**3GPP TSG-RAN WG4 Meeting #94-e R4-2002381**

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

**Agenda item:** 8.9.1.1

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for RAN4#94e\_#90\_NR\_L1enh\_URLLC\_Demod\_Test

**Document for:** Information

# Introduction

## Background

As part of the URLLC package, features have been introduced to support link operation at very low BLER (10^-5 in release 15) as well as ultra-low latency. Part of the objectives of the RAN4 Rel-16 WI are to assess the testability of the low BLER requirements and propose solutions:

Phase 1:

Study the test methodology for both BS and UE [RAN4]

Test methodology for the test metric of 99.999% reliability with testing time into consideration

Test methodology for low latency requirements

For the low latency requirements, it was concluded that low latency is not directly testable (but that requirements will be introduced for low latency features). At RAN4#93, some further agreements were made on the scope of the testability investigations:

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| * Introduce PUSCH low BLER high confidence requirement   + If feasible, define [1] test case to verify 10^-5 BLER     - Target BLER: 10^-5     - Target test confidence level: 99.999%     - Propagation conditions: Static channel     - MCS: MCS5 from MCS Table 2 for PUSCH     - Duplex mode: Both TDD and FDD       * FFS TDD patterns     - SCS:       * TDD: 30KHz         + FFS 15kHz       * FDD: 15KHz         + FFS 30KHz     - Test method: refer to R4-1915866 (ad hoc minutes for NR URLLC test feasibility)       * Method 1: Consider aggregation 1 or 2, but no HARQ for non-boosted SNR       * Method 2: No aggregation or HARQ for boosted SNR.   FFS whether to use method 1 or method 2 for testing (as described below). Adjustment of the baseline parameters for the long test after simulations is not precluded.  Methods:  1. SINR set to target 10^-5 BLER. RAN5 test methodology adapted so that pass/fail decision is evaluated every N error reports instead of every error report  2. SINR set to target BLER much lower than 10^-5. RAN5 test methodology re-used with early pass expected. Potentially allow for early pass even with zero error reports, after sufficient sub-frames observed.  • This kind of test is observing lack of error floor, not testing SNR vs BLER  3. Other optimizations not precluded as long as they are in line with the existing methodology. |

## Moderators observations

Based on contributions to this meeting, the following observations are made:

* There is some variation in the estimations of test time:
  + Intel: 20 mins minimum to 13.4 hours maximum (N=1)
  + Rohde and Schwarz: Worst case 9.5 hours, can be shorter
  + Huawei: 6-18 second for “bad” DUT (10^-3), 1-2 hours for “good” DUT (10^-6), long time for marginal DUT
  + Nokia: For marginal DUTs with common uplink TDD pattern: Method 1: 60 hours, method 2: 2.5 hours
  + Ericsson: Method 1: 10-20 hours for longest tests, Method 2: 10s of minutes or 1-2 hours depending on underlying error rate
  + Qualcomm: For 90% of good UEs (which have error rate between 10^-5 and 10^-6), 1 hour
* The variation depends on whether average, worst case or best case is considered. It also depends on the assumptions on parameters such as aggregation factor, SCS, TDD pattern etc.
* Method 2 is not clearly defined (whether it means define a specific SINR to make more devices “good” devices or aim for zero BLER)
* The following parameters for the ultra-low BLER test have already been agreed:
  + Propagation conditions: Static channel
  + MCS: MCS5 from MCS Table 2 for PUSCH
  + Duplex mode: Both TDD and FDD
    - FFS TDD patterns
  + SCS:
    - TDD: 30KHz
      * FFS 15kHz
    - FDD: 15KHz
      * FFS 30KHz
  + HARQ: No HARQ
  + Slot aggregation: no aggregation or aggregation factor 2.
* The following parameters remain to be agreed for the ultra-low BLER test:
  + TDD pattern
  + SCS
  + Slot aggregation factor
  + Transform precoding enable/disabled
  + Antenna configuration
  + DM-RS & PT-RS configuration
  + Time and frequency domain resource assignment

## E-mail discussion plan

The aim of this e-mail discussion will be two-fold:

* Agree as many parameters as possible for the ultra-low BLER test; this will facilitate convergence on the estimations of test times
* Agree on the test methodology, the number of requirements and whether an ultra-low BLER CQI requirement is needed.

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

* 1st round:
  + Key parameters
    - Pass/fail decision evaluation frequency (whether every error or otherwise)
    - Whether to apply slot aggregation for the ultra-low BLER test
    - SCS applicability for the ultra-low BLER test
    - TDD pattern for ultra-low BLER test
      * Elaborate “DL heavy” and “UL heavy” pattern if needed
  + Other parameters
    - Aim to make progress on other parameters for the ultra-low BLER test (the parameters have less or little impact on the test time)
  + Definition of method 1 and method 2
  + First views on how many requirements to define, which method to use and whether to define CQI requirements for ultra-low BLER
* 2nd round:

Conclude on the following (plus any left-over from first round):

* + How many requirements and tests to define for ultra-low BLER
  + Whether to define CQI requirements for ultra-low BLER
  + Whether to take method 1 or method 2a or 2b

# Topic #1: Key parameters for ultra-low BLER test time estimation

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000370 + R4-2000371 (submitted to AI 8.9.1.2) | Intel | **Proposal #1: Introduce test cases with 30KHz SCS for TDD and FDD mode to reduce test time**  **Proposal #2: Introduce performance requirements for testing 10-5 BLER for URLLC**  **Proposal #3: To achieve overall confidence level of 99.999% define statistical testing methodology based on D=4e-7 and N=1**  **Observation #1:** By increasing N, overall CL of 5-9s can be achieved with lower value of D and smaller maximum testing time, at the same time minimum testing time increases.  **Observation #2:** Overall CL of 5-9s can be achieved with very small D (4e-7) and testing at every error observed.  **Observation #3:** The BLER achieved at SNR specified in performance tests is usually lower than requirement  **Observation #4:** The testing time for target BLER < 1e-5 is shorter than target BLER of 1e-5  **Observation #5:** The average testing time for 1e-5 BLER is reasonable and max testing time is smaller than that derived from statistical method  **Observation #6:** Method 2 would test for error floor rather than performance and would be a functional test.  **Proposal #1: Introduce PDSCH demodulation test cases for target BLER 10-5  with the following parameters: Target BLER: 10^-5; Target test confidence level: 99.999%**  **Propagation channel: Static; MCS: MCS5 from MCS table 3**  **SCS: 30KHz for both FDD and TDD**  **Duplex mode: Both TDD and FDD. For TDD mode use DL heavy DL:UL configuration**  **HARQ: no ReTx**  **Aggregation level on PDSCH: 1**  **Proposal #2: Introduce PUSCH demodulation test cases for target BLER 10-5  with the following parameters: Target BLER: 10^-5; Target test confidence level: 99.999%**  **Propagation channel: Static; MCS: MCS5 from MCS table 2**  **SCS: 30KHz for both FDD and TDD**  **Duplex mode: Both TDD and FDD. For TDD mode use UL heavy DL:UL configuration**  **HARQ: no ReTx**  **Aggregation level on PUSCH: 1** |
| R4-200566 | Rohde and Schwarz | **Observation 1:** The absolute maximum test time is around 9.5 hours.  **Observation 2:** The actual test times depend on DUT behaviour, but are likely much shorter than the maximum.  **Observation 3:** The shortest test time can be achieved when checking the pass/fail criteria after every error. |
| R4-2001178 | Ericsson | **Observation 1: Evaluating the pass/fail only after each N errors reduces the theoretical maximum test time, but does not appear to reduce the mean or longest test time in practice.**  **Observation 2: Raw test time (i.e. just the time taken to transmit the total number of needed slots) is in the order of hours on average, or 10-20 hours longest.**  **Observation 3: Actual time needed for testing will be some factor larger than raw test time.**  **Observation 4: If the SINR is biased for the error floor test, then it is essential to define other demodulation requirements to verify demodulation performance at higher BLER and/or lower confidence level.**  **Observation 5: Biasing the SINR to get lower BLER can reduce the expected test time to hours or tens of minutes.**  **Proposal 1: For the error floor test, use sufficient SINR to ensure a BLER well below target (potentially even zero BLER) and hence avoid long test time.**  **Proposal 2: Adopt the test parameters proposed in section 3** |
| R4-2001483 + R4-2001484 (submitted to AI 8.9.1.2) | Huawei | **Observation 1: For bad DUTs (BLER=10^-3) with FDD mode, the test can be stopped when ne=7.**  **Observation 2: the test time is short for bad DUTs with FDD mode.**  **Observation 3: For good DUTs (BLER=10^-6) with FDD mode, the test can be stopped when ne=7.**  **Observation 4: For good DUTs (BLER=10^-6) with FDD mode, the test time is 2.21 hours.**  **Observation 5: For bad DUTs (BLER=10^-3) with TDD mode, the test can be stopped when ne=7.**  **Observation 6: the test time is short for bad DUTs with TDD mode.**  **Observation 7: For good DUTs (BLER=10^-6) with TDD mode, the test can be stopped when ne=7.**  **Observation 8: For good DUTs (BLER=10^-6) with FDD mode, the test time is 1.02 hours.**  **Observation 9: As for non-marginal DUTs, the test can be stopped at a very early stage (e.g. ne=7), we propose N=1.**  **Observation 10: Method 1 is effectively shorten the test time for non-marginal DUTs**  **Observation 11: For marginal DUTs, the long test is still needed.**  **Proposal 1: The pass/fail criterion reports results after observing every error, N=1.**  **Proposal 2: We prefer to use Method 1 to test the high reliability.**  **Proposal 1: Using existing TDD pattern ‘7D1S2U (S=6:4:4)’ for SCS 30 KHz.**  **Proposal 2: Only 15 KHz SCS is configured for FDD.**  **Proposal 3: 5 MHz bandwidth is used for TDD and 10 MHz bandwidth is used for TDD.** |
| R4-2001695 | Nokia | 1. Marginal DUTs are almost always decided in the “bin” covering the last decision coordinate. Hence, netarget dominates the number of required error samples, and virtually no early termination is observed.   Due to fewer decision coordinates, and hence less risk accumulation, the netarget values are reduced, when compared to the unmodified methodology, however the gain is surprisingly low. For BLER=1e-5 with CLtest = 1-1e-5 we extrapolate a required number of error observations of 513, which is a reduction of 15%, when compared to the unmodified test methodology (“607”, see [3, Table 6]). This value also approximately holds for the number of samples, i.e., testing time, that is evaluated later.  The expected testing time using M1 for the scenario (PUSCH, marginal DUTs, 30kHz SCS, aggregation factor n2, TDD pattern 7D1S2U) is 42.1e6 x 0.5ms x 2 x 10/2 = 60 hours.  The expected testing time using M2 for the scenario (PUSCH, perfect DUTs, 30kHz SCS, aggregation factor n1, TDD pattern 7D1S2U) is 1.15e6 x 0.5ms x 1 x 10/2 = 1.6 hours.  The expected testing time using M2 for the scenario (PUSCH, BLERtarget/10 good DUTs, 30kHz SCS, aggregation factor n1, TDD pattern 7D1S2U) is 1.75e6 x 0.5ms x 1 x 10/2 = 2.5 hours.  M1 has to deal with a test scenario, where the tested DUTs are marginal DUTs. M2 has an advantage, as the removal of channel uncertainty improves the BLER performance in the test environment, due to back-off from design targets. Thus, it is a reasonable assumption that M2 will terminate with less observed error events, i.e., faster, than M1 and within a practical timeframe of less than 3 hours.   1. RAN4 to adapt method 2 or declare high reliability KPI not testable. |
| R4-2002115, R4-2002142 (Submitted to AI 8.9.1.2) | Qualcomm | **Proposal 1: Use Method 1 for testing 99.999% reliability with 99.999% confidence level.**  **Observation 1: For bad UEs, 90th percentile of time taken to early fail for 1e-5 test requirement is < 10 minutes, which is reasonable test time.**  **Observation 2: For good UEs with BLER between 1e-5 and 1e-6, 90th percentile of time taken to early fail for 1e-5 test requirement is ~1 hour, which is reasonable test time.**  **Observation 3: For very good UEs, it takes a long time to get the first error instance resulting into very long test time. This can be shortened by setting a threshold on number of slots without any error.**  **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.**  **Proposal 5: Only consider aggregation factor of 1 for low BLER high confidence level test. Define a separate test case for testing aggregation factor.** |
| R4-2000313  (Submitted to AI 8.9.1.3) | Samsung | **Proposal 1: Reuse the existing TDD pattern defined in the NR Rel-15 demodulation requirement to specify PUSCH lower BLER high confidence requirement as**  **TDD: 30 KHz SCS: 7D1S2U, S=6D: 4G: 4U**  **Only FDD with 15 KHz SCS and TDD with 30 KHz SCS configuration are considered to introduce PUSCH lower BLER high confidence requirement.** |
| R4-2000944  R4-2001197 (submitted to AIs 8.9.2.1, 8.9.3.1) | DoCoMo | **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 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** |
| R4-20001696 (Submitted to 8.9.3.1) | Nokia | PUSCH low BLER high confidence requirement   1. **RAN4 to not define requirements and/or test cases for 1e-5 PUSCH BLER with high confidence requirement.** 2. With a large amount of resources spent on testing and accepting feature introduction delays, it can be conceivable to define requirements and/or test cases for 1e-5 PUSCH BLER with high statistical confidence requirements using test method 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.** |

## Open issues summary

There are a number of key parameters that impact the estimates of test time. These include the decision evaluation frequency, SCS, TDD pattern, aggregation factor. An agreement on these will facilitate convergence of views on test time. Note that discussing and aligning on parameter assumptions does not presuppose that an ultra-low BLER test will be created.

### Sub-topic 1-1 Decision frequency

The decision frequency is whether early pass/fail is evaluated on every block error, or every N block errors.

**Issue 1-1: Decision frequency**

* Proposals
  + Option 1 (Intel, Ericsson, Rohde & Schwarz, Huawei, Qualcomm, NTT DoCoMo, Samsung): Make pass/fail decision every error (N=1)
  + Option 2: Make pass/fail decision every 10th error (N=10)
  + Option 3: Make pass/fail decision every 100th error (N=100)
* Recommended WF
  + Agree option 1

### Sub-topic 1-2 Sub-carrier spacing for FR1

The sub-carrier spacing will impact the symbol and slot lengths and the test duration. Note: The discussion in this thread on SCS concerns only the ultra-low BLER/ultra-high confidence requirement and tests. Other URLLC requirements will be discussed in the relevant thread.

**Issue 1-2: SCS for FR1**

This issue is split into BS and UE, since handling of FDD and TDD may be different.

* Proposals for UE (PDSCH) for FR1:
  + Option 1 (Intel): 30kHz SCS only
  + Option 2 (Huawei, Samsung, NTT DoCoMo, Qualcomm): FDD 15kHz, TDD 30kHz
  + Option 3: FDD both 15 and 30kHz, TDD 30kHz
* Recommended WF
  + Agree option 2
* Proposals for BS (PUSCH) for FR1:
  + Option 1 (Intel): 30kHz SCS only
  + Option 2: 15kHz SCS only
  + Option 3 (Ericsson, NTT DoCoMo, Nokia, Huawei, Samsung): Both 15kHz and 30kHz (with applicability rule)
  + Option 4 (): 15kHz for FDD, 30kHz for TDD [Moderator note: Requires creating FDD requirements for the BS spec]
* Recommended WF
  + Agree option 3

### Sub-topic 1-3 Sub-carrier spacing for FR2

The sub-carrier spacing will impact the symbol and slot lengths and the test duration. Note: The discussion in this thread on SCS concerns only the ultra-low BLER/ultra-high confidence requirement and tests. Other URLLC requirements will be discussed in the relevant thread.

**Issue 1-3: SCS for FR2**

* + Option 1 (Samsung): 60kHz SCS only
  + Option 2 (Intel, Samsung): 120kHz SCS only
  + Option 3 (NTT DoCoMo, Ericsson): Both 60kHz and 120kHz (with applicability rule)
* Recommended WF
  + For the second round, discuss need for requirements and testing for FR2:
    - Is there a need to create an ultra-low BLER requirement for FR2
    - If an ultra low BLER requirement for FR2 is created, can there be some form of applicability test.
  + Moderator of discussion#91 on URLLC demod is requested to hold a similar discussion for the other URLLC demod requirements in that thread.

### Sub-topic 1-4 TDD patterns

Note: The discussion in this thread on TDD pattern concerns only the ultra-low BLER/ultra-high confidence requirement and tests. Other URLLC requirements will be discussed in the relevant thread.

The issue is split for FR1 and FR2, since few proposals have been submitted for FR2. The agreement may be unified into one. If needed, BS testing and UE testing can be split.

**Issue 1-4: TDD patterns**

* Proposals FR1
  + Option 1 (Samsung, DoCoMo, Ericsson, Nokia, Huawei, Intel for UE): 3D1S1U (S=10:2:2) for 15kHz, 7D1S2U (S=6:4:4) for 30kHz (as applicable depending on SCS decision)
  + Option 2 (): 7D1S2U (S=6:4:4) for 30kHz
  + Option 3 (Intel): DL heavy pattern when testing PDSCH (7D1S2U (S=6:4:4)), UL heavy pattern when testing PUSCH (please elaborate proposed patterns)
* Recommended WF
  + Agree 7D1S2U (S=6:4:4) for UE
* Proposals FR2
  + Option 1 (DoCoMo, Samsung, Ericsson):3D1S1U (S=10:2:2) for 60 and 120kHz (as applicable depending on SCS decision)
  + Option 2
* Recommended WF
  + For the second round, discuss need for requirements and testing for FR2:
    - Is there a need to create an ultra-low BLER requirement for FR2
    - If an ultra-low BLER requirement for FR2 is created, can there be some form of applicability test.
  + Moderator of discussion#91 on URLLC demod is requested to hold a similar discussion for the other URLLC demod requirements in that thread.

### Sub-topic 1-5 Slot aggregation

Note: The discussion in this thread on slot aggregation factor concerns only the ultra-low BLER/ultra-high confidence requirement and tests. Other URLLC requirements will be discussed in the relevant thread.

**Issue 1-5: Slot aggregation factor**

* Proposals
  + Option 1 (Intel, Ericsson, Qualcomm, Huawei, DoCoMo, Nokia for method 2, Samsung for method 2): 1 (no slot aggregation)
  + Option 2 (Nokia for method 1, Samsung for method 1): aggregation factor = 2
* Recommended WF
  + Agree option 1 and agree low SE MCS table to be used

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| Ericsson | Sub topic 1-2: For the BS, our proposal to do 15 and 30 is considering both FDD and TDD. For the BS, we defined up to now requirements only with a TDD pattern but for both SCS. We could do an applicability rule that only 1 SCS is tested. Regarding option 4; this would necessitate an FDD test pattern; if we would create that then we would be OK.  For the UE, we are OK with option 2.  Sub topic 1-3: Again if we define a requirement for both SCS but with an applicability rule such that only 1 SCS is tested, we are OK.  Sub-topic 1-4: We are OK to use existing TDD patterns. One unanswered question is whether we define an FDD pattern for the BS (which may correspond to Intel’s UL heavy pattern)  ….  Others: |
| Nokia, Nokia Shanghai Bell | 1-1: Nokia also proposes option 1.  Our analysis showed negligible and/or negative gains when reducing the decision frequency.  1-2 (BS only). Nokia agrees with option 3. Considering allowing possibly accelerated testing configurations, we are opposed to options that require distinction between FDD and TDD.  1-3: Nokia does not think it is necessary to test both FR1 and FR2 in the ultra low BLER regime. So either FR1 or FR2.  1-4 (FR1): Nokia agrees with option 1. We don’t see a reason to abandon the patterns used in eMBB requirements.  1-4 (FR2): Nokia agrees with option 1, with the caveat that we only see FR1 or FR2 required for test.  1-5: Nokia’s goal is to have at least one high reliability related feature activated, during the low BLER test. Looking at the WF from last time, we would have aggregation turned off and MCS table 2 (not low SE), which would not make this requirement a high reliability requirement.  = = Update 2020-02-26  1-5: We cannot agree on the WF, at least not directly after the first round. In our opinion, method 1 requires the test case to be representative of real use cases to be meaningful (or rather to deliver on the strong “ultra high reliability in practice/real world” statement associated with M1). Hence, for M1 we expect both low SE MCS and aggregation to be used at the same time. |
| NTT DOCOMO, INC. | Sub topic 1-1: We prefer Option 1.  Sub topic 1-2: For UE, we are OK with Option 2. For BS, basically common requirements can be used for both FDD and TDD. We can reuse applicability rule for SCS from the existing. i.e., only 1 SCS will be tested.  Sub topic 1-4: For UE, for FR1 30kHz SCS, we prefer DDDSUUDDDD, S=6D:4G:4U and for FR2, we prefer 3D1S1U (S=10:2:2) .  For BS, for FR1 30kHz SCS, if the requirements are applicable for any TDD patterns including DDDSUUDDDD, S=6D:4G:4U and DSUU, S=12D:2G, we prefer Option 1. If not applicable, we need further discussion on how to support other TDD patterns. For FR2, we prefer 3D1S1U (S=10:2:2).  Sub topic 1-5: We prefer method 1 with aggregation factor = 1. |
| Huawei | Issue 1-2: (BS) We change to option 3.  Issue 1-3: For low BLER test, Huawei prefer only test FR1 or FR2.  Issue 1-4: (FR1) We change to option 1. |
| Qualcomm | Sub topic 1-1: We also prefer N = 1 so that early pass/fail could happen as soon as possible.  Sub topic 1-2: We prefer Option 2 (FDD 15kHz, TDD 30kHz) for UE PDSCH.  Sub topic 1-3: We prefer not to define/deprioritize any test for FR2 to minimize the number of long tests as most UEs will initially support URLLC in FR1.Sub topic 1-4: We prefer Option 2 (7D1S2U) for FR1. |
| Intel | Sub topic 1-1: Decision Frequency  Option1: N=1  Sub topic 1-2: SCS for FR1  In order to reduce the testing time we propose to use 30KHz for both FDD and TDD. For BS testing 30KHz is already used. We should introduce 30KHz for FDD for UE as well  Sub topic 1-3: SCS for FR2  There has not been discussion on introducing high reliability / 1e-5 BLER tests in FR2. In case there consensus to define requirements in FR2, then introduce BS and UE tests with 120KHz SCS  Sub topic 1-4: TDD patterns  The existing TDD patterns in FR1 (and FR2) used in Rel-15 seem fine for UE demodulation (60% or 70% slots are DL) but for BS testing they are not suitable because only 20% of slots are for UL and it would be a better use of resources especially for long tests to have UL heavy TDD pattern. Example UL heavy pattern: SU (discussed in Rel-15) Request operators input for it.  Sub topic 1-5: Slot aggregation  Option 1 – no aggregation for high BLER tests  ---Update 02-27-2020—  Sub-topic 1-4: The TDD patterns for UE as ok (7D1S2U for 30KHz), but for BS (3D1S1U and 7D1S1U) it would be a waste of 80% of transmission time with so many DL slots. Propose to consider and discuss SU or DDSU for BS. |
| Samsung | Issue 1-1: Decision frequency  We prefer option 1  Issue 1-2: SCS for FR1  For UE side, we are ok with option 2. For BS side, we prefer with option3,  Issue 1-3: SCS for FR2  We are ok with option 1 or option 2. While for ultra- low BLER test, either FR1 or FR2 is selected with applicability rule.  Issue 1-4: TDD patterns  For FR1 and FR2, reusing the existing TDD pattern defined in NR demodulation requirement for high reliability requirement and testing.  Issue 1-5: Slot aggregation factor  We prefer no slot aggregation for method2, as for method 1, 2 slot aggregation factor. |

## 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.

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|  | **Status summary** |
| **Sub-topic#1** | Tentative agreements:  Decision frequency (N) is 1 (i.e. early pass/fail evaluation on every detected block error)  SCS for UE: 15kHz for FDD, 30kHz for TDD  SCS for BS: 15kHz and 30kHz  TDD pattern: 7D1S2U (S=6:4:4) for UE  Candidate options:  Recommendations for 2nd round:  Further discussion is needed on the following topics:  TDD pattern for BS  Whether to create FR2 requirements and tests for ultra-low BLER  Whether slot aggregation should be applied with n=2 or not |

Recommendations on WF/LS assignment

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| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | A WF is requested for capturing all agreements, to be submitted after the second round (just one WF for all topics in this e-mail discussion) | Ericsson |

### CRs/TPs

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

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | No CR/TP needed at this stage |

## Discussion on 2nd round (if applicable)

**Issue 1.5.1: Requirements and tests for FR2:**

* Option 1: Create requirements for FR2. No explicit applicability rule needed.
* Option 2: Create requirements for FR2 with applicability rule
  + Proponents of option 2 please clarify what applicability rule you propose
* Option 3: Do not create requirements for FR2

**Issue 1.5.2: Slot aggregation factor**

* Proposals
  + Option 1 (Intel, Ericsson, Qualcomm, Huawei, DoCoMo, Nokia for method 2, Samsung for method 2): 1 (no slot aggregation)
  + Option 2 (Nokia for method 1, Samsung for method 1): aggregation factor = 2

**Issue 1-5-3: TDD patterns for BS**

* Proposals FR1
  + Option 1 (Samsung, DoCoMo, Ericsson, Nokia, Huawei): 3D1S1U (S=10:2:2) for 15kHz, 7D1S2U (S=6:4:4) for 30kHz (as applicable depending on SCS decision)
  + Option 2 (Intel): UL heavy pattern when testing PUSCH (please elaborate proposed patterns)
* Recommended WF

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | 1.5.1: We support option 3. We do not see a need for ultra-low BLER requirements for FR2  1.5.2: We do not see an immediate need for aggregation to be tested together with ultra-low BLER  1.5.3: We do not see an immediate need to change the TDD configuration for uplink. We believe that anyhow ensuring that devices are not marginal is needed to avoid long test time (even with different TDD patterns) and then the TDD factor will not be so important. |
| Intel | 1.5.1: Option 3. May not be feasible to introduce radiated test requirements for ultra low BLER. The test time might be very long than we have analyzed so far.  1.5.2: Still support option 1. Introducing higher aggregation level would double the testing time. We will have tests with PDSCH and PUSCH slot aggregation. Don’t see the need to introduce it in ultra-low BLER test case.  Issue 1-5-3: The purpose of proposing UL heavy TDD pattern for BS testing for ultra low BLER is to reduce the testing time. With other TDD patterns only 20% of slots are used for UL transmission. With SU or DSUU pattern 50% would be used for UL and testing time would be reduced by a factor of 2.5. Would request companies to consider new patterns in order to reduce test time and justify why we cannot introduce new TDD patterns that would be very beneficial in reducing test time significantly |
| NTT DOCOMO | Issue 1-5-1: For BS, we prefer Option 1. In our understanding, general applicability rule can be applied (e.g., SCS, CBW, etc.). For UE, we prefer Option 1. Applicability rule is not necessary.  Issue 1-5-2: We prefer Option 1.  Issue 1-5-3: We prefer Option 1. We need a study on whether the same requirement can be used for other TDD patterns in next meeting. If the performance difference among different TDD patterns is not negligible, we need to find the solution to support any TDD patterns. |
| Samsung | **Issue 1.5.1: Requirements and tests for FR2:**  We prefer option 3. As mentioned, in terms of ultra-BLER performance, there is no different with different SCS, only impact on the test time.  **Issue 1.5.2: Slot aggregation factor**  With considering method 2, the test is under boosted SNR condition. There is no need to configure slot aggregation level to improve SNR.  While considering method 1, the test is under boosted SNR condition. Since the test should verify the URLLC requirement, in my understanding, at least URLLC feature with slot aggregation level shall be considered. Either option 1 or option 2 is fine for us, We can compromise with option 1 with 1 slot aggregation  **Issue 1-5-3: TDD patterns for BS**  We prefer option 1 |
| Nokia, Nokia Shanghai Bell | Issue 1-5-1: The practical testing issues for FR2 are even more pronounced than for FR1, so another analysis would be required to see, if high reliability testing is feasible there (from an engineering pov). As we also don’t see the use case for FR2, we clearly prefer option 3.  Issue 1.5.2: Since the definition of the method has changed during the decision, we want to rephrase as AF=2, if [X]>=3dB. For this value of X the testing time is reduced enough to make it feasible to include the PUSCH aggregation feature, which bring the SNR into very reasonable operating ranges (see our simulation results from the last two meetings.)  Issue 1.5.3: UL heavy TDD patterns do not correspond to any use case that we can think of for eMBB and even less for URLLC.  We have previously shown that URLLC requirements are very sensitive to the chosen TDD pattern (see R4-1913406) for fading channels, but almost no difference in AWGN. Hence we are open to allow all TDD patterns for AWGN later in this WI, but for now we want decide requirements based on common use cases. |

## 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: Other parameters for ultra-low BLER test

## Companies’ contributions summary

See section 1.1 for a full list of relevant contributions.

## Open issues summary

There are a number of other parameters that need to be agreed for the ultra-low BLER test. These are not critical to estimating test time but may have some impact. The other parameters are discussed in this e-mail thread to prevent the URLLC discussion threads overlapping, and in case they have some impact to the testability discussion. Note that discussing and aligning on parameter assumptions does not presuppose that an ultra-low BLER test will be created. Also, the parameter decisions for the ultra-low BLER requirement may not be the same as the parameter decisions for the other URLLC requirements.

### Sub-topic 2-2 Transform precoding for PUSCH

For PUSCH, transform precoding or not

**Issue 2-1: Transform precoding (for PUSCH)**

* Proposals
  + Option 1 (Ericsson, Nokia, Samsung, Huawei, Intel, Samsung): Disabled
  + Option 2 (DoCoMo): Enabled
  + Option 3: Both
* Recommended WF
  + Agree option 1

### Sub-topic 2-2 Antenna configuration for PUSCH

**Issue 2-2: Antenna configuration for PUSCH**

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

### Sub-topic 2-3 Antenna configuration for PDSCH

**Issue 2-3: Antenna configuration for PDSCH**

* Proposals
  + Option 1 (Huawei, Intel, Nokia, Qualcomm, Samsung): 2x2 ULA low
  + Option 2:

Recommended WF

* + Agree option 1, but continue to discuss whether to define a test for 2x4

### Sub-topic 2-4 Reference signal configuration for PUSCH

**Issue 2-4: PT-RS and DM-RS configuration**

* Proposals
  + Option 1 (Ericsson, Nokia, DoCoMo (FR1), Samsung, Huawei):

|  |  |
| --- | --- |
| DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| Additional DM-RS position | pos1 |
| Number of DM-RS CDM group(s) without data | 2 |
| Ratio of PUSCH EPRE to DM-RS EPRE | -3 Db |
| DM-RS port | {0} |
| DM-RS sequence generation | NID0=0 |
| PT-RS | TBD |

* + Option 2 (, Intel, Samsung): DM-RS type 1, zero additional DM-RS
* Recommended WF
  + Agree no PT-RS for FR1. Postpone discussion on FR2 until decision made on FR2 requirements.
  + For DM-RS, continue to discuss. Companies requested to check how strong is your opinion for second round.
* Recommended WF

### Sub-topic 2-5 Reference signal configuration for PDSCH

**Issue 2-5: PT-RS , CSI-RS and DM-RS configuration**

* Proposals
  + Option 1 (Intel, Samsung):

|  |  |  |
| --- | --- | --- |
| PDSCH DMRS configuration | DMRS Type | Type 1 |
| Number of additional DMRS | 0 |
| CSI-RS configuration | PeriodicityAndOffset | 5 slots, 0 slots |
| nrofPorts | 2 |
| frequencyDomainAllocation | Row3, ‘000001 |
| firstOFDMSymbolInTimeDomain | 7 |
| cdm-Type | CDM2 |
| Density | 1 |

* + Option 2 (Qualcomm, Huawei): 1 additional DM-RS

Recommended WF

* + For DM-RS, continue to discuss. Companies requested to check how strong is your opinion for second round.

### Sub-topic 2-6 Time and frequency domain configuration for PUSCH

**Issue 2-6: Time and frequency domain resource assignment for PUSCH**

For the BS (PUSCH):

* Proposals (Differences between the proposals are highlighted red)
  + Option 1 (Ericsson, DoCoMo length 14 and type A/B, not other things):

|  |  |  |
| --- | --- | --- |
| Time domain resource assignment | PUSCH mapping type | A, B |
| Start symbol | 0 |
| Allocation length | 14 |
| Frequency domain resource assignment | RB assignment | 25 RB |
| Frequency hopping | Disabled |

* + Option 2 (Nokia):

|  |  |  |
| --- | --- | --- |
| Time domain resource assignment | PUSCH mapping type | B |
| Start symbol | 0 |
| Allocation length | 5 |
| Frequency domain resource assignment | RB assignment | Full applicable test bandwidth  25MHz / 65 PRB |
| Frequency hopping | Disabled |

* Option 3 (Samsung):
  + Mapping type A
  + Symbol length 14
  + 10MHz for 15k SCS, 40MHz for 30k SCS, [use all available PRBs] ?
* Option 4 (Huawei):

|  |  |  |
| --- | --- | --- |
| PUSCH configuration | Mapping type | Type B |
| Starting symbol (S) | 0 |
| Length (L) | 14 |
| SCS and BW | | FDD:15KHz, 5MHz  TDD:30KHz,10MHz |
| Frequency domain resource | | Full BW |

* Recommended WF
  + Agree the following:
    - Start symbol 0
    - Length 14
    - Mapping type, Bandwidths & RBs continue to discuss

### Sub-topic 2-7 Time and frequency domain configuration for PDSCH

**Issue 2-7: Time and frequency domain resource assignment for PDSCH**

* Proposals
  + Option 1 ( Intel):

|  |  |  |
| --- | --- | --- |
| PDSCH configuration | Mapping type | Type B |
| Starting symbol (S) | 2 |
| Length (L) | 4 |
| SCS and BW | | FDD:15KHz, 5MHz  TDD:30KHz,10MHz |
| Frequency domain resource | | Full BW |

* Option 2 (Ericsson, Huawei, NTT DoCoMo, Qualcomm): Mapping type A, 12 symbols, start symbol

Recommended WF

* + Agree option 2
  + Bandwidths & RBs to be discussed further

### Sub-topic 2-8 MCS table

**Issue 2-8: MCS table**

* Proposals
  + Option 1 (Nokia, Samsung, Intel, Qualcomm): Use low spectrum efficiency MCS tables for ultra-low BLER requirement evaluation and definition
  + Option 2:

Recommended WF

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Sub topic 2-6: The Nokia proposal of 65 PRBs implies >10MHz bandwidth for 15k SCS, which is too large. I see Huawei and Nokia propose short slots; could you explain more the rationale behind that ?  Sub topic 2-8: Option 1 is OK for us  Update 2020-02-25:  Sub-topic 2-6: Comment/Questions to Nokia  Clearly Type B and 5 symbols is advantageous for latency. However, this test is aiming at high reliability. We are discussing some tests for Type B and fewer symbols in the other thread. It is not obvious to us that we would need to mix the two here.  From a link budget perspective, transmitting in more symbols is advantageous as more energy is transmitted. The SNR for achieving 10^-5 is likely to be relatively large, so link budget may be more the concern.  Regarding frequency diversity and 65 PRBs; of course, there may be greater frequency diversity depending on the channel. However, the PSD scales down with the number of PRBs and so the link budget may be more degraded. So, in relatively flat fading channels, fewer PRBs may be more optimal. Do you have some reference to the channels/use case (maybe from RAN1) ?  Nokia on 2-6, 2020-02-26:  Yes, this subtopic is about high reliability and not low latency. Though, in the absence of technical reasons to choose a certain TDRA type and length, we should orient ourselves towards the complete use cases of URLLC. The link budget argument makes sense, if the additional symbols/energy is not used to increase MCS. We will take it into account for the next round, under the constraint of the MCS agreement. The PSD will only scale down, if the UE is already transmitting at max allowed power. Otherwise, power control will increase the sum power transmitted by the UE, which seems advantageous in high reliability cases. We did not look into regulatory issues (e.g., limits of UT tx power per 5MHz) that might decrease UE transmit power with a too narrow PRB allocation. We don’t have reference on hand right now, before the deadline for round 1, however for AWGN there will be no results in RAN1 that take regulations into account (and probably no power control either).  Sub-topic 2-7: We agree with DoCoMo that we should consider more symbols for similar reasons to the BS. |
| Nokia, Nokia Shanghai Bell | 2-1: Nokia remains with option 1. No transform precoding.  2-2: Nokia remains with option 1. 1T2R.  2-4: Nokia remains with option 1. For high reliability use cases, a higher number of DM-RS is beneficial. 2 is max up to 7 symbols.  2-6: Nokia remains with option 2. Type B is advantageous for high reliability with low latency in mind, since we can have 2 DM-RS symbols starting from 5 symbols. Allocation length 5 is advantageous for high reliability with low latency in mind, since we have already 2 DM-RS symbols for only 5 symbols. Full applicable test bandwidth is advantageous for high reliability, since frequency diversity is required in real systems. We should take the use case into account, even though this is not an issue in AWGN only.  2-8 (MCS table) The high reliability test should have at least one URLLC feature activated. We assumed the discussion in the last meeting had concluded with MCS 5 from the low spectral efficiency table, but this is contradicted by the last WF. |
| NTT DOCOMO, INC. | Sub topic 2-1: We support Option 2. For URLLC scenario, DFT-s-OFDM is more typical than CP-OFDM because of the benefits of low PAPR.  Sub topic 2-2: We support Option 1.  Sub topic 2-3: We support Option 1.  Sub topic 2-4: For DMRS, we prefer 1 additional DMRS for FR1 and 0 additional DMRS for FR2. For PTRS, we prefer to adopt “with PTRS”.  Sub topic 2-5: Number of additional DMRS can be discussed after PDSCH symbol length is agreed.  Sub topic 2-6 (for BS): We prefer to adopt both mapping type A and B with the same CBW sets as existing normal PUSCH demodulation. 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. Applicability rule can be considered to test only one case.  Sub topic 2-7 (for UE): We prefer PDSCH mapping type A with 12 symbols. Regarding SCS and CBW, we prefer 10MHz for FDD 15kHz SCS and 40MHz for TDD 30kHz SCS. |
| Huawei | Issue 2-1: Huawei prefer option 1. No transform precoding.  Issue 2-2: We change to option 1.  Issue 2-4: The DM-RS configuration relates to the mapping type and symbol length. Although mapping type B with mini-slot can reduce the latency, the test here is defined to test high reliability. Huawei is ok with mapping type A with DM-RS reused from the existing configuration for PUSCH. This test is defined under AWGN condition to test the ultra-low BLER target, there is no necessary to adopt PT-RS.  Issue 2-6: (PUSCH) Huawei is ok with using existing configuration for PUSCH which is configured with both mapping type A and B with start symbol of 0 and length of 14. Full bandwidth is allocated.  Issue 2-7: (PDSCH) Huawei is ok with using existing configuration for PDSCH. For FR1, mapping type A and B with start symbol of 2 and length of 12 are configured in Rel-15. To test the low BLER target, we prefer mapping type A.  Issue 2-8: MCS table. From the last WF, we agreed to use MCS5 from table 3 for PDSCH and using MCS5 from table 2 for PUSCH.  Updates 2020-02-26:  Issue 2-5: With mapping type A, we prefer 1 additional DM-RS. Other parameters in issue 2-5 should be reselected according to existing Rel-15. |
| Qualcomm | Sub topic 2-3: We are ok with 2x2 ULA low. However, we are wondering how to test the UE for bands which mandate 4Rx. So, we are ok to define the test for 2x2 and we further ask to discuss whether to define the test for 2x4 or not.  Sub topic 2-5: We prefer 1 additional DMRS.  Sub topic 2-7: We prefer full slot PDSCH Type A allocation as this is only high reliability test. We should test PDSCH Type B grant in low latency test cases. Also, I am wondering why we cant reuse default BW/SCS configurations that we have been using so far, i.e., 10MHz/15kHz for FDD and 40MHz/30kHz for TDD.  Sub topic 2-8: We are ok with Option 1 (MCS Table 3). |
| Intel | Sub topic 2-1: Transform Precoding  Disabled  Sub topic 2-2: Antenna configuration for PUSCH  1x2 ULA Low  Sub-topic 2-4: Reference signal configuration for PUSCH  Option 2: 1 additional DMRS is not beneficial in static channel  Sub-topic 2-5 Reference signal configuration for PDSCH  Option 1 (we didn’t propose in our paper)  Sub-topic 2-6 Time and frequency domain configuration for PUSCH  Option 1 : Either Type A or Type B is fine, not both  Sub-topic 2-6 Time and frequency domain configuration for PDSCH  We didn’t propose option 1 in our paper. But option 1 is fine  Sub-topic 2-7 MCS table  Low SE MCS table – Table 3 for PDSCH, Table 2 for PUSCH |
| Samsung | Issue 2-1: Transform precoding (for PUSCH)  Prefer option 1:  In terms of ultra-low BLER test procedure, there is no different with different waveform.  Issue 2-2: Antenna configuration for PUSCH  Prefer option 1  URLLC feature is limited to a single transmission layer with repetition.  Issue 2-3: Antenna configuration for PDSCH  Prefer option 1  Issue 2-4: PT-RS and DM-RS configuration  Both option 1 and option 2 are fine for us. Considering the ultra-low BLER is under AWGN condition, it seems that it is not necessary to configure additional DMRS.  In order to align with high BLER test and requirement, we prefer to reuse the existing parameters for Rel-15 NR BS demodulation requirement.  Regarding PTRS, we prefer to follow the rule in Rel-15, There is no PTRS configuration for QPSK demodulation.  Issue 2-5: PT-RS , CSI-RS and DM-RS configuration  We prefer option 1  Issue 2-6: Time and frequency domain resource assignment for PUSCH  We prefer option 3 with Full BW.  Considering the ultra-low BLER is under AWGN condition, there is no different form the test procedure and performance perspective.  Issue 2-7: Time and frequency domain resource assignment for PDSCH  Issue 2-8: MCS table  We prefer option 1 |

## 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 transform precoding (CP-OFDM waveform)  Antenna configuration for BS: 1x2  Antenna configuration for UE: 2x2 + continue to discuss whether to include 2x4  No PT-RS for FR1  PUSCH configuration: Start symbol 0, length 14 symbols  PDSCH configuration: Mapping type A, start symbol 2, length 12 symbols  MCS table: Use low spectrum efficiency MCS  Candidate options:  Recommendations for 2nd round:  Discuss further whether to include 2x4 UE antenna configuration  Discuss further whether 1 or 2 DM-RS symbols for both BS and UE  Discuss Bandwidths for PUSCH and PDSCH  Discuss RB allocations for PUSCH and PDSCH  Discuss mapping type A, B or both for PUSCH. |

Recommendations on WF/LS assignment

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | A WF is requested for capturing all agreements, to be submitted after the second round (just one WF for all topics in this e-mail discussion) | Ericsson |

### 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 CR/TP at this stage |

## Discussion on 2nd round (if applicable)

**Issue 2.5.1: PT-RS and DM-RS configuration for PUSCH**

* Proposals
  + Option 1 (Ericsson, Nokia, DoCoMo (FR1), Samsung):

|  |  |
| --- | --- |
| DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| Additional DM-RS position | pos1 |
| Number of DM-RS CDM group(s) without data | 2 |
| Ratio of PUSCH EPRE to DM-RS EPRE | -3 Db |
| DM-RS port | {0} |
| DM-RS sequence generation | NID0=0 |
| PT-RS | TBD |

* + Option 2 (Huawei, Intel, Samsung): DM-RS type 1, zero additional DM-RS

**Issue 2.5.2: PT-RS , CSI-RS and DM-RS configuration for PDSCH**

* Proposals
  + Option 1 (Intel, Samsung):

|  |  |  |
| --- | --- | --- |
| PDSCH DMRS configuration | DMRS Type | Type 1 |
| Number of additional DMRS | 0 |
| CSI-RS configuration | PeriodicityAndOffset | 5 slots, 0 slots |
| nrofPorts | 2 |
| frequencyDomainAllocation | Row3, ‘000001 |
| firstOFDMSymbolInTimeDomain | 7 |
| cdm-Type | CDM2 |
| Density | 1 |

* + Option 2 (Qualcomm, Huawei): 1 additional DM-RS

**Issue 2.5.3: Number of RB for PUSCH**

* **Option 1 (Ericsson): 25 RB**
* **Option 2 (Nokia): 65 RB**
* **Option 3 (Huawei): Full bandwidth for 5MHz/15k SCS and 10MHz/30Kscs**

**Issue 2.5.4: Number of RB for PDSCH**

* **Option 1 (Intel): Full bandwidth for 5MHz/15k SCS and 10MHz/30Kscs**

**Issue 2.5.5: Bandwidth for PUSCH**

* **Option 1 (Huawei): 5MHz for 15k SCS, 10MHz for 30k SCS**
* **Option 2 (Samsung): 10MHz for 15k SCS, 40MHz for 30k SCS**
* **Option 3 (NTT DoCoMo) 5/10/20MHz for 15k SCS, 10/20/40/100MHz for 30k SCS, applicability rule to ensure just one test**

**Issue 2.5.6: Bandwidth for PDSCH**

* **Option 1 (Intel): 5MHz for 15k SCS, 10MHz for 30k SCS**
* **Option 2 (NTT DoCoMo, Qualcomm ?): 10MHz for 15k SCS, 40MHz for 30k SCS**

**Issue 2.5.7: PDSCH antenna configuration**

* **Option 1: Include 2x4 antenna configuration**
* **Option 2: Do not include 2x4 antenna configuration**

**Issue 2.5.8: PUSCH mapping type**

* **Option 1: Type A**
* **Option 2: Type B**
* **Option 3: Type A and Type B**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Issue 2.5.1: 1+1 DM-RS was agreed for the high BLER slot aggregation requirement. We think that the ultra-low BLER requirement should be aligned in FRC to the slot aggregation requirement.  Issue 2.5.3: We propose a fixed number of RBs. 25 RB enables a requirement to be defined for all bandwidths and also gives a realistic payload size for URLLC.  Issue 2.5.5: If we fix the number of RBs as 25 then option 3 can be supported with a common requirement. If we would use full bandwidth then we would prefer option 1.  Issue 2.5.8: There are companies supporting both A and B, and no clear technical reason to justify one way or the other. Doing a requirement for both type A and B but using an applicability rule is a pragmatic way forward. |
| Intel | Issue 2.5.1/2.5.2: We propose no additional DMRS since it is static channel.  Issue 2.5.3: Option 3 – Full BW but with SCS +CBW combinations used in Rel-15  Issue 2.5.4: Option 1: Full BW, but with 10MHz for 15k SCS, 40MHz for 30k SCS  Issue 2.5.5: Option 2  Issue 2.5.6: Our preference is option 2. Our proposal is incorrectly captured as Option 1  Issue 2.5.7: Option 1: There could be UE that only supports 4RX and we might not have requirements for URLLC for such Ues. Suggest introducing requirements for 4RX with applicability rule similar to Rel-15.  Issue 2.5.8: Option 3 is fine with us, but we recommend having applicability rule as in Rel-15 such that only – Mapping type A or mapping type B is tested |
| NTT DOCOMO | Issue 2-5-1: In normal PUSCH demodulation requirements, both “no additional DMRS” and “one additional DMRS” are defined with applicability rule. We can compromise that adopt both options and introduce applicability rules. In addition, we should separate the discussion for FR1 and FR2. For FR2, we need another discussion.  Issue 2-5-3: We prefer to configure RB to full bandwidth. If we adopt Option 3 in issue 2-5-4, we need another option. Regarding Option 2, if a BS support small channel bandwidth with smaller than 65RB, how do we test URLLC feature??  Issue 2-5-4: Issue 2-5-4 and Issue 2-5-6 should be discussed together.  Issue 2-5-5: We prefer Option 3. Regarding Option 2, if a BS support 5MHz for 15kHz SCS, or 10/15/20/25/30MHz for 30kHz SCS, how do we test URLLC feature??  Issue 2-5-6: We prefer Option 2  Issue 2-5-7: We prefer Option 1.  Issue 2-5-8: For FR1, we agree with Option 3 since the normal PUSCH requirements have test cases for type A and B with applicability rule.  Other:  Regarding Issue 2-2, 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. |
| Samsung | Issue 2.5.1: PT-RS and DM-RS configuration for PUSCH  Since the test for ultra-low BLER test with static channel, 1 DMRS symbol should be enough  Issue 2.5.3: Number of RB for PUSCH  Prefer option 3, full bandwidth  Issue 2.5.5: Bandwidth for PUSCH  Issue 2.5.8: PUSCH mapping type  Prefer type A, since there is no impact on ultra-low test, the performance with type B and type A should be same with static channel condition.  if RAN4 agree both type A and type B, the test applicability rule should be defined, similar with Embb |
| Nokia, Nokia Shanghai Bell | Issue 2.5.1: Nokia’s use cases for high reliability always foresee the usage of as many DM-RS as possible. Since it does neither impact the testing time/feasibility, nor limits the use to non-static channels, we don’t see why we would want to create requirements that do not represent the high reliability use case.  Issue 2.5.2: No opinion.  Issue 2.5.3: Our initial round 1 comment was for full bandwidth. Full applicable test bandwidth is advantageous for high reliability, since frequency diversity is required in real systems. We should take the use case into account, even though this is not an issue in our AWGN only setup. As we discussed in our R1 response to E///, there is a power advantage to using full BW when the UE is not transmitting at max power. The adjustment of the payload size does not need to be done via FDRA. In summary: We prefer “full bandwidth”.  Issue 2.5.4: No opinion.  Issue 2.5.5 No strong opinion, but a compromise might be 5+10MHz at 15kHz and 10+40MHz at 30kHz.  Issue 2.5.6: No opinion.  Issue 2.5.7: No opinion.  Issue 2.5.6: Following the direction of the previous companies’ comments, we can compromise to 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: Test method

## Companies’ contributions summary

See section 1.1 for a full list of relevant contributions.

## Open issues summary

Two methods were proposed at RAN4#93 for the ultra low BLER test. However, method 2 is not entirely clear and so for this discussion, it is proposed to split method 2 into method 2a and method 2b as described below to facilitate discussion:

Method 1: SNR identified to target 10^-5 BLER. Test SINR = Identified SINR + IM. RAN5 test methodology applied (with N=1 or some other N as decided for issue 1-1)

Method 2a: SNR identified to target 10^-5 BLER. Test SINR = Identified SINR + IM + X. RAN5 test methodology applied (with N=1 or some other N as decided for issue 1-1). X is an addition to the SNR to increase the proportion of “good” devices and ensure no excessively long test time. The value of X is TBD (but will be written in the spec as a fixed number, not a vendor declaration. X should aim to produce a lower error rate e.g. 10^-6 for most devices)

Method 2b: SNR applied is sufficiently large to ensure very low, possibly zero BLER. It is not important to specify the specific SNR level in the specification; the point is to demonstrate no error floor.

### Sub-topic 3-1 Test method

**Issue 3-1: Test method**

Nokia, Ericsson: Please clarify option 2a or 2b or both

Others: Please double check if you prefer option 1 or 2a with this definition

* Proposals
  + Option 1 (Qualcomm, Samsung, Huawei, Intel): Method 1
  + Option 2 (Ericsson, Nokia): Method 2a
  + Option 3 (Ericsson, Nokia): Method 2b
* Recommended WF
  + Reformulate the discussion as follows:
    - Test requirement = SNR for 10^-5 + IM + [X]
    - X is FFS and could be zero
    - FFS whether X appears in the core spec or test spec, or is just considered part of IM

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| Ericsson | Sub topic 3-1:  At least from a network perspective, link level performance is only one part of an ultra-reliable connection. Aspects such as protocol software reliability, scheduler software behavior and reliability, internal interfaces in the BS and the wider network, hardware reliability will all need to be designed and tested. For safety or mission critical applications, a wider set of testing will be needed than the 3GPP demodulation requirements. For this reason, we are cautious about the amount of test time we bake into the specification for this ultra-low BLER test in isolation. We agree that regular demod tests are needed; hence the need for the “high BLER” tests as discussed in the other thread. After discussing the parameters more, we will get a better idea of test times, but for now we propose method 2a or 2b. Note that the “X” in 2b could be considered as a test tolerance in the test specification designed to allow testing within a reasonable time.  ….  Update 2020-02-25:  Comment to NTT DoCoMo:  Our understanding is that all of options 1, 2a, 2b verify the performance with 10^-5 BLER and 99.999 CL in the sense that they demonstrate that the BLER is achievable (in the case of 1 and 2a that it is achievable towards some standardized SNR). The question is then whether the requirement sets the lowest possible test SNR threshold or allows for SNR to be increased somewhat for testing to ensure that there are not marginal DUT that take an infeasibly long time (something like a test tolerance). For the network, as discussed above, for safety and mission critical applications a much wider scope of testing will be needed than just RAN4. For other types of URLLC application, we should take care that we do not bake into the specification costly and long testing when it is not fully clear how necessary it is. We do see the need for good SNR/BLER requirements and discuss some practically testable requirements in the other thread; in this thread the question is whether the added value of setting X=0 would justify the cost and complexity of very long testing. |
| Nokia, Nokia Shanghai Bell | 3-1: Nokia sees only ostensible differences between 2a and 2b. Hence, we are fine with either, as long as “X” in 2b is larger than 4Db. Our analysis has resulted in infeasibly high testing sample requirements for Method 1, so we cannot agree with M1 as a way forward. When talking about testing times, we recognize that “hours” was the wrong approach. The testing time in hours differs substantially between UL and DL (and configurations in general), even when starting from the same testing time in samples. Only method 2 (a or b) has a high enough probability to result in early termination, for all types of DUTs, to be usable in practical testing. We have a reliably feasible method in M2, no matter the true BLER. So, this one should be chosen to avoid unresolvable issues (e.g., undecidable DUTs) in conformance testing.  Update 2020-02-26  The updated WF seems like a possible way to break the stalemate for us. We would prefer to specifically capture X in the specification to make it clear that the test is biased towards early termination. |
| NTT DOCOMO, INC. | Sub topic 3-1: We support Option 1 to verify the performance with 10^-5 BLER and 99.999% CL. |
| Qualcomm | Sub topic 3-1: Based on our simulation results, testing times seem reasonable for most Ues under Method 1 and we prefer to use Method 1 as it establishes the performance requirement for SNR-BLER relationship. |
| Intel | Sub-topic 3-1 Test method  We still prefer to use method 1 as performance is tested. Also, with the margins added to derive actual requirement SNR, the SNR would likely be for BLER lower than 1e-5. Given static channel conditions, a small increase in SNR would result in much lower BLER than 1e-5. |
| Samsung | Issue 3-1: Test method  We prefer option 1. Eventually, the SNR with targeting 10^-5 BLER should be derived for requirement and testing with margin |
| Huawei | Issue 3-1: We prefer option 1. For method 2, it is error floor testing, not performance testing. |
| S |  |

### 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 |
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## 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.

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|  | **Status summary** |
| **Sub-topic#1** | Tentative agreements:  The test method discussion is reformulated as follows. Discussion on X continues in round 2:   * + Reformulate the discussion as follows:     - Test requirement = SNR for 10^-5 + IM + [X]     - X is FFS and could be zero     - FFS whether X appears in the core spec or test spec, or is just considered part of IM   Candidate options:  Recommendations for 2nd round:  Continue discussion focused on X; what the value may be and (if needed) how to incorporate into the specifications. |

Recommendations on WF/LS assignment

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | A WF is requested for capturing all agreements, to be submitted after the second round (just one WF for all topics in this e-mail discussion) | Ericsson |

### CRs/TPs

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

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | No CR/TP at this stage |

## Discussion on 2nd round (if applicable)

Test requirement = SNR for 10^-5 + IM + [X]

**Issue 3.5.1: Value for X**

**Issue 3.5.2: Whether X is specified in the core spec and if so whether it is explicit or part of the IM**

* **Option 1: Core spec and explicit**
* **Option 2: Core spec and implicit (in IM)**
* **Option 3: Not in core spec**
* **Note: Issue is only applicable if X is non-zero**

**Issue 3.5.3: Whether X is specified in the conformance spec, and if so whether it is explicit or part of the TT**

* **Option 1: Conformance spec and explicit**
* **Option 2: Conformance spec and implicit (in TT)**
* **Option 3: Not in Conformance spec**
* **Note: Issue is only applicable if X is non-zero**

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| **Company** | **Comments** |
| Ericsson | We have a question to Qualcomm on this; you suggest that the test time is not long for 90% of devices. How about the test time for the remaining 10% ? Also, what is the distribution of device performance behind the result ?  Towards Intel: The average time is low, but the longest tests are still pretty long. It should also be considered that the test may not be continuous; breaks for resynchronization, cooling etc. are needed.  Our concern remains that we should not bake long test times into the specification. We agree with other companies that the test time for non-marginal devices and BS is OK. However, we should ensure that there is not a significant amount of non-marginal testing. Our preliminary view is that the X can be in the conformance spec; it may be interesting to gather more data on the operating SNR and IM to get a better idea of the risk of a BS being marginal. Right now, we believe that some X should be included if there is a significant chance of marginal behavior. Potentially X may differ between UL and DL. |
| Intel | Issue 3.5.1: The value of X should not be very high ~ 0.5 dB to ensure we are testing SNR-BLER requirement. Very large X might pass UEs that don’t have error floor but don’t meet performance requirement  No need to separately capture it in core spec, just like IM is not captured in core spec. We prefer to add X to IM while deriving the SNR requirement. |
| Samsung | In the conformance test, we have added the similar value with considering MU and TT.  IM should be depended the implementation for each company. Therefore, I do not think X should be explicit or part of the IM.  If needed, we are fine to capture into core spec and explicit with conformance test and implicit in TT. |
| Nokia, Nokia Shanghai Bell | Issue 3.5.1: Value should be greater than 1dB to “simulate” a channel/marginal DUT that supports 1e-6 operation (see simulations in R4-1913406). Lower than 1dB will not allow for sufficient early termination and might make UL tests infeasible and/or leave too many DUTs undecided in time limited testing. Our preferred value would be 3dB, to make sure the UL tests are feasible and economically viable.  Issue 3.5.2: Option 3.  Issue 3.5.3: Option 1. Core spec and explicit. We need to publicly and explicitly disclose how the numbers were achieved and how we make URLLC testable. The minimum requirements in 38.104 can then still give a good indication of the expected real-world performance. |

## 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

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| **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: Tests to define

## Companies’ contributions summary

See section 1.1 for a full list of relevant contributions.

## Open issues summary

During RAN4#93, it was decided to create [1] test cases if feasible. Apart from the number of test cases, the number of requirements needs to be decided; it is possible to write more than 1 requirement but only 1 test case using an applicability rule, in order to account for different implementations. A further possibility remains to decide that the ultra-low BLER test is not feasible.

It has been proposed to also set a requirement on CQI reporting considering ultra-low BLER.

### Sub-topic 4-1 Number of ultra-low BLER requirements and tests

How many ultra-low BLER (10^-5) and ultra-high confidence (99.999%) tests and requirements to define.

**Issue 4-1: Number of requirements**

Nokia propose option 1 if method 2 not used.

* Proposals
  + Option 1 (Samsung ??, Nokia if method 1): zero requirements/tests
  + Option 2 (Intel): One requirement/test
  + Option 3 (DoCoMo for BS): TBD requirements, but only one test (using applicability rule)
  + Option 4 (DoCoMo for UE): more than one requirement and more than one test
* Recommended WF
  + Continue discussion

### Sub-topic 4-2 CQI tests relating to ultra-low BLER

Whether to define CQI tests with ultra-low BLER and ultra-high confidence

**Issue 4-2: CQI testing at ultra-low BLER**

* Proposals
  + Option 1 (Qualcomm, DoCoMo): Define CQI testing with ultra-low BLER
  + Option 2 (Huawei, Ericsson, Intel): Do not define CQI testing with ultra-low BLER
* Recommended WF
  + Continue discussion

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |
| Nokia, Nokia Shanghai Bell | 4-1: Nokia prefers option 1, but can compromise to option 2 in case test method 2 (a or b) is used. Our analysis has resulted in infeasibly high testing sample requirements for Method 1; 60 hours to be able to be sure a device with design target BLER 1e-5 is decided, while testing with no undecidable DUTs remaining. Remark: When talking about testing times, we recognize that “hours” was the wrong approach. The testing time in hours differs substantially between UL and DL (and configurations in general), even when starting from the same testing time in samples. Nokia has disclosed the detailed formulae for calculating testing time (in samples and converting to hours). We encourage others to do the same we and consider our 60 hours (in UL) result to be valid and justified in the meantime.  Possibly a split in feasibility for UL and DL is required, since the testing times are one order of magnitude apart. |
| NTT DOCOMO, INC. | Sub topic 4-1: For BS, we prefer Option 3. For UE, we prefer Option 4. As discussed in other sub topics, multiple configurations can be considered. e.g., FDD/TDD, 15/30/120kHz SCS, etc.  Sub topic 4-2: We prefer Option 1. |
| Huawei | Issue 4-2: Huawei prefer option 2. The experiment of testing the ultra-low BLER target tells us it takes very long time to achieve 10^-5, as the CQI reporting test is more complex than the single BLER test, we propose do not test the CQI table with 10^-5 BLER target. |
| Qualcomm | Sub topic 4-1/4-2: We prefer to define CQI reporting test with ultra low BLER and high confidence level. As explained in our paper R4-2002142, we only need one long test for CQI reporting under AWGN. If we define both FMCS test and CQI reporting test at same SNR, we can define an applicability rule between those two tests to reduce the number of test cases. For example, if we define FMCS test for MCS5 and during CQI reporting test, we find that UE BLER for some MCS <=5 is > 1e-5, then UE automatically fails the FMCS test. |
| Intel | Sub-topic 4-1 Number of ultra-low BLER requirements and tests  Issue 4-1: Option 1 - We prefer to define 1 test for FR1 FDD, FR1 TDD for UE and BS demod.requirements respectively. We need to discuss if FR2 test cases are feasible and necessary  Sub-topic 4-2 CQI tests relating to ultra-low BLER  Issue 4-2: Option 2 – We recommend to test CQI table 3 in fading channel without having to test at low BLER |
| Samsung | Issue 4-1: Number of requirements  We prefer option 1. Based on method2, there is no relationship with BLER and SNR. |
| Ericsson | Issue 4-1: We reserve judgement on this until we have more clarity on how the test would be defined and the test time for marginal DUT. As discussed above, from the network perspective it does not make sense to define an extreme long duration test just in RAN4; for mission critical operations a large amount of other testing is likely to be needed anyway and the RF/baseband is only one part of the network system.  Issue 4-2: We do not see a need for a CQI test with ultra-low BLER. Since the CQI is a prediction of the future based on the past, for ultra-low BLER the network will anyhow need to allow a margin (in SNR or MCS selection) compared to the reported CQI to allow for unexpected changes in the channel, interference conditions etc. The CQI accuracy established by testing at higher BLER should be sufficient. |

### CRs/TPs comments collection

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|  |  |
| --- | --- |
| **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:  None  Candidate options:  Recommendations for 2nd round:  Continue discussion on the number of requirements and tests to define  Continue discussion on the need for ultra-low BLER CQI test |

Recommendations on WF/LS assignment

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | A WF is requested for capturing all agreements, to be submitted after the second round (just one WF for all topics in this e-mail discussion) | Ericsson |

### 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 CR/TP needed at this stage |

## Discussion on 2nd round (if applicable)

**Issue 4.5.1: Number of requirements**

Nokia propose option 1 if method 2 not used.

* Proposals
  + Option 1 (Samsung ??, Nokia if method 1): zero requirements/tests
  + Option 2 (Intel): One requirement/test
  + Option 3 (DoCoMo for BS): TBD requirements, but only one test (using applicability rule)
  + Option 4 (DoCoMo for UE): more than one requirement and more than one test
* Recommended WF

**Issue 4.5.2: CQI testing at ultra-low BLER**

* Proposals
  + Option 1 (Qualcomm, DoCoMo): Define CQI testing with ultra-low BLER
  + Option 2 (Huawei, Ericsson, Intel): Do not define CQI testing with ultra-low BLER
* Recommended WF

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| NTT DOCOMO | Issue 4.5.1: We prefer Option 4 since multiple configurations can be considered And, we need clarification of Option 2. In the case of FR1, does Option 2 mean two tests, FR1 TDD and FR1 FDD?  Issue 4.5.2: We prefer Option 1 |
| Nokia, Nokia Shanghai Bell | Issue 4.5.1: Option 1 for [X] <1dB. Option 2 for [X] >=1dB.  Issue 4.5.2: No opinion. |

## 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” |