**3GPP TSG RAN WG1 Meeting #106bis-e R1-21xxxxx**

**e-Meeting, October 11th – October 19th, 2021**

**Agenda Item: 8.9**

**Source: WI rapporteur (Huawei)**

**Title: RAN1 agreements of Additional enhancements for NB-IoT and LTE-MTC**

**Document for: Information**

# Introduction

This contribution lists RAN1 agreements made for the Rel-17 WI on ‘Additional enhancements for NB-IoT and LTE-MTC’ (WI code NB\_IOTenh4\_LTE\_eMTC6; WID in RP-211340), until and including RAN1#106.

Notes:

* The WI objective from the WID is inserted below for convenience.
* The list of submitted feature lead summaries is included.
* RAN2 agreements are summarised in R2-21xxxxx.
* RRC parameters for L1 configuration are summarized in R1-21xxxxx.

# WI objective

Core part WI objective:

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| The objective is to specify the following enhancements to NB-IoT and/or LTE-MTC for BL/CE UEs. When an objective applies to NB-IoT, it is indicated with [NB-IoT]. When an objective applies to LTE-MTC, it is indicated with [LTE-MTC].   * Specify 16-QAM for unicast in UL and DL, including necessary changes to DL power allocation for NPDSCH and DL TBS. This is to be specified without a new NB-IoT UE category. For DL, increase in maximum TBS of e.g. 2x the Rel-16 maximum, and soft buffer size will be specified by modifying at least existing Category NB2. For UL, the maximum TBS is not increased. [NB-IoT] [RAN1, RAN4]   + Extend the NB-IoT channel quality reporting based on the framework of Rel-14—16, to support 16-QAM in DL. [NB-IoT] [RAN2, RAN1, RAN4] * Support additional PDSCH scheduling delay for introduction of 14-HARQ processes in DL, for HD-FDD Cat M1 UEs. [LTE-MTC] [RAN1] * Specify signaling for neighbor cell measurements and corresponding measurement triggering before RLF, to reduce the time taken to RRC reestablishment to another cell, without defining specific gaps. [NB-IoT] [RAN2, RAN4]. * Introduce support for NB-IoT carrier selection based on the coverage level, and associated carrier specific configuration (e.g. maximum repetitions UL/DL, DRX configurations, etc.). [NB-IoT] [RAN2, RAN3] * For UEs supporting PUSCH sub-PRB resource allocation, study and if found feasible, specify support power reduction for PRACH, PUCCH, and full-PRB PUSCH, with a maximum reduction of e.g. 3 dB below sub-PRB PUSCH power. [LTE-MTC] [RAN4] * Add a Rel-17 optional UE capability to support a maximum DL TBS of 1736 bits for HD-FDD Cat. M1 UEs in CE mode A only. [LTE-MTC] [RAN1, RAN2]   + Determine soft buffer size [RAN1]   + Capability signaling without introducing a new UE category [RAN2]   + There shall be no changes to: DCI formats, TBS tables, CQI tables   + This objective begins work from RAN#90, i.e. December 2020 |

Performance part WI objective:

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| Specify necessary performance requirements, measurement accuracy requirements and test cases related to the above-mentioned enhancements and core requirements. |

# List of RAN1 agreements

## Support of 16-QAM for unicast in UL and DL for NB-IoT

RAN1#102-e:

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| [**R1-2007239**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23102%20-%20202008%20-%20eMeeting\Docs\R1-2007239.zip) **Feature lead summary on 102-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)**  Agreement  At least for standalone and guard-band deployments, the maximum TBS to support 16-QAM for unicast in DL is select one option from following:   * Option 1: 4968 bits with *ISF*=7 * Option 2: 5072 bits with *ISF*=7 * Option 3: 5736 bits with *ISF*=7 * FFS on *ISF*>7 for this maximum TBS   FFS for inband deployments  Agreement  Further study on TBS/MCS table design, resource assignment and TBS allocation to support 16QAM in DL considering at least:   * MCS field size * Achievable code rates * Avoidance of link-adaptation issues (i.e., large SINR differences between different entries within one TBS row or between different entries in adjacent TBS rows) * The break point between different modulation schemes * Impacts of deployment modes * Indication of modulation scheme for retransmissions * Applicability of repetitions * UE data rate   Agreement  Further study on TBS/MCS table design, resource assignment and TBS allocation to support 16QAM in UL based at least on the following:   * MCS field size * Achievable code rates * Avoidance of link-adaptation issues (i.e., large SINR differences between different entries within one TBS row or between different entries in adjacent TBS rows) * Throughput/UE data rate increase while keeping the max TBS from Rel-16 * The break point between different modulation schemes * Indication of modulation scheme for retransmissions * Applicability of repetitions * Applicability to different number of subcarriers   Agreement  For DL power allocation, support signaling the ratio of NPDSCH EPRE to NRS EPRE. FFS signaling details, including how/whether to signal the ratio for the following cases   * NPDSCH in symbols without NRS and CRS * NPDSCH in symbols with CRS (only for “In-band” deployment) * NPDSCH in symbols with NRS   Agreement   * Adopt the following evaluation assumptions for support of 16QAM in DL and UL for NB-IoT   <Simulation assumptions for DL>   |  |  | | --- | --- | | **Parameter** | **Value/Description** | | Operation mode for DL | Stand-alone, Guard-band, and In-band with 2 or 4 CRS ports | | Number of antennas | 1T or 2T, 1R | | Channel model | AWGN | | Frequency Resource | 1 PRB | | Number of repetitions | Baseline number of repetitions = 1  (Companies can provide results for other repetition) | | Modulation Order | QPSK, 16-QAM | | Noise Estimation | Ideal | | Channel Estimation | Realistic | | Frequency Offset | 0 | | Time Offset | 0 |   <Simulation assumptions for UL>   |  |  | | --- | --- | | **Parameter** | **Value/Description** | | Number of antennas | 1T, 2R | | Channel model | AWGN | | Frequency Resource | 12-tone | | Number of repetitions | Baseline number of repetitions = 1  (Companies can provide results for other repetition) | | Modulation Order | QPSK, 16-QAM | | Noise Estimation | Ideal | | Channel Estimation | Realistic | | Frequency Offset | 0 | | Time Offset | 0 | |

RAN1#103-e:

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| [**R1-2009477**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23103%20-%20202010%20-%20eMeeting\Docs\R1-2009477.zip) **Feature lead summary #1 on [103-e-LTE-Rel17\_NB\_IoT\_eMTC-01] Moderator (Huawei)**  **Decision:** From GTW session on Nov.2nd,  Agreement  At least for standalone and guard-band deployments, the maximum TBS to support 16-QAM for unicast in DL is 4968 bits with ISF=7.  Agreement  For inband deployment, the maximum TBS to support 16-QAM for unicast in DL is 3624 bits (ISF=7).  Agreement  Different breaking points (QPSK🡪16QAM) are used for standalone/guardband and inband deployments.   * FFS the details of the breaking point.   **Decision:** As per email decision posted on Nov.8th,  Agreement  Explicit or implicit signaling of power ratios of NPDSCH EPRE to NRS EPRE for the following cases is supported.   * NPDSCH in symbols without NRS and CRS * NPDSCH in symbols with CRS (only for “In-band” deployment) * NPDSCH in symbols with NRS   Agreement  For 16-QAM in NB-IoT, separate optional UE capabilities for UL and DL are supported:   * The support of 16QAM in DL is indicated by an optional UE capability signaling. * The support of 16QAM in UL is indicated by an optional UE capability signaling.   Agreement  For 16-QAM in NB-IoT, separate UE-specific RRC signaling for UL and DL are supported:   * 16QAM for UL is configured by UE-specific RRC signaling. * 16QAM for DL is configured by UE-specific RRC signaling.   **Decision:** From GTW session on Nov.9th,  Working Assumption   * The following TBS indices are introduced for downlink  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **I\_TBS** | **I\_SF** | | | | | | | | | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | | 14 | 256 | [552, 536] | 840 | 1128 | 1416 | 1736 | 2280 | 2856 | | 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 | | 16 | [328, 296] | 632 | 968 | 1288 | 1608 | 1928 | 2600 | 3240 | | 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 | 2856 | 3624 | | 18 | 376 | 776 | 1160 | 1544 | 1992 | 2344 | 3112 | 4008 | | 19 | 408 | 840 | 1288 | 1736 | 2152 | 2600 | 3496 | 4264 | | 20 | 440 | 904 | 1384 | 1864 | 2344 | 2792 | 3752 | 4584 | | 21 | 488 | 1000 | 1480 | 1992 | [2472, 2536] | 2984 | 4008 | 4968 |  * FFS: Support of legacy TBS indices with 16-QAM at least for some deployment modes. * FFS: Mapping of (a subset of) TBS entries to modulation schemes for different deployment modes. * FFS for I\_SF > 7   Working Assumption   * The following TBS indices are introduced for uplink  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **I\_TBS** | **I\_RU** | | | | | | | | | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | | 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 |  | | 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 |  | | 16 | 328 | 632 | 968 | 1288 | 1608 | 1928 | 2536 |  | | 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 |  |  | | 18 | 376 | 776 | 1160 | 1544 | 1992 | 2344 |  |  | | 19 | 408 | 840 | 1288 | 1736 | 2152 | 2536 |  |  | | 20 | 440 | 904 | 1384 | 1864 | 2344 |  |  |  | | 21 | 488 | 1000 | 1480 | 1992 | 2536 |  |  |  |   [**R1-2009658**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23103%20-%20202010%20-%20eMeeting\Docs\R1-2009658.zip) **Feature lead summary #2 on [103-e-LTE-Rel17\_NB\_IoT\_eMTC-01] Moderator (Huawei)**  Working Assumption   * For standalone and guardband deployments, the downlink TBS entries between 14 (TBS of 2856 for I\_SF=7) and 21 are used for 16QAM. * For inband deployments, the downlink TBS entries between 11 (TBS of 2024 for I\_SF=7) and [17] are used for 16QAM.   Agreement  Repetitions larger than 2 are not supported in case of 16QAM for downlink   * FFS: Whether repetition of 2 is supported or not   [**R1-2009730**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23103%20-%20202010%20-%20eMeeting\Docs\R1-2009730.zip) **Feature lead summary #3 on [103-e-LTE-Rel17\_NB\_IoT\_eMTC-01] Moderator (Huawei)**  **Decision:** From GTW session on Nov.12th,  Agreement  16QAM can be used at least for multi-tone transmission with 12 subcarriers.   * FFS: 3 and 6 subcarriers. |

RAN1#104-e:

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| [**R1-2101868**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23104%20-%20202101%20-%20eMeeting\Docs\R1-2101868.zip) **Feature lead summary #1 on 104-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)**  **Decision:** As per email decision posted on Jan 28th,  Agreement  DL 16-QAM is applicable for NPDSCH scheduled from a DCI with CRC scrambled by C-RNTI.   * At least C-RNTI from USS is supported, FFS if 16-QAM is applied to C-RNTI from CSS. * FFS: Applicability of 16-QAM for PUR.   Agreement  Repetition is not used for 16-QAM in uplink.  Agreement  UL 16-QAM is applicable for NPUSCH scheduled from a DCI with CRC scrambled by C-RNTI.   * At least C-RNTI from USS is supported, FFS if 16-QAM is applied to C-RNTI from CSS. * FFS: Applicability of 16-QAM for PUR or EDT.   Agreement  The soft buffer size for Cat. NB2 UEs supporting 16QAM for downlink is 12800 bits.  [**R1-2102030**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23104%20-%20202101%20-%20eMeeting\Docs\R1-2102030.zip) **Feature lead summary #2 on 104-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)**  Working Assumption  The previous working assumption on the following TBS indices for downlink is updated with following modifications:   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | | | | | | | | | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | | 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 | 2856 | | 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 | | 16 | ~~[~~328~~, 296]~~ | 632 | 968 | 1288 | 1608 | 1928 | 2600 | 3240 | | 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 | 2856 | 3624 | | 18 | 376 | 776 | 1160 | 1544 | 1992 | 2344 | 3112 | 4008 | | 19 | 408 | 840 | 1288 | 1736 | 2152 | 2600 | 3496 | 4264 | | 20 | 440 | 904 | 1384 | 1864 | 2344 | 2792 | 3752 | 4584 | | 21 | 488 | 1000 | 1480 | 1992 | ~~[~~2472~~, 2536]~~ | 2984 | 4008 | 4968 |   Agreement  I\_SF>7 is not supported in Rel-17.  Agreement  Confirm the following working assumption:   * The following TBS indices are introduced for uplink  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **I\_TBS** | **I\_RU** | | | | | | | | | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | | 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 |  | | 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 |  | | 16 | 328 | 632 | 968 | 1288 | 1608 | 1928 | 2536 |  | | 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 |  |  | | 18 | 376 | 776 | 1160 | 1544 | 1992 | 2344 |  |  | | 19 | 408 | 840 | 1288 | 1736 | 2152 | 2536 |  |  | | 20 | 440 | 904 | 1384 | 1864 | 2344 |  |  |  | | 21 | 488 | 1000 | 1480 | 1992 | 2536 |  |  |  |   Agreement  The following working assumption is confirmed with following modifications:   * For inband deployments, the downlink TBS entries between 11 (TBS of 2024 for I\_SF=7) and ~~[~~17~~]~~ are used for 16QAM.   Agreement  Repetition of 2 is NOT supported for 16-QAM in downlink.  Agreement  On the breaking point between QPSK and 16QAM for NPUSCH, the UL TBS entries only between 14 and 21 are used for 16QAM if 16QAM is configured.  Agreement  16-QAM can be used for 3 and 6 subcarriers NPUSCH format 1  Agreement  The NPDSCH EPRE in symbols with NRS can be different and can be the same with the NPDSCH EPRE in symbols without CRS and NRS.   * FFS on signaling details * FFS for the handling on whether the PCI is different or the same |

RAN1#104bis-e:

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| **R1-2103853 Feature lead summary #1 on 104b-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)**  Agreement  Confirm the working assumption that the following TBS indices are introduced for downlink with modification in RED:   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  |  | | | | | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 | 2856 | | 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 | | 16 | ~~328~~296 | 632 | 968 | 1288 | 1608 | 1928 | 2600 | 3240 | | 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 | 2856 | 3624 | | 18 | 376 | 776 | 1160 | 1544 | 1992 | 2344 | 3112 | 4008 | | 19 | 408 | 840 | 1288 | 1736 | 2152 | 2600 | 3496 | 4264 | | 20 | 440 | 904 | 1384 | 1864 | 2344 | 2792 | 3752 | 4584 | | 21 | 488 | 1000 | 1480 | 1992 | 2472 | 2984 | 4008 | 4968 |   Agreement  Confirm the working assumption:   * For standalone and guardband deployments, the downlink TBS entries between 14 (TBS of 2856 for I\_SF=7) and 21 are used for 16QAM.   Agreement  For both uplink and downlink   * 16-QAM is not applied to C-RNTI from CSS. * 16-QAM is not applied to EDT.   Working Assumption  The DCI size is not increased to support 16-QAM in uplink and downlink.  **R1-2103954 Feature lead summary #2 on 104b-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)**  Agreement  The following options on the indication of downlink 16-QAM can be considered:   * Option 1: MCS field is increased to 5 bits to indicate modulation and TBS, and repetition field is reduced to 3 bits to indicate the repetition number; * Option 2: MCS field is 4 bits to indicate TBS, and repetition field is reduced to 3 bits to indicate the repetition number;   + 1 bit is used to indicate legacy QPSK or 16QAM * Option 3: MCS field is 4 bits to indicate modulation and TBS   + A reserved state of MCS field indicates use of 16QAM,   + Repetition field indicates 16QAM MCS if 16QAM is indicated to be used. * Option 4: MCS is 4 bits,   + If repetition is indicated as one, 16QAM and QPSK can be indicated by MCS field;   + If repetition is indicated larger than one, the legacy QPSK MCS can be indicated by MCS field. * Option 5: {repetition, MCS} are indicated by 8 bits (a combination of the MCS field and repetition field) * Note: other options are not precluded.   Agreement  For downlink power allocation to support 16QAM:   * For standalone and guard-band deployments:   + Option 1: Two power ratios are signaled     - NPDSCH EPRE to NRS EPRE in symbols with NRS     - NPDSCH EPRE to NRS EPRE in symbols without NRS   + Option 2: the power ratio of NPDSCH EPRE to NRS EPRE in symbols with NRS is signaled, assuming the same transmit power of different symbols.   + Option 3: the power ratio of NPDSCH EPRE to NRS EPRE in symbols without NRS is signaled, assuming the same transmit power of different symbols.   + If the signaling(s) is(are) not indicated, the legacy power allocation is used.     - i.e., the ratio of NPDSCH EPRE to NRS EPRE is 0dB for one NRS antenna port, and -3dB for two NRS antenna ports * For inband deployments, the power ratio of NRS EPRE to CRS EPRE is signaled in addition to the signaling for standalone and guard-band deployments.   + FFS to reuse the existing parameter nrs-CRS-PowerOffset. * FFS: Whether UE specific or cell-specific or carrier-specific signaling is used   Agreement  If 16-QAM is configured for NPDSCH, the channel quality report for 16-QAM is based on NPDSCH transport block that achieves an error probability not exceeding 10% BLER.  **For future meeting:**   * Additional power control parameter for 16-QAM (e.g. similar to Δ*TF*) * Applicability of 16QAM for PUR and multi-TB scheduling |

RAN1#105-e:

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| [**R1-2106042**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23105%20-%20202105%20-%20eMeeting\Docs\R1-2106042.zip) **Feature lead summary #1 on 105-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)**  From GTW sessions:  Agreement   * Support 16-QAM for multi-TB scheduling.   Working Assumption  Support 16-QAM for NPUSCH in PUR procedure.   * FFS on support of 16-QAM for NPDSCH in PUR procedure.   Agreement  Confirm the working assumption.   * The DCI size is not increased to support 16-QAM in uplink and downlink.   Agreement  For the indication of 16-QAM in downlink:   * The “Modulation and coding scheme” field in DCI Format N1 is utilized as in legacy for scheduling QPSK. * One reserved state in the “Modulation and coding scheme” field in DCI Format N1 is utilized to indicate the use of 16QAM. * The “Repetition number” field in DCI Format N1 is utilized to indicate the TBS indices for 16-QAM in DL when the reserved state in MCS field is indicated. * FFS: The manner of distinguishing the different ranges of TBS indices for “Stand-alone/Guard-band” (i.e., I\_TBS indices from 14 to 21) and “In-band” (i.e., I\_TBS indices from 11 to 17) deployments.   Working Assumption  For downlink power allocation to support 16QAM:   * For standalone and guard-band deployments:   + One power ratio is signaled optionally     - NPDSCH EPRE to NRS EPRE in symbols without NRS   + The same transmit power is assumed across different symbols.   + If the signalling is not indicated, the legacy power allocation is used.     - i.e., the ratio of NPDSCH EPRE to NRS EPRE is 0dB for one NRS antenna port, and -3dB for two NRS antenna ports * UE specific signalling is used   Agreement   * Introduce a new term in uplink power control of NPUSCH using 16-QAM. FFS on the details.   Agreement   * When configured with downlink 16-QAM, the channel quality can be reported in MAC CE.   + FFS on support in Msg3 in connected mode   [**R1-2106104**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23105%20-%20202105%20-%20eMeeting\Docs\R1-2106104.zip) **Feature lead summary #2 on 105-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)**  Agreement  On the indication of downlink 16-QAM, when the reserved state in MCS field is indicated, the “Repetition number” field in DCI Format N1 is utilized to indicate the TBS indices   * From 14 to 21 for standalone/guardband deployments, * From 11 to 17 for inband deployment. * FFS: How UE distinguishes the deployment   [**R1-2106219**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23105%20-%20202105%20-%20eMeeting\Docs\R1-2106219.zip) **Feature lead summary #3 on 105-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)**  Working Assumption  For the indication of 16-QAM in uplink   * The “Modulation and coding scheme” field in DCI Format N0 is utilized as in legacy for scheduling QPSK. * One reserved state in the “Modulation and coding scheme” field in DCI Format N0 is utilized to indicate the use of 16QAM. * The “Repetition number” field in DCI Format N0 is utilized to indicate the TBS indices (i.e., I\_TBS indices from 14 to 21) for 16-QAM in UL.   Agreement  For CQI table for downlink 16-QAM, down-select between following options in RAN1#106-e:   * Option 1: More than three candidate values for 16-QAM are added in the legacy table.   + FFS: Which of the legacy entries are removed * Option 2: Three candidate values for 16-QAM are added in the legacy table. * Option 3: A new CQI table is defined for 16-QAM based on the eMTC table (CQI Tables in 36.213) as a starting point   Agreement  For downlink power allocation to support 16QAM:   * For inband deployments, a power ratio is signaled in addition to the signalling for standalone and guard-band deployments which in this case applies to “symbols with NRS” and “symbols without NRS nor CRS”. Down-select from the following options in RAN1#106-e:   + Alt 1:     - The existing parameter nrs-CRS-PowerOffset is reused for same PCI case, and is signaled for different PCI case.     - The same transmit power of different symbols is assumed as to derive from *nrs-CRS-PowerOffset* the NPDSCH EPRE in symbols with CRS.   + Alt 2:     - the power ratio between NPDSCH EPRE and NRS EPRE in symbols with CRS is signaled   + FFS: NPDSCH EPRE to NRS EPRE in symbols with NRS   FFS: Whether UE specific or cell-specific or carrier-specific signalling is used. |

RAN1#106-e:

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| [R1-2108466](file:///C:\3gpp\Meetings\TSGR1\TSGR1_106-e\Docs\R1-2108466.zip) Feature lead summary #2 on 106-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)  [R1-2108275](file:///C:\3gpp\Meetings\TSGR1\TSGR1_106-e\Docs\R1-2108275.zip) Feature lead summary #1 on 106-e-LTE-Rel17\_NB\_IoT\_eMTC-01 Moderator (Huawei)  Agreement:  Confirm the following working assumption:   * Working Assumption   + Support 16-QAM for NPUSCH in PUR procedure.   Confirm the working assumption:  Working Assumption  For the indication of 16-QAM in uplink   * The “Modulation and coding scheme” field in DCI Format N0 is utilized as in legacy for scheduling QPSK. * One reserved state in the “Modulation and coding scheme” field in DCI Format N0 is utilized to indicate the use of 16QAM. * The “Repetition number” field in DCI Format N0 is utilized to indicate the TBS indices (i.e., I\_TBS indices from 14 to 21) for 16-QAM in UL.   Agreement  **For the UE configured with 16-QAM for NPDSCH, the deployment of the carrier is signaled by *operationModeInfo* in MIB or *inbandCarrierInfo* in SIB.**  **Confirm working assumption:**  Working Assumption  For downlink power allocation to support 16QAM:   * For standalone and guard-band deployments:   + One power ratio is signaled optionally     - NPDSCH EPRE to NRS EPRE in symbols without NRS   + The same transmit power is assumed across different symbols.   + If the signalling is not indicated, the legacy power allocation is used.     - i.e., the ratio of NPDSCH EPRE to NRS EPRE is 0dB for one NRS antenna port, and -3dB for two NRS antenna ports * UE specific signalling is used   Agreement  Down-select one option from Cat 1 as starting point   * Cat 1: Option 1, Option 2/Option 4, Option 5   FFS Cat 2: Option 3, for close-loop power control   * Option 1: Reuse the LTE definition simplified for NB-IoT: for and for , where is given by higher layer parameter *deltaMCS-Enabled*, and where K is the code block size. * Option 2: is given in table based on MCS index if enabled, 0 otherwise. * Option 3: A TPC command is introduce to indicate the power offset for NPUSCH with 16-QAM. * Option 4: is configured by high layer parameter. * Option 5: ΔTF = for *Ks* = 1.25 or ΔTF = 0 for *Ks* = 0, where BPRE =. is the highest code rate in the TBS/MCS table used for the Modulation Scheme, and is the number of bits per M-ary symbol of the Modulation Scheme.   **Working Assumption**  For downlink power allocation to support 16QAM:   * For inband deployments, a power ratio is signaled in addition to the signalling for standalone and guard-band deployments which in this case applies to “symbols with NRS” and “symbols without NRS nor CRS”.   + the power ratio between NPDSCH EPRE and NRS EPRE in symbols with CRS is signalled   + the signalling is UE specific   Note: “symbols with NRS” and “symbols without NRS nor CRS” have the same power.  Conclusion  The channel quality report is not supported in Msg3 in connected mode in Rel-17. |

RAN1#106bis-e:

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| **R1-2110555 Feature lead summary #1 on 106bis-e-LTE-Rel17-NB-IoT-eMTC-01 Moderator (Huawei)**  **R1-2110459 Feature lead summary #1 on 106bis-e-LTE-Rel17-NB-IoT-eMTC-01 Moderator (Huawei)**  **Working Assumption**  **For the new term**  **introduced for power control of NPUSCH,**   * Reuse the LTE definition simplified for NB-IoT: for and for , where is given by higher layer parameter *deltaMCS-Enabled*, and where K is the code block size. * FFS: whether the new term applies to QPSK when configured with 16QAM, if it does not, whether an additional term is introduced to avoid jump between QPSK and 16QAM    Agreement  Support 16-QAM for NPDSCH in PUR procedure   * CSI report is not supported/expected during PUR procedure.      Agreement  To support 16-QAM for NPDSCH and NPUSCH in PUR procedure,   * 16-QAM can be enabled/disabled by UE specific RRC signaling for NPDSCH and NPUSCH separately   + The corresponding configurations and signaling details are up to RAN2      Agreement  The reserved state to indicate the use of 16QAM in DCI format N0 and DCI format N1 should be “1111”.     Agreement  Confirm the following working assumption:  Working Assumption  For downlink power allocation to support 16QAM:   * For inband deployments, a power ratio is signaled in addition to the signalling for standalone and guard-band deployments which in this case applies to “symbols with NRS” and “symbols without NRS nor CRS”.               o   the power ratio between NPDSCH EPRE and NRS EPRE in symbols with CRS is signalled          o   the signalling is UE specific       Note: “symbols with NRS” and “symbols without NRS nor CRS” have the same power**.**  Agreement  For the UE configured with 16-QAM for NPDSCH, the deployment of the carrier is signaled by *operationModeInfo* in MIB or *inbandCarrierInfo* in SIB/UE specific signaling.  Note: Existing agreement from RAN1#106e is "For the UE configured with 16-QAM for NPDSCH, the deployment of the carrier is signaled by *operationModeInfo* in MIB or *inbandCarrierInfo* in SIB", which is replaced by the updated agreement above from RAN1#106bis-e. |

## Support additional PDSCH scheduling delay for introduction of 14-HARQ processes in DL for eMTC

RAN1#102:

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| [**R1-2007265**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23102%20-%20202008%20-%20eMeeting\Docs\R1-2007265.zip) **Feature Lead Summary: [102-e-LTE-Rel17\_NB\_IoT\_eMTC-02] Moderator (Ericsson)**  Agreement  Introduce a new RRC configuration parameter to enable 14 HARQ processes.  Agreement  For a UE configured with 14 HARQ processes, a PDSCH scheduling delay of 2 BL/CE DL subframes and 7 [FFS subframes type(s)] is supported at least in the PUCCH non-repetition case:   * FFS details of signaling. * FFS other delay values to account for the presence of non-BL/CE subframes in the PUCCH non-repetition case. * FFS if the 14 HARQ processes feature is supported in PUCCH repetition case.   Working Assumption   * Introduce a new optional UE capability to support 14 HARQ processes. |

RAN1#103-e:

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| [**R1-2009513**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23103%20-%20202010%20-%20eMeeting\Docs\R1-2009513.zip) **Feature Lead Summary [103-e-LTE-Rel17\_NB\_IoT\_eMTC-02] Moderator (Ericsson)**  **Decision:** From GTW session on Nov.4th,  Agreement: The following working assumption is confirmed   * Introduce a new optional UE capability to support 14 HARQ processes   Agreement  The design of the 14 HARQ processes feature accounts for the presence of non-BL/CE UL and DL subframes in the PUCCH non-repetition case.   * FFS: PDSCH scheduling delays * FFS: HARQ-ACK delays * FFS: Configurable/dynamic set of PDSCH delays/HARQ-ACK delays   **For future meetings:**  Companies to further study on the impact of measurement gaps on the 14 HARQ processes feature.  [**R1-2009514**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23103%20-%20202010%20-%20eMeeting\Docs\R1-2009514.zip) **Feature Lead Summary#2 [103-e-LTE-Rel17\_NB\_IoT\_eMTC-02] Moderator (Ericsson)**  **Decision:** From GTW session on Nov.11th,  Agreement  For the support of 14 HARQ processes, the solution to assign PDSCH scheduling delays should be able to minimize unnecessary waste of subframes derived from the presence of non-BL/CE DL subframes and non-BL/CE UL subframes.   * The following solutions will be further investigated:   + The indication of subframe types for the PDSCH scheduling delay of 7 are:     - 1 BL/CE DL subframe + 1 subframe + 3 [BL/CE UL subframes] + 1 subframe + 1 BL/CE DL subframe.     - 1 subframe + 3 [BL/CE UL subframes] + 1 subframe + 2 BL/CE DL subframes.   + Configurable delays including other values than 2 and 7. * Other solutions are not precluded.   Agreement  For the support of 14 HARQ processes, the solution to assign HARQ-ACK delays should aim to maximize the number of HARQ processes that can be scheduled in presence of non-BL/CE DL subframes and non-BL/CE UL subframes.   * Different percentages of presence of non-BL/CE subframes can be analyzed as to represent typical scenarios and determine which HARQ-ACK delays should be included.   [**R1-2009515**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23103%20-%20202010%20-%20eMeeting\Docs\R1-2009515.zip) **Feature Lead Summary#3 [103-e-LTE-Rel17\_NB\_IoT\_eMTC-02] Moderator (Ericsson)**  No further progress. |

RAN1#104-e:

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| [**R1-2101845**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23104%20-%20202101%20-%20eMeeting\Docs\R1-2101845.zip) **Feature Lead Summary [104-e-LTE-Rel17\_NB\_IoT\_eMTC-02] 1st check point Moderator (Ericsson)**  Agreement  The PDSCH scheduling delay for the PUCCH non-repetition case (i.e., PUCCH repetitions = 1):   * 2 BL/CE DL subframes. * The PDSCH scheduling delay of 7 is expressed as:   + 1 BL/CE DL subframe + 1 subframe + [3 subframes] + 1 subframe + 1 BL/CE DL subframe.   + 1 subframe + [3 subframes] + 1 subframe + 2 BL/CE DL subframes.   [**R1-2101846**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23104%20-%20202101%20-%20eMeeting\Docs\R1-2101846.zip) **Feature Lead Summary [104-e-LTE-Rel17\_NB\_IoT\_eMTC-02] 2nd check point Moderator (Ericsson)**  [**R1-2101847**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23104%20-%20202101%20-%20eMeeting\Docs\R1-2101847.zip) **Feature Lead Summary [104-e-LTE-Rel17\_NB\_IoT\_eMTC-02] 3rd check point Moderator (Ericsson)**  From GTW session on Feb 4th,  Agreement  For the 14 HARQ processes feature, when PUCCH is used with 1 repetition and there is presence of non-BL/CE UL subframes (i.e., invalid UL subframes):   * The term surrounded by brackets in Solution 1 is resolved as 3 BL/CE UL subframes. |

RAN1#104bis-e:

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| **R1-2103859 Feature Lead Summary [104b-e-LTE-Rel17\_NB\_IoT\_eMTC-02] 1st check point Moderator (Ericsson)**  Agreement  In Rel-17, for the 14 HARQ processes feature, PUCCH repetition is not supported with HARQ-ACK bundling.  Conclusion  In Rel-17, the 14 HARQ processes feature is not supported when the multi-TB grant feature is enabled.  **R1-2103860 Feature Lead Summary [104b-e-LTE-Rel17\_NB\_IoT\_eMTC-02]: 2nd check point Moderator (Ericsson)**  Agreement  In Rel-17, for the 14 HARQ process feature the HARQ-ACK delay solution will be down-selected in RAN1#105-e from:   * Alt-1: The HARQ-ACK delay is determined through an expression consisting of different subframe types (Using a similar principle as the PDSCH scheduling delay).   + FFS: The expression consisting of different subframe types.   + FFS: Signaling Details. * Alt-2: The HARQ-ACK delay is determined following the legacy approach. That is, the “HARQ-ACK delay” is kept expressed in terms of “absolute subframes”.   + FFS: The percentage of presence of non-BL/CE DL subframes and non-BL/CE UL subframes to be handled.   + FFS: HARQ-ACK delay values and length of the HARQ-ACK delay set.   + FFS: Signaling Details.   The following aspects will be considered towards the down-selection of one of the two alternatives (i.e., Alt-1 or Alt-2) for the HARQ-ACK delay solution:   * Total number of bits required in DCI * Scenarios that can be handled, including:   + different numbers of scheduled HARQ processes per burst (including dynamically switching between more than 10 HARQ processes and 10 or less HARQ processes)   + different % of invalid subframes for both 10 and 40 SF long bitmaps * Robustness against loss of DCIs * Flexibility * RRC signaling overhead |

RAN1#105-e:

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| [**R1-2106028**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23105%20-%20202105%20-%20eMeeting\Docs\R1-2106028.zip) **Feature Lead Summary [105-e-LTE-Rel17\_NB\_IoT\_eMTC-02] checkpoint#1 Moderator (Ericsson)**  From GTW sessions:  Agreement  In Rel-17, for the 14 HARQ process feature the HARQ-ACK delay solution will be supported with multiple solutions:  **Alt-1 for full flexibility and Alt-2e for support of legacy delay**   * Alt-1: The HARQ-ACK delay is determined through an expression consisting of different subframe types (Using a similar principle as the PDSCH scheduling delay).   + Without using more than 6 bits   + FFS: How to minimize the overhead by using joint encoding * Alt-2e: The HARQ-ACK delay is determined following the legacy approach. That is, the “HARQ-ACK delay” is kept expressed in terms of “absolute subframes”.   + The HARQ-ACK delay values and the length of the HARQ-ACK delay set will be based on     - Alt-2e: “3 bits (same as legacy)”     - FFS: Whether HARQ delay set is to use range1 or range2 * RRC signaling will be used to configure between Alt-1 and Alt-2e * FFS: Signaling details * FFS: Joint encoding   [**R1-2106029**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23105%20-%20202105%20-%20eMeeting\Docs\R1-2106029.zip) **Feature Lead Summary [105-e-LTE-Rel17\_NB\_IoT\_eMTC-02] checkpoint#2 Moderator (Ericsson)**  Working Assumption  The PDSCH scheduling delay and HARQ-ACK delay are jointly encoded in a single DCI field:   * The field uses no more than 7 bits if Alt-1 is configured. * The field is 5 bits if Alt-2e is configured. * FFS: Details of the joint encoding. * FFS: Legacy DCI fields that might be re-purposed for the jointly encoded solution of Alt-1 and Alt-2e respectively.   Note: Alt-1 expresses the HARQ-ACK delay as: (y) BL/CE DL subframe + 1 subframe + (z) BL/CE UL subframes, where y = {0, 1, 2, … 11} and z = {1, 2, 3}.  **Conclusion:**  In Rel-17, for the 14 HARQ processes feature:  When the HARQ-ACK delay is configured to use Alt-1 “PUCCH using Repetition = 1 is postponed”, whereas when the HARQ-ACK delay is configured to use Alt-2e “PUCCH using Repetition = 1 is not postponed (legacy behavior)”.  Agreement  In Rel-17, the 14 HARQ processes feature is applicable for HD-FDD Cat M1 UEs in CE Mode A only.  **For discussion in future meetings:**  Whether 14 HARQ processes feature can be enabled for PDSCH repetition case |

RAN1#106-e:

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| [R1-2108296](file:///C:\3gpp\Meetings\TSGR1\TSGR1_106-e\Docs\R1-2108296.zip) Feature Lead Summary [106-e-LTE-Rel17\_NB\_IoT\_eMTC-02] - 2st check point Moderator (Ericsson)  [R1-2108295](file:///C:\3gpp\Meetings\TSGR1\TSGR1_106-e\Docs\R1-2108295.zip) Feature Lead Summary [106-e-LTE-Rel17\_NB\_IoT\_eMTC-02] - 1st check point Moderator (Ericsson)  Agreement  Confirm the below Working Assumption for Alt-2e with following updates  The PDSCH scheduling delay and HARQ-ACK delay are jointly encoded in a single DCI field:   * The field is 5 bits if Alt-2e is configured. * FFS: Details of the joint encoding. * FFS: Legacy DCI fields that might be set to zero bits in length for the jointly encoded solution Alt-2e.   For Alt-1, it will be separate discussion based existing working assumption  Agreement  Confirm the below Working Assumption for Alt-1 with following updates  The PDSCH scheduling delay and HARQ-ACK delay are jointly encoded in a single DCI field:   * The field is no more than 7 bits if Alt-1 is configured. * FFS: Details of the joint encoding. * FFS: Legacy DCI fields that might be set to zero bits in length for the jointly encoded solution Alt-1.   Note: Alt-1 expresses the HARQ-ACK delay as: (y) BL/CE DL subframe + 1 subframe + (z) BL/CE UL subframes, where y = {0, 1, 2, … 11} and z = {1, 2, 3}.  Agreement  For the PDSCH scheduling delay and HARQ-ACK delay jointly encoded in a single DCI field:   * The DCI field uses 7 bits if Alt-1 is configured.   Conclusion  How to implement/describe the states, e.g., table, resulting from the joint encoding solution of Alt-1 is left up to the Editor, based on the agreements for the PDSCH scheduling delay, HARQ-ACK delay and the WA confirmed for Alt-1. |

RAN1#106bis-e:

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| R1-2110414 Feature Lead Summary [106bis-e-LTE-Rel17-NB-IoT-eMTC-02] - final checkpoint Moderator (Ericsson)  R1-2110413 Feature Lead Summary [106bis-e-LTE-Rel17-NB-IoT-eMTC-02] Moderator (Ericsson)  Working Assumption  For the joint encoding of “PDSCH Scheduling delay” and “HARQ-ACK delay” when Alt-2e is configured, the HARQ-ACK delay set has a size of:   * Alt-C:   + - 12 elements: HARQ-ACK delay set = {a, b, c, d, e, f, g, h, i, j, k, l} for the PDSCH Scheduling delay expression associated to the delay of 2.     - 10 elements: HARQ-ACK delay set = {o, p, q, r, s, t, u, v, x, w} for the two PDSCH Scheduling delay expressions associated to the delay of 7.       * FFS: The values of {a, b, c, d, e, f, g, h, i, j, k, l}, {o, p, q, r, s, t, u, v, x, w} where some of these elements may share the same value.   Conclusion:  How to implement/describe the states, e.g., table, resulting from the joint encoding solution of Alt-2e is left up to the Editor, based on the agreements for the PDSCH scheduling delay, HARQ-ACK delay and the WA confirmed for Alt-2e.  Agreement  The Rel-17 14 HARQ processes feature only applies to User Specific Search Space (USS)  Agreement  In Rel-17, for the 14 HARQ processes feature the “HARQ-ACK process number” field uses 4-bits.  Agreement  In Rel-17, for the 14 HARQ processes feature the following updates on the technical specification are to be performed.   * The maximum number of received PDSCH receptions pending HARQ-ACK is set to W = 12 (in Sect. 7.3.1 of TS 36.213) when the UE is configured with 14 HARQ processes.   Agreement  In Rel-17, one option will be downselected from Opt-2 and Opt-3 for the 14 HARQ processes feature the “Repetition number” field in RAN1#107e:        Opt-2: 0-bits when the 14 HARQ processes feature is configured (i.e., 2-bits from this field become available for jointly-encoding purposes).          Opt-3: 2-bits as in legacy. |

## Support a maximum DL TBS of 1736 bits as a Rel-17 optional UE capability

RAN1#104-e:

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| [**R1-2101908**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23104%20-%20202101%20-%20eMeeting\Docs\R1-2101908.zip) **Feature Lead Summary [104-e-LTE-Rel17\_NB\_IoT\_eMTC-03] 1st check point Moderator (Sony)**  From GTW session:  Agreement  The number of soft channel bits is calculated based on the equation:    Working Assumption: N=8  **Conclusion**  It is RAN1 assumption that 1736 DL TBS feature is compatible with all other eMTC features applicable for HD-FDD Cat. M1 UEs in CE mode A. It is assumed that there’s no change to DCI formats, TBS tables and CQI tables.  [**R1-2102124**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23104%20-%20202101%20-%20eMeeting\Docs\R1-2102124.zip) **Feature Lead Summary [104-e-LTE-Rel17\_NB\_IoT\_eMTC-03] 2nd check point Moderator (Sony)**  From GTW session:  Agreement  The 1736 bits DL TBS feature is enabled by unicast RRC configuration.  **Decision:** As per email posted on Feb 5th,  Agreement  For a UE configured with “1736 bits DL TBS” and 64-QAM:   * If the UE is signaled with a TBS of up to and including 1736 bits, the UE shall apply the signaled TBS. * If the UE is signaled with a TBS of greater than 1736 bits, the UE shall apply a TBS of 1736 bits. |

RAN1#104bis-e:

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| **R1-2104087 Summary of NWM discussion for [104b-e-LTE-Rel17\_NB\_IoT\_eMTC-03] Moderator (Sony)**  Agreement  The working assumption on the value of N is confirmed for the calculation of the number of soft channel bits based on the equation:  where *N*=8.  Agreement  The soft channel bits for UEs supporting maximum DL TBS of 1736 bits is 43008 bits.  Agreement  Send an LS to RAN2 informing them of RAN1’s decisions on the following:   * The soft channel bits for UEs supporting maximum DL TBS of 1736 bits is 43008 bits. * The 1736 bits DL TBS feature is enabled by unicast RRC configuration.   **R1-2103942 LS on Agreements Related to Support of a maximum DL TBS of 1736 bits as a Rel-17 optional UE capability RAN1, Sony**  Decision: As per decision posted on April 16th, the LS is approved. |

RAN1#105-e:

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| [**R1-2106256**](file:///D:\Study\works\3GPP%20meetings\RAN1\RAN1%23105%20-%20202105%20-%20eMeeting\Docs\R1-2106256.zip) **Feature Lead Summary [105-e-LTE-Rel17\_NB\_IoT\_eMTC-03] Moderator (Sony)**  **Decision:** As per email decision posted on May 27th, there is no conclusion made or agreements endorsed. |