericsson, Intel if retransmission disabled, Samsung if 10% BLER)
  + Option 2: BLER after all transmission if HARQ activated ( Nokia, Huawei, Intel, Samsung and Ericsson if 1% BLER)
* Recommended WF
  + Agree option 2

**Issue 4-1-2: Target confidence level**

* Proposals
  + Option 1: 99% , i.e. 1-BLER or better (Nokia, Ericsson, Intel, Samsung)
  + Option 2: 95% (Ericsson, Samsung as baseline)
* Recommended WF
  + TBA

**Issue 4-1-3: PUSCH aggregation level**

* Proposals
  + - Option 1: 2 (Samsung Intel)
    - Option 2: 4 (Nokia, Huawei, Intel)
    - Option 3: 2, 4 (Ericsson)
    - Option 3: 8 (DoCoMo)
* Recommended WF

**Issue 4-1-4: Number of HARQ transmission**

* Proposals
  + Option 1: 1 (Ericsson, Intel)
  + Option 2: 4 (Samsung, Huawei, Ericsson in case AL=2, DoCoMo, Nokia)
  + Option 3: Other value greater than 1 (Nokia)
* Recommended WF
  + Agree Option 2

**Issue 4-1-5: Waveform**

* Proposals
  + Option 1: CP-OFDM (Ericsson, Huawei, Samsung, Nokia, Intel)
  + Option 2: DFT-s-OFDM (DoCoMo)
* Recommended WF
  + Agree option 1

**Issue 4-1-6: MCS**

* Proposals
  + Option 1: MCS 5 in table 3 (Huawei, Nokia, Samsung, Ericsson, DoCoMo, Intel)
* Recommended WF
  + Agree option 1

**Issue 4-1-7: SCS&BW**

* Proposals for SCS & BW
  + FR1:
    - 15kHz SCS:
      * Option 1: 10MHz/15kHz (Samsung, Nokia, Huawei)
      * Option 2: 5/10/20MHz (DoCoMo)
    - 30kHz SCS
      * Option 1: 40MHz/30kHz (Samsung, Nokia, Huawei)
      * Option 2: 10/20/40/100MHz (DoCoMo)
  + FR2:
    - 60kHz SCS
      * Option 1: 50/100MHz (DoCoMo)
      * Option 2: No test (Nokia)
    - 120kHz SCS
      * Option 1: 50/100/200MHz (DoCoMo)
      * Option 2: No test (Nokia)
* Recommended WF
  + Postpone discussion FR2 parameters until decision made on FR2 requirements.

**Issue 4-1-8: Number of PRBs**

* Proposals
  + Option 1: 25 (Ericsson, Samsung)
  + Option 2: Full bandwidth (DoCoMo, Nokia)
* Recommended WF
  + TBA

**Issue 4-1-9: TDD pattern**

* Proposals
  + 15kHz SCS: 3D1S1U, S=10D:2G:2U (DoCoMo, Ericsson, Nokia, Samsung)
  + 30kHz SCS:
    - Option 1: 7D1S2U, S=6D:4G:4U (DoCoMo, Huawei, Ericsson, DCM, Nokia, Samsung)
    - Option 2: DDDSUUDDDD, S=6D:4G:4U(1st priority), DSUU, S=12D:2G (2nd priority) (DoCoMo)
  + 60kHz SCS (FR2): 3D1S1U, S=10D:2G:2U (DoCoMo, Ericsson)
  + 120kHz SCS: 3D1S1U, S=10D:2G:2U (DoCoMo, Ericsson)
* Recommended WF
  + Agree on 3D1S1U, S=10D: 2G: 2U for 15 kHz, 7D1S2U, S=6D: 4G: 4U for 30 kHz.
  + Postpone discussion FR2 parameters until decision made on FR2 requirements.

**Issue 4-1-10: Mapping type**

* Proposals
  + FR1
    - Option 1: Type A (Samsung, Nokia, Intel)
    - Option 2: Type B (Huawei, Intel)
    - Option 3: Type A and B (Ericsson, DoCoMo)
  + FR2
    - Option 1: Type A
    - Option 2: Type B (Huawei, DoCoMo)
    - Option 3: Type A and B
    - Option 4: No test (Nokia)
* Recommended WF
  + Postpone discussion FR2 parameters until decision made on FR2 requirements.

**Issue 4-1-11: Symbol length**

* Proposals
  + FR1
    - Option 1: 14 (Samsung, Ericsson, DoCoMo, Huawei, Nokia)
    - Option 2: 4
  + FR2
    - Option 1:
* Recommended WF
  + Agree option 1

**Issue 4-1-12: Starting symbol**

* Proposals
  + Option 1: 0 (Ericsson, Nokia, Huawei, Samsung)
  + Option 2:
* Recommended WF
  + Agree option 1

**Issue 4-1-13: DM-RS configuration** Type 1 with single-symbol

* Proposals
  + FR1
    - Option 1:1+1 (Ericsson, DoCoMo, Nokia, Intel, Samsung)
    - Option 2:
  + FR2
    - Option 1: 1+0 (DoCoMo)
    - Option 2: 1+1 (Ericsson)
* Recommended WF
  + Agree option 1
  + Postpone discussion FR2 parameters until decision made on FR2 requirements.

**Issue 4-1-14: Antenna configuration**

* Proposals
  + Option 1: 1x2, ULA low (Ericsson, Samsung, DoCoMo, Huawei, Nokia, Intel)
* Recommended WF
  + Agree option 1

**Issue 4-1-15: Propagation condition**

* Proposals
* FR1:
  + Option 1: TDLB100-400 (Samsung, Ericsson, Huawei, DoCoMo, Nokia in case of 1% and 10% BLER, Intel)
  + Option 2: AWGN with BLER <= 1e-3 (Nokia in case of 0.1% BLER)
* FR2: TDLA30-300 (Ericsson)
* Recommended WF
  + Agree option 1
  + Postpone discussion FR2 parameters until decision made on FR2 requirements.

### Sub-topic 4-2: Others

**Issue 4-2-1: Safety critical aspects:**

* Proposals
* Proposal 11: If high reliability will be tested with BLER metric, add the following note to the test specification: “Note that this test procedure will only provide an indication to a certain confidence level that the target reliability requirements are likely to be satisfied, and it is assumed that for critical applications further testing would be done to ensure suitability of the equipment for the intended application.” (Nokia)
* Recommended WF
  + TBA

**Issue 4-2-2: Whether to define URLLC requirements for FR2**

* Proposals
  + Option 1: No test (Nokia)
  + Option 2: FFS (Samsung)
  + Option 3: Define FR2 requirements with slot aggregation and type B (Ericsson)
* Recommended WF
  + Companies requested to check your opinion for 2nd round.

**Issue 4-2-3: Test applicability rule for FR1 and FR2 performance requirements**

* Proposals
  + Option 1: Based on BS declaration of support FR1 or FR2 (Ericsson)
  + Option 2:
* Recommended WF
  + TBA

## Companies’ views collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Issue 4-1-1: It is not clear whether this BLER, in case of HARQ is 1st transmission BLER or BLER after all transmissions. In our paper on PUCCH, we justify not needing new PUCCH requirements by assuming that the 1st transmission BLER on HARQ should be 10^-3 or lower. So in our view this BLER should be the 1st transmission BLER. We do not have a very strong opinion about the BLER value; any of the proposed values are OK with us.  Issue 4-1-2: We do not have a strong opinion on the confidence level and are OK with either suggestion.  Issue 4-1-3: For the basestation, an important question relating to the aggregation factor is whether we use the same TDD pattern for the demod requirements, or another TDD pattern or FDD. If we us the same TDD pattern, only aggregation 2 contiguous or 4 with not contiguous aggregated slots is possible.  Issue 4-1-4: If we have a high aggregation factor (e.g. 8) and up to 4 transmissions then the scenario seems a bit unlikely from a resource usage perspective; it could take 32 slots worst case to transmit 1 packet! If we have aggregation 4, then HARQ may also be needed, although possibly fewer than 4 max transmissions otherwise the resource usage could still be high. If we agree only aggregation factor 2 then HARQ with 4 transmissions seems reasonable.  As discussed in our paper on PUCCH, if really operating at 10^-5 BLER, then the 1st transmission BLER would need to be around 10^-3. If we agree a reasonably low 1st transmission BLER then anyhow the average resource usage will be OK and we can consider HARQ.  Issue 4-1-6: We are also OK with MCS 5  Issue 4-1-7 (SCS): This topic is also a bit linked with whether we define requirements with a TDD pattern like in rel-15 or for both FDD and TDD patterns. Our assumption is that we define requirements like today, which is why we suggest both SCS. We can use an applicability rule and only test 1 SCS.  Issue 4-1-7 (BW), 4-1-8: We think that we just need to agree the number of PRBs. Since the scenario is one in which the UE is power limited (i.e. aggregation is needed to achieve sufficient SINR to reach the target BLER), we do not see a need for more PRBs than 25. Otherwise, in a scenario where more than 25 PRBs would be allocated, it would be better for the network to assign fewer PRBs, hence getting higher PSD and not do aggregation.  Issue 4-1-9: Apart from the TDD pattern, nobody seems to have proposed to use FDD. So should we agree that the requirements are defined based on a TDD pattern ? This has implications to some of the other questions above.  Issue 4-1-11: I don’t follow why we would allocate fewer than the maximum number of symbols and then do slot aggregation ? If aggregation is needed to achieve sufficient SINR, why not use all slots ?  Issue 4-1-14: It is not clear why to do 2x2 instead of 1x2 like we use for other requirements.  Sub-topic 4-2: We support to add some kind of clarification on how to interpret the requirements; we would need to work on the exact wording. The same should be done for the ultra-low BLER test.  ….  Update 2020-02-25:  Issue 4-1-1a: Our current preference is option 1. This is because for high reliability operation, as we discuss in our contribution on PUCCH the PUCCH performance will dominate reliability if the 1st transmission BLER is not low. Also, if the retransmission rate is high the resource usage would be high.  Issue 4-1-3: To clarify, aggregation factor 8 requires FDD. We do not see AF8 testing as highly important and so far we have avoided defining FDD or different TDD patterns for requirements. So if we would define an FDD pattern, we think AF8 should be tested, but we would be OK to define TDD only. For TDD only, we would be OK to do 4 in addition to 2.  Issue 4-1-5: CP-OFDM is needed as a baseline since DFT-S-OFDM is optional. Then, although DFT-s-OFDM is useful for URLLC, we think that the test coverage is sufficient if URLLC demod is tested with CP-OFDM and other tests establish that the receiver can also demodulate DFT-S-OFDM.  Issue 4-1-10: Question to DoCoMo: Could you clarify why you see the need for both mappings for FR1, but only mapping B for FR2 ?  Issue 4-1-13: For FR2, we prefer DM-RS 1+1; it is not clear for us why 1+1 would be needed for performance for FR1 but not for FR2.  Update 2020-02-26:  Issue 4-1-1, 4-1-1a: We are OK to compromise to HARQ with BLER on the end transmission. If Samsung are right, there is not much difference between options 1 and 2; 10% on first transmission leads to around 1% on the final transmission.  Issue 4-2-2: The FR2 issue should be resolved for URLLC ultra-low BLER test and URLLC demod. For URLLC ultra-low BLER test, we think that FR2 can be deprioritized in rel-16 (we will discuss that in the other thread). For URLLC demod, we are considering requirements for slot aggregation and for non-slots. There are a number of applications for which these features may be used with different levels of reliability that could also relate to FR2, even in some cases for eMBB. So, we think it could be useful to set FR2 demod minimum requirements for slot aggregation and type B.  Regarding test applicability, for the basestation we think that there is anyhow a natural applicability rule. It seems unlikely that a BS supports both FR1 and FR2 so the test will be for whichever FR the BS supports. In addition, the tests can be optional. |
| NTT DOCOMO | Issue 4-1-3: Our preference is to include at least 8. As a base line, maximum aggregation level should be used to verify the functionality of PUSCH aggregation.  Issue 4-1-4: We prefer Option 2 since it is more typical assumption.  Issue 4-1-5: Our preference is to introduce DFT-s-OFDM. This is a typical assumption in URLLC scenario since DFT has a lower PAPR and is more reliable than CP-OFDM.  Issue 4-1-6: We support Option 1.  Issue 4-1-7: Regarding SCS, our original proposal is to introduce 15/30/60/120kHz SCS. (i.e., For FR1, 15kHz and 30kHz for FDD/TDD, for FR2, 60kHz and 120kHz). If we can have common requirements for both TDD and FDD, we don't need to split the requirements to TDD and FDD for FR1 (NOTE: this principle is the same as existing normal demodulation requirements). However, if this principle cannot be used for high reliability requirements, we would like to prioritize 15kHz for FR1 FDD, 30kHz for FR1 TDD and 120kHz for FR2.  Regarding CBW, the same sets as existing normal PUSCH demodulation can be used. i.e., 5/10/20MHz for FR1 15kHz SCS, 10/20/40/100MHz for FR1 30kHz SCS, 50/100MHz for 60kHz SCS, 50/100/200MHz for 120kHz SCS.  Issue 4-1-8: Basically, number of PRB depends on CBW. We prefer to use full PRB allocation.  Issue 4-1-9: For 30kHz SCS, if the requirements are applicable for any TDD patterns including DDDSUUDDDD, S=6D:4G:4U and DSUU, S=12D:2G, we are OK with Option 1. If not applicable, we need further discussion on how to support other TDD patterns.  Issue 4-1-10: We prefer Option 3 for FR1 and Option 2 for FR2.  Issue 4-1-11: It depends on mapping types. For mapping type A, we are OK with 14 symbols. For mapping type B, we need further discussion.  Issue 4-1-13: We prefer 1+1 for FR1 and 1+0 for FR2.  Issue 4-1-14: We support Option 1.  Issue 4-1-15: We support Option 1. The performance of AWGN channel can be considered in other requirement with 10^-5 BLER and 99.999% CL, so we should focus on fading channel in this requirement. |
| Huawei | Issue 4-1-3: The slot aggregation related to TDD patterns.  Issue 4-1-11: The symbol length relates to the mapping type. We should decide the mapping type firstly. For URLLC scenarios, fewer symbols are normally used, this is why we configure mapping type B.  Issue 4-1-12: Huawei agrees with option 1.  Issue 4-1-13: The DM-RS relates to the mapping type and symbol length.  Issue 4-1-14: Huawei changes to option 1.  Update 2020-02-26:  4-1-1a: We prefer option 2. The BLER target is achieved after all re-transmission.  To Ericsson: The discussion on PUCCH is based on the ultra-low BLER target. In this case, higher BLER target is considered. |
| Nokia, Nokia Shanghai Bell | 4-1-1: Nokia remains with option 1. Given the understanding of BLER after all reTx.  4-1-1a: Option 2. Nokia understood the target BLER to mean after conclusion of the HARQ process (if activated).  4-1-2: Nokia remains with option 1.  4-1-3: Nokia prefers to remain with n4 aggregation level for TDD and FDD. We think 4 is the most likely use case for the envisioned non-extreme BLER targets.  4-1-4: Nokia is fine with all values greater than 1, which includes option 2.  4-1-4: Nokia agrees with option 1. Practical use cases might not be limited to contiguous FDRA and it is unnecessary to test both options.  4-1-6: Nokia remains with option 1. MCS 5 in table 3 (low SE).  4-1-7: We agree with option 1 in both 15 and 30 kHz SCS. Concerning FR2, we don’t think that FR2 is a common enough use case for high reliability communication, so we propose a new option: No test.  4-1-8: Nokia agrees with option 2: full allocated BW. Maximum frequency diversity is a must in the design of high reliability products (based on R15).  4-1-9 Nokia agrees with 15kHz 3D1S1U, and 30kHz 7D1S2U.  4-1-10: Nokia proposes to only test type A, since type B will likely be covered by low latency testing. We still don’t think that both FR1 and FR2 need to be tested and see FR1 as the more common use case.  4-1-11: Nokia agrees with 14 symbols for FR1, and none for FR2.  4-1-12: Nokia agree with option 1: starting symbol 0.  4-1-13: Nokia agrees with FR1 option 1, and none for FR2.  4-1-14: Nokia agrees with option 1: 1T2R.  4-1-15: Nokia agrees with option 1 for FR1 given that BLER target is chosen to be 1% or 10%.  In case 0.1% is chosen, we prefer to stay with option 2. No test for FR2.  4-2: We remain with our proposal. |
| Intel | Sub-topic 4-1: PUSCH performance requirements with higher BLER and/or lower confidence level  Issue 4-1-1: Option 1; but can be discussed based on the other simulation assumptions and parameters chosen. Eventually we would like to ensure that the SNR requirement is not very low.  Issue 4-1-1a: Option 1 if HARQ re transmission is disabled, otherwise option 2  Issue 4-1-2: Option 1  Issue 4-1-3: Option 1; Aggregation level of 2 or 4 is fine with us. Also need to discuss along with TDD pattern  Issue 4-1-4: Option 1; No HARQ re transmission with PUSCH aggregation. Same reasoning as for PDSCH  Issue 4-1-5: Option 1  Issue 4-1-6: Option 1  Issue 4-1-7: Same as Rel-15  Issue 4-1-9: For TDD patterns we need to discuss and introduce new patterns more suited to URLLC for high reliability and low latency. Suggestion is to discuss patterns with relatively equal number of DL and UL slots in order to be better suited for low latency. For high reliability with high target BLER, the existing Rel-15 patterns should be fine, but we should aim at using configs that are likely to be used in actual deployment for URLLC.  Issue 4-1-10: Either Mapping Type A or Type B, not both  Issue 4-1-13: Option 1  Issue 4-1-14: Option 1  Issue 4-1-15: Option 1 as baseline |
| Samsung | Issue 4-1-1: Target BLER  Prefer option 1 and option 2, option 2 should be targeting 1st BLER  Regarding with option 2: 10%BLER is normally metric with NR and LTE. This metric should be the BLER for 1st transmission. The purpose is to do the UL schedule and CQI measurement. With HARQ combination after all the transmissions, the target is about 1% BLER.  For URLLC with reliability, it is reasonable to consider stricter target BLER with option 1  Regard with option 3, since the test purpose is related high BLER and/or lower confidence, the BLER is close to the 10^-5. Considering RAN4 has defined the requirement with 10^-5, I do not think it is necessary to define 0.1% BLER considering the test complexity.  Issue 4-1-1a: How to calculate the target BLER  Prefer option 1: 1st BLER  In case of with 1%BLER test metric, we are fine with the BLER after all the transmission. Since in LTE, for most feature, such as VoLTE, and TTI banding, RAN4 has already defined the metric with residual BLER of 2%, even with 1%.  In case of with 10% BLER test metric, it should be 1st BLER, similarly with existing system. While option 2 with targeting 10% BLER, it is not typical scenario for URLLC with high reliability.  Issue 4-1-2: Target confidence level  Both option1 and option 2 is fine for us. Option 2 is same with existing confidence level, can be regarded as baseline.  Issue 4-1-3: PUSCH aggregation level  Prefer option 1: 2 aggregation level is reasonable considering the complexity and performance if considering HARQ combination.  Similar with PUCCH multi-slot, RAN4 only defined the requirement with 2 slot repetition. We prefer to align with other channel  For PUSCH, excepting with aggregation level to achieve the repetition gain, the normal HARQ combination with different RV can also be regarded as an efficient way to improve the reliability.  In case of PUSCH aggregation level without HARQ combination, 4 repetition level can cover all the RV version, no need to cover 8.  Meanwhile, in some high SNR region, we do not think mandatory is meaningful, considering the targeting BLER is 1%.  We do not prefer PUSCH aggregation level =4 and HARQ combination.  The buffer size and transmission delay will be increased, especially for TDD. In TDD, the available continuous UL slot is limited, it is difficult to support 4 continuous UL slot. In order to complete all the transmission, the process delay is very large. It is not the typical scenario for URLLC scheduling.  Issue 4-1-4: Number of HARQ transmission  Prefer option 2: 4 HARQ  Issue 4-1-5: Waveform  Prefer option 1:  Considering the test of URLLC is functionality test, there is not too much different for CP-OFDM and DFT-s-OFDM  Issue 4-1-6: MCS  Prefer option 1:  Issue 4-1-7: SCS&BW  Prefer option 1:  Issue 4-1-8: Number of PRBs  Prefer option 1: [25] RB is fine for us. The typical URLLC deployment should be considered with limited information bit. In case of larger number of RB, we should check whether MCS table can apply very lower coding rate.  Issue 4-1-9: TDD pattern  Prefer option 1: reuse the TDD configuration for Rel-15 NR BS demodulation requirement  Issue 4-1-10: Mapping type  Prefer option 1 for FR1.  For high reliability requirement, I am not sure whether the requirement in FR2 is needed? We should discuss the typical scenario, before discussion the FR2 parameters with high reliability requirements  Issue 4-1-11: Symbol length  Prefer option 1 for FR1  Issue 4-1-12: Starting symbol  Prefer option 1  Issue 4-1-13: DM-RS configuration  Prefer option 1 ,reuse the Rel-15 parameters in FR1  Issue 4-1-14: Antenna configuration  Prefer option 1: URLLC with aggregation is only available for 1layer.  Issue 4-1-15: Propagation condition  Prefer option 1 in FR1 |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Topic #4** | Tentative agreements:  **BS FR1 URLLC PUSCH demodulation requirement for high reliability with high BLER**   * Target BLER : 1% * Target confidence level: 99% * Calculate the target BLER after all transmission if HARQ activated. * Number of HARQ transmission: 4 * Waveform: CP-OFDM * MCS: MCS 5 in table 3 * TDD pattern:   + 15kHz SCS: 3D1S1U, S=10D: 2G: 2U   + 30kHz SCS: 7D1S2U, S=6D: 4G: 4U * Symbol length is 14 with starting symbol 0 * DM-RS configuration: Type 1 with single-symbol: 1+1 * Antenna configuration: 1x2, ULA low * Propagation condition: TDLB100-400   Candidate options:  Recommendations for 2nd round:   * Whether to define BS URLLC performance requirements and tests for FR2. * The left open test parameters that are captured in section 4.5 |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
|  |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX |  |

## Discussion on 2nd round

### Open issues

**Issue 4-5-1: Whether to define BS FR2 URLLC performance requirements for high reliability**

* Proposals
  + Option 1: Do not define (Nokia)
  + Option 2: Define.
* Recommended WF

**Issue 4-5-2: Test applicability rule for FR1 and FR2 performance requirements**

* Proposals
  + Option 1: Based on BS declaration of support FR1 or FR2 (Ericsson)
  + Option 2:
* Recommended WF

This depends on the discussion on Issue 4-5-1

**Issue 4-5-3: PUSCH aggregation level**

* Proposals
  + Option 1: 2 (Samsung Intel)
  + Option 2: 4 (Nokia, Huawei, Intel)
  + Option 3: 2, 4 (Ericsson)
  + Option 3: 8 (DoCoMo)
* Recommended WF

**Issue 4-5-4: Number of HARQ transmission**

* Proposals
  + Option 1: 1 (Ericsson, Intel)
  + Option 2: 4 (Samsung, Huawei, Ericsson in case AL=2, DoCoMo, Nokia)
  + Option 3: Other value greater than 1 (Nokia)
* Recommended WF

**Issue 4-5-5: Number of PRBs**

* Proposals
  + Option 1: 25 (Ericsson, Samsung)
  + Option 2: Full bandwidth (DoCoMo, Nokia)
* Recommended WF

**Issue 4-5-6: Mapping type**

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

**Issue 4-5-7: SCS&BW**

* Proposals for SCS & BW
  + FR1:
    - 15kHz SCS:
      * Option 1: 10MHz/15kHz (Samsung, Nokia, Huawei)
      * Option 2: 5/10/20MHz (DoCoMo)
    - 30kHz SCS
      * Option 1: 40MHz/30kHz (Samsung, Nokia, Huawei)
      * Option 2: 10/20/40/100MHz (DoCoMo)
  + FR2:
    - 60kHz SCS
      * Option 1: 50/100MHz (DoCoMo)
      * Option 2: No test (Nokia)
    - 120kHz SCS
      * Option 1: 50/100/200MHz (DoCoMo)
      * Option 2: No test (Nokia)
* Recommended WF

**Issue 4-5-8: Number of PRBs**

* Proposals
  + Option 1: 25 (Ericsson, Samsung)
  + Option 2: Full bandwidth (DoCoMo, Nokia)
* Recommended WF

**Issue 4-5-9: Safety critical aspects:**

* Proposals
* Proposal 11: If high reliability will be tested with BLER metric, add the following note to the test specification: “Note that this test procedure will only provide an indication to a certain confidence level that the target reliability requirements are likely to be satisfied, and it is assumed that for critical applications further testing would be done to ensure suitability of the equipment for the intended application.” (Nokia)
* Recommended WF
  + TBA

### Companies’ views collection for 2nd round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 4-5-1:  Issue 4-5-2:  …. |
| Samsung | Issue 4-5-1: Whether to define BS FR2 URLLC performance requirements for high reliability  Samsung still prefer option 1, as mentioned, since the purpose is define requirement with high reliability, there is not impact on the final requirement with different SCS for reliability  Issue 4-5-2: Test applicability rule for FR1 and FR2 performance requirements  Samsung prefer option 1, if RAN4 agreed to define requirement with both FR1 and FR2, the test applicability rule should be defined based on BS declaration  Issue 4-5-3: PUSCH aggregation level  Samsung Still prefer option 1, with 2 slot aggregation, to align with other channel with repetition  With considering HARQ operation, 2 slot aggregation can achieve better performance with tradeoff delay and diversity gain.  Large aggregation level will result in the larger buffer size and delay, especially for TDD, it is difficult to allow with 4 continue UL slots, which will increase process delay and buffer size.  Meanwhile, for high SNR region, it is not necessary to configure 4 aggregation level. The performance gain is limited.  With 2 aggregation level can allow the scheduling flexibility with considering HARQ operation.  Issue 4-5-4: Number of HARQ transmission  Samsung still prefer option 2, with 4 HARQ. If RAN4 agree to use 1 HARQ, we are fine with aggregation with 4. Again, not prefer with 4 HARQ+ 4 aggregation level.  Issue 4-5-6: Mapping type  Still prefer option 1. if RAN4 agree both type A and type B, the test applicability rule should be defined, similar with eMBB.  Issue 4-5-7: SCS&BW  Prefer 10MHz/15kHz and 40MHz/ 30KHz, no requirement for FR2  Issue 4-5-9: Safety critical aspects:  Could Nokia provide more motivation of adding this kind of sentence?  Nokia: Please see our comment on 4-5-9 below. |
| Ericsson | Issue 4-5-1/2: we believe that there can be some application scenarios for FR2 that can benefit from aggregation or mapping type B with fewer symbols. These applications are not likely to involve ultra-reliability, and in some cases may even be related to eMBB. We think it is useful to develop some demodulation requirements at high BLER for FR2. There is no need to develop ultra-low BLER requirements for FR2. For most BS, either FR1 or FR2 will be applicable as either one or the other will be supported.  Issue 4-5-5: We think that defining a requirement with a fixed number of PRBs is useful as it enables a single requirement to be applicable for all bandwidths. We propose 25 RB as it is then compatible towards all bandwidths, and also corresponds to a payload size that is typical for URLLC applications. Full bandwidth and a large bandwidth would correspond to very large payload sizes, not typical for URLLC.  Issue 4-5-6: The opinion is fairly split on this. We do not see a strong reason for one or the other and consider that defining a requirement for both with an applicability rule is OK.  Issue 4-5-7: This issue is linked to the number of RB. If we would agree 25RB then the requirement could be applicable for all bandwidths without the need for additional simulations (and would correspond to a typical URLLC payload size).  Issue 4-5-8: Seems to be the same question as 4-5-5 ?  Issue 4-5-9: Question to Nokia: Do you propose this just for the demod requirements or also for the ultra-low BLER ? We are OK with the principle, may have some more comments on the specific wording.  Nokia: Please see our comment on 4-5-9 below.  Update 20-03-03:  Issue 4-5-9: (To Nokia) Thanks for clarification; we support to introduce some statement and can work on the wording (maybe in a later meeting?)  Issue 4-5-5: (To Nokia) Could you clarify the extent of the frequency diversity gain you see (we are running a simulation but do not have the result just yet) ?  If the link is power limited, presumably with 65PRB the gain of frequency diversity has to be more than 4.1dB; otherwise it would be better to use the smaller amount of RB and increase the PSD.  If the link is not power limited, then the lower SNR needed due to frequency diversity is obtained at the cost of a 160% greater use of bandwidth resources. If the link is not power limited then the SNR can be increased to compensate the difference in frequency diversity gain; that would lead to increased inter-cell interference. Presumably the gain in frequency diversity would need to be large enough to justify the increased bandwidth usage.  …. |
| Nokia, Nokia Shanghai Bell | Issue 4-5-1: We don’t think that FR2 is a common enough use case for high reliability communication and we agree with Samsung in observing that the reliability of demodulation does not depend on the chosen FR. Hence now FR2 requirements are needed.  Issue 4-5-3: We think 4 is the most likely use case for the envisioned non-extreme BLER targets. An aggregation level of 8 would also be acceptable from a use case point of view but would unnecessarily complicate testing. A factor of 2 is too low to stress the receiver implementation in term of memory and how long previous samples/LLR need to be “carried around” in L1/L2.  Issue 4-5-4: Nokia is fine with all values greater than 1. High reliability communication will not be deployed without HARQ. And an implementation that supports values >1 will also support =1, so this does not preclude HARQ-less deployments.  Issue 4-5-5: Frequency diversity is cornerstone in the design of high reliability products (based on R15). For non-AWGN channel models it is a must. For AWGN channel we can compromise.  Issue 4-5-6: Nokia proposes to only introduce requirements for type A, since type B will likely be covered by low latency testing. We should not duplicate the same/similar tests.  Issue 4-5-7: We have no strong opinion.  Issue 4-5-8: Duplicate of 4-5-5. Same answer, but should probably be removed.  Issue 4-5-9: To answer the questions from other companies, we seek this proposal for all URLLC named requirements; be it extremely low BLER or low BLER.  The wording is not final, and changes are welcome, as long as they preserve the intention:  Since the URLLC features of 5G NR will potentially be used in safety critical applications, the ultimately chosen statistical testing methodology for testing of these features must be verified by an independent body of experts/statisticians, before requirements and test can be used as basis for safety critical implementations. All statistical analysis and discussions provided in this meeting are to be taken as a best effort and is not to be taken as due diligence. To be a bit more direct: Accidents will happen even with URLLC, as it is not infinitely low error probability. Some higher layers applications will have relied on the latency and reliability numbers written down in demodulation tests (i.e., “5-9s”). It is understood that RAN4 is not a certification body for high reliability hardware/software (like are used in aviation for example) and delegates are usually not statisticians. I want this to be immediately clear when someone from outside 3GPP goes through the specification. |
| NTT DOCOMO | Issue 4-5-1: We prefer Option 2 since the URLLC feature is not limited to FR1. There are use cases for FR2. In addition, some use cases require both ultra-reliability and low-latency features. From low-latency perspective, FR2 has an advantage due to shorter SCS than FR1. When both ultra-reliability and low-latency feature are required, we need to test both features. If we take Option 1, the reliability performance cannot be verified. We would like to ask to Nokia, do you have any plans to solve this issues?  Issue 4-5-2: If a BS supports both FR1 and FR2, both FR1 and FR2 shall be tested. In the normal demodulation, we don’t have such declaration.  Issue 4-5-3: In our understanding, this test is functional test to confirm capability of PUSCH aggregation. We prefer to include at least maximum number of aggregation (i.e., “8”).  Issue 4-5-4: We prefer Option 2.  Issue 4-5-5: We prefer Option 2.  Issue 4-5-6: We prefer Option 3.  Issue 4-5-7: We prefer Option 2. Regarding Option 1, if a BS supports if a BS support 10/15/20/25/30MHz for 30kHz SCS, how do we test this requirement??  For FR2, some use cases require both ultra-reliability and low-latency features. From low-latency perspective, FR2 has an advantage due to shorter SCS than FR1. When both ultra-reliability and low-latency feature are required, we need to test both features. If we take Option 1, the reliability performance cannot be verified. We would like to ask to Nokia, do you have any plans to solve this issues?  Issue 4-5-8: We prefer Option 2.  Issue 4-5-9: We are not sure whether we need such a note. We can keep open.  Other:  Regarding Issue 4-1-5, we are OK to introduce requirement for CP-OFDM. For DFT-s-OFDM, we are not sure how to support URLLC without requirements. For BS demodulation, we can introduce applicability rule, so only one test per SCS will be tested even if the requirement for DFT-s-OFDM is introduced. We prefer to keep FFS on whether to introduce requirements for DFT-s-OFDM. |
| Huawei | Issue 4-5-1: We prefer option 1 considering the current deployment scenario.  Issue 4-5-3: We change to support Option 1, we have agreed TDD patterns of DDDSU and 7D1S2U in the first around discussion (tentative agreement), and aggregation level 2 is the most meaningful configuration. Even we choose aggregation level 4 or 8, actually only 2 repetitions are transmitted.  Issue 4-5-5: We prefer Option 2.  Issue 4-5-6: We prefer Option 2, but all companies are agreed Option 3 with test applicability rule by following existing Release 15 eMBB, we are fine.  Issue 4-5-8: it is same as Issue 4-5-5 and will be deleted in next version.  Issue 4-5-9: We can understand Nokia’s concern that the whole URLLC system safety can only be ensured by considering many aspects and not only the demodulation performances, but we think that people should know we just focus on the demodulation performance from physical layer features designed for URLLC and not a verification body, it is hard to capture such concern in 3GPP specification, |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #5: BS demodulation requirements for low latency

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000371**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000371.zip) | Intel Corporation | Proposal #9: For BS demodulation introduce requirements with PUSCH mapping Type B with 4 symbols |
| [**R4-2000313**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000313.zip) | Samsung | Proposal 5: No BS demodulation requirements for UL transmission with grant free/UL configured grant.  Proposal 6: Non-slot scheduling with 2 symbols can be considered for the lower latency requirement.  Proposal 7: The following test parameters for PUSCH with lower latency requirement could be considered:  PUSCH aggregation Factor: 1  SCS &BW: 120 KHz, 50 MHz;  HARQ: 4  Antenna configuration: 1x2  Mapping type: type B  DMRS symbol: 1  Channel condition: TDLB100-400  Symbol length: 2  Waveform: CP-OFDM  MCS: 5 |
| [**R4-2001180**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001180.zip) | Ericsson | *Parameters are listed in tables, please see the documents for details* |
| [**R4-2001181**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001181.zip) | Ericsson | Proposal: No need to introduce new demodulation performance requirements in RAN4 to test the reception of the PUSCH grant free transmissions. |
| [**R4-2001197**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001197.zip) | NTT DOCOMO, INC. | Proposal 1: For URLLC requirements, consider the following SCS:   * 15/30/60(FR2)/120kHz SCS   NOTE: For FR1, the same requirements are applicable to both TDD and FDD.  Proposal 2: For URLLC requirements, the following TDD UL-DL patterns are used as simulation assumptions:   * 15kHz SCS: 3D1S1U, S=10D:2G:2U * 30kHz SCS: 7D1S2U, S=6D:4G:4U * 60kHz SCS: 3D1S1U, S=10D:2G:2U * 120kHz SCS: 3D1S1U, S=10D:2G:2U   Proposal 2: For URLLC requirements, the following TDD UL-DL patterns are used as simulation assumptions:   * 15kHz SCS: 3D1S1U, S=10D:2G:2U * 30kHz SCS: 7D1S2U, S=6D:4G:4U * 60kHz SCS: 3D1S1U, S=10D:2G:2U * 120kHz SCS: 3D1S1U, S=10D:2G:2U   Proposal 3: If no performance difference among different TDD UL-DL patterns is observed, the same requirements are applicable to any TDD UL-DL patterns. Otherwise, RAN4 to study how to support other TDD UL-DL patterns.  NOTE: From our perspective, at least the following TDD UL-DL patterns need to be supported.   * 1st priority   + 30kHz SCS: DDDSUUDDDD, S=6D:4G:4U   + 120kHz SCS: DDDSU, S=10D:2G:2U * 2nd priority   + 30kHz SCS: DSUU, S=12D:2G   Proposal 4: For non-slot based PUSCH, L = 2, 4, 7 should be considered.  Proposal 5: Introduce BS performance requirements for UL configured grant (grant-free). |
| [**R4-2001488**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001488.zip) | Huawei, HiSilicon | Proposal 1: To verify mapping Type B, we propose to use symbol length is 4 and start symbol is 0.  Proposal 2: 15 KHz SCS is configured for FDD mode, and 30KHz SCS is configured for TDD mode.  Proposal 3: UL-DL pattern ‘7D1S2U (S=6D+4G+4U)’ is used for TDD.  Proposal 4: We propose the number of Tx antennas is 2 and the number of Rx antennas is 2.  Proposal 5: Only requirements for PUSCH with transform precoding disabled is defined.  Proposal 6: We propose to use MCS5 from MCS table 3.  Proposal 7: There is no need to introduce the new demodulation performance requirements to verify uplink grant free transmissions. |
| [**R4-2001696**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001696.zip) | Nokia, Nokia Shanghai Bell | Low latency BS demodulation requirements  Type B PUSCH time domain resource allocation can provision 2 DM-RS symbols starting from an allocation length of 5 symbols.   1. RAN4 to introduce PUSCH Type B demodulation requirements with an allocation length of 5 symbols and using the R15 PUSCH KPIs.   Demodulation performance is expected to be independent from the grant choice.   1. RAN4 to not introduce requirements for UL transmission with grant free/UL configured grant. |

## Open issues summary

Two sub-topics are included in this section: demodulation requirements for PUSCH mapping mapping Type B and conclusions about whether to define the demodulation requirements for UL transmission grant free.

### Sub-topic 5-1: PUSCH mapping Type B

*From the approved WF R4-1915913 in RAN4#93 meeting, following were agreed:*

* *Introduce PUSCH demodulation requirements to verify the support of PUSCH mapping Type B with non-slot configured with fewer symbols than Rel-15*

The demodulation requirements for PUSCH mapping Type B has already been decided to be defined in #93. In this meeting, parameters of the test case should be discussed and decided.

*Open issues and candidate options before e-meeting:*

**Issue 5-1-1: Symbol length (L)**

* Proposals
  + Option 1: 4os (Intel, Huawei, Samsung)
  + Option 2: 2os (Ericsson, DoCoMo)
  + Option 3: 5os (Nokia)
  + Option 4: 7os (Ericsson, DoCoMo, Nokia)
* Recommended WF

**Issue 5-1-2: Starting symbol (S)**

* Proposals
  + Option 1: 0 (Huawei, Ericsson, Nokia, Intel, Samsung)
* Recommended WF
  + Agree option 1

**Issue 5-1-3: DM-RS configuration Type 1 with single symbol**

* Proposals for symbol lengths of 5os or 7os based on the options in Issue 5-1-1
  + Option 1:1+0
  + Option 2: 1+1 (Nokia, Ericsson)
* Recommended WF
  + The DM-RS configuration is also related to the agreed symbol length. As per TS 38.211 Table 6.4.1.1.3-3, symbol length L<= 4 only DMRS 1+0 is applicable. 4< L <=7, both 1+0 and 1+1 are applicable.

**Issue 5-1-4: PUSCH aggregation factor**

* Proposals
  + Option 1: 1 (Samsung, Ericsson, Huawei, Nokia, Intel)
* Recommended WF
  + Agree option 1.

**Issue 5-1-5: Number of HARQ transmission**

* Proposals
  + Option 1: 4 (Samsung, Huawei)
  + Option 2: 1 (Ericsson, DoCoMo, Nokia, Intel)
* Recommended WF

**Issue 5-1-6: Waveform**

* Proposals
  + Option 1: CP-OFDM (Samsung, Huawei, Ericsson, Nokia, Intel)
  + Option 2: DFT-s-OFDM (DoCoMo)
* Recommended WF
  + Agree option 1

**Issue 5-1-7: MCS**

* Proposals
  + Option 1: MCS 5 from Table 3 (Samsung, Huawei, DoCoMo, Nokia, Intel)
  + Option 2: MCS 21 (658/1024) from Table 2 (Ericsson, DoCoMo?)
* Recommended WF
  + TBA

**Issue 5-1-8: SCS &BW**

* Proposals for SCS
  + FR1
    - TDD
      * Option 1: 15 kHz and 30 kHz (DoCoMo, Ericsson)
      * Option 2: 30 kHz (Huawei)
  + FR2
    - TDD
      * Option 1: 60 kHz and 120 kHz (DoCoMo, Ericsson)
      * Option 2: 50MHz/120 kHz (Samsung)
* Proposals for BW
  + 15kHz SCS
    - Option 1: 5/10/15/20MHz (DoCoMo)
    - Option 2:
  + 30kHz SCS
    - Option 1: 10/40/100MHz (DoCoMo)
    - Option 2:
  + 60 kHz SCS FR2
    - Option 1: 50/100MHz (DoCoMo)
    - Option 2:
  + 120 kHz SCS
    - Option 1: 50MHz/120 kHz (Samsung)
    - Option 2: 50/100/200MHz (DoCoMo)
* Recommended WF
  + TBA

**Issue 5-1-9: Number of PRB**

* Proposals
  + Option 1: full bandwidth (Huawei, DoCoMo, Nokia, Samsung)
  + Option 2: 8 (Ericsson)
* Recommended WF
  + TBA

**Issue 5-1-10: TDD patterns**

* Proposals
  + 15kHz SCS:
    - Option 1: 3D1S1U, S=10D:2G:2U (DoCoMo, Ericsson, Nokia, Samsung)
    - Option 2: Others with relatively equal number of DL and UL slots (Intel)
  + 30kHz SCS:
    - Option 1: 7D1S2U, S=6D:4G:4U (DoCoMo, Huawei, Ericsson, Nokia, Samsung)
    - Option 2: 30kHz SCS: DDDSUUDDDD, S=6D:4G:4U (1st priority), DSUU, S=12D:2G (2nd priority) (DoCoMo)
    - Option 3: Others with relatively equal number of DL and UL slots (Intel)
  + 60kHz SCS: 3D1S1U, S=10D:2G:2U (DoCoMo, Ericsson)
  + 120kHz SCS: 3D1S1U, S=10D:2G:2U (DoCoMo, Ericsson)
* Recommended WF
* Agree on 3D1S1U, S=10D:2G:2U for 15 kHz SCS, 7D1S2U, S=6D:4G:4U for 30 kHz
* Postpone discussion FR2 parameters until decision made on FR2 requirements.

**Issue 5-1-11: Antenna configuration**

* Proposals
  + Option 2: 1x2 (Samsung, Ericsson, DoCoMo, Huawei, Nokia, Intel, Samsung)
* Recommended WF
  + Agree option 2

**Issue 5-1-12: Channel condition**

* Proposals
  + FR1: TDLC300-100 Low (Huawei, Ericsson, Nokia, Intel)
  + FR2:
    - Option 1: TDLA30-300 Low (Ericsson)
    - Option 2: TDLB100-400 Low (Samsung)
* Recommended WF
  + Agree TDLC300-100 Low for FR1
* Postpone discussion FR2 parameters until decision made on FR2 requirements.

**Issue 5-1-13: Test metrics**

* Proposals
  + Option 1: 70% throughput (Huawei, DoCoMo, Samsung)
  + Option 2: 10% BLER (Ericsson, Nokia)
* Recommended WF

**Issue 5-1-14: PT-RS for FR2**

* Proposals
  + Option 1: with and without PT-RS configured (Ericsson, DoCoMo)
  + Option 2: without (Nokia, Huawei, Intel, Samsung)
  + Option 3: with
* Recommended WF
  + TBA

### Sub-topic 5-2: UL transmission with grant free/configured grant

From the WF in RAN4 #93 meeting, following were agreed:

* *FFS requirements for UL transmission with grant free/UL configured grant*

*Open issues and candidate options before e-meeting:*

**Issue 5-2-1: Whether to define PUSCH performance requirements for UL transmission with grant free/UL configured grant**

* Proposals
  + Option 1: No (Samsung, Nokia, Huawei, Ericsson, Intel)
  + Option 2: Yes (DoCoMo)
* Recommended WF
  + Agree option 1

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Sub topic 5-1-4: There is a mistake in our paper; the proposal should be 1 (i.e. option 1)  Sub topic 5-1-5: We don’t follow the logic of using 4 HARQ transmissions for low latency; if the aim is to test the most stringent latency criteria and use mini-slots, wouldn’t a packet retransmitted 3 times be too late ?  Subtopic 5-1-6: We propose transform precoding *disabled* ; i.e. option 1.  Subtopic 5-1-7: The rationale behind proposing 16QAM here is that for low latency, few symbols are transmitted but it is not clear that the payload will be so extremely small (e.g. with 2 symbols, the payload would only be 1/7 of the size with 14 symbols). There may be situations in which low latency transmissions are not link budget limited. So, we think that 16QAM is a quite possible and more robust scenario to test in than QPSK.  Subtopic 5-1-11: In general, we don’t follow the rational for 2x2 for PUSCH for these URLLC scenarios (both for aggregation and PDSCH with fewer symbols) and kindly request Huawei to explain further the proposal.  Subtopic 5-1-12: The channel condition should correspond to the modulation scenario, so we should decide MCS first.  Subtopic 5-1-13: The difference here relates to HARQ or no HARQ. Regarding HARQ, as commented above our question is whether HARQ would be configured for a latency critical service for which short subframes are required.  Update 2020-02-25:  Issue 5-1-8, 5-1-9: The bandwidth and number of PRB are related (if the number of PRB is fixed then the same requirement can be written into many bandwidths).  Issue 5-1-13: Note that if we have 1 HARQ transmission, then 70% throughput is the same as writing 30% BLER. As discussed for 5-1-5, we think that if a reduced symbol slot is used to meet a stringent latency, then HARQ re-transmissions do not make so much sense because the latency would be missed.  Issue 5-1-7: We do not believe that the MCS issue is only related to high payloads. For low latency, it is not always the case that the target UE has low SNR. For Ues close the basestation, SNR may be higher. In such cases, scheduling the UE to transmit with a low code rate and large number of PRBs would waste system resources, because the UE could be scheduled with a smaller number of PRBs and a higher code rate or modulation. This is why we think that the higher code rate/modulation is relevant. For demodulation requirements, we should make requirements at the highest end of realistic conditions.  Of course, large number of RBs and a low code rate/modulation is also a valid scenario for cell edge Ues and we could consider that, but it is not the most appropriate condition for good SNR users.  Update 2020-02-26:  Issue 5-1-3: Some text is deleted; we support option 1 for the case of 2os, but not for the other cases 5/7os. |
| NTT DOCOMO | Issue 5-1-1: Our proposal is Option 3 since only PUSCH requirements with 14 symbol length were introduced in Rel.15, which does not cover small number of symbols. If we need to reduce test cases, We prefer 2os and 7os.  Issue 5-1-3: This issue can be discussed after PUSCH symbol length is agreed.  Issue 5-1-5: We prefer Option 2 since it is more typical assumption.  Issue 5-1-6: Our preference is to introduce DFT-s-OFDM (i.e., Option 2). This is a typical assumption in URLLC scenario since DFT has an advantage on PAPR perspective and is more reliable than CP-OFDM.  Issue 5-1-7: For URLLC test, Option 1 should be prioritized first. If we consider high data rate scenarios such as VR/AR, we might be able to consider Option2.  Issue 5-1-8: Regarding duplex mode, if there is no performance difference between FDD and TDD, we can define common requirements for FDD and TDD. It would be noted that this approach is the same as existing normal PUSCH demodulation requirements.  Regarding CBW, the same sets as existing normal PUSCH demodulation can be used. i.e., 5/10/15/20MHz for FR1 15kHz SCS, 10/40/100MHz for FR1 30kHz SCS, 50/100MHz for 60kHz SCS, 50/100/200MHz for 120kHz SCS.  Issue 5-1-9: We prefer Option 1  Issue 5-1-10: For 30kHz SCS, if the requirements are applicable for any TDD patterns including DDDSUUDDDD, S=6D:4G:4U and DSUU, S=12D:2G, we are OK with Option 1. If not applicable, we need further discussion on how to support other TDD patterns.  Issue 5-1-11: We support Option 2.  Issue 5-1-13: We support Option 1.  Issue 5-1-14: We support Option 1.  Issue 5-2-1: We prefer Option 2. We need the functional tests to verify to blindly receive and demodulate data. Otherwise, the function and the performance of grant free reception are not guaranteed. |
| Huawei | Issue 5-1-3: DM-RS relates to symbol length.  Issue 5-14: Huawei prefer option 1.  Issue 5-1-11: Huawei changes to option 2. |
| Nokia, Nokia Shanghai Bell | 5-1-1: Nokia can agree to either 5 symbols or 7 symbols. We want to harness the reliability gains of two DM-RS, at the shortest TDRA possible; or least without increasing max DM-RS to data distance (i.e., 7 symbols is also acceptable).  5-1-2: Nokia agrees with option 1 (starting symbol 0), since it is the most adapted choice for low latency transmission, by giving the BS the maximum time to react.  5-1-3: We agree with choosing 1+1 for all symbol allocation lengths 5, 6, 7.  We agree with type 1 in general. The configuration 1+0 is forced for symbol allocation lengths <5.  5-1-4: Nokia agrees with option 1. Other aggregation factors rely on specific use cases in low latency transmission.  5-1-5: Nokia agrees with option 2: HARQ deactivated.  With HARQ activated the 1ms second use cases are not achievable. One might also see HARQ deactivation as a R15 low latency features.  5-1-6: Nokia agrees with option 1 (CP-OFDM). It is reasonable to assume that processing times are lower for CP-OFDM, which helps the low latency aspect.  5-1-6: Nokia prefer option 1. The payload in low latency applications is expected to be small. Hence one can use coding gain to improve reliability. High modulation orders are not required.  5-1-8: Nokia prefers to only specify for TDD, FDD testing can be handled like in R15 Embb. The tested CBWs should be aligned with high reliability testing.  5-1-9: Nokia prefers option 1 (full allocated CBW). We don’t see an advantage to restricting the FDRA for low latency requirements.  5-1-10: Nokia proposes to re-use the TDD patterns from R15 Embb, i.e., 15Khz 3D1S1U, 30kHz 7D1S2U. Given that the performance indicator will be TPUT/BLER, it is unclear why the FDD/TDD method from R15 Embb should show different results. Maybe we can skip the FFS from the proposed WF?  5-1-11: Option 2.  5-1-12: TDLc300-100 for FR1.  5-1-13: We prefer to use 10%BLER (=90% TPUT or 95%TPUT), i.e., option 2. In URLLC re-transmission are to be avoided. So, we should improve the chances to transmit on the “1st try”. Note that there are mathematical relationships between relative TPUT and BLER: - 10%BLER (per transmission) ~= 95% TPUT (precisely: 94.82% for 4 HARQ tx. From the calculation 1\*0.9+1/2\*0.1\*0.9 +1/3\*0.1\*0.1\*0.9 +1/4\*0.1\*0.1\*0.1\*0.9 +[0\*0.1\*0.1\*0.1\*0.1] =0.9482. See R4-1911197 for an extensive note about our understanding of the relationship between TPUT and number of reTx.) - 10% BLER (per TB including reTx) = 90% TPUT.  5-1-14: In FR1 we propose without PT-RS only.  5-2-1: Nokia remains with option 1 (no). In a certain sense, the currently discussed tests with a known TDD pattern and no true scheduling implementation, are already representative of GF/CG operation. |
| Intel | Sub-topic 5-1: PUSCH mapping Type B  Issue 5-1-2: Option 1  Issue 5-1-3: Option 1  Issue 5-1-4: Option 1  Issue 5-1-5: Option 2 – No HARQ re transmission would be better for low latency feature test requirement  Issue 5-1-6: Option 1  Issue 5-1-7: Option 1  Issue 5-1-8: Same as Rel-15  Issue 5-1-10: For TDD patterns we need to discuss and introduce new patterns more suited to URLLC for high reliability and low latency. Suggestion is to discuss patterns with relatively equal number of DL and UL slots in order to be better suited for low latency.  Issue 5-1-11: Option 2  Issue 5-1-12: Option 1  Issue 5-1-13: Option 2 – BLER if HARQ re transmission is not enabled. Otherwise 70% of Max TP with HARQ  Issue 5-1-14: Option 2 – There might not be a need for PTRS with small number of PUSCH symbols and low MCS, but we should check performance with and without PTRS to conclude  Sub-topic 5-2: UL transmission with grant free/configured grant  Issue 5-2-1: Option 1 – Given limited time, we can focus introducing requirements on more important features |
| Samsung | Issue 5-1-1: Symbol length (L)  Samsung changed our proposal, with prefer option 1, symbol =4  Regarding 7, In rel-15, we have define with 10 symbols requirement for FR2, I do not think there is much different.  Meanwhile, the requirement is for low latency, it is straightforward the processing timing with 7 is larger based on our contribution analysis.  Issue 5-1-2: Starting symbol (S)  Prefer option 1  Issue 5-1-3: DM-RS configuration  Prefer Type 1 with single-symbol 1+0  Issue 5-1-4: PUSCH aggregation factor  Prefer option 1: as agreed, no combined requirement for latency and high reliability is defined for URLLC. Aggregation is the URLLC feature with related high reliability  Issue 5-1-5: Number of HARQ transmission  Prefer option 1:  Issue 5-1-6: Waveform  Prefer option 1  Issue 5-1-7: MCS  Prefer option 1:  Issue 5-1-9: Number of PRB  Prefer option 1  Issue 5-1-10: TDD patterns  Prefer reuse NR Rel-15 configuration for BS demodulation requirement  Issue 5-1-11: Antenna configuration  Prefer Option 2  Issue 5-1-13: Test metrics  Prefer Option 1  Issue 5-1-14: PT-RS for FR2  Prefer Option 2. Follow the rule of Rel-15, no PTRS configuration for QPSK  Sub-topic 5-2  Prefer option 1: it is related to UL scheduling |

### CRs/TPs comments collection

*Major close to finalize Wis and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going Wis, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Topic #5** | Tentative agreements:  **BS FR1 URLLC demodulation requirements for low latency**  **Test parameters for PUSCH mapping Type B**   * Starting symbol: 0 * PUSCH aggregation level is 1. * Waveform: CP-OFDM. * TDD pattern:   + 15kHz SCS: 3D1S1U, S=10D: 2G: 2U   + 30kHz SCS: 7D1S2U, S=6D: 4G: 4U * Antenna configuration: 1x2. * Channel condition: TDLC300-100 Low for FR1.   No PUSCH performance requirements for UL transmission with grant free/UL configured grant.  Candidate options:  Recommendations for 2nd round:  The left open test parameters that are captured in section 5.5 |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
|  |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX |  |

## Discussion on 2nd round

### Open issues

**Issue 5-5-1: Whether to define requirements for BS FR2 URLLC performance requirements for low latency**

* Proposals
  + Option 1: Do not define
  + Option 2: Define.
* Recommended WF

**Issue 5-5-2: Symbol length (L)**

* Proposals
* Option 1: 4os (Intel, Huawei, Samsung)
* Option 2: 2os (Ericsson, DoCoMo)
* Option 3: 5os (Nokia)
* Option 4: 7os (Ericsson, DoCoMo, Nokia)
* Recommended WF

**Issue 5-5-3: DM-RS configuration Type 1 with single symbol**

* Proposals for symbol lengths of 5os or 7os based on the options in Issue 5-5-2
  + Option 1:1+0
  + Option 2: 1+1 (Nokia, Ericsson)
* Recommended WF
  + The DM-RS configuration is also related to the agreed symbol length. As per TS 38.211 Table 6.4.1.1.3-3, symbol length L<= 4 only DMRS 1+0 is applicable. 4< L <=7, 1+0 and 1+1 are applicable.

**Issue 5-5-4: Number of HARQ transmission**

* Proposals
  + Option 1: 4 (Samsung, Huawei)
  + Option 2: 1 (Ericsson, DoCoMo, Nokia, Intel)
* Recommended WF

**Issue 5-5-5: MCS**

* Proposals
  + Option 1: MCS 5 from Table 3 (Samsung, Huawei, DoCoMo, Nokia, Intel)
  + Option 2: MCS 21 (658/1024) from Table 2 (Ericsson, DoCoMo?)
* Recommended WF

**Issue 5-5-6: SCS &BW**

* Proposals for SCS
  + Option 1: 15 kHz and 30 kHz (DoCoMo, Ericsson)
  + Option 2: 30 kHz (Huawei)
* Proposals for BW
  + 15kHz SCS
    - Option 1: 5/10/15/20MHz (DoCoMo)
    - Option 2:
  + 30kHz SCS
    - Option 1: 10/40/100MHz (DoCoMo)
    - Option 2:
* Recommended WF
  + TBA

**Issue 5-5-7: Number of PRB**

* Proposals
  + Option 1: full bandwidth (Huawei, DoCoMo, Nokia, Samsung)
  + Option 2: 8 (Ericsson)
* Recommended WF

**Issue 5-5-8: Test metrics**

* Proposals
  + Option 1: 70% throughput (Huawei, DoCoMo, Samsung)
  + Option 2: 10% BLER (Ericsson, Nokia)
* Recommended WF

### Companies’ views collection for 2nd round

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 5-5-1:  Issue 5-5-2:  …. |
| Samsung | Issue 5-5-1: Whether to define requirements for BS FR2 URLLC performance requirements for low latency  Samsung prefer option 1, not define  Issue 5-5-2: Symbol length (L)  Samsung still prefer option 1, with 4symbols。  Regarding with 2OS, the payload is very small with considering MCS5 coding rate around 0.2, if we consider the minimum RB  E,g, 25RB, so information bit is around 120 . It is not typical use case for URLLC scenario.  Meanwhile, in RAN1 discussion for Rel-16 URLLC enhancement, 4 OS is typical scenario with considering the repetition scheme within slot. Therefore, to align with Rel-16 URLLC RAN1 WI feature, we prefer with 4OS  Regarding with 5 OS, It is not the useful case for mini-slot  Regarding with 7Os, as mentioned, we have defined requirement with 10 symbol, I do not see there is much different with 10OS  Issue 5-5-3: DM-RS configuration Type 1 with single symbol  Samsung still prefer 4OS, since 4 OS is the typical scenario in Rel-16 URLLC RAN1WI. Under this condition, only one DMRS symbol can be supported.  Issue 5-5-5: MCS  Samsung still prefer option 1  Issue 5-5-6: SCS &BW  Samsung prefer opton2, As our analysis, In terms of latency, with 30KHz SCS and higher, mini-slot HARQ based retransmission can fulfill latency target.  If RAN4 agrees both SCS with 15KHz and 30KHz, only one SCS is selected to test with defined test applicability rule.  Regarding BW, the typical scenario should be considered. If both 15KHz and 30KHz SCS are agreed, 15KHz with 10MHz, and 30KHz with 40MHz are preferred.  Issue 5-5-7: Number of PRB  Samsung prefer opton1 with full bandwidth. 8RB with 1 data OFDM symbol, the payload of information bit is very low, it is not the typical use case for URLLC.  Issue 5-5-8: Test metrics  Samsung still prefer option 1, 70% TP. Since the purpose is to define the requirement of latency, not for high reliability. As agreed, there is no combined requirement with latency and reliability.  As for option 2, it seems that combined these two metric, although the BLER is not very low. |
| Ericsson | Issue 5-5-1: See comment on issue 5-4-1.  Issue 5-5-2: We propose 2os and 7os. These test somewhat different demodulation (different number of RS etc.)  Issue 5-5-4: We propose option 2 because the intention of the requirement is low latency; HARQ retransmsisions would arrive too late.  Issue 5-5-5: As discussed in the first round, we propose a higher MCS because low latency UEs may also be close to the cell centre and experience higher SNR. Even if the payload size is limited, a higher MCS can reduce the amount of RBs that need to be assigned and so increase efficiency; it is always better to exploit high SNR when it is available. So we see the high SNR use-case as relevant.  Issue 5-5-6: For the bandwidth, we think it relates to the number of RB. With a fixed number of RB, the requirement can be applied for all applicable BW.  Issue 5-5-7: We propose a fixed number of RB. It is not clear whether allocating full bandwidth, especially over a large bandwidth such as 50 or 100MHz for a couple of symbols would be a good use of resources. (For large bandwidths, it could also correspond to quite a large payload size). We are open to discuss the specific number.  Issue 5-5-8: This is a bit connected to the HARQ; 70% throughput is similar to 30% BLER.  ….  Update 20-03-03: (to Nokia, Intel): Issue 5-5-5: We do not think that the higher coding rate/modulation is associated with a larger transport block size. Operating a higher code rate/modulation if SNR is good can be connected with using a smaller amount of RBs together with the same transport block size. This means less use of system resources and hence greater overall capacity. We view the high SNR case as different to the low SNR case but quite relevant. A system that would always allocate low code rate even to users near the cell centre would waste capacity. From a demodulation perspective, demodulating 16QAM differs from QPSK and it is not obvious that because the receiver operates well with QPSK then performance with higher code rate/modulation is guaranteed (hence the reason in rel-15 for including higher modulations in the demod requirements). |
| Nokia, Nokia Shanghai Bell | Issue 5-5-1: Prefer not to define. We have already decided to not test for delay targets, so testing higher SCS will not change the demodulation performance results.  Issue 5-5-2: Nokia can agree to either 5 symbols or 7 symbols. We want to harness the reliability gains of two DM-RS, at the shortest TDRA possible; or least without increasing max DM-RS to data distance (i.e., 7 symbols are also acceptable).  Issue 5-5-3: We agree with choosing 1+1 for all symbol allocation lengths 5, 6, 7. As the WF points out (app) the configuration 1+0 is forced for symbol allocation lengths <5. For the payloads envisioned in low latency communication, all TDRA with more than 4 symbols can easily afford a second DM-RS.  Issue 5-5-4: We have agreed to keep low latency and high reliability testing separate, and HARQ less operation is a big use case for low latency. Hence, we should go with option 2: HARQ off.  Issue 5-5-5: The payload in low latency applications is expected to be small. Hence one can use coding gain to improve reliability. High modulation orders are not required and MCS 5 is sufficient. We don’t see a need to test the high SNR use case, as it should be easier to achieve than the low SNR case. As a compromise we could envision to test two MCSs, but priority should be given to the new extremely low coding rates afforded by the new table 3.  Issue 5-5-6: Nokia prefers only the typical scenarios to be considered. If both 15KHz and 30KHz SCS are agreed, 15KHz with 10MHz, and 30KHz with 40MHz are preferred. As usual the supported SCS should be declarable.  Issue 5-5-7: Nokia prefers to test with the largest possible number of RBs. It seems more useful to know the minimum performance for the “worst case” and then observe gains by restricting FDRA to the practical payload.  Issue 5-5-8: Nokia observes that a (reasonably) low BLER, i.e., high rel. TPUT, is required for lower latencies, as it keeps the number of re-transmissions low (usually to zero). Option 2 (90% TPUT) should be chosen to reflect low latency use cases. |
| Intel | Issue 5-5-1: Option1: Define requirements in FR2  Issue 5-5-3: Option 1  Issue 5-5-4: Option 2. No HARQ re-transmissions would be better suited to verify low latency requirements  Issue 5-5-5: Option 1: For URLLC use case we usually consider small packet size, do not see the need to have test case with high MCS  Issue 5-5-8: Option 2. With no HARQ re-transmissions, 10% BLER would be a better test metric than 30% BLER |
| NTT DOCOMO | Issue 5-5-1: We prefer Option 2 since the URLLC feature is not limited to FR1. There are use cases for FR2. In addition, some use cases require both ultra-reliability and low-latency features. From low-latency perspective, FR2 has an advantage due to shorter SCS than FR1. When both ultra-reliability and low-latency feature are required, we need to test both features. If we take Option 1, the reliability performance cannot be verified. We would like to ask to Nokia, do you have any plans to solve this issues?  Issue 5-5-2: We prefer both Option 2 and Option 4.  Issue 5-5-3: We agree with Recommended WF.  Issue 5-5-4: We prefer Option 2.  Issue 5-5-5: As 1st priority, we agree with Option 1.  Issue 5-5-6: We prefer Option 1. When we consider refarming-band (e.g., Band n1), there are use cases to use not only 30kHz SCS but also 15kHz SCS.  Other:  Regarding Issue 5-1-6, we are OK to introduce requirement for CP-OFDM. For DFT-s-OFDM, we are not sure how to support URLLC without requirements. For BS demodulation, we can introduce applicability rule, so only one test per SCS will be tested even if the requirement for DFT-s-OFDM is introduced. We prefer to keep FFS on whether to introduce requirements for DFT-s-OFDM. |
| Huawei | Issue 5-5-1: We prefer option 1  Issue 5-5-2: We change to support Option 2. Considering the low latency, we think 2os is more typical. The larger payload size can be achieved by using more RBs, such as full bandwidth.  Issue 5-5-4: We change to support Option 2. For low latency test, HARQ mostly will be turned off.  Issue 5-5-6: We change to support Option 1 for SCS selection if test applicability rule for selection SCS for test is to be defined. But we prefer to choose typical bandwidth for each selected SCS not cover many bandwidths like did for eMBB.  Issue 5-5-7: We do not think that we should constraint the small payload size for URLLC, to achieve low latency, smaller symbols are chosen, larger bandwidth should be considered. |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #6: PUCCH demodulation requirements for high reliability

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000313**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000313.zip) | Samsung | Proposal 4: No PUCCH demodulation performance requirements for ULRRC. |
| [**R4-2001182**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001182.zip) | Ericsson | Proposal 1: Do not create new PUCCH requirements for URLLC |
| [**R4-2001489**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001489.zip) | Huawei, HiSilicon | Proposal 1: More discussion is need for defining the URLLC PUCCH performance requirements.  Proposal 2: Only PUCCH performance requirements for format 0 and 2 are considered if the requirements will be defined. |
| [**R4-2001696**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001696.zip) | Nokia, Nokia Shanghai Bell | PUCCH demodulation performance requirements  PUCCH DTX to ACK probability is to be kept one order of magnitude lower than the BLER target of the corresponding data transmission. Issues are currently observed in testing down to such targets.   1. RAN4 to not introduce PUCCH demodulation performance requirements for high reliability. |

## Open issues summary

### Sub-topic 6-1: PUCCH performance requirements

*From the approved WF R4-1915913 in RAN4#93 meeting, following were agreed:*

* *FFS on introduction of PUCCH demodulation performance requirements*

*Open issues and candidate options before e-meeting:*

**Issue 6-1-1: Whether to define the PUCCH performance requirements for high reliability**

* Proposals

Option 1: No need to define. (Samsung, Nokia, Ericsson, Huawei, Intel)

Option 2: Discuss the necessity of the following test cases (DoCoMo)

* + - * Multi-slot PUCCH format 1 with 15kHz SCS (NOTE: The requirement with 30kHz SCS is already defined.)
      * Multi-slot PUCCH format 3 with 15/30kHz SCS
* Recommended WF
  + Agree option 1

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| NTT DOCOMO | Sub topic 6-1: For multi-slot PUCCH, Duplex mode/SCS/CBW sets are limited. The necessity of other test cases should be discussed. For PUSCH requirement for URLLC, 15kHz SCS for FDD is also discussed. We prefer to discuss on the necessity of the following test cases:   * multi-slot PUCCH format 1 with 15kHz SCS (NOTE: The requirement with 30kHz SCS is already defined.) * multi-slot PUCCH format 3 with 15/30kHz SCS |
| Nokia, Nokia Shanghai Bell | 6-1-1: We remain with our proposal to not define PUCCH requirements. We recognize that multi-slot PUCCH are probably advantageous for reliability, however this feature is already covered by the R15 eMBB requirements. |
| Intel | Sub-topic 6-1: PUCCH performance requirements  Option 1: Not necessary to introduce requirements for PUCCH. |
| Samsung | Issue 6-1-1: Whether to define the PUCCH performance requirements for high reliability  Prefer option 1 |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  Do not define the PUCCH performance requirements for high reliability |

*Suggestion on WF/LS assignment*

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

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |