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

**E-Meeting, August 17 – 28, 2020**

**Agenda Item: 8.9.1**

**Source: Moderator (Huawei)**

**Title: Feature summary on support of 16-QAM for unicast in UL and DL for NB-IoT**

**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]

[102-e-LTE-Rel17\_NB\_IoT\_eMTC-01] Email discussion on support of 16-QAM for unicast in UL and DL for NB-IoT by 8/28 – Yubo (Huawei)

* Prioritize topics to be resolved in RAN1#102-e by 8/19

# Issues

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

There are following options:

* Maximum TBS is 4986 bits with *ISF*=7
	+ ZTE, Nokia, Nokia Shanghai Bell, Ericsson, MTK, Lenovo, Moto,
* Maximum TBS is 5352 bits with *ISF*=7
	+ ZTE,
* Maximum TBS is 5736 bits with *ISF*=7
	+ Huawei, HiSilicon
* New TBS entries with code rate less than 0.85 for all deployment scenarios
	+ Sierra Wireless
* Maximum TBS is 1352 bits with *ISF*=7
	+ Xiaomi
* Maximum TBS is 2x the R16 maximum TBS
	+ Qualcomm

Based on the majority view, the following is proposed:

Proposal : The maximum TBS to support 16-QAM for unicast in DL is 4986 bits with *ISF*=7

Please input your comments in the following table

|  |  |
| --- | --- |
| Companies | Comments |
|  |  |
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Issue 2: The design of TBS to support 16-QAM for unicast in DL.

The following are proposed on the design of TBS:

|  |  |
| --- | --- |
| Sourcing | Proposals |
| [2] |

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

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| [3] |

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

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| [4] |

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

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| [5] | * Increasing the throughput with respect to QPSK by reducing the resource utilization in the time-domain (i.e., the throughput is not only increased through e.g., doubling the max TBS with respect to Rel-16).
* Avoid link adaptation issues, that is:
	+ Avoid large differences in achievable code rates when for a given ITBS, a different number of NSF is allocated
	+ Avoid large differences in achievable code rates when passing from QPSK to 16-QAM and vice versa (i.e., At 10% BLER, the SINR gap between QPSK and 16-QAM is no larger than ⁓ 3dB).
* Use a single TBS Table including TBS entries for both QPSK and 16-QAM
	+ In-band deployment is a subcase of the stand-alone and guard-band deployments unless a performance issue were found.

Standalone and gurad-band

|  |  |  |
| --- | --- | --- |
| 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 | 144 | 328 | 504 | 680 | 872 | 1032 | 1384 | 1736 |
| 10 | 176 | 376 | 584 | 776 | 1000 | 1192 | 1608 | 2024 |
| 11 | 224 | 488 | 744 | 1032 | 1256 | 1544 | 2024 | 2536 |
| 16-QAM only | 12 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 |
| 13 | 344 | 744 | 1128 | 1544 | 1928 | 2280 | 3112 | 3880 |
| 14 | 424 | 872 | 1352 | 1736 | 2280 | 2536 | 3496 | 4264 |
| 15 | 488 | 1000 | 1544 | 2024 | 2536 | 3112 | 4008 | 4968 |

Inband

|  |  |  |
| --- | --- | --- |
| Modulation Scheme |  | Number of NPDSCH Subframes (NSF) |
| 1 | 2 | 3 | 4 | 5 | 6 | 8 | 10 |
| QPSK only | 0 | 0.13 | 0.09 | 0.09 | 0.09 | 0.09 | 0.1 | 0.1 | 0.09 |
| 1 | 0.16 | 0.13 | 0.12 | 0.14 | 0.13 | 0.13 | 0.12 | 0.12 |
| 2 | 0.18 | 0.16 | 0.18 | 0.16 | 0.15 | 0.15 | 0.14 | 0.15 |
| 3 | 0.21 | 0.21 | 0.22 | 0.19 | 0.18 | 0.19 | 0.19 | 0.19 |
| 4 | 0.26 | 0.24 | 0.25 | 0.23 | 0.23 | 0.24 | 0.24 | 0.23 |
| 5 | 0.32 | 0.28 | 0.27 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 |
| 6 | 0.37 | 0.33 | 0.31 | 0.34 | 0.35 | 0.34 | 0.34 | 0.35 |
| 7 | 0.42 | 0.41 | 0.39 | 0.41 | 0.4 | 0.39 | 0.41 | 0.41 |
| 8 | 0.47 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.45 |
| 9 | 0.55 | 0.58 | 0.58 | 0.58 | 0.59 | 0.58 | 0.58 | 0.58 |
| 10 | 0.66 | 0.66 | 0.67 | 0.66 | 0.67 | 0.67 | 0.67 | 0.67 |
| 11 | 0.82 | 0.84 | 0.84 | 0.87 | 0.84 | 0.86 | 0.84 | 0.84 |
| 16-QAM only | 12 | 0.50 | 0.51 | 0.51 | 0.51 | 0.52 | 0.50 | 0.51 | 0.52 |
| 13 | 0.61 | 0.63 | 0.63 | 0.64 | 0.64 | 0.63 | 0.64 | 0.64 |
| 14 | 0.74 | 0.74 | 0.75 | 0.72 | 0.76 | 0.70 | 0.72 | 0.71 |
| 15 | 0.84 | 0.84 | 0.86 | 0.84 | 0.84 | 0.86 | 0.83 | 0.82 |

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| [6] |

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| 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 |

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| [7] |

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

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| [8] | Proposal 1: New TBS entries shall have a code rate of <=0.85 for all deployment scenarios (i.e. in-band, guard band, stand-alone)Proposal 2: To support 16-QAM and higher TBS, • The current values in the TBS table are kept• Add more columns with new TBS entries. FFS: number of columns and values.• For ITBS => 9, 16-QAM is used. |
| [9] |

|  |  |
| --- | --- |
|  |  |
| 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~~1352  | ~~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~~1352 | ~~1736~~ | ~~2280~~ | ~~2600~~ |
| 15 | 280 | 600 | 904 | 1224 | ~~1544~~ | ~~1800~~ | ~~2472~~ | ~~2728~~ |
| 16 | 328 | 632 | 968 | 1288 | ~~1608~~ | ~~1928~~ | ~~2600~~ | ~~2984~~ |
| 17 | 336 | 680 | 1064 | ~~1416~~1352 | ~~1800~~ | ~~2152~~ | ~~2856~~ | ~~3240~~ |
| 18 | 376 | 776 | 1160 | ~~1544~~ | ~~1992~~ | ~~2344~~ | ~~3112~~ | ~~3624~~ |
| 19 | 408 | 840 | 1288 | ~~1736~~ | ~~2152~~ | ~~2600~~ | ~~3496~~ | ~~3880~~ |

 |
| [10] | **Proposal 1: The maximum TBS for DL 16-QAM is 2x the Rel-16 maximum TBS.** |

As the design of TBS table depends on the maximum TBS value, thus it is proposed:

Observation : The design of TBS table is discussed after the maximum TBS is agreed.

Please input your comments in the following table

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

Issue 3: Scheduling of TBS and modulation to support 16-QAM for unicast in DL.

The following are proposed on scheduling of TBS and modulation:

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | Proposal 5: The introduction of 16-QAM shall not increase the NPDCCH blind decodes.Proposal 6: The introduction of 16-QAM shall avoid increasing DCI size. |
| [3] | ***Proposal 2: New MCS table should be defined for DL 16QAM.**** ***Alt 1: 4-bit MCS table***
* ***Alt 2: 5-bit MCS table***
 |
| [4] | **Proposal 6: The size of the MCS field in DCI N1 in UE-specific search space is increased to 5 bits.** |
| [5] | Standalone and gurad-band

|  |  |  |
| --- | --- | --- |
| 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 | 144 | 328 | 504 | 680 | 872 | 1032 | 1384 | 1736 |
| 10 | 176 | 376 | 584 | 776 | 1000 | 1192 | 1608 | 2024 |
| 11 | 224 | 488 | 744 | 1032 | 1256 | 1544 | 2024 | 2536 |
| 16-QAM only | 12 | 280 | 600 | 904 | 1224 | 1544 | 1800 | 2472 | 3112 |
| 13 | 344 | 744 | 1128 | 1544 | 1928 | 2280 | 3112 | 3880 |
| 14 | 424 | 872 | 1352 | 1736 | 2280 | 2536 | 3496 | 4264 |
| 15 | 488 | 1000 | 1544 | 2024 | 2536 | 3112 | 4008 | 4968 |

Inband

|  |  |  |
| --- | --- | --- |
| Modulation Scheme |  | Number of NPDSCH Subframes (NSF) |
| 1 | 2 | 3 | 4 | 5 | 6 | 8 | 10 |
| QPSK only | 0 | 0.13 | 0.09 | 0.09 | 0.09 | 0.09 | 0.1 | 0.1 | 0.09 |
| 1 | 0.16 | 0.13 | 0.12 | 0.14 | 0.13 | 0.13 | 0.12 | 0.12 |
| 2 | 0.18 | 0.16 | 0.18 | 0.16 | 0.15 | 0.15 | 0.14 | 0.15 |
| 3 | 0.21 | 0.21 | 0.22 | 0.19 | 0.18 | 0.19 | 0.19 | 0.19 |
| 4 | 0.26 | 0.24 | 0.25 | 0.23 | 0.23 | 0.24 | 0.24 | 0.23 |
| 5 | 0.32 | 0.28 | 0.27 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 |
| 6 | 0.37 | 0.33 | 0.31 | 0.34 | 0.35 | 0.34 | 0.34 | 0.35 |
| 7 | 0.42 | 0.41 | 0.39 | 0.41 | 0.4 | 0.39 | 0.41 | 0.41 |
| 8 | 0.47 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.45 |
| 9 | 0.55 | 0.58 | 0.58 | 0.58 | 0.59 | 0.58 | 0.58 | 0.58 |
| 10 | 0.66 | 0.66 | 0.67 | 0.66 | 0.67 | 0.67 | 0.67 | 0.67 |
| 11 | 0.82 | 0.84 | 0.84 | 0.87 | 0.84 | 0.86 | 0.84 | 0.84 |
| 16-QAM only | 12 | 0.50 | 0.51 | 0.51 | 0.51 | 0.52 | 0.50 | 0.51 | 0.52 |
| 13 | 0.61 | 0.63 | 0.63 | 0.64 | 0.64 | 0.63 | 0.64 | 0.64 |
| 14 | 0.74 | 0.74 | 0.75 | 0.72 | 0.76 | 0.70 | 0.72 | 0.71 |
| 15 | 0.84 | 0.84 | 0.86 | 0.84 | 0.84 | 0.86 | 0.83 | 0.82 |

 |
| [6] |

|  |  |  |
| --- | --- | --- |
| MCS Index | Modulation Order | TBS Index |
| 14 | 4 | 14 |
| 15 | 4 | 15 |
| 16 | 4 | 16 |
| 17 | 4 | 17 |
| 18 | 4 | 18 |
| 19 | 4 | 19 |
| 20 | 4 | 20 |
| 21 | 4 | 21 |

 |
| [7] |

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

***Proposal 2: To support 16QAM of NPDSCH, the MCS field in DCI format N1 is enlarged or reinterpreted, which needs further discussion.*** |
| [8] | Proposal 2: To support 16-QAM and higher TBS, • The current values in the TBS table are kept• Add more columns with new TBS entries. FFS: number of columns and values.• For ITBS => 9, 16-QAM is used. |
| [9] | **Proposal 2:** * **Redesign the mapping relationship between MCS index and TBS index to keep no increase in the MCS field in DCI**
* **Further discuss the detailed mapping schemes for TBS index, MCS index and modulation order.**
 |
| [10] | **Observation 1: The optimum *breakpoint* between different modulation schemes depends on the assumed overhead.****Proposal 2: Different deployment modes (from guardband/standalone to in-band with 4 CRS ports) should be evaluated when defining the mechanism for modulation/TBS determination.** **Proposal 3: RAN1 to study the benefits of defining different MCS/TBS tables for downlink 16-QAM in different deployment modes.****Proposal 4: RAN1 to discuss whether to introduce one or more “implicit MCS” entries for retransmissions in the MCS table for DL 16-QAM.** |

From the inputs, the following is proposed for further discussion:

Proposal : further study on the scheduling of TBS and modulation to support 16QAM:

* **MCS field size: [4, 5] bits**
* **The break point between different modulation schemes**
* **Impacts of deployment modes**
* **Indication of modulation scheme for retransmissions**

Please input your comments in the following table

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

Issue 4: The TBS design to support 16-QAM for unicast in UL.

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

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | Proposal 2: For 16-QAM, the UL maximum TBS with 2536 bits can be mapped to at least 5 RUs.

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

 |
| [3] | ***Proposal 5: UL 16QAM is supported only for multi-tone transmission.*** |
| [4] |

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

 |
| [5] | Proposal 2 The design targets to introduce 16-QAM for NB-IoT in UL include:• Increasing the throughput with respect to QPSK by reducing the resource utilization in the time-domain.• Avoid link adaptation issues, that is:o Avoid large differences in achievable code rates when for a given ITBS, a different number of RUs is allocated.o Avoid large differences in achievable code rates when passing from QPSK to 16-QAM and vice versa (i.e., At 10% BLER, the SINR gap between QPSK and 16-QAM is no larger than ⁓ 3dB).• Use a single TBS Table including TBS entries for both QPSK and 16-QAM. |
| [6] | Proposal 1 Adding TBS index ITBS 14 to ITBS 21 in NB-iot TBS table, DL maximum TBS should be extended to 4968 bits. UL maximum TBS should be extended to 4968 bits to get 310.5kbps UL data rate. |
| [7] |

|  |  |
| --- | --- |
|  |  |
| 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 |  |  |
| 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 7: 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.***
 |

Based on the inputs, the following can be proposed:

Proposal 3: RAN1 to down-select from the following options to support 16-QAM for unicast in UL.

* Option 1:

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

* Option 2:

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

* Option 3:

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

Please input your comments in the following table

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

Issue 5: Scheduling of TBS and modulation to support 16-QAM for unicast in UL.

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

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | Proposal 5: The introduction of 16-QAM shall not increase the NPDCCH blind decodes.Proposal 6: The introduction of 16-QAM shall avoid increasing DCI size. |
| [3] | ***Proposal 5: UL 16QAM is supported only for multi-tone transmission.******Proposal 6: 4-bit MCS table should be baseline for UL 16QAM.***Table 8.6.1-2: Modulation and TBS index table for PUSCH

|  |  |  |
| --- | --- | --- |
| 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** | 4 | 10 |
| **12** | 4 | 11 |
| **13** | 4 | 12 |
| **14** | 4 | 13 |
| **15** | 4 | 14 |

 |
| [4] | **Proposal 11: The size of the MCS field in DCI N0 in UE-specific search space is increased to 5 bits.****Proposal 12: 16-QAM is not supported for sub-PRB allocation.** |
| [5] | Proposal 2 The design targets to introduce 16-QAM for NB-IoT in UL include:• Increasing the throughput with respect to QPSK by reducing the resource utilization in the time-domain.• Avoid link adaptation issues, that is:o Avoid large differences in achievable code rates when for a given ITBS, a different number of RUs is allocated.o Avoid large differences in achievable code rates when passing from QPSK to 16-QAM and vice versa (i.e., At 10% BLER, the SINR gap between QPSK and 16-QAM is no larger than ⁓ 3dB).• Use a single TBS Table including TBS entries for both QPSK and 16-QAM. |
| [7] | ***Proposal 7: 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.***
 |
| [10] | **Proposal 11: RAN1 to discuss whether to introduce one or more “implicit MCS” for retransmissions in the MCS table for UL 16-QAM.****Proposal 15: UL 16-QAM is applicable at least to NPUSCH with full-PRB allocations. FFS NPUSCH with sub-PRB allocations.** |

Based on the input, the following is proposed:

Proposal : further study on the scheduling of TBS and modulation to support 16QAM:

* **MCS field size: [4, 5] bits**
* **The break point between different modulation schemes**
* **Indication of modulation scheme for retransmissions**
* **Single-tone/multi-tone**

Please input your comments in the following table

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

Issue 6: Power allocation.

There are following proposals on power allocation

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | Proposal 7: Signal the ratio of NPDSCH EPRE to NRS EPRE for 16-QAM. FFS the detailed signaling.Proposal 8: For 16-QAM, FFS whether or not the PDSCH EPRE is the same in OFDM symbols containing NRS and not containing NRS. |
| [3] | ***Proposal 3: UE-specific DL power allocation between NPDSCH and NRS can be supported to handle different modulation modes.*** |
| [4] | **Proposal 7: Discuss whether the ratio of NPDSCH EPRE to NRS EPRE for 16-QAM should be different than legacy and whether UE-specific signaling is needed.** |
| [7] | ***Proposal 4: Network should semi-statically configure three types of NPDSCH EPRE separately.**** Type A OFDM: without NRS or CRS, symbol (1),2,4
* Type B OFDM: with NRS, symbol 5,6
* Type C OFDM: with CRS, symbol 0,(1),3
 |
| [10] | **Observation 2: 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 9: 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.**
 |

Based on the input, the following is proposed:

Proposal : The signal of ration of NPDSCH EPRE to NRS EPRE is supported. FFS the details signaling and following cases

* **NPDSCH in symbols without NRS and CRS**
* **NPDSCH in symbols with CRS and without NRS**
* **NPDSCH in symbols without CRS and with NRS**

Please input your comments in the following table

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

Issue 7: Evaluation assumptions.

There are following proposals on evaluation assumptions:

|  |  |
| --- | --- |
| Sourcing | proposals |
| [2] | Table 5: Simulation assumptions for DL

|  |  |
| --- | --- |
| **Parameter** | **Value/Description** |
| Operation mode for DL | Stand-alone |
| Number of antennas | 1T1R |
| Channel model  | AWGN |
| Frequency Resource | 1 PRB |
| Number of repetitions | 1 |
| Number of subframes | 5 |
| Modulation Order | QPSK, 16-QAM |
| Noise Estimation | Ideal |
| Channel Estimation | Ideal |
| Frequency Offset | 0 |
| Time Offset | 0 |

Table 6: Simulation assumptions for UL

|  |  |
| --- | --- |
| **Parameter** | **Value/Description** |
| Number of antennas | 1T2R |
| Channel model  | AWGN |
| Frequency Resource | 12-tone |
| Number of repetitions | 1 |
| Number of RUs | 5 |
| Modulation Order | QPSK, 16-QAM |
| Noise Estimation | Ideal |
| Channel Estimation | Ideal |
| Frequency Offset | 0 |
| Time Offset | 0 |

 |
| [5] |

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Propagation conditions | AWGN, ETU |
| Fading | Rayleigh, 1 Hz Doppler spread |
| Raster offset | Stand-alone: 0Hz; in-band and guard-band: 7.5 kHz |
| Device antenna configuration | One transmit antenna and one receive antenna |
| Base station antenna configuration | Stand-alone, guard-band, and in-band: Two transmit antennas and two receive antennas |
| MCL | ≤ 144 dB |
| Number of NPDCCH/NPDSCH REs per subframe | Stand-alone and guard-band: 152, In-band: 104 |
| Resource Bandwidth | DL: 1 PRB | UL: 1 PRB, optional 3, 6 tones. |
| Number of repetitions | DL(NPDCCH/NPDSCH): 1 | UL(NPDCCH/NPUSCH): 1 |
| Number of HARQ processes | Up to 2 (Cat N2) |
| Max number of retransmissions | Up to 4 |
| Coding Method | DL: Convolutional coding | UL: Turbo coding |
| Channel Estimation | Ideal, Realistic |
| 16-QAM modulation | Gray coded QAM |
| Valid NB-IoT subframes | All subframes not carrying NPBCH, NPSS, and NSSS are assumed valid subframes. |

 |
|  |  |
|  |  |

As evaluation would be needed for further discussion such as MCS, it is proposed that:

Proposal : RAN1 to discuss and agree on the evaluation assumptions for support of 16QAM in DL and UL for NB-IoT.

Please input your comments in the following table

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

Issue 8: Others

If you have other issues that should be prioritized in this meeting, please input in the following table:

|  |  |
| --- | --- |
| Sourcing | proposals |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# Summary

# References

1. RP-201306, “WID revision: Additional enhancements for NB-IoT and LTE-MTC”, Huawei, HiSilicon, RAN#88e, E-meeting, June 2020.
2. R1-2005304 Support of 16QAM for unicast in UL and DL in NB-IoT Huawei, HiSilicon
3. R1-2005479 Discussion on UL and DL 16QAM for NB-IoT ZTE
4. R1-2005529 Support of 16-QAM for NB-IoT Nokia, Nokia Shanghai Bell
5. R1-2005557 Support of 16-QAM for unicast in UL and DL in NB-IoT Ericsson
6. R1-2005648 Considerations on support of 16QAM for NB-IOT MediaTek Inc.
7. R1-2005837 Support 16QAM for NBIoT Lenovo, Motorola Mobility
8. R1-2005941 Design consideration to support 16-QAM for NB-IOT Sierra Wireless, S.A.
9. R1-2005974 Initial discussion on support of 16 QAM for NB-IoT Beijing Xiaomi Software Tech
10. R1-2006192 Support of 16-QAM for NB-IoT Qualcomm Incorporated