**3GPP TSG RAN WG1 #108-e R1-2nnnnn**

**e-Meeting, February 21st – March 3rd, 2022**

**Agenda Item: 8.16.16**

**Source: Moderator (AT&T)**

**Title: Summary of UE features for DL 1024QAM for NR FR1**

**Document for:** **Discussion/Decision**

# Introduction

This document presents the summary of email discussion/approval [108-e-R17-UE-features-1024QAM-01] during RAN1 #108-e. According to the Chairman’s Notes:

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| [108-e-R17-UE-features-1024QAM-01] Email discussion on UE features for DL 1024QAM for NR FR1 – Ralf (AT&T)   * 1st check point: February 25 * Final check point: March 3 |

The following was discussed and/or agreed during RAN1 #108-e within the scope of [108-e-R17-UE-features-1024QAM-01]. All proposals are based on the latest RAN1 UE features list for Rel-17 NR in [1].

# Summary of Contributions Submitted to RAN1 #108-e

The following is the moderator’s summary of contributions submitted to RAN1 #108-e in this agenda item.

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| 36. NR\_DL1024QAM\_FR1 | 36-1 | 1024QAM for PDSCH for FR1 | Support 1024QAM for PDSCH for FR1 including 1024QAM modulation scheme as defined in TS 38.211, MCS and CQI feedback tables based on 1024QAM modulation order as defined in TS 38.214. | pdsch-256QAM-FR1 | Yes | N/A | No support of 1024 QAM for PDSCH | Per Band | N/A | Applicable only to FR1 | N/A | Note from WI objective: DL PDSCH 1024QAM for FR1 should be defined as a per-band UE capability | Optional with capability signalling |
| 36. NR\_DL1024QAM\_FR1 | 36-2 | scalingFactor for 1024QAM | Indicates the scaling factor to be applied to the band in the max data rate calculation as defined in 4.1.2 when support of 1024-QAM is signalled for the band | 36-1 | Yes | N/A |  | Per FS | N/A | Applicable only to FR1 | N/A | Candidate component values:  {0.4, 0.75, 0.8, 1.0} | Optional with capability signaling |

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| Company | Summary |
| Ericsson [2] | Two FGs 36-1 (1024-QAM on DL for FR1) and 36-2 (data rate scaling factor for 1024-QAM) were agreed for support of 1024-QAM. The data rate section (from 38.306) needs to reflect new FG for 1024-QAM scaling factor, and the corresponding value utilized for the parameter supportedModulationOrderDL.  Regarding introducing a new capability for *supportedModulationOrderDL-r17 for* 1024QAM (especially as per FSPC),we are not supportive since it is unnecessary (leading to extremely low data rates with 1024-QAM support, (e.g. when supportedModulationOrderDL = pi/2-BPSK, scalingFactor = 0.4)) given the scaling factor FG 36-2 is enough for indicating lower data rate. Moreover per-FSPC signaling leads to large signaling overhead.  Nonetheless, *supportedModulationOrderDL* needs to be definedfor 1024-QAM data rate calculation. For this out of below two options, we prefer Option 1.  Option 1 : Define supportedModulationDL = 1024QAM for the case of 1024QAM indication for a band.  Option 2 : Update the field description for existing capability supportedModulationOrderDL as shown below, allowing applying the existing UE reported parameter value (supportedModulationOrderDL) with 1024-QAM scaling factor (in which case the existing parameter description must be updated to allow it to take the value of 1024-QAM).   | ***supportedModulationOrderDL***  Indicates the maximum supported modulation order to be applied for downlink in the carrier in the max data rate calculation as defined in 4.1.2. If included, the network may use a modulation order on this serving cell which is higher than the value indicated in this field as long as UE supports the modulation of higher value for downlink. If not included:  - for FR1, the network uses the modulation order signalled per band i.e. [pdsch-1024QAM-FR1] when [pdsch-1024QAM-FR1] is signalled for the band , otherwise the network uses the modulation order signalled in *pdsch-256QAM-FR1*.  - for FR2, the network uses the modulation order signalled per band i.e. *pdsch-256QAM-FR2* if signalled. If not signalled in a given band, the network shall use the modulation order 64QAM.  In all the cases, it shall be ensured that the data rate does not exceed the max data rate (*DataRate*) and max data rate per CC (*DataRateCC*) according to TS 38.214 [12]. | FSPC | No | N/A | N/A | | --- | --- | --- | --- | --- |   In either case, the main point is that since the UE signals both 1024-QAM and 256-QAM, the data rate calculation for 1024-QAM case is based on the 1024-QAM scaling factor and the 1024-QAM modulation order (i.e. supportedModulationOrderDL = 1024-QAM), and for the case of 256-QAM, it would be based on the legacy scaling factor, legacy modulation order (supportedModulationOrderDL).   1. Adopt below updates for UE FGs for support of 1024-QAM (red text highlights the relative change on top of the agreed FG table). 2. When UE indicates 1024QAM support for a band, supportedModulationDL is set to 1024QAM, and is not explicitly indicated by the UE.  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | 36. NR\_DL1024QAM\_FR1 | 36-2 | scalingFactor for 1024QAM | Indicates the scaling factor to be applied to the band in the max data rate calculation as defined in 4.1.2 when support of 1024-QAM is signalled for the band | 36-1 | Yes | N/A |  | Per FS | N/A | Applicable only to FR1 | N/A | Candidate component values:  {0.4, 0.75, 0.8, 1.0}  If absent, the scaling factor 1 is applied to the band in the max data rate calculation. | Optional with capability signaling | |

# Discussion/Approval Items during RAN1 #108-e — First Checkpoint

After review of contributions submitted to RAN1 #108-e in this agenda item, the following topics were identified by the moderator for discussion/approval during RAN1 #108-e.

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG 36-2

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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| 36. NR\_DL1024QAM\_FR1 | 36-2 | scalingFactor for 1024QAM | Indicates the scaling factor to be applied to the band in the max data rate calculation as defined in 4.1.2 when support of 1024-QAM is signalled for the band | 36-1 | Yes | N/A |  | Per FS | N/A | Applicable only to FR1 | N/A | Candidate component values:  {0.4, 0.75, 0.8, 1.0}  If absent, the scaling factor 1 is applied to the band in the max data rate calculation. | Optional with capability signaling |

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| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | We support the proposal to add the note. |
| ZTE, Sanechips | Okay to add the note |
| Ericsson | Support. |
| Qualcomm | Support the added note. |

# Issue 2: supportedModulationDL

After review of contributions submitted to RAN1 #108-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: When UE indicates 1024QAM support for a band, supportedModulationDL is set to 1024QAM, and is not explicitly indicated by the UE**

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| Company | Comments/Questions/Suggestions |
| NTT DOCOMO | We are fine with the proposal (Option 1 in [2]) or Option 2 in [2]. |
| ZTE, Sanechips | Option 2 is preferred. |
| Ericsson | Support the FL proposal.  Regarding option 2 in [2], we do not prefer it since it unnecessarily leads to extremely low data rates with 1024-QAM support. For example, UE indicates 1024-QAM support but indicates supportedModulationOrderDL = pi/2-BPSK, scalingFactor = 0.4. |
| Qualcomm | Support option 2, i.e., update the field description for existing capability supportedModulationOrderDL in similar way as FR2 256-QAM is described. |

# Discussion/Approval Items during RAN1 #108-e — Second Checkpoint

Based on the comments/questions/suggestions received by the first checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 3 will not be considered]***

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Discussion/Approval Items during RAN1 #108-e — Third Checkpoint

Based on the comments/questions/suggestions received by the second checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 4 will not be considered]***

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Summary of Final Proposals for Agreements

This Section summarizes the final proposals for agreement in RAN1 #108-e by email. There are no tables for comments.

***[All comments must be directly made on the RAN1 email reflector]***

Companies can continue to update their comments in the previous Sections, however, these are no longer monitored by the moderator. Any such comments will be for archival purposes only and will not influence the outcome of this email discussion. Any objection to any of the proposals in this Section must be voiced directly on the RAN1 email reflector.

**Possible Agreement: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Conclusion

After further discussion on the RAN1 email reflector the following was agreed as part of this email discussion:

# References

1. R1-2200780, Updated RAN1 UE features list for Rel-17 NR after RAN1 #107bis-e, Moderators (AT&T, NTT DOCOMO, INC.)
2. R1-2202226, UE features for DL 1024-QAM, Ericsson