**3GPP TSG RAN WG1 Meeting #102-e R1-20xxxxx**

**E-Meeting, October 26 – November 13, 2020**

**Agenda Item: 8.9.1**

**Source: Moderator (Huawei)**

**Title: Feature lead summary #1 on [103-e-LTE-Rel17\_NB\_IoT\_eMTC-01]**

**Document for: Discussion and Decision**

# Introduction

The WID for Rel-17 enhancements for NB-IoT and LTE-MTC [1] includes an objective to support 16-QAM for unicast in UL and DL in NB-IoT.

* *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]*

This documents provides the proposals and summary of discussions of the following email discussion according to the inputs [2-10]

[103-e-LTE-Rel17\_NB\_IoT\_eMTC-01] Email discussion on support of 16-QAM for unicast in UL and DL for NB-IoT – Yubo (Huawei)

* 1st check point: 11/5
* 2nd check point: 11/10
* 3rd check point: 11/12

# Issues

## Support of 16QAM for NB-IoT downlink

**Issue 1: The maximum TBS to support 16-QAM for unicast in DL for standalone and guardband.**

The following are proposed:

|  |  |
| --- | --- |
| Sourcing | Proposals |
| [2] | Proposal 1: 5736 bits with ISF = 7 (i.e. option 3) is the maximum TBS to support 16-QAM for unicast in DL for standalone and guard-band deployments. |
| [3] | **Proposal 4: For stand-alone and guard-band deployments, the maximum TBS to support 16-QAM for unicast in DL is 4968 bits for both 1-HARQ and 2-HARQ UEs.** |
| [4] | ***Observation 1: For guard-band/standalone deployment, the TBS of 5736 bits cannot be applied for 2Tx antennas since the code rate of 5736 exceeds the upper limit of 0.932 when 2 NRS ports are configured.******Proposal 1: 4968 bits with ISF=7 can be defined as the maximum TBS for DL 16QAM in guard-band/standalone deployment.*** |
| [5] | ***Proposal 2: For all operation modes, the maximum TBS to support 16-QAM for unicast in DL is 4968 bits with ISF=7.*** |
| [6] | Observation 1 On the new max TBS to be supported for 16-QAM in DL, “Option 1: 4968 bits with ISF =7” seems to be a better choice as to avoid using a TBS that has not been previously used in the standard, or going beyond twice the max TBS in Rel-16.Proposal 1 The maximum TBS to support 16-QAM for unicast in DL for stand-alone and guard-band deployments is “Option 1: 4968 bits with ISF =7”. |
| [8] | **Proposal 1: The maximum TBS for DL 16-QAM is 5736.*** **Target a maximum code rate of ~0.9 for all cases (deployment scenarios and N\_SF)**
 |
| [9] | Proposal 5: For all deployment scenarios, the max DL TBS should be 4968. |

For the following options:

* Option 1: 4968 bits with *ISF*=7
	+ Nokia, Nokia Shanghai Bell, ZTE, Lenovo, Motorola Mobility, Ericsson, Sierra Wireless
* Option 2: 5072 bits with *ISF*=7
* Option 3: 5736 bits with *ISF*=7
	+ Huawei, HiSilicon, Qualcomm,

Based on the intpus, the following is proposed:

Proposal 1: At least for standalone and guard-band deployments, the maximum TBS to support 16-QAM for unicast in DL is down-selected from following options in RAN1#103e:

* **Option 1: 4968 bits with ISF=7**
* **Option 3: 5736 bits with ISF=7**

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

**Issue 2: The maximum TBS to support 16-QAM for unicast in DL for inband.**

The following are proposed:

|  |  |
| --- | --- |
| Sourcing | Proposals |
| [2] | **Proposal 5: For in-band deployments, the maximum TBS to support 16-QAM in DL is 3624 bits.** |
| [3] | **Proposal 5: For in-band deployment, the maximum TBS to support 16-QAM for unicast in DL is 3624 bits for both 1-HARQ and 2-HARQ UEs.** |
| [4] | ***Proposal 6: In-band uses the same DL TBS table as guard-band/standalone for DL 16QAM.**** ***TBS configured for in-band should be less than or equal to TBS16 i.e. 3240 bits with ISF=7.***
 |
| [6] | Proposal 3 For in-band deployments, the TBS/MCS Table to support 16-QAM is a sub-case of the TBS/MCS Table used for stand-alone and guard-band deployments.• The entries for 16-QAM ranges from a TBS = 176 bits to TBS = 3624 as to keep below 0.88 the achievable code rates in in-band deployments. |

Based on the inputs, there are following options for maximum TBS for inband deployment:

* Option 1: 3624 bit
	+ Huawei, HiSilicon, Nokia, Nokia Shanghai Bell, Ericsson
* Option 2: 3240 bit
	+ ZTE,

Based on the majority view, the following is proposed:

Proposal 2: For inband deployment, the maximum TBS to support 16-QAM for unicast in DL is 3624 bits.

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

**Issue 3: The TBS table.**

The following are proposed:

|  |  |
| --- | --- |
| Sourcing | Proposals |
| [2] | Table 1 An example of TBS table for DL

|  |  |
| --- | --- |
|  |  |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | 16 | 32 | 56 | 88 | 120 | 152 | 208 | 256 |
| 1 | 24 | 56 | 88 | 144 | 176 | 208 | 256 | 344 |
| 2 | 32 | 72 | 144 | 176 | 208 | 256 | 328 | 424 |
| 3 | 40 | 104 | 176 | 208 | 256 | 328 | 440 | 568 |
| 4 | 56 | 120 | 208 | 256 | 328 | 408 | 552 | 680 |
| 5 | 72 | 144 | 224 | 328 | 424 | 504 | 680 | 872 |
| 6 | 88 | 176 | 256 | 392 | 504 | 600 | 808  | 1032  |
| 7 | 104 | 224 | 328 | 472 | 584 | 680 | 968  | 1224  |
| 8 | 120 | 256 | 392 | 536 | 680 | 808  | 1096  | 1352  |
| 9 | 136 | 296 | 456 | 616 | 776  | 936  | 1256  | 1544  |
| 10 | 144 | 328 | 504 | 680 | 872  | 1032  | 1384  | 1736  |
| 11 | 176 | 376 | 584 | 776  | 1000  | 1192  | 1608  | 2024  |
| 12 | 208 | 440 | 680 | 904  | 1128  | 1352  | 1800  | 2280  |
| 13 | 224  | 488  | 744  | 1032 | 1256  | 1544  | 2024  | 2536  |
| 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 | 2856 |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 |
| 16 | 328 | 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 |
| 22 | 520 | 1064 | 1608 | 2152 | 2664 | 3240 | 4264 | 5352 |
| 23 | 552 | 1128 | 1736 | 2280 | 2856 | 3496 | 4584 | 5736 |

Proposal 3: Adopt table 1 as the TBS design to support 16-QAM in DL.Proposal 2: I\_SF>7 for 16-QAM is not supported. |
| [3] | Table . DL TBS table with 16-QAM.

|  |  |
| --- | --- |
|  |  |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | 16 | 32 | 56 | 88 | 120 | 152 | 208 | 256 |
| 1 | 24 | 56 | 88 | 144 | 176 | 208 | 256 | 344 |
| 2 | 32 | 72 | 144 | 176 | 208 | 256 | 328 | 424 |
| 3 | 40 | 104 | 176 | 208 | 256 | 328 | 440 | 568 |
| 4 | 56 | 120 | 208 | 256 | 328 | 408 | 552 | 680 |
| 5 | 72 | 144 | 224 | 328 | 424 | 504 | 680 | 872 |
| 6 | 88 | 176 | 256 | 392 | 504 | 600 | 808  | 1032  |
| 7 | 104 | 224 | 328 | 472 | 584 | 680 | 968  | 1224  |
| 8 | 120 | 256 | 392 | 536 | 680 | 808  | 1096  | 1352  |
| 9 | 136 | 296 | 456 | 616 | 776  | 936  | 1256  | 1544  |
| 10 | 144 | 328 | 504 | 680 | 872  | 1032  | 1384  | 1736  |
| 11 | 176 | 376 | 584 | 776  | 1000  | 1192  | 1608  | 2024  |
| 12 | 208 | 440 | 680 | 904  | 1128  | 1352  | 1800  | 2280  |
| 13 | 224  | 488  | 744  | 1032 | 1256  | 1544  | 2024  | 2536  |
| 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 | 2856 |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 |
| 16 | 328 | 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 |

**Proposal 6: Keep all existing MCS values in the TBS table and extend the TBS table to support 16-QAM. The TBS table for DL 16-QAM is given in Table 1.** |
| [4] | Table 2: Extended TBS entries for DL 16QAM

|  |  |
| --- | --- |
|  |  |
| 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 | 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 |

***Proposal 2: TBS table for DL 16QAM can be expanded to 0~21 based on Table 16.4.1.5.1-1 of [2].**** ***Reuse the existing TBS 0~13 in Table 16.4.1.5.1-1***
* ***Reuse TBS 14~21 in LTE TBS table***
 |
| [6] |

|  |  |  |
| --- | --- | --- |
| Modulation Scheme |  | Number of NPDSCH Subframes (NSF) |
| 1 | 2 | 3 | 4 | 5 | 6 | 8 | 10 |
| QPSK only | 0 | 16 | 32 | 56 | 88 | 120 | 152 | 208 | 256 |
| 1 | 24 | 56 | 88 | 144 | 176 | 208 | 256 | 344 |
| 2 | 32 | 72 | 144 | 176 | 208 | 256 | 328 | 424 |
| 3 | 40 | 104 | 176 | 208 | 256 | 328 | 440 | 568 |
| 4 | 56 | 120 | 208 | 256 | 328 | 408 | 552 | 680 |
| 5 | 72 | 144 | 224 | 328 | 424 | 504 | 680 | 872 |
| 6 | 88 | 176 | 256 | 392 | 504 | 600 | 808  | 1032  |
| 7 | 104 | 224 | 328 | 472 | 584 | 680 | 968  | 1224  |
| 8 | 120 | 256 | 392 | 536 | 680 | 808  | 1096  | 1352  |
| 9 | 136 | 296 | 456 | 616 | 776  | 936  | 1256  | 1544  |
| 10 | 144 | 328 | 504 | 680 | 872  | 1032  | 1384  | 1736  |
| 11 | 176 | 376 | 584 | 776  | 1000  | 1192  | 1608  | 2024  |
| 12 | 208 | 440 | 680 | 904  | 1128  | 1352  | 1800  | 2280  |
| 13 | 224  | 488  | 744  | 1032 | 1256  | 1544  | 2024  | 2536  |
| 16-QAM only | 14 | 256 | 536 | 840 | 1128 | 1416 | 1736 | 2280 | 2856 |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 |
| 16 | 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 | 2536 | 2984 | 4008 | 4968 |

|  |  |  |
| --- | --- | --- |
| Modulation Scheme |  | Number of NPDSCH Subframes (NSF) |
| 1 | 2 | 3 | 4 | 5 | 6 | 8 | 10 |
| QPSK only | 0 | 16 | 32 | 56 | 88 | 120 | 152 | 208 | 256 |
| 1 | 24 | 56 | 88 | 144 | 176 | 208 | 256 | 344 |
| 2 | 32 | 72 | 144 | 176 | 208 | 256 | 328 | 424 |
| 3 | 40 | 104 | 176 | 208 | 256 | 328 | 440 | 568 |
| 4 | 56 | 120 | 208 | 256 | 328 | 408 | 552 | 680 |
| 5 | 72 | 144 | 224 | 328 | 424 | 504 | 680 | 872 |
| 6 | 88 | 176 | 256 | 392 | 504 | 600 | 808  | 1032  |
| 7 | 104 | 224 | 328 | 472 | 584 | 680 | 968  | 1224  |
| 8 | 120 | 256 | 392 | 536 | 680 | 808  | 1096  | 1352  |
| 9 | 136 | 296 | 456 | 616 | 776  | 936  | 1256  | 1544  |
| 10 | 144 | 328 | 504 | 680 | 872  | 1032  | 1384  | 1736  |
| 16-QAM only | 11 | 176 | 376 | 584 | 776  | 1000  | 1192  | 1608  | 2024  |
| 12 | 208 | 440 | 680 | 904  | 1128  | 1352  | 1800  | 2280  |
| 13 | 224  | 488  | 744  | 1032 | 1256  | 1544  | 2024  | 2536  |
| 14 | 256 | 536 | 840 | 1128 | 1416 | 1736 | 2280 | 2856 |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 |
| 16 | 296 | 632 | 968 | 1288 | 1608 | 1928 | 2600 | 3240 |
| 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 | 2856 | 3624 |
| 18 | - | - | - | - | - | - | - | - |
| 19 | - | - | - | - | - | - | - | - |
| 20 | - | - | - | - | - | - | - | - |
| 21 | - | - | - | - | - | - | - | - |

 |
| [9] | Proposal 1: TBS table(s) should be designed to support data rates of at least 180 kbps for all deployment scenarios (i.e. in-band, guard band, stand-alone)Proposal 2: The same TBS table should be used for all deployment scenariosProposal 3: For the SA/GB scenario, the TBS table should be designed such that the code rate is always <= 0.85.Proposal 4: To support the in-band scenario, the maximum number of SFs (NSF) per TBS should be 15 (i.e. up from 10).

|  |  |
| --- | --- |
| ITBS | ISF (NSF) |
| 0 (1) | 1 (2) | 2 (4) | 3 (6) | 4 (8) | 5 (10) | 6 (12) | 8 (15) |
| 0 | 16 | 32 | 88 | 152 | 208 | 256 | 328 | 392 |
| 1 | 24 | 56 | 144 | 208 | 256 | 344 | 424 | 520 |
| 2 | 32 | 72 | 176 | 256 | 328 | 424 | 520 | 648 |
| 3 | 40 | 104 | 208 | 328 | 440 | 568 | 680 | 872 |
| 4 | 56 | 120 | 256 | 408 | 552 | 696 | 840 | 1064 |
| 5 | 72 | 144 | 328 | 504 | 680 | 872 | 1032 | 1320 |
| 6 | 328 | 176 | 392 | 600 | 808 | 1032 | 1224 | 1544 |
| 7 | 104 | 224 | 472 | 712 | 968 | 1224 | 1480 | 1800 |
| 8 | 120 | 256 | 536 | 808 | 1096 | 1384 | 1672 | 2088 |
| 9 | 136 | 296 | 616 | 936 | 1256 | 1544 | 1864 | 2344 |
| 10 | 144 | 328 | 680 | 1032 | 1384 | 1736 | 2088 | 2664 |
| 11 | 176 | 376 | 776 | 1192 | 1608 | 2024 | 2408 | 2984 |
| 12 | 208 | 440 | 904 | 1352 | 1800 | 2280 | 2728 | 3368 |
| 13 | 224 | 488 | 1000 | 1544 | 2024 | 2536 | 3112 | 3880 |
| 14 | 256 | 552 | 1128 | 1736 | 2280 | 2856 | 3496 | 4264 |
| 15 | 280 | 600 | 1224 | 1800 | 2472 | 3112 | 3624 | 4584 |
| 16 | 328 | 632 | 1288 | 1928 | 2600 | 3240 | 3880 | 4968 |
| 17 | **336** | **696** | **1416** | **2152** | **2856** | **3624** | **4392** |  |
| 18 | **376** | **776** | **1544** | **2344** | **3112** | **4008** | **4776** |  |
| 19 | **408** | **840** | **1736** | **2600** | **3496** | **4264** |  |  |
| 20 | **440** | **904** | **1864** | **2792** | **3752** | **4584** |  |  |
| 21 | **488** | **1000** | **1992** | **2984** | **4008** | **4968** |  |  |

Proposal 6: Adopt the above TBS table to support max TBS =4968 for all deployment scenarios (in-band, standalone, guard band) |

Based on the inputs, the following is proposed:

Proposal 3: to support 16QAM for NB-IoT DL, at least the following TBS indices are introduced

|  |  |
| --- | --- |
|  |  |
| 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 for I\_SF > 7**

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

**Issue 4: The switching point from QPSK to 16QAM.**

The following are proposed:

|  |  |
| --- | --- |
| Sourcing | Proposals |
| [3] | **Proposal 7: For stand-alone and guard-band deployments, the break-point for 16-QAM in DL is I\_TBS ≥ 14 based on Table 1.****Proposal 8: For in-band deployment, the break-point for 16-QAM in DL is I\_TBS ≥ 11 based on Table 1.** |
| [4] | ***Observation 2: For NPDSCH in guard-band/standalone deployment, 16QAM performance is slightly better than QPSK performance at TBS= 2024 with ISF=7, i.e. TBS 11.******Proposal 5: TBS 11 or 12 could be adopted as DL 16QAM switching point for guard-band/standalone deployment.******Observation 3: For NPDSCH in in-band deployment, 16QAM performance is better than QPSK performance at TBS=1736 with ISF=7, i.e. TBS 10.******Proposal 7: TBS 10, i.e. 1736 bits with ISF=7, could be adopted as DL 16QAM switching point for in-band deployment.*** |
| [8] | **Observation 1:** **The breakpoint between QPSK and 16-QAM for DL is at approximately at 1.8 (total bits)/#REs (code rate of 0.9 for QPSK)****Observation 2:** **For a given TBS, the optimum modulation scheme is different for different deployment scenarios.****Proposal 2: For downlink, specify different MCS/TBS tables for different deployment scenarios (to optimize the switching point between 16-QAM and QPSK). The switching point between QPSK and 16-QAM is at approximately at (total bits)/#REs** $≈1.65$ **Consider at least the following scenarios:*** **In-band with [3] symbol control, 2/4 port CRS**
* **Guard-band/standalone with 0 symbol control**
 |

On the switching point from QPSK to 16QAM for standalone and guardband deployments, there are following options:

* + The TBS entries of 14 (TBS of 2856 for I\_SF=7) and above are used for 16QAM
		- Nokia, Nokia Shanghai Bell, Ericsson, MediaTek
	+ The TBS entries of [11 (TBS of 2024 for I\_SF=7) or 12 (TBS of 2280 for I\_SF=7)] and above are used for 16QAM
		- ZTE

For inband deployment, there are following options:

* + The TBS entries of 11 (TBS of 2024 for I\_SF=7) and above are used for 16QAM
		- Nokia, Nokia Shanghai Bell, Ericsson
	+ The TBS entries of 10 (TBS of 1736 for I\_SF=7) and above are used for 16QAM
		- ZTE,

In addition, [8] also proposed that the switching point if at approximately at (total bits)/#REs$≈1.65$.

As not many companies provides Thus it is proposed:

Proposal 4: Different switching points are used for standalone/guradband and inband deployments.

* + **FFS the details of the switching point.**

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

**Issue 5: Applicability**

The following are proposed on scheduling of TBS and modulation:

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | **Proposal 4: Repetition is not supported for 16-QAM in DL.** |
| [3] | **Proposal 11: Support 16-QAM with repetition in the DL.****Proposal 12: Support modulation adjustment to QPSK when 16-QAM is scheduled with repetition in the DL.** |
| [4] | ***Observation 4: For DL, 16QAM with 2 repetitions can still provide a higher peak data rate compared to QPSK. But 16QAM may show worse data rate after the number of repetitions increases to 4.******Proposal 8: At least 2 repetitions should be supported for DL 16QAM.*** |
| [7] | **Observation: Repetition for 16QAM has much worse performance under AWGN.** |
| [8] | **Proposal 5: DL 16-QAM is only 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.**

**Proposal 6: 16-QAM NPDSCH is only supported for R=1.** **- FFS whether to support the new TBSs with QPSK and increased RU**  |

As there are diverse views, the following is proposed to collect more views

Proposal 5: Further study on the following to support 16QAM for NB-IoT DL:

* + **Whether repetition can be used for 16QAM in DL.**
	+ **Whether DL 16QAM is only used for NPDSCH scheduled from a DCI with CRC scrambled by C-RNTI from USS.**
	+ **Whether to support the new TBS with QPSK and increased RU.**

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

## Support of 16QAM for NB-IoT uplink

**Issue 6: The TBS/MCS table to support 16-QAM for unicast in UL.**

There are following proposals on TBS design of 16-QAM for UL unicast

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | Table 4 An example of TBS table for UL

|  |  |
| --- | --- |
|  |  |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | 16 | 32 | 56 | 88 | 120 | 152 | 208 | 256 |
| 1 | 24 | 56 | 88 | 144 | 176 | 208 | 256 | 344 |
| 2 | 32 | 72 | 144 | 176 | 208 | 256 | 328 | 424 |
| 3 | 40 | 104 | 176 | 208 | 256 | 328 | 440 | 568 |
| 4 | 56 | 120 | 208 | 256 | 328 | 408 | 552 | 680 |
| 5 | 72 | 144 | 224 | 328 | 424 | 504 | 680 | 872 |
| 6 | 88 | 176 | 256 | 392 | 504 | 600 | 808 | 1000 |
| 7 | 104 | 224 | 328 | 472 | 584 | 712 | 1000 | 1224 |
| 8 | 120 | 256 | 392 | 536 | 680 | 808 | 1096  | 1384  |
| 9 | 136 | 296 | 456 | 616 | 776 | 936 | 1256  | 1544  |
| 10 | 144 | 328 | 504 | 680 | 872 | 1000 | 1384  | 1736  |
| 11 | 176 | 376 | 584 | 776 | 1000 | 1192 | 1608  | 2024  |
| 12 | 208 | 440 | 680 | 1000 | 1128 | 1352  | 1800  | 2280  |
| 13  | 224  | 488  | 744  | 1032 | 1256  | 1544  | 2024  | 2536  |
| 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 |  |  |  |

Proposal 6: Adopt table 4 as the TBS design to support 16-QAM in UL. |
| [3] | Table . UL TBS table with 16-QAM.

|  |  |
| --- | --- |
|  |  |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | 16 | 32 | 56 | 88 | 120 | 152 | 208 | 256 |
| 1 | 24 | 56 | 88 | 144 | 176 | 208 | 256 | 344 |
| 2 | 32 | 72 | 144 | 176 | 208 | 256 | 328 | 424 |
| 3 | 40 | 104 | 176 | 208 | 256 | 328 | 440 | 568 |
| 4 | 56 | 120 | 208 | 256 | 328 | 408 | 552 | 680 |
| 5 | 72 | 144 | 224 | 328 | 424 | 504 | 680 | 872 |
| 6 | 88 | 176 | 256 | 392 | 504 | 600 | 808  | 1032  |
| 7 | 104 | 224 | 328 | 472 | 584 | 680 | 968  | 1224  |
| 8 | 120 | 256 | 392 | 536 | 680 | 808  | 1096  | 1352  |
| 9 | 136 | 296 | 456 | 616 | 776  | 936  | 1256  | 1544  |
| 10 | 144 | 328 | 504 | 680 | 872  | 1032  | 1384  | 1736  |
| 11 | 176 | 376 | 584 | 776  | 1000  | 1192  | 1608  | 2024  |
| 12 | 208 | 440 | 680 | 904  | 1128  | 1352  | 1800  | 2280  |
| 13 | 224  | 488  | 744  | 1032 | 1256  | 1544  | 2024  | 2536  |
| 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 |  |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 |  |
| 16 | 328 | 632 | 968 | 1288 | 1608 | 1928 |  |  |
| 17 | 336 | 696 | 1064 | 1416 | 1800 | 2152 |  |  |
| 18 | 376 | 776 | 1160 | 1544 | 1992 | 2344 |  |  |
| 19 | 408 | 840 | 1288 | 1736 | 2152 |  |  |  |
| 20 | 440 | 904 | 1384 | 1864 | 2344 |  |  |  |
| 21 | 488 | 1000 | 1480 | 1992 | 2472 |  |  |  |

**Proposal 13: Keep all existing MCS values in the TBS table and extend the TBS table to support 16-QAM. The TBS table for UL 16-QAM is given in Table 2.** |
| [4] | ***Proposal 10: For UL 16QAM, TBS table can be extended to up to 2536 bits for each IRU.***Table 6: TBS table for UL 16QAM

|  |  |
| --- | --- |
|  |  |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 0 | 16 | 32 | 56 | 88 | 120 | 152 | 208 | 256 |
| 1 | 24 | 56 | 88 | 144 | 176 | 208 | 256 | 344 |
| 2 | 32 | 72 | 144 | 176 | 208 | 256 | 328 | 424 |
| 3 | 40 | 104 | 176 | 208 | 256 | 328 | 440 | 568 |
| 4 | 56 | 120 | 208 | 256 | 328 | 408 | 552 | 696 |
| 5 | 72 | 144 | 224 | 328 | 424 | 504 | 680 | 872 |
| 6 | 328 | 176 | 256 | 392 | 504 | 600 | 808 | 1032 |
| 7 | 104 | 224 | 328 | 472 | 584 | 712 | 968 | 1224 |
| 8 | 120 | 256 | 392 | 536 | 680 | 808 | 1096 | 1384 |
| 9 | 136 | 296 | 456 | 616 | 776 | 936 | 1256 | 1544 |
| 10 | 144 | 328 | 504 | 680 | 872 | 1032 | 1384 | 1736 |
| 11 | 176 | 376 | 584 | 776 | 1000 | 1192 | 1608 | 2024 |
| 12 | 208 | 440 | 680 | 904 | 1128 | 1352 | 1800 | 2280 |
| 13 | 224 | 488 | 744 | 1000 | 1256 | 1544 | 2024 | 2536 |
| 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 |  |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2536 |  |
| 16 | 328 | 632 | 968 | 1288 | 1608 | 1928 |  |  |
| 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 |  |  |  |

 |
| [5] | ***Proposal 8: Support 16QAM for NPUSCH needs further study:**** ***Option1: Extend TBS table and generate modulation, TBS and MCS table.***
* ***Option2: Reinterpret the number of resource unit for modulation order of 16QAM.***
 |
| [6] | Proposal 8 The TBS/MCS Table to support 16-QAM in UL consists of:- All legacy QPSK entries.- The entries for 16-QAM are from legacy LTE Table 7.1.7.2.1-1 in TS 36.213 ranging from a TBS = 280 bits to TBS = 4968, with only two changes:o In the above-mentioned TBS range, the TBS > 2536 are excluded as to be compliant with the objective of preserving for UL the max TBS for Rel-16.o To transmit the max Rel-16 TBS with half of the time domain resources replacing TBS = 2472 bits by TBS = 2536 bits. |
| [8] | **Proposal 12: RAN1 to discuss whether to introduce one or more “implicit MCS” for retransmissions in the MCS table for UL 16-QAM.** |

Based on the inputs, the following can be proposed:

Proposal 6: to support 16QAM for NB-IoT UL, at least the following TBS indices are introduced

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 14 | 256 | 552 | 840 | 1128 | 1416 | 1736 | 2280 | 2856 |
| 15 | 280 | 600 | 904 | 1224 | 1544 | 1800 | [2472, 2536] | 3112 |
| 16 | 328 | 632 | 968 | 1288 | 1608 | 1928 | [2536] | 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 | [2536] | 3496 | 4264 |
| 20 | 440 | 904 | 1384 | 1864 | 2344 | 2792 | 3752 | 4584 |
| 21 | 488 | 1000 | 1480 | 1992 | [2472,2536] | 2984 | 4008 | 4968 |

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

**Issue 7: The crossing point from QPSK to 16QAM.**

There are following proposals on TBS design of 16-QAM for UL unicast

|  |  |
| --- | --- |
| Sourcing | proposals |
| [3] | **Proposal 15: The break-point for 16-QAM in UL is I\_TBS ≥ 14 based on Table 2.** |

As not many companies provide input, the following is proposed:

Proposal 7: further study on the switching point from QPSK to 16QAM for NB-IoT UL.

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

**Issue 8: Applicability**

The following are proposed on scheduling of TBS and modulation:

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | **Proposal 7: Repetition is not supported for 16-QAM in UL.** **Proposal 8: 16-QAM can be used for NPUSCH with at least multi-tone 3, 6 and 12 subcarriers.** |
| [3] | **Proposal 16: FFS whether to Support 16-QAM with repetition in the UL.****Proposal 17: 16-QAM is not supported for sub-PRB allocation.** |
| [4] | ***Proposal 9: UL 16QAM should be supported for 3/6/12 subcarriers allocation.*** |
| [6] | Observation 2 Although 16-QAM requires a high SNR and resource allocations < 12 subcarriers are mainly targeted towards low SNR regimes (especially single-tone allocations), still there are scenarios (e.g., NPRACH and NPUSCH coexistence) where multi-tone allocations could benefit from a higher order modulation. Proposal 7 The support of 16-QAM in UL is only for NPUSCH Format 1 using both full-PRB allocations and multi-tone allocations consisting of 6 and 3 allocated subcarriers. |
| [8] | **Proposal 15: 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.**

**Proposal 16: UL 16-QAM is applicable at least to NPUSCH with full-PRB allocations. FFS NPUSCH with sub-PRB allocations.** |

On the application of 16QAM to full PRB/sub-PRB allocations, there are following options:

* + Multi-tone transmission with 3, 6 and 12 subcarriers
		- Huawei, HiSilicon, ZTE, Ericsson,
	+ Multi-tone transmission with only 12 subcarriers
		- Nokia, Nokia Shanghai Bell,
	+ FFS on sub-PRB allocation
		- Qualcomm

Therefore, the following is proposed based on the input:

Proposal 8: RAN1 to further discuss on the applicability to different number of subcarriers.

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

## DCI

**Issue 9: MCS field.**

There are following proposals on power allocation

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | Proposal 9: The introduction of 16-QAM shall not increase the NPDCCH blind decodes.Proposal 10: The introduction of 16-QAM shall avoid increasing DCI size. |
| [3] | **Proposal 9: The size of the MCS field in DCI N1 in UE-specific search space is increased to 5 bits.****Proposal 14: The size of the MCS field in DCI N0 in UE-specific search space is increased to 5 bits.** |
| [4] | ***Proposal 3: 4-bit MCS table could be defined for DL 16QAM in guard-band/standalone deployment.***Table 3: Possible 4-bit MCS table for DL 16QAM

|  |  |  |
| --- | --- | --- |
| MCS Index | Modulation Order | TBS Index |
| **0** | 2 | 0 |
| **1** | 2 | 2 |
| **2** | 2 | 4 |
| **3** | 2 | 6 |
| **4** | 2 | 8 |
| **5** | 2 | 10 |
| **6** | 4 | 12 |
| **7** | 4 | 13 |
| **8** | 4 | 14 |
| **9** | 4 | 15 |
| **10** | 4 | 16 |
| **11** | 4 | 17 |
| **12** | 4 | 18 |
| **13** | 4 | 19 |
| **14** | 4 | 20 |
| **15** | 4 | 21 |

***Proposal 4: 4-bit MCS table for DL 16QAM can be defined based on the MCS entries of Rel-16 NB-IoT.**** ***Remove the existing 6 MCS entries***
* ***Add new 8 MCS entries***

***Proposal 11: 5-bit MCS table could be used for UL 16QAM.**** ***MCS 0~13 correspond to TBS 0~13 with QPSK modulation***
* ***MCS 14~24 correspond to TBS 11~21 with 16QAM modulation***

Table 7: Possible 5-bit MCS table for UL 16QAM

|  |  |  |
| --- | --- | --- |
| MCS Index | Modulation Order | TBS Index |
| **0** | 2 | 0 |
| **1** | 2 | 1 |
| **2** | 2 | 2 |
| **3** | 2 | 3 |
| **4** | 2 | 4 |
| **5** | 2 | 5 |
| **6** | 2 | 6 |
| **7** | 2 | 7 |
| **8** | 2 | 8 |
| **9** | 2 | 9 |
| **10** | 2 | 10 |
| **11** | 2 | 11 |
| **12** | 2 | 12 |
| **13** | 2 | 13 |
| **14** | 4 | 11 |
| **15** | 4 | 12 |
| **16** | 4 | 13 |
| **17** | 4 | 14 |
| **18** | 4 | 15 |
| **19** | 4 | 16 |
| **20** | 4 | 17 |
| **21** | 4 | 18 |
| **22** | 4 | 19 |
| **23** | 4 | 20 |
| **24** | 4 | 21 |
| **25~31** | reserved | reserved |

***Proposal 12: The most significant bit of the subcarrier indication field can be used for UL 5-bit MCS indication.*** |
| [5] | ***Proposal 3: To support 16QAM of NPDSCH, the MCS field in DCI format N1 is enlarged, optimized or reinterpreted, which needs further discussion.*** |
| [7] |

|  |  |  |
| --- | --- | --- |
| MCS Index | Modulation Order | TBS Index |
| **0** | 2 | 0 |
| **1** | 2 | 1 |
| **2** | 2 | 2 |
| **3** | 2 | 3 |
| **4** | 2 | 4 |
| **5** | 2 | 5 |
| **6** | 2 | 6 |
| **7** | 2 | 7 |
| **8** | 2 | 8 |
| **9** | 2 | 9 |
| **10** | 2 | 10 |
| **11** | 2 | 11 |
| **12** | 2 | 12 |
| **13** | 2 | 13 |
| **14** | 4 | 13 |
| **15** | 4 | 14 |
| **16** | 4 | 15 |
| **17** | 4 | 16 |
| **18** | 4 | 17 |
| **19** | 4 | 18 |
| **20** | 4 | 19 |
| **21** | 4 | 20 |
| **22** | 4 | 21 |

**Table 2: DL MCS table for NB-IOT 16QAM****Proposal: 5-bit MCS should be adopted and Table 2 should be DL MCS table**  |
| [9] | Proposal 7: Increase the Modulation and coding scheme DCI field from 4 to 5 bits |

On the size of the MCS field, there are following options:

* + 4 bits as legacy
		- Huawei, HiSilicon, ZTE (for DL),
	+ 5 bits
		- Nokia, Nokia Shanghai Bell, ZTE (for UL), MediaTek, Sierra Wireless, Ericsson

Based on the majority view, the following is proposed

Proposal 9: The MCS field to support 16QAM is increased from 4bits to 5 bits.

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

## Downlink power allocation to support 16QAM

**Issue 10: Power allocation.**

There are following proposals on power allocation

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | **Proposal 11: The ratio of NPDSCH EPRE to NRS EPRE should be signaled 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**
 |
| [4] | ***Proposal 13: The same total transmit power is set for each OFDM symbol for Rel-17 DL power allocation.******Proposal 14: Only a new higher layer parameter Pn which indicates the ratio of NPDSCH EPRE and NRS EPRE in symbols with NRS needs to be introduced for Rel-17 DL power allocation.*** |
| [5] | ***Proposal 5: Network should semi-statically configure three types of NPDSCH EPRE separately.*** |
| [6] | Proposal 4 The data-to-power ratios for 16-QAM in DL, uses as baseline the DL power control definitions in LTE Stand-alone and Guard-band deployments:- Type A refers to the NPDSCH symbols without NRS: NPDSCH EPRE = NRS EPRE + ρ\_a [dB]- Type B refers to the NPDSCH symbols with NRS: NPDSCH EPRE = NRS EPRE + ρ\_b [dB] In-band deployments:- Type A refers to the NPDSCH symbols without NRS and without CRS: NPDSCH EPRE = NRS EPRE + ρ\_a [dB]- Type B refers to the NPDSCH symbols with NRS and without CRS: NPDSCH EPRE = NRS EPRE + ρ\_b [dB]- Type C refers to the NPDSCH symbols without NRS and with CRS: NPDSCH EPRE = NRS EPRE + ρ\_c [dB]Where:ρ\_a = PA [dB]PB is the index that refers to the linear ratio between ρ\_b and ρ\_aPC is the index that refers to the linear ratio between ρ\_c and ρ\_aFFS: signaling details of ρ\_a, ρ\_b, ρ\_c. or PB, PC. |
| [8] | **Observation 3: In NB-IoT, the power level change of NPDSCH relative to NRS does not have impact on legacy NPDSCH with QPSK. This does not hold anymore with 16-QAM NPDSCH.****Proposal 8: Define three different levels** $ρ\_{A},ρ\_{B},ρ\_{C}$ **of EPRE of NPDSCH with respect to EPRE of NRS:*** $ρ\_{A}$**: Applicable to NPDSCH in symbols with NRS.**
* $ρ\_{B}$**: Applicable to NPDSCH in symbols with CRS (required for in-band NB-IoT only).**
* $ρ\_{C}$**: Applicable to NPDSCH in symbols without NRS and CRS.**

**Proposal 9: RAN1 to decide among the following alternatives:*** **Alt1: Rel-16 NRS power levels are kept (**$ρ\_{A}=ρ\_{C}$**).**
* **Alt2: An additional “power boost” value for NRS is introduced (**$ρ\_{A}\ne ρ\_{C}$**).**

**Proposal 10: The UE derives the values of** $ρ\_{A}$**,** $ρ\_{B}$**,** $ρ\_{C}$ **implicitly based on*** **Power boost value for NRS (if introduced)**
* **NRS and CRS relative power level.**
* **Number of NRS and CRS ports.**
 |

Based on the input, the following is proposed:

Proposal 10: The signal of ration of NPDSCH EPRE to NRS EPRE for following cases explicitly or implicitly are supported.

* **NPDSCH in symbols without NRS and CRS**
* **NPDSCH in symbols with CRS (only for “In-band” deployment)**
* **NPDSCH in symbols with NRS**

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

## Configuration and capability

**Issue 11: capability**

There are following proposals on power allocation

|  |  |
| --- | --- |
| Sourcing | proposals |
| [3] | **Proposal 1: Support of 16-QAM by UE is indicated by UE capability signalling.** |
| [5] | ***Proposal 1: Introduce UE capability signaling for the support of 16QAM for unicast NPDSCH.******Proposal 6: Introduce UE capability signaling for the support of 16QAM for unicast NPUSCH.*** |
| [8] | **Proposal 4: Introduce a unicast RRC parameter to enable 16-QAM for NPDSCH. Introduce an optional UE capability indicating support of DL 16-QAM.****Proposal 11: Introduce a unicast RRC parameter to enable 16-QAM for NPUSCH. Introduce an optional UE capability indicating support of UL 16-QAM.** |

Based on the input, the following is proposed:

Proposal 11: Support of 16QAM of DL and UL are indicated by an optional UE capability signaling separately.

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

**Issue 12: configuration**

There are following proposals on power allocation

|  |  |
| --- | --- |
| Sourcing | proposals |
| [3] | **Proposal 2: 16-QAM feature is configured (e.g. enabled/disabled) via UE-specific RRC signalling.****Proposal 3: Consider separate 16-QAM capability signalling and configuration for UL and DL.** |
| [5] | ***Proposal 4: The configuration of 16QAM for NPDSCH can be enabled/disabled by eNB through RRC signaling.******Proposal 7: The configuration of 16QAM for NPUSCH can be enabled/disabled by eNB through RRC signaling.*** |
| [8] | **Proposal 4: Introduce a unicast RRC parameter to enable 16-QAM for NPDSCH. Introduce an optional UE capability indicating support of DL 16-QAM.****Proposal 11: Introduce a unicast RRC parameter to enable 16-QAM for NPUSCH. Introduce an optional UE capability indicating support of UL 16-QAM.** |

Based on the input, the following is proposed:

Proposal 12: 16QAM for UL and DL are configured by UE-specific RRC signaling separately.

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

## Channel quality reporting

**Issue 13: Channel quality reporting**

There are following proposals on power allocation

|  |  |
| --- | --- |
| Sourcing | proposals |
| [3] | **Proposal 10: Study further channel quality reporting to support 16-QAM in DL.**In the WID, one of the objective is to extend the NB-IoT channel quality reporting based on the framework of Rel-14-16, to support 16-QAM in DL. We see two potential areas here –* Extend the channel quality report to cover the relevant spectral efficiency range for 16-QAM.
* Extend the channel quality report to UE in CONNECTED mode (in addition to Msg3).
 |
| [4] | ***Proposal 15: For Rel-17 channel quality report, the CQI table needs to be discussed in RAN1.*** |
| [6] | **Proposal 5 The CQI reporting definition to support 16-QAM in DL is as in clause 7.2.3 of TS 36.213 for LTE-MTC with the corresponding updates to adapt it to NB-IoT.****Proposal 6 The three unused entries in the legacy CQI mapping Table in clause 9.1.22.15 of TS 36.213 (i.e., Table 9.1.22.15-1) are used for the CQI reporting of 16-QAM in DL.****- The NPDCCH and NPDSCH repetition level is equal to 1.****o candidateRep-M is reported when the SINR is suitable for 16-QAM with ITBS =A/D.**** FFS: A for stand-alone and guard-band deployments, and D for in-band deployments.****o candidateRep-N is reported when the SINR is suitable for 16-QAM with ITBS =B/E.**** FFS: B for stand-alone and guard-band deployments, and E for in-band deployments.****o candidateRep-O is reported when the SINR is suitable for 16-QAM with ITBS =C/F.**** FFS: C for stand-alone and guard-band deployments, and F for in-band deployments.** |
| [10] | **Observation 1:** **In current NB-IoT, the channel quality reporting in Msg3 and** **connected mode are NPDCCH repetition level reporting.****Observation 2:** **For UE in good coverage and hence not needing repetition, the repetition-level based channel quality reporting does not convey sufficiently fine-grained channel quality information.** **Proposal 1: Finer NB-IoT channel quality reporting is supported to provide sufficient channel quality information in good coverage, particularly for 16-QAM.****Proposal 2: Re-purpose the channel quality reporting field in Msg3 and MAC CE to support finer channel quality reporting.** |

As the channel quality report depends on the discussion of max DL TBS, application on repetition etc, the following is proposed:

Observation 1: The channel quality report depends on discussion of DL TBS and needs further discussion.

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

## Others

**Issue 16: Others**

There are also other proposals as below:

|  |  |
| --- | --- |
| Sourcing | proposals |
| [3] | **Proposal 18: 16-QAM can be supported together with DL/UL multi-TB scheduling in unicast.****Proposal 19: 16-QAM can be supported together with PUR.****Proposal 20: 16-QAM is not supported for UL EDT.** |
| [4] | ***Proposal 16: Soft buffer size needs to be specified based on maximum TBS for DL 16QAM.*** |
| [8] | **Proposal 7: Do not introduce LBRM for 16-QAM. The soft buffer size is doubled with respect to QPSK.****Proposal 14: RAN1 to consider adding an additional power control parameter to allow for increased power with 16-QAM (e.g. similar to** $Δ\_{TF}$**)** |

Please input your comments if you think any proposed listed in this section (2.7) or any other issue can be discussed in this meeting:

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
|  |  |
|  |  |

# Summary

# References

1. RP-201306, “WID revision: Additional enhancements for NB-IoT and LTE-MTC”, Huawei, HiSilicon, RAN#88e, E-meeting, June 2020.
2. R1-2007618 Support of 16QAM for unicast in UL and DL in NB-IoT Huawei, HiSilicon
3. R1-2008073 Support of 16-QAM for NB-IoT Nokia, Nokia Shanghai Bell
4. R1-2008697 Discussion on UL and DL 16QAM for NB-IoT ZTE
5. R1-2008920 Support 16QAM for NBIoT Lenovo, Motorola Mobility
6. R1-2008930 Support of 16-QAM for unicast in UL and DL in NB-IoT Ericsson
7. R1-2008969 Further considerations on support of 16QAM for NB-IOT MediaTek Inc.
8. R1-2009112 Support of 16-QAM for NB-IoT Qualcomm Incorporated
9. R1-2009125 Design considerations to support 16-QAM for NB-IOT Sierra Wireless, S.A.
10. R1-2007620 Channel quality reporting in NB-IoT to support 16QAM Huawei, HiSilicon