[101-bis-e][323] NB-IOT_MTC_Demod_NWM - Version 0.0.3
RAN4

3GPP TSG-RAN WG4 Meeting # 101-bis-e R4-2202979

Electronic Meeting, 17 – 25 January, 2022

Agenda item: 8.9.6.2.1, 8.9.6.2.2, 8.9.6.3

Source: Huawei, HiSilicon

Title: Email discussion summary for [101-bis-e][323] NB-IOT_MTC_Demod_NWM

Document for: Information

1 Introduction

As per the RP-211340, WID revision: Additional enhancements for NB-IoT and LTE-MTC, RAN#92-e. and the work plan R4-2107255, Work plan of Rel-17 enhancements for NB-IoT and LTE-MTC, RAN4#99-e. The demodulation requirements for Rel-17 NB-IoT and MTC will be discussed from this meeting.

1st round discussion:

Based on companies' inputs by contributions, collect companies' view on those left open issues and some new issues raised in this meeting, and try to reach some consensus.

2nd round discussion:

Try to find some way forward by certain compromise among companies and continue discussion on some left open issues.

2 Topic#1: UE requirements for Rel-17 NB-IOT

2.1 Companies' contributions summary

Table 1: Companies' contributions about Rel-17 NB-IOT UE demodulation requirements

T-doc number	Company	Proposals / Observations

R4-2200763	Qualcomm Incorporated	Proposal 1: Define minimum requirements for NPDSCH demodulation with 16-QAM for UE category NB2, Half-duplex FDD and TDD. Minimum requirements are defined in a similar way as the existing requirements for QPSK: SNR reference value at 70% of maximum throughput. Proposal 2: Introduce new tests of NPDSCH demodulation of 16-QAM for UE category NB2, Half-duplex FDD and TDD, in Standalone mode. Proposal 3: For testing NPDSCH demodulation requirements take the existing test configurations for UE category NB2 in Standalone mode as the baseline for the new 16-QAM demodulation tests Use reference channels R.NB.7 FDD and R.NB.7 TDD as the baseline for HD-FDD and TDD, respectively. Change the modulation order to 16-QAM and adjust the coding rate and TBS. Reuse test configuration from TS 36.101 Table 8.12.1.1.3-2/8.12.1.2.3-2, as shown below
R4-2200995	Huawei, HiSilicon	Proposal 1: Introduce the soft buffer test with maximum TBS and 16QAM for Cat NB2 UE to verify: 16 QAM reception New TBSs Maximum soft buffer size Proposal 2: Use the test parameters in Table 2 for NPDSCH soft buffer test definition for 16QAM and larger TBS: (refer to the contribution)

R4-2201432	Ericsson	Proposal 1: RAN4 define NPDSCH demodulation requirements with 16QAM. Proposal 2: RAN4 assumes the simulation assumption below for NPDSCH with 16QAM. Proposal 3: RAN4 focus on the requirements for HD-FDD. RAN4 wait for RAN1 conclusion whether to define NPDSCH requirements with 16QAM for TDD. Proposal 4: RAN4 define CQI reporting definition requirements under AWGN condition for the Cat-NB2 UE supporting 16QAM. Proposal 5: RAN4 assume the reported NPDSCH MCS and repetition shall be derived from the channel quality measured from the time UE finish the decode of Downlink Channel Quality report MAC CE to the end of NPDCCH carrying the uplink grant of channel quality report. Note UL transmission period and RF switching period is excluded from the measurement period. Proposal 6: RAN4 assume UE determines the reporting value based on: NPDCCH repetition level satisfying the hypothetical NPDCCH block error rate of 1%, if UE determines the required NPDCCH repetition level > 1, NPDSCH MCS and repetition level satisfying the hypothetical PDSCH block error not exceeding 10%, if UE determines the required NPDCCH repetition level is 1. Proposal 7: RAN4 capture Proposals 5 and 6 in TS36.101. Proposal 8: RAN4 reuses the existing Cat-M1 UE CQI reporting definition test framework for NB-IoT Cat-NB2 UE CQI reporting definition test. Proposal 9: The test metric of NB-IoT CQI reporting definition test is set as follows: The reported candidateRep value shall be in the range of +/- 1 of the reported median more than 90% of the time.

2.2 Open issues summary

2.2.1 Sub-topic 1-1 Demodulation test for NB-IOT UE

Issue 1-1-1: Performance requirements to be defined

- Proposals
  - Option 1: Introduce test cases to verify UE supporting 16QAM reception (QC, Ericsson)
  - Option 2: Introduce new soft buffer test with 16QAM to verify UE supporting both 16QAM reception and maximum TBS as defined in new TBS table. (Huawei)
- Recommended WF
  - TBA

Feedback Form 1: Performance requirements to be defined for Rel-17 NB-IOT UE

1 – Ericsson Japan K.K. Option 1. We prefer to reuse the existing Cat-NB2 test cases for NPDSCH QPSK as much as possible. Option 2 sounds like the sustained data rate (SDR) test. RAN4 has not defined SDR test for NB-IoT and even for Cat-M1/M2 UEs from Rel-13. We want to understand why RAN4 need to define such a requirements for NB-IoT UE now in Rel-17.
2 – Nokia Germany We support option 1.
3 – Qualcomm Incorporated We also support option 1. Also, we would like to minimize the number of new tests. We would not be in favor of adding a separate SDR test.
4 – HiSilicon Technologies Co. Ltd Support option 2 @QC: We propose to introduce one case to verify soft buffer size and 16 QAM together. The main purpose for RAN 1 design is to increase the max date rate two times, hence max TBS is newly defined. So we think it is necessary to be verified. For reducing test number, we propose to define one test case such as soft buffer test that 16 QAM also be verified in this test. @ Ericsson: In previous release, increase the max TBS is not the main feature and WI requirement from RAN 1 side, therefore it was not be defined. However, increase the TBS and date is main requirement for Rel-17 and RAN 1 spend much time on this topic, hence, we think it is necessary to be verified from RAN 4 side.

Issue 1-1-2: Operation mode

- Proposals
  - Option 1: Only standalone (QC, Huawei, Ericsson)
- Recommended WF
  - Only consider standalone

Feedback Form 2: Operation mode

1 – Ericsson Japan K.K. Support the recommended WF.
2 – Nokia Germany We support the recommended WF.
3 – Qualcomm Incorporated Support the recommended WF.
4 – HiSilicon Technologies Co. Ltd Support the recommended WF

Issue 1-1-3: Duplex mode

- Proposals
  - Option 1: HD-FDD and TDD (QC, Huawei)
  - Option 2: HD-FDD only and wait for RAN1 conclusion whether to define NPDSCH requirements with 16QAM for TDD. (Ericsson)
- Recommended WF
  - TBA

Feedback Form 3: Duplex mode

1 – Ericsson Japan K.K. Option 2, since RAN1 is still discussing the 16QAM support for NB-IoT TDD. RAN4 should wait for RAN1 conclusion. If RAN1 agree to support 16QAM for TDD, we are fine to define NPDSCH with 16QAM for TDD.

2 – Nokia Germany We support option 2.
3 – Qualcomm Incorporated We're not sure if TDD should be excluded. We'll check internally and comment further.
4 – HiSilicon Technologies Co. Ltd Support option 1, we didn't find any agreement that this feature is only applicable for HD-FDD

Issue 1-1-4: Antenna configuration

- Proposals
  - Option 1: 1T1R (QC, Huawei, Ericsson)
- Recommended WF
  - Only consider 1T1R

Feedback Form 4: Antenna configuration

1 – Ericsson Japan K.K. Support the recommended WF.
2 – Nokia Germany We support the recommended WF.
3 – Qualcomm Incorporated Support the recommended WF.
4 – HiSilicon Technologies Co. Ltd Support the recommended WF.

Issue 1-1-5: Number of NRS ports

- Proposals
  - Option 1: 1 (QC, Huawei, Ericsson)
- Recommended WF
  - Only consider 1 NRS port

Feedback Form 5: Number of NRS ports

1 – Ericsson Japan K.K. Support the recommended WF.
2 – Nokia Germany We support the recommended WF.
3 – Qualcomm Incorporated Support the recommended WF.
4 – HiSilicon Technologies Co. Ltd Support the recommended WF.

Issue 1-1-6: NPDSCH repetition number

- Proposals
  - Option 1: 1 (QC, Ericsson, Huawei)
- Recommended WF
  - Agree with 1 for NPDSCH repetition number, i.e. no repetition

Feedback Form 6: NPDSCH repetition number

1 – Ericsson Japan K.K. Support the recommended WF.
2 – Nokia Germany We support the recommended WF.
3 – Qualcomm Incorporated Support the recommended WF.
4 – HiSilicon Technologies Co. Ltd Support the recommended WF.

Issue 1-1-7: Carrier Type

- Proposals
  - Option 1: Non-anchor (QC, Huawei, Ericsson)

- Recommended WF
  - Only consider non-anchor

Feedback Form 7: Carrier Type

1 – Ericsson Japan K.K. Support the recommended WF.
2 – Nokia Germany We support the recommended WF.
3 – Qualcomm Incorporated Support the recommended WF.
4 – HiSilicon Technologies Co. Ltd Support the recommended WF.

Issue 1-1-8: Propagation condition

- Proposals
  - Option 1: EPA5 (QC, Ericsson)
  - Option 2: AWGN (Huawei)
  - Note that it depends on conclusion of Issue 1-1-1
- Recommended WF
  - TBA

Feedback Form 8: Propagation condition

1 – Ericsson Japan K.K. Option 1. This this the demodulation requirements, we should use fading channel model.
2 – Nokia Germany We support option 1.
3 – Qualcomm Incorporated Our preference is option 1. Pending outcome of issue 1-1-1.
4 – HiSilicon Technologies Co. Ltd Option 2, since propagation conditions only has impact on channel estimation performance rather than LLR

calculation which is associated to modulation order. Also, we think it is more practical to consider AWGN in soft buffer test

Issue 1-1-9: NPDCCH repetition number

- Proposals
  - Option 1: 1 (Huawei)
- Recommended WF
  - Agree with 1 for NPDCCH repetition number, i.e. no repetition

Feedback Form 9: NPDCCH repetition number

1 – Ericsson Japan K.K. It depends on the SNR test point, but it should be ok to assume no repetition for NPDCCH because 16QAM requires higher SNR.
2 – Nokia Germany We support the recommended WF.
3 – Qualcomm Incorporated Support the recommended WF.
4 – HiSilicon Technologies Co. Ltd We support the recommended WF.

Issue 1-1-10: Number of scheduled subframes and TBS

- Proposals
  - Option 1: Use (I_{TBS}, I_{SF}) = (21,7) which corresponds to TBS = 4968 (Huawei)
  - Option 2: Use (I_{TBS}, I_{SF}) = (16, 5) which corresponds to TBS = 1928bits and effective code rate 0.51 (Ericsson)
  - Note that it depends on conclusion of Issue 1-1-1
- Recommended WF
  - TBA

Feedback Form 10: Number of scheduled subframes and TBS

1 – Ericsson Japan K.K. Option 2. We prefer to reuse the existing Cat-NB2 test setup as much as possible.
2 – Nokia Germany We support option 2.
3 – Qualcomm Incorporated FFS. First let's agree on the test conditions and simulation assumptions.
4 – HiSilicon Technologies Co. Ltd Option 1, same comments as Issue 1-1-1

Issue 1-1-11: The ratio of EPRE of NPDSCH in symbols with and without NRS to NRS

- Proposals
  - Option 1: 0dB (Huawei)
- Recommended WF
  - TBA

Feedback Form 11: The ratio of EPRE of NPDSCH in symbols w and w/o NRS to NRS

1 – Ericsson Japan K.K. We are fine with option 1 as far as it is same configuration as existing Cat-NB2 test cases.
2 – Nokia Germany Option 1 is supported.
3 – Qualcomm Incorporated We can support option 1.
4 – HiSilicon Technologies Co. Ltd We support the recommended WF.

Issue 1-1-12: Test metric

- Proposals
  - Option 1: 70% (Qualcomm, Huawei)

- Option 2: ()

- Recommended WF
  - Agree test metric of 70% max TP

Feedback Form 12: Test metric

1 – Ericsson Japan K.K. Support the recommended WF.
2 – Nokia Germany We are fne with the recommended WF.
3 – Qualcomm Incorporated Support the recommended WF.
4 – HiSilicon Technologies Co. Ltd Support the recommended WF.

2.2.2 Sub-topic 1-2 CQI demodulation test

Issue 1-2-1: Whether to introduce CQI demodulation test for Rel-17 NB-IOT

- Proposals
  - Option 1: Yes (Ericsson)
  - Option 2: No (Huawei)
- Recommended WF
  - There is discussion about where to capture CQI table and then how to performance test cases definition in RRM, RAN4 demodulation should wait for RRM discussion.

Feedback Form 13: Whether to introduce CQI demodulation test for Rel-17 NB-IOT UE

1 – Ericsson Japan K.K. We think RAN4 need to define CQI reporting performance requirements but we can discuss it is defined in RRM part or Demod part. Our preference is to define CQI reporting test cases in demodulation part because Rel-17 CQI report corresponds to NPDSCH MCS in CONNECTED mode. On the other hand, Rel-14 NB-IoT channel quality report requires to report the NPDCCH repetition level

and it should be reported in IDLE mode. This is the reason RAN4 defined Rel-14 channel quality report requirements in RRM.

We also understand TS36.101 cannot specify the core requirements such as measurement resources. One possible way is to specify the core part (CQI table, measurement resources) in TS36.133 and define CQI report test in TS36.101.

2 – Nokia Germany

We support option 1.

3 – Qualcomm Incorporated

We support adding a CQI test but the specifics need more discussion, including whether to do it in RRM or demod. Note that for Rel-16 NB-IoT DCQR in connected mode, the test was specified in RRM.

4 – Ericsson Japan K.K.

To Qualcomm, it is true Rel-16 NB-IoT channel quality is also applicable for CONNECTED mode using MAC-CE.

The difference from Rel-16 channel quality report is now UE need to report NPDSCH MCS/repetition and it is only applicable for Cat-NB2 UE capable of 16QAM and in CONNECTED mode. For us, it is exactly same as CQI report test RAN4 defined in UE demodulation performance part.

But we can discuss how/where this CQI reporting requirement is specified.

5 – HiSilicon Technologies Co. Ltd

We are OK to define the CQI requirements but it is better to capture the CQI table and measurement resources in RRM spec and requirements in TS 36.101

Issue 1-2-6: Assumptions about the reported NPDSCH MCS and repetition derivation (If agreed)

- Proposals
  - Option 1: (Ericsson): Agree the following assumptions and capture them in TS 36.101
    - RAN4 assume the reported NPDSCH MCS and repetition shall be derived from the channel quality measured from the time UE finish the decode of Downlink Channel Quality report MAC CE to the end of NPDCCH carrying the uplink grant of channel quality report. Note UL transmission period and RF switching period is excluded from the measurement period.
  - Other options
- Recommended WF
  - Company can share view if Option 1 is agreeable if RAN4 agrees to define CQI demodulation test finally.

Feedback Form 14: Assumptions about the reported NPDSCH MCS and repetition derivation

1 – Nokia Germany Option 1 is supported.
2 – Qualcomm Incorporated We understand that this requirement should be defined in the RRM discussion. While we see merit in the proposal in option 1, we also think that a cap on the measurement duration could be considered. Should be discussed further in RRM.
3 – HiSilicon Technologies Co. Ltd We think it should be captured in RRM spec

Issue 1-2-6: Assumptions about the NPDCCH repetition level and NPDSCH MCS and repetition level derivation(If agreed)

- Proposals
  - Option 1: (Ericsson): Agree the following assumptions and capture them in TS 36.101
    - NPDCCH repetition level satisfying the hypothetical NPDCCH block error rate of 1%, if UE determines the required NPDCCH repetition level > 1,
    - NPDSCH MCS and repetition level satisfying the hypothetical PDSCH block error not exceeding 10%, if UE determines the required NPDCCH repetition level is 1.
  - Other options
- Recommended WF
  - Company can share view if Option 1 is agreeable if RAN4 agrees to define CQI test finally.

Feedback Form 15: Assumptions about the NPDCCH repetition level and NPDSCH MCS and repetition level derivation

1 – Nokia Germany Option 1 is agreeable. The CQI test should be preferably in 36.101.
2 – Qualcomm Incorporated We support option 1. It seems consistent with the new CQI table introduced by RAN1.
3 – HiSilicon Technologies Co. Ltd Option 1

Issue 1-2-2: Simulation assumptions for CQI test (If agreed)

- Proposals
  - Option 1: (Ericsson)
    - Applicability: Cat-NB2 UE capable of 16QAM
    - Deployment mode: stand-alone
    - Carrier type: Non anchor carrier (to avoid overhead)
    - Number of NRS ports: 1
    - Antenna configuration: 1x1
    - Propagation condition: AWGN
    - No HARQ retransmission
  - Other options
- Recommended WF
  - TBA

Feedback Form 16: Simulation assumptions for CQI demodulation test

1 – Nokia Germany We support option 1.
2 – Qualcomm Incorporated Option 1 can be used as the baseline.
3 – HiSilicon Technologies Co. Ltd Option 1 can be used as the baseline.

Issue 1-2-3: Scheduling pattern for CQI demodulation test (If agreed)

- Proposals
  - Option 1: (Ericsson)
    - Rmax (npdcch-NumRepetitions): 4
    - G (nPDCCH-startSF-USS): 2
    - Repetition numbers of NPDCCH and NPUSCH: 1
    - ISF=1 for NPDSCH and IRU=NPUSCH format 1 to transmit MAC CE
    - CQI reporting period: 40ms

        - CQI delay: 14ms

    - Other options

- Recommended WF

    - TBA

Feedback Form 17: Scheduling pattern for CQI demodulation test

1 – Nokia Germany Option 1 can serve as baseline for further discussion.
2 – Qualcomm Incorporated FFS
3 – HiSilicon Technologies Co. Ltd FFS

Issue 1-2-4: Test metric for CQI demodulation test (If agreed)

- Proposals

    - Option 1: (Ericsson)

        - The reported candidateRep value shall be in the range of +/- 1 of the reported median more than 90% of the time.

            - If the NPDSCH BLER using the transport format indicated by median candidateRep value is less than or equal to 0.1, the BLER using the transport format indicated by the (median candidateRep value + 1) shall be greater than 0.1.

            - If the NPDSCH BLER using the transport format indicated by the median candidateRep value is greater than 0.1, the BLER using transport format indicated by (median candidateRep value – 1) shall be less than or equal to 0.1.

    - Other options

- Recommended WF

    - TBA

Feedback Form 18: Test metric

1 – Nokia Germany Option 1 can serve as baseline for further discussion.
2 – Qualcomm Incorporated The proposal can be considered but more discussion may be needed.
3 – HiSilicon Technologies Co. Ltd Option 1 can serve as baseline for further discussion.

Issue 1-2-5: Test point for CQI demodulation test (If agreed)

- Proposals
  - Option 1: RAN4 sets SNR test point for NB-IoT CQI reporting test so that the reported value corresponds to 16QAM, i.e, candidateRep-K to candidateRep-O (Ericsson)
  - Other options
- Recommended WF
  - TBA

Feedback Form 19: Test point for CQI demodulation test

1 – Nokia Germany Option 1 can serve as baseline for further discussion.
2 – Qualcomm Incorporated Option 1 is a good starting point.
3 – HiSilicon Technologies Co. Ltd Option 1

2.3 Summary for 1st round

Table 2: Summary after 1st round for NB-IOT demodulation tests and CQI tests

Sub-Topic#	Status summary

Sub-topic #1-1 Demodulation test for NB-IOT UE	**Issue 1-1-1: Performance requirements to be defined** Tentative agreements: Need further discussion Candidate options: Option 1: Introduce test cases to verify UE supporting 16QAM reception (QC, Ericsson, Nokia) Option 2: Introduce new soft buffer test with 16QAM to verify UE supporting both 16QAM reception and maximum TBS as defined in new TBS table. (Huawei) Recommendations for 2nd round: Continue to discuss **Issue 1-1-2: Operation mode** Tentative agreements: Only consider standalone Candidate options: None Recommendations for 2nd round: N/A **Issue 1-1-3: Duplex mode** Tentative agreements: Agree on HD-FDD and FFS TDD Candidate options on whether to include TDD besides HD-FDD: Option 1: TDD (Huawei) Option 2: Wait for RAN1 conclusion whether to define NPDSCH requirements with 16QAM for TDD. (Ericsson, Nokia) Option 3: Need further check (Qualcomm) Recommendations for 2nd round Continue discussion **Issue 1-1-4: Antenna configuration** Tentative agreements: Only consider 1T1R Candidate options: None Recommendations for 2nd round: N/A **Issue 1-1-5: Number of NRS ports** Tentative agreements: Only consider 1 NRS port Candidate options: None Recommendations for 2nd round: N/A **Issue 1-1-6: NPDSCH repetition number** Tentative agreements: Agree with 1 for NPDSCH repetition number, i.e. no repetition Candidate options: None Recommendations for 2nd round: N/A **Issue 1-1-7: Carrier Type** Tentative agreements: Only consider non-anchor Candidate options: None Recommendations for 2nd round: N/A **Issue 1-1-8: Propagation condition** Tentative agreements: Need further discussion Candidate options: Option 1: EPA5 (QC, Ericsson, Nokia) Option 2: AWGN (Huawei) Note that it depends on conclusion of Issue 1-1-1 Recommendations for 2nd round Continue to discuss **Issue 1-1-9: NPDCCH repetition number** Tentative agreements: Agree with 1 for NPDCCH repetition number, i.e. no repetition

Sub-topic #1-2 CQI test for NB-IOT UE	**Issue 1-2-1: Whether to introduce CQI test for Rel-17 NB-IOT** Tentative agreement: Define CQI reporting requirements for Rel-17 NB-IOT UE Candidate options: Option 1: Capture CQI table and measurement resources in RRM specification TS 36.133; Introduce the CQI reporting requirements in TS 36.101 (Huawei, Ericsson, Nokia?) Option 2: Further discuss whether introduce the CQI requirements in specification TS 36.133 or TS 36.101 (QC, Nokia?) Recommendations for 2nd round Continue discussion **Issue 1-2-2: Assumptions of UE behaviour on CQI measurement (If agreed)** Tentative agreement: Need further discussion Candidate options: on whether the following assumptions are agreeable and where to capture them: *Assumptions: RAN4 assume the reported NPDSCH MCS and repetition shall be derived from the channel quality measured from the time UE finish the decode of Downlink Channel Quality report MAC CE to the end of NPDCCH carrying the uplink grant of channel quality report. Note UL transmission period and RF switching period is excluded from the measurement period.* Option 1: Agree the assumptions and capture them in TS 36.101(Ericsson, Nokia) Option 2: Use the assumptions as starting point and capture them in RRM specification TS 36.133 (Huawei) Option 3: A cap on the measurement duration should be considered, need further discussion in RRM, and capture the assumption in RRM specification TS 36.133 Recommendations for 2nd round: Continue to discuss in this demodulation session [323] and also suggest to discussion in RRM session [229] Firstly focus on whether the assumptions is agreeable and then discuss to capture them in specification TS 36.133 or TS 36.101 **Issue 1-2-3: Assumptions about the NPDCCH repetition level and NPDSCH MCS and repetition level derivation (If agreed)** Tentative agreement: Agree the following assumptions Candidate options on capture the following assumption in TS 36.133 or TS 36.101: NPDCCH repetition level satisfying the hypothetical NPDCCH block error rate of 1%, if UE determines the required NPDCCH repetition level > 1, NPDSCH MCS and repetition level satisfying the hypothetical PDSCH block error not exceeding 10%, if UE determines the required NPDCCH repetition

3 Topic #2: BS requirements for Rel-17 NB-IOT

3.1 Companies' contributions summary

Table 3: Companies' contributions about NB-IOT BS demodulation requirements

T-doc number	Company	Proposals / Observations
R4-2200751	Samsung	Proposal 1: BS demodulation requirement with 16QAM transmission can be considered in RAN4 Proposal 2: The following simulation assumption for 16QAM requirement can be considered as starting point. □refer to the contribution□
R4-2201433	Ericsson	Proposal 1: RAN4 define NPUSCH format 1 demodulation requirements with 16QAM. Proposal 2: RAN4 assumes the simulation assumption below for NPUSCH format 1 with 16QAM. □refer to the contribution□
R4-2201984	Nokia	Proposal 1: To define the new uplink FRCs for 16QAM NPUSCH format 1 demodulation requirements in TS 36.104 as shown in table 2. Proposal 2: To select ETU 1Hz Low propagation channel for aligning to existing NPUSCH format 1 demodulation requirements in TS 36.104.
R4-2200996	Huawei, HiSilicon	Proposal 1: Define the BS requirements to verify the 16 QAM reception. Proposal 2: Use Table 3 as simulation assumptions (refer to the contribution)

3.2 Open issues summary

3.2.1 Sub-topic 2-1 NPUSCH format 1 demodulation requirements

Issue 2-1-1: Whether to define demodulation requirements for NPUSCH format 1 with 16QAM

- Proposals
  - Option 1: Yes (Huawei, Ericsson, Samsung, Nokia)
    - Samsung, Huawei: Not consider multi-TB scheduling
- Recommended WF
  - Define the NPUSCH format 1 requirements with 16QAM and single-TB scheduling.

Feedback Form 20: Whether to define demodulation requirements for NPUSCH format 1 with 16QAM

1 – Samsung Electronics Benelux BV Samsung: We are fine with option 1 and recommended WF
2 – Ericsson Japan K.K. Support the recommended WF.
3 – Nokia Germany We support option 1.
4 – HiSilicon Technologies Co. Ltd Support the recommended WF.

3.2.2 Sub-topic 2-2 Test setup

Issue 2-2-1: Number of antennas

- Proposals
  - Option 1: 1T2R (Samsung, Ericsson, Huawei)
- Recommended WF
  - Agree with 1T2R

Feedback Form 21: Number of antennas

1 – Samsung Electronics Benelux BV Samsung: We are fine with option 1 and recommended WF
2 – Ericsson Japan K.K. Support the recommended WF.
3 – Nokia Germany We support the recommended WF.
4 – HiSilicon Technologies Co. Ltd Support the recommended WF.

Issue 2-2-2: Number of allocated subcarriers

- Proposals
  - Option 1: 3,6,12 tones (Samsung, Nokia)
  - Option 2: 12 tones (Huawei, Ericsson)
- Recommended WF
  - TBA

Feedback Form 22: Number of allocated subcarriers

1 – Samsung Electronics Benelux BV Samsung Based on RAN1 agrement, 16QAM can be used at least for multi-tone transmission with 12 subcarriers, and can be used for 3 and 6 subcarriers NPUSCH format 1. In Rel-13/14, 3 tone, 6 tone and 12 tones performance are specfied with QPSK, it is necessary to guarantee the test coverage compared with Rel-13/14, We prefer to check the performance with different tones at current stage
2 – Ericsson Japan K.K. Option 2. One test with 12 tones is sufficient because the purpose of this test is to verify the new modulation.
3 – Nokia Germany We support option 1. We share Samsung's view. 3 and 6 tones are also valid configurations for performance requirements.

4 – HiSilicon Technologies Co. Ltd Option 2, same views with Ericsson

Issue 2-2-3: Number of scheduled RUs and TBS

- Proposals
  - Option 1: (I_{RU}, I_{TBS})=(0,15), TBS=280 bits (Ericsson)
  - Option 2: (I_{RU}, I_{TBS})=(19,3), TBS=1736 bits (Nokia)
  - Option 3: (I_{RU}, I_{TBS})=(0,14), TBS=256 bits (Huawei)
- Recommended WF
  - TBA

Feedback Form 23: Number of scheduled RUs and TBS

1 – Samsung Electronics Benelux BV Samsung: From RAN1 spec, 16QAM is applied for ITBS from 14 to 21, and applied for IRU from 0 to 6. With large number of TBS, the codring rate is large, less coding gain is ahcived, and with large number of RU, the related TBS is large and the transmission period is long, which will increase the test and simulation time. At current stage, since it is the 1st meeting to discuss the scope of NB-IoT, we prefer to keep it open and not preculde other options, further check the performance difference with different RU and I_TBS to choose proper one for requirement
2 – Ericsson Japan K.K. We prefer Option 1 to keep the similar code rate with the existing FRC A16-5 in TS36.104. We are also ok to I_TBS=14 in Option 3, although the effective code rate is slight low.
3 – Nokia Germany We suggest to keep this open. All three options can be evaluated for next meeting and then a selection of the configuration can be done.
4 – HiSilicon Technologies Co. Ltd Option 3

Issue 2-2-4: Frequency offset and timing offset

- Proposals
  - Option 1: 0 for both frequency and time offset. (Samsung, Huawei, Nokia)

- Recommended WF
  - Without frequency offset and time offset considered.

Feedback Form 24: Frequency offset and timing offset

1 – Samsung Electronics Benelux BV Samsung: We are fine with option 1 and recommended WF, apply the same assumption as in Rel-13/14
2 – Ericsson Japan K.K. Support the recommended WF.
3 – Nokia Germany We support the recommended WF.
4 – HiSilicon Technologies Co. Ltd We support the recommended WF.

Issue 2-2-5: Propagation conditions

- Proposals
  - Option 1: ETU 1Hz Low (Ericsson, Nokia, Huawei)
- Recommended WF
  - Agree with propagation condition of ETU 1Hz Low

Feedback Form 25: Propagation condittions

1 – Samsung Electronics Benelux BV Samsung: we are fine with option 1 and apply the same channel model assumption as Rel-13/14
2 – Ericsson Japan K.K. Support the recommended WF.
3 – Nokia Germany We support the recommended WF.

4 – HiSilicon Technologies Co. Ltd We support the recommended WF.

Issue 2-2-6: Repetition number

- Proposals
  - Option 1: 1 (Ericsson, Samsung, Huawei, Nokia)
- Recommended WF
  - No repetition considered.

Feedback Form 26: Repetition number

1 – Samsung Electronics Benelux BV Samsung we are fine with Option 1 and recommented WF, since repetition is not avaiable for 16QAM
2 – Ericsson Japan K.K. Support the recommended WF.
3 – Nokia Germany We support the recommended WF.
4 – HiSilicon Technologies Co. Ltd We support the recommended WF.

3.3 Summary for 1st round

Table 4: Summary after 1st round for NB-IOT BS demodulation requirements

Sub-Topic#	Status summary
Sub-topic#2-1: NPUSCH format 1 requirements	**Issue 2-1-1: Whether to define demodulation requirements for NPUSCH format 1 with 16QAM** Tentative agreements: Define the NPUSCH format 1 requirements with 16QAM and single-TB scheduling. Candidate options: None Recommendations for 2nd round: N/A

Sub-topic 2-2 Test setup	**Issue 2-2-1: Number of antennas** Tentative agreements: 1T2R. Candidate options: None Recommendations for 2nd round: N/A **Issue 2-2-2: Number of allocated subcarriers** Tentative agreements: Need further discussion Candidate options: Option 1: 3,6,12 tones (Samsung, Nokia) Option 2: 12 tones (Huawei, Ericsson) Recommendations for 2nd round: Continue discussion **Issue 2-2-3: Number of scheduled RUs and TBS** Tentative agreements: Keep open, interested companies can bring the simulation results for next meeting and select one based on the evaluation results in next meeting Candidate options: Option 1: (I_{RU}, I_{TBS})=(0,15), TBS=280 bits (Ericsson) Option 2: (I_{RU}, I_{TBS})=(19,3), TBS=1736 bits Option 3: (I_{RU}, I_{TBS})=(0,14), TBS=256 bits (Huawei, Ericsson) Option 4: Keep it open and choose one based on evaluation in next meeting (Samsung, Nokia) Recommendations for 2nd round: N/A **Issue 2-2-4: Frequency offset and time offset** Tentative agreements: No frequency offset and timing offset considered Candidate options: None Recommendations for 2nd round: N/A **Issue 2-2-5: Propagation conditions** Tentative agreements: ETU 1Hz Low Candidate options: None Recommendations for 2nd round: N/A **Issue 2-2-6: Repetition number** Tentative agreements: No repetition Candidate options: None Recommendations for 2nd round: N/A

4 Topic#3: Demodulation requirements for Rel-17 eMTC

4.1 Companies' contributions summary

Table 5: Companies' contributions for Rel-17 LTE MTC demodulation

T-doc number	Company	Proposals / Observations

R4-2201434	Ericsson	Proposal 1: No new UE demodulation requirements are defined for Rel-17 LTE-MTC. Proposal 2: No new BS demodulation requirements are defined for Rel-17 LTE-MTC.
R4-2200750	Samsung	Observation 1: No BS performance requirements impact foreseen for Rel-17 eMTC sub-feature: power reduction Observation 2: RAN4 has already specified the BS demodulation requirement for PUSCH sub-PRB resource allocation feature. Proposal 1: No BS performance requirement is introduced for Rel-17 eMTC. Observation 3: No UE performance requirements impact foreseen for Rel-17 eMTC sub-feature: additional scheduling delay Observation 4: No UE performance requirements impact foreseen for Rel-17 eMTC sub-feature: maximum DL TBS 1736bit Proposal 2: No UE performance requirement is introduced for Rel-17 eMTC.

R4-2200997	Huawei, HiSilicon	Proposal 1: Define the following two cases for Cat M1 UE: Case 1: Define the 14 HARQ processes reception performance requirements for UE supporting 14 HARQ processes and HD-FDD Case 2: Define the performance requirements for TBS 1736 bit and corresponding buffer size for UE supporting 1736 bits TBS and HD-FDD. Proposal 2: For 14 HARQ processes test, use following simulations: For scheduling pattern, scheduling period is 17ms. In every period, 0th to 11th subframes are used for MPDCCH/PDSCH transmission, subframes from 13th to 15th are used for PUCCH transmission and 12th and 16th subframes are used for gaps. For scheduling delay, 2 is defined for PDSCH transmitted in subframes from 0th to 9th and 7 is defined for PDSCHs transmitted in subframe 10th and 11th As for HARQ delay, ACK/-NACKs related to PDSCHs in subframe from 0th to 3th are transmitted in 13th subframe, ACK/NACKs related to PDSCHs in subframe from 4th to 7th are transmitted in 14th subframe and ACK/NACKs related to PDSCHs in subframe from 8h to 11th are transmitted in 15th subframe. TM2 HD-FDD Bandwidth: 10MHz MCS: 16QAM 1/2 TBS: 744 CE mode A No repetition for MPDCCH and PDSCH Propagation condition: EPA5 MIMO configuration: 2x1 Low HARQ transmissions: 4 HARQ bundling: enabled Proposal 3: For maximum TBS and soft buffer size test, use 30% instead of 70% of maximum TP to let more HARQ transmissions per TB to verify the soft buffer size. Proposal 4: For maximum TBS

4.2 Open issues summary

4.2.1 Sub-topic 3-1: Performance requirements for Rel-17 LTE MTC UE

Issue 3-1-1: Whether to define performance requirements to verify UE supporting 14 HARQ processes

- Proposals
  - Option 1: Yes (Huawei)
  - Option 2: No (Samsung, Ericsson)
- Recommended WF
  - TBA

Feedback Form 27: Whether to define performance requirements to verify UE supporting 14 HARQ processes

1 – Samsung Electronics Benelux BV Samsung This is related with scheduling restriction of PDSCH, there is no receiver impact foreseen
2 – Ericsson Japan K.K. When RAN1 increased the number of HARQ processes for Cat-M1 from 8 to 10 in Rel-14 (ce-PDSCH-TenProcesses-r14), RAN4 did not add PDSCH requirements to verify to support 10 HARQ processes. We don't think RAN4 need to define PDSCH requirements to verify to support 14 HARQ processes also.
3 – Nokia Germany We support option 2.
4 – Qualcomm Incorporated We support option 2.
5 – HiSilicon Technologies Co. Ltd Option 1.In Rel-14, 2 HARQ processes has been verified for NB2 UE, Follow the same logic, increasing the HARQ processes number should be verified. UE supporting 14 HARQ processes should be tested as optional feature.

Issue 3-1-2: Whether to define performance requirements to verify UE supporting 1736 bits TBS and corresponding soft buffer

- Proposals

- Option 1: Yes (Huawei)
- Option 2: No (Samsung, Ericsson)

– Recommended WF

- TBA

Feedback Form 28: Whether to define performance requirements to verify UE supporting 1736 bits TBS and corresponding soft buffer

1 – Samsung Electronics Benelux BV Samsung This is related with UE capability to support the maximum DL 1736 TBS. It will impact on the soft buffer size calculation, pending on UE capability. There is no changed with existing TCI formats, TBS tables and CQI tables. From baseband processing perspective, there is no impact on demodulation requirement and CSI requirement. Meanwhile, based on the WID, this is no RAN4 related objective included.
2 – Ericsson Japan K.K. We are not sure RAN4 need to define new requirements because this features just extend the maximum TBS from 1000 bits to 1736 bits for Cat-M1 but RAN1 keeps the same DCI format, MCS table.
3 – Nokia Germany We support option 2.
4 – Qualcomm Incorporated We are also not sure if this is within scope of the WI.
5 – HiSilicon Technologies Co. Ltd Based on our understanding, soft buffer size requirements is changed which has big impact on demodulation part. Hence it should be verified

4.2.2 Sub-topic 3-2: Test setup for performance of LTE MTC UE

Issue 3-2-1: Test setup for performance requirements of supporting 14 HARQ processes (If agreed)

– Proposals

- Option 1: Use following test setups (Huawei)
  - For scheduling pattern, scheduling period is 17ms.

- □ • In every period, 0th to 11th subframes are used for MPDCCH/PDSCH transmission, subframes from 13th to 15th are used for PUCCH transmission and 12th and 16th subframes are used for gaps.
- □ • For scheduling delay, 2 is defined for MPDCCH transmitted in subframes from 0th to 9th and 7 is defined for MPDCCH transmitted in subframe 10th and 11th
- □ • As for HARQ delay, ACK/NACKs related to PDSCHs in subframe from 0th to 3th are transmitted in 13th subframe, ACK/NACKs related to PDSCHs in subframe from 4th to 7th are transmitted in 14th subframe and ACK/NACKs related to PDSCHs in subframe from 8h to 11th are transmitted in 15th subframe.

- TM2
- HD-FDD
- Bandwidth: 10MHz
- MCS: 16QAM 1/2
- TBS: 744
- CE mode A
- No repetition for MPDCCH and PDSCH
- Propagation condition: EPA5
- MIMO configuration: 2x1 Low
- HARQ transmissions: 4
- HARQ bundling: enabled

– Recommended WF

- TBA

Feedback Form 29: Test setup for performance requirements of supporting 14 HARQ processes

1 – Nokia Germany This issue is dependent on issue 3-1-1.
2 – HiSilicon Technologies Co. Ltd Option 1

Issue 3-2-2: Test setup for supporting 1736 bits TBS and corresponding max soft buffer (If agreed)

– Proposals

- Option 1: Use following test setups (Huawei)

- Use 30% instead of 70% of maximum TP to let more HARQ transmissions per TB to verify the soft buffer size.
- EPA5
- CE mode A
- TBS: 1736 bits
- 64 QAM
- HD-FDD
- 8 HARQ processes
- NRB=6
- HARQ transmission number: 4
- No repetition for MPDCCH and PDSCH
- 64QAM
- Transmission mode: TM2

- Recommended WF
  - TBA

Feedback Form 30: Test setup for supporting 1736 bits TBS and corresponding max soft buffer

1 – Nokia Germany This issue is dependent on issue 3-1-2.
2 – HiSilicon Technologies Co. Ltd Option 1

4.2.3 Sub-topic 3-3: Performance requirements for Rel-17 LTE MTC BS

Issue 3-3-1: Whether to introduce BS performance requirement for Rel-17 LTE-MTC

- Proposals
  - Option 1: No (Samsung, Ericsson, Huawei)
  - Option 2: Yes
- Recommended WF
  - Agree with Option 1.

Feedback Form 31: Whether to introduce BS performance requirement for Rel-17 LTE-MTC

1 – Samsung Electronics Benelux BV Samsuung: we are fine with option 1 and recommended WF
2 – Ericsson Japan K.K. Support the recommended WF.
3 – Nokia Germany We support the recommended WF.
4 – HiSilicon Technologies Co. Ltd Support the recommended WF.

4.3 Summary for 1st round

Table 6: Summary after 1st round for UE and BS demodulation requirements for Rel-17 LTE MTC

Sub-Topic#	**Status summary**
Sub-topic#3-1: Performance requirements for Rel-17 LTE MTC UE	**Issue 3-1-1: Whether to define performance requirements to verify UE supporting 14 HARQ processes** Tentative agreements: Need further discussion Candidate options: Option 1: Yes (Huawei) Option 2: No (Samsung, Ericsson, Nokia, Qualcomm) Recommendations for 2nd round Continue discussion **Issue 3-1-2: Whether to define performance requirements to verify UE supporting 1736 bits TBS and corresponding soft buffer** Tentative agreements: Need further discussion Candidate options: Option 1: Yes (Huawei) Option 2: No (Samsung, Ericsson, Nokia, Qualcomm) Recommendations for 2nd round Continue discussion

Sub-topic#3-2: Test setup of requirements for LTE MTC UE	**Issue 3-2-1: Test setup for performance requirements of supporting 14 HARQ processes (If agreed)** Tentative agreements: Need further discussion pending on Issue 3-1-1 Candidate options: Option 1: Use following test setups (Huawei) For scheduling pattern, scheduling period is 17ms. • In every period, 0th to 11th subframes are used for MPDCCH/PDSCH transmission, subframes from 13th to 15th are used for PUCCH transmission and 12th and 16th subframes are used for gaps. • For scheduling delay, 2 is defined for MPDCCH transmitted in subframes from 0th to 9th and 7 is defined for MPDCCH transmitted in subframe 10th and 11th • As for HARQ delay, ACK/NACKs related to PDSCHs in subframe from 0th to 3th are transmitted in 13th subframe, ACK/NACKs related to PDSCHs in subframe from 4th to 7th are transmitted in 14th subframe and ACK/NACKs related to PDSCHs in subframe from 8h to 11th are transmitted in 15th subframe. TM2 HD-FDD Bandwidth: 10MHz MCS: 16QAM 1/2 TBS: 744 CE mode A No repetition for MPDCCH and PDSCH Propagation condition: EPA5 MIMO configuration: 2x1 Low HARQ transmissions: 4 HARQ bundling: enabled Option 2: Depend on issue 3-1-2 (Nokia) Recommendations for 2nd round Further discuss this issue if option 1 in Issue 3-1-1 is agreed. **Issue 3-2-2: Test setup for supporting 1736 bits TBS and corresponding max soft buffer (If agreed)** Tentative agreements: Need further discussion pending on Issue 3-1-1 Candidate options: Option 1: Use following test setups (Huawei) Use 30% instead of 70% of maximum TP to let more HARQ transmissions per TB to verify the soft buffer size. EPA5 CE mode A TBS: 1736 bits 64 QAM HD-FDD 8 HARQ processes NRB=6

Sub-topic#3-3: Performance requirements for Rel-17 LTE MTC BS	**Issue 3-3-1: Whether to introduce BS performance requirement for Rel-17 LTE-MTC** Tentative agreements: Not introduce BS performance requirements for Rel-17 LTE-MTC Candidate options: Recommendations for 2nd round: N/A

5 Recommendations for Tdocs

5.1 1st round

New tdocs

Table 7: New Tdocs after 1st round discussion

Title	Source	Comments
WF on Rel-17 NB-IOT and eMTC performance requirements	Huawei, HiSilicon	

Existing tdocs

Table 8: Summary of recommendation for existing tdocs handling

Tdoc number	Title	Source	Recommendation	Comments
R4-2200750	View on demodulation requirement for Rel-17 eMTC	Samsung	Noted	
R4-2200751	View on demodulation requirement for Rel-17 NB-IoT	Samsung	Noted	
R4-2200763	On UE demodulation requirements for 16-QAM NB-IoT	Qualcomm Incorporated	Noted	
R4-2200995	Discussion on UE demodulation requirements for additional enhancements of NB-IoT	Huawei,HiSilicon	Noted	

R4-2200996	Discussion on BS demodulation requirements for additional enhancements of NB-IoT	Huawei,HiSilicon	Noted	
R4-2200997	Discussion on UE demodulation requirements for additional enhancements of LTE-MTC	Huawei,HiSilicon	Noted	
R4-2201432	View on Rel-17 NB-IoT UE demodulation requirements	Ericsson	Noted	
R4-2201433	View on Rel-17 NB-IoT BS demodulation requirements	Ericsson	Noted	
R4-2201434	View on Rel-17 LTE-MTC demodulation requirements	Ericsson	Noted	
R4-2201984	Discussion on BS demodulation requirements for Additional enhancements for NB-IoT	Nokia, Nokia Shanghai Bell	Noted	