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

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

**Agenda Item: 8.3.1.2**

**Source: Moderator (InterDigital, Inc.)**

**Title: [Draft] Feature lead summary #2 on CSI feedback enhancements for enhanced URLLC/IIoT**

**Document for: Discussion and Decision**

# Introduction

This contribution is a summary of contributions [2]-[18] submitted under AI 8.3.1.2 (CSI feedback enhancements) The AI is related to the following objective of the revised work item on Enhanced IIoT and URLLC support for NR [1]:

|  |
| --- |
| 1. Study, identify and specify if needed, required Physical Layer feedback enhancements for meeting URLLC requirements covering
	* + UE feedback enhancements for HARQ-ACK [RAN1]
		+ CSI feedback enhancements to allow for more accurate MCS selection [RAN1]

Note: DMRS-based CSI feedback is not in scope of this WI  |

In RAN1#106-e, RAN1 agreed to the following:

|  |
| --- |
| **Agreement**For subband CQI reporting with more than 2 bits per subband* Support 4-bits CQI only

**Agreement**For subband CQI reporting in Rel-17, RRC can configure use of legacy 2-bits D-CQI or 4-bits CQI for each CSI report configuration.* This feature is subject to UE capability
* FFS: Whether wideband CQI report can be omitted
 |

Here is the color code used in this summary:

* FL’s proposals
* Questions for the inputs from companies
* FL summary based on the companies’ input
* RAN1 agreements

# Collection of agreements/conclusion in RAN1 #106-e

To be captured once agreement is made during this meeting

# Proposals for 1st check point

TBD

# Proposals for 2nd check point

TBD

# Proposals for 3rd check point

TBD

# Proposals for 4th check point

TBD

# Topic #1: 4-bits CQI

In this section, we provide summary of contributions discussing candidate enhancement schemes involving 4-bits CQI.

## Summary of issues for Topic #1

Most contributions discuss whether to include the wideband CQI report in case of 4-bits subband CQI reporting.

**Issue #1-1: Include wideband CQI report in 4-bits subband CQI report?**

Included: Huawei [2], Ericsson [3], ZTE [4], Vivo [5], Oppo [6], Quectel [8], CMCC [9], NTT DoCoMo [11], Sony [13], Lenovo [14], LG [15], Apple [16]

* WB-CQI still useful when there are not sufficient UCI resources available to carry full payload [2]
* 2-bits D-CQI should be used instead if overhead saving is important [2]
* WB-CQI and SB-CQI may assume different TB sizes, UE-implementation dependent [3]
* WB-CQI still needed for subbands not part of csi-ReportingBand [5][6][8][11][13][14]
* Overhead not an issue if all subbands are part of csi-ReportingBand [5][11][13]
* Minimize spec impact, avoid change to CSI reporting structure [2][4][5][9][11]
* WB-CQI and SB-CQI may be conditioned on different precoders [3], WB-CQI is based on wideband PMI [4][8][11][18]
* Extra RRC parameter may be needed [9]
* Higher UE/gNB implementation effort to decide whether to calculate/report or calculate WB-CQI [9][15]
* Overhead does not need to be optimized for industry automation scenario [9]
* Difficult to recover WB-CQI from SB-CQI if assumed quantizers are not same [16]

Omitted: CATT [7], InterDigital [12]

* Saves overhead [7] may be significant for small number of subbands [12]
* Separate WB-CQI can be configured separately if needed [7]
* WB-CQI is already conditioned on subband PMI. When subband PMI is configured, WB-PMI is not reported. [12]
* WB-CQI already only covers subbands that are part of csi-ReportingBand [12]

Reinterpreted to indicate more information: Intel [10]

* Indicates either minimum SINR/SE among subbands or CQI offset [10]

**Issue #1-2: Extend SINR range supported by CQI tables?**

Yes: Intel [10]

* Very low SINR information is beneficial for URLLC/IIoT [10]

No: InterDigital [12], Sony [13], Nokia [18]

* gNB can predict low values from variance of reports [12]
* CQI less than 1 may not offer reliable DL [13]

**Other proposals related to 4-bits subband CQI**

1. Proposed changes to 38.212, 38.214 to support 4-bits CQI are suggested by Ericsson [3].
	1. In moderator’s understanding, this input could be utilized by the editors of corresponding specifications when drafting CR’s.
2. 4-bits subband CQI is applicable for all the existing CQI tables [11]
	1. This may not require making additional agreement as it would apply by default.
3. 4-bits subband CQI is applicable to all subbands selected within csi-ReportingBand [12]
	1. This may not require making additional agreement as it would apply by default.
4. Network can configure 4-bits or 2-bits CQI on a per-CSI report basis [16]
	1. In moderator’s understanding, this is already agreed.
5. UE chooses between 2-bits D-CQI and 4-bits CQI and includes size in CSI part 1 [15]
6. Discuss priority between 2-bits and 4-bits [15]
7. (If WB-CQI omission is supported), UE requests and gNB confirms [8]

**Observations on 4-bits subband CQI report.**

On the issue of whether to include or omit the wideband CQI report in a 4-bits subband CQI report, 12 companies prefer to include it, 2 companies prefer to not include it and 1 company proposes to re-interpret it to indicate more information.

The main concerns about omitting WB-CQI are that it would have impact on CSI report structure and specification and that it may not be possible or easy to recalculate it from the individual subband CQI’s. Many companies also think that the benefit is small (4 bits reduction) and may not be relevant in scenarios where 4 bits CQI would need to be configured.

About the concern about difficulty of inferring WB-CQI from the SB-CQI, it may be worth that the group converges on a common understanding on the R15 behaviour to ensure that RAN1 takes the agreement based on the right considerations:

* Several companies seem to have the understanding that when subband PMI is configured, WB-CQI is conditioned on a WB-PMI while SB-CQI is conditioned on SB-PMI. However, this seems not supported by the specifications (e.g. TS38.214 section 5.2.1.4 copied below, as well as TS38.212 Table 6.3.1.1.2-10) which indicate that only the i1 portion of the PMI is reported with wideband granularity in that case. The full PMI combining i1 and i2 and is only available with subband granularity which implies that WB-CQI is calculated conditioned on the SB-PMI on each subband just as SB-CQI. This behaviour is also consistent with LTE. When wideband PMI is configured, both WB-CQI and SB-CQI are conditioned on the same wideband PMI so that the precoder assumption is the same in that case also.
* Several companies seem to have the understanding that W-CQI is calculated for the whole bandwidth part such that it provides additional information when csi-ReportingBand configures the CSI reporting band as a subset of subbands. However, the specification indicate that the W-CQI is calculated for the entire CSI reporting band, not the whole bandwidth part.

|  |
| --- |
| [38.214] 5.2.1.4 Reporting configurations[…]The *reportFreqConfiguration* contained in a *CSI-ReportConfig* indicates the frequency granularity of the CSI Report. A CSI Reporting Setting configuration defines a CSI reporting band as a subset of subbands of the bandwidth part, where the *reportFreqConfiguration* indicates: - the *csi-ReportingBand* as a contiguous or non-contiguous subset of subbands in the bandwidth part for which CSI shall be reported. - A UE is not expected to be configured with *csi-ReportingBand* which contains a subband where a CSI-RS resource linked to the CSI Report setting has the frequency density of each CSI-RS port per PRB in the subband less than the configured density of the CSI-RS resource.- If a CSI-IM resource is linked to the CSI Report Setting, a UE is not expected to be configured with *csi-ReportingBand* which contains a subband where not all PRBs in the subband have the CSI-IM REs present.- wideband CQI or subband CQI reporting, as configured by the higher layer parameter *cqi-FormatIndicator*. When wideband CQI reporting is configured, a wideband CQI is reported for each codeword for the entire CSI reporting band. When subband CQI reporting is configured, one CQI for each codeword is reported for each subband in the CSI reporting band.- wideband PMI or subband PMI reporting as configured by the higher layer parameter *pmi-FormatIndicator*. When wideband PMI reporting is configured, a wideband PMI is reported for the entire CSI reporting band. When subband PMI reporting is configured, except with 2 antenna ports, a single wideband indication (*i1* in Clause 5.2.2.2) is reported for the entire CSI reporting band and one subband indication (*i2* in clause 5.2.2.2) is reported for each subband in the CSI reporting band. When subband PMIs are configured with 2 antenna ports, a PMI is reported for each subband in the CSI reporting band.  |

On the issue of whether to extend SINR range supported by CQI tables, one company supports this and three companies think this is not needed. Based on this, there seems to be little chance of agreement and moderator suggests to not discuss this any further.

The following FL proposal corresponds to preference of a majority of companies from contributions:

**FL proposal 7.1-1:**

**When subband CQI reporting is configured with 4-bits per subband, UE includes wideband CQI in report.**

## E-mail discussion (1st round) for Topic #1

**Question 1-1**: Please provide feedback if you would like to either (a) make correction in this moderator summary about your position (Topic #1) or (b) add your company position

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
|  |  |  |
|  |  |  |
|  |  |  |

**Question 1-2**: Please indicate if you agree with moderator’s understanding in the above, and (if yes) if it should impact the decision (or not) on whether to omit WB-CQI.

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Ericsson |  | We have the view that “WB-CQI is conditioned on a WB-PMI while SB-CQI is conditioned on SB-PMI”. We disagree with FL that this is not supported in spec. In general, there are many different configurations of wideband/subband PMI/CQI. The question here seems to refer to the configuration {*pmi-FormatIndicator=* *subbandPMI* or *cqi-FormatIndicator=subbandCQI* }. According to 38.212 tables below, when{ *pmi-FormatIndicator=* *subbandPMI* or *cqi-FormatIndicator=subbandCQI* }, wideband PMI and wideband CQI are also reported. According to 38.214 Table 5.2.3-1, these wideband CSI has higher priority (priority 0) than subband CSI (priority >=1). This indicates that wideband CQI is conditioned on wideband PMI.38.212,Table 6.3.1.1.2-10: Mapping order of CSI fields of one CSI report, CSI part 2 wideband, *pmi-FormatIndicator=* *subbandPMI* or *cqi-FormatIndicator=subbandCQI*

|  |  |
| --- | --- |
| CSI report number | CSI fields |
| CSI report #nCSI part 2 wideband | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3/4/5, if present and reported |
| Layer Indicator as in Tables 6.3.1.1.2-3/4/5, if reported |
| PMI wideband information fields , from left to right as in Tables 6.3.1.1.2-1/2, if reported |
| PMI wideband information fields , from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if *pmi-FormatIndicator=* *widebandPMI* and if reported |

38.212,Table 6.3.1.1.2-11: Mapping order of CSI fields of one CSI report, CSI part 2 subband, *pmi-FormatIndicator=* *subbandPMI* or *cqi-FormatIndicator=subbandCQI*

|  |  |
| --- | --- |
| CSI report #nPart 2 subband | Subband differential CQI for the second TB of all even subbands with increasing order of subband number, as in Tables 6.3.1.1.2-3/4/5, if *cqi-FormatIndicator=subbandCQI* and if reported |
| PMI subband information fields  of all even subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] of all even subbands with increasing order of subband number, if *pmi-FormatIndicator=* *subbandPMI* and if reported |
| Subband differential CQI for the second TB of all odd subbands with increasing order of subband number, as in Tables 6.3.1.1.2-3/4/5, if *cqi-FormatIndicator=subbandCQI* and if reported |
| PMI subband information fields  of all odd subbands with increasing order of subband number, from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214] of all odd subbands with increasing order of subband number, if *pmi-FormatIndicator=* *subbandPMI* and if reported |

 |
| Moderator |  | @Ericsson: I agree that Table 6.3.1.1.2-10 states that the “wideband X1” is reported, but the “wideband X2” in the fourth row is only reported if pmi-FormatIndicator = widebandPMI:

|  |  |
| --- | --- |
| CSI report number | CSI fields |
| CSI report #nCSI part 2 wideband | Wideband CQI for the second TB as in Tables 6.3.1.1.2-3/4/5, if present and reported |
| Layer Indicator as in Tables 6.3.1.1.2-3/4/5, if reported |
| PMI wideband information fields , from left to right as in Tables 6.3.1.1.2-1/2, if reported |
| PMI wideband information fields , from left to right as in Tables 6.3.1.1.2-1/2, or codebook index for 2 antenna ports according to Clause 5.2.2.2.1 in [6, TS38.214], if *pmi-FormatIndicator=* *widebandPMI* and if reported |

When *pmi-FormatIndicator=subbandPMI*, the information in the fourth row (“Wideband X2”) is not included and the full wideband PMI (X1 and X2) is not available. Also note that the title of the Table does not imply that subbandPMI is configured, because of the “or”. |
| HW/HiSi |  | We think regardless of the understanding of the WB-CQI calculation, it is always useful to include the wideband CQI in the report. That is because it might not always be the case that there are enough resources available to report all configured sub-band CQIs. Then, some sub-band CQI’s will be dropped. If the wideband CQI is omitted, no information about these dropped sub-bands will be available for the gNB. |

**Question 1-3**: Please indicate if FL proposal 7.1-1 is acceptable

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Sony | Yes | Agree to the proposal |
| Ericsson | Yes | Support FL proposal 7.1-1  |
| Futurewei | Yes | Support FL proposal 7.1-1. |
| OPPO | Yes |  |
| DOCOMO | Yes |  |
| Quectel | Yes |  |
| HW/HiSi | Yes | Agree to the proposal.At least for the reason mentioned in 1-2, i.e. it might not always be the case that there are enough resources available to report all sub-band CQIs. Then, some sub-band CQI’s will be dropped. If the wideband CQI is omitted, no information about these sub-bands will be available for the gNB |
| QC | Yes |  |
| vivo | Yes | Support FL proposal 7.1-1  |
| Intel | Yes |  |
| MediaTek | Yes |  |

**Question 1-4**: Please indicate if you would support any of the “other proposals related to 4-bits subband CQI” listed above or if you think any need(s) to be discussed further.

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| HW/HiSi | No |  |
| QC | No |  |
| vivo | No |  |
| Intel |  | Although we had some specific proposal, we don’t think it has chances to be discussed. Thus we accept P 7.1-1 to close CSI enhancements topic in R17. |

# Topic #2: Other

Contributions discuss enhancements that do not fall in one of the above categories.

## Summary of issues for Topic #3

**Issue #2.1:** Indication of the number of true NACKs in the codebook

Support appending X bits to the end of a HARQ-ACK codebook to indicate the number of true NACKs (excluding DTX) in the codebook [17]

**Issue #2.2**: Support A-CSI on PUCCH

Yes: ZTE [4]

* More efficient and flexible than P/SP-CSI, more flexible than A-CSI on PUSCCH, saves PDCCH
* Introduce A-CSI request field in DL DCI with separate trigger state list
* Same PUCCH resource as HARQ-ACK or dedicated PUCCH resource
* Same priority as priority indicator field in DL grant

No: Quectel [8], LG [15]

* Already discussed, not enough time left [8]
* SP-CSI also works [15]

**Observations**

The proposal in issue #2.1 corresponds to Case 2-6 as identified in RAN1#104b-e. At that meeting it was decided to focus further study on Delta-CQI/MCS since there were more interested companies.

A-CSI on PUCCH was discussed extensively from RAN1#102-e to RAN1#104-e and no consensus could be achieved.

## E-mail discussion (1st round) for Topic #2

**Question 2-1**: Please provide feedback if you would like to either (a) make correction in this moderator summary (Topic #2) or (b) add your company position

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Sony |  | It was concluded that there is no time for other topics in this agenda apart from 4-bit sub-band CQI Hence we do not think we should re-consider topics that had already been filtered out. |
| Ericsson |  | Our understanding is also that RAN1 has concluded that RAN1 does not investigate further other enhancements (e.g., Issue #2.1, #2.2). |
| OPPO |  | Given the remaining TU before Rel-17 closing, it could be risky to open new enhancements.  |
| Quectel |  | Same view as companies above. |
| HW/HiSi |  | Our understanding is in-line with companies above, we think it has been agreed (and also is more realistic) to only focus on the last remaining FFS for the 4-bit sub-band CQI and no other topics should be re-opened. However, if questions about Case 2-6 are asked (see Question 2-2 below), which already has been precluded in RAN1#104b-e, then it would also be fair to ask the group whether they would support A-CSI on PUCCH, which is a scheme that had gained a lot of support from companies and has not been precluded yet. Since Question 2-2 has been added, we would also suggest to ask a similar question for the support of A-CSI on PUCCH.  |
| vivo |  | Similar view as other companies. |

**Question 2-2**: Please indicate if you would support introducing scheme to add X bits to the end of a HARQ-ACK codebook to indicate the number of true NACKs (excluding DTX) in the codebook.

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Sony | No | Although we do support soft NACK, we should just stick to the conclusion that we would not specify anything further apart from 4 bits sub-band CQI. |
| Ericsson | No | Same view as Sony. While we support soft HARQ-ACK, it’s not constructive to overturn RAN1 conclusion and re-open the topic in Rel-17. |
| Futurewei | No | Similar to many other schemes, the proposed scheme has been discussed in previouss meetings and it has been decided to not have further investigation on the scheme. We should respect the agreements/conclusions made by the group.  |
| OPPO | No | Similar views with other companies.  |
| Moderator |  | @Sony, Ericsson, Futurewei, Oppo: to clarify, my understanding is that this scheme is not the same as soft NACK/soft ACK/delta-MCS, so would not be “covered” by the RAN1 conclusion of RAN1#106-e. This scheme has been proposed during Case 2 discussions and implicitly deprioritized in RAN1#104b-e compared to the Case 2 scheme that had more interest at that time, (i.e. delta-CQI/MCS). |
| DOCOMO | No | As NACK probability should be low in URLLC scenario, we don’t see strong motivation to reopen the discussion on Case 2-6 at this stage. |
| Quectel | No | Although it may not be precluded by the conclusion as clarified by FL, it would not be helpful at this point to reopen the discussions on Case 2. |
| HW/HiSi | No | In our view this scheme has been precluded already in RAN 1#104b-e.It was described as case 2-6, and in RAN 104-e, the following conclusion was made:**Conclusion:** Continue evaluation of new reporting Case 1 and Case 2 for the schemes identified in Appendix B of [R1-2102131](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104/Docs/R1-2102131.zip). * Companies are encouraged to provide their views on each scheme against each criterion in respective Tables in Appendix B.
* Companies are encouraged to provide additional evaluation results for as many schemes as possible, based on assumptions agreed in RAN1#102-e.
* Aim for down-selection at RAN1#104-b-e by taking into account evaluation results and assessment against criteria from Appendix B.

 In RAN1 #104b-e it was decided to focus on delta-MCS (Case 2-3), which precludes Case 2-6.Agreements:For new reporting Case 2, focus study on reporting of delta-CQI/MCS (Case 2-3):* Note: this delta-CQI/MCS is determined based on UE implementation (for example, using SINR, LLR, raw BER, flipped bits, LDPC iterations, BLEP, # fail parity checks, etc.)
	+ Companies are encouraged to provide more details in their analysis
* FFS: Granularity of new report type (e.g. units of CQI or MCS, how many bits)
* FFS: Whether quantity reported is relative to the scheduled MCS

In addition, no gain has been shown in simulations. Also, we agree with DOCOMO, since the BLER already is very low in URLLC, no benefits can be expected. On the contrary, the extension of the HARQ-ACK codebook (even for the cases of ACK) could even introduce a not justifiable UL overhead and degradation of the UL performance. |
| QC | Yes | Like FL clarified, this scheme was categoried as case 2-6 a few meetings back. It was not discussed/treated since then because RAN1 decided to focus on study of delta MCS. The conclusion made in RAN1 106e excluded delta-MCS. But it did not exclude this scheme. That is why we propose to reconsider it under case 2. Hope this clarifies our intention. If majority of companies do not want to further pursue enhancement under previous agreed case 2, we are fine to go with majority view and only specify 4-bits subband CQI for Rel-17 URLLC CSI enhancement. |
| vivo | No | We share the similar views with other companies that we need to respect the agreements/conclusions that have been made. |
| Intel | No | The discussion is closed on this topic a few meetings back |
| MediaTek | No |  |

# References

1. RP-210854 Revised WID: Enhanced IIoT and URLLC support for NR, Nokia, Nokia Shanghai Bell.
2. R1-2108727 CSI feedback enhancements Huawei, HiSilicon
3. R1-2108830 CSI Feedback Enhancements for IIoT/URLLC Ericsson
4. R1-2110395 Discussion on CSI feedback enhancements for eURLLC ZTE
5. R1-2108967 CSI feedback enhancements for Rel-17 URLLC vivo
6. R1-2109094 CSI feedback enhancements for URLLC OPPO
7. R1-2109216 CSI feedback enhancements CATT
8. R1-2109259 Discussion on CSI Feedback Enhancements Quectel, Langbo
9. R1-2109278 Discussion on CSI feeback enhancements for URLLC CMCC
10. R1-2109605 Remaining issues of enhanced sub-band CQI indication granularity Intel Corporation
11. R1-2109672 Discussion on CSI feedback enhancements for Rel.17 URLLC NTT DOCOMO, INC.
12. R1-2109729 CSI feedback enhancements InterDigital, Inc.
13. R1-2109783 Remaining issues in 4 bits sub-band CQI reporting Sony
14. R1-2109941 CSI feedback enhancements for URLLC/IIoT Lenovo, Motorola Mobility
15. R1-2109971 Discussion on CSI feedback enhancements for URLLC LG Electronics
16. R1-2110028 Rel-17 URLLC UE feedback enhancement for CSI Apple
17. R1-2110179 CSI enhancement for IOT and URLLC Qualcomm Incorporated
18. R1-2110303 CSI feedback enhancements for URLLC/IIoT use cases Nokia, Nokia Shanghai Bell

# Appendix: Previous agreements

RAN1#106-e

**Agreement**

For subband CQI reporting with more than 2 bits per subband

* Support 4-bits CQI only

**Agreement**

For subband CQI reporting in Rel-17, RRC can configure use of legacy 2-bits D-CQI or 4-bits CQI for each CSI report configuration.

* This feature is subject to UE capability
* FFS: Whether wideband CQI report can be omitted

**R1-2108450** Feature lead summary #4 on CSI feedback enhancements for enhanced URLLC/IIoT Moderator (InterDigital)

**Conclusion**

There is no consensus in RAN1 on the support of delta-MCS in Rel-17.

Guidance from RAN#92-e

(RP-211297)

RAN1 to further investigate the following for CSI enhancements for IIoT/URLLC:

* Increasing the number of bits used for the reported subband CQI (3-bits differential subband CQI or 4-bits CQI)
* Reporting of delta-MCS:
	+ Report consists of delta-MCS for a TB received with MCS index IMCS:

delta-MCS is calculated from the difference between IMCS\_tgt and IMCS, where IMCS\_tgt is the largest MCS index such that the estimated BLER for a TB received with this MCS index would be smaller than or equal to a BLER target, and IMCS is the MCS index of the received TB.

Agreements from RAN1#104b-e

**Conclusion:**

For new reporting Case 1, do not consider further the following schemes:

* Case 1-2: CSI prediction
* Case 1-4: Interference covariance matrix
* Case 1-9: Reference wideband CQI excludes worst sub-bands
* Case 1-10: CSI expiration time

Agreements:

For new reporting Case 2, focus study on reporting of delta-CQI/MCS (Case 2-3):

* Note: this delta-CQI/MCS is determined based on UE implementation (for example, using SINR, LLR, raw BER, flipped bits, LDPC iterations, BLEP, # fail parity checks, etc.)
	+ Companies are encouraged to provide more details in their analysis
* FFS: Granularity of new report type (e.g. units of CQI or MCS, how many bits)
* FFS: Whether quantity reported is relative to the scheduled MCS

Agreement: Focus study on the following for new reporting Case 1:

* Reporting of new metric, where new metric shall be determined based on network configured channel and interference measurement interval (multiple CMR and/or IMR instances) to enable accurate MCS selection.
	+ Downselect by RAN1#105 to at most a single method from the following options:
		- Mean-CQI/SINR and stdev-CQI/SINR (FFS details)
		- CSI based on worst IMR occasion (FFS details)
		- Interference standard deviation (FFS details)
		- Worst-M CQI (FFS details)
	+ FFS: Whether network configured channel and interference measurement interval can also be applied to existing CSI type
* Increasing granularity of subband CQI (e.g. 3-bits differential subband CQI or 4-bits full subband CQI).
* Updating only CQI in a report, where CQI is conditioned on a previous instance in which RI/PMI/(CRI) is updated.
	+ Applicable for same reporting quantity as R16 for CQI.
	+ FFS: Whether network configured channel and interference measurement interval can also be applied
	+ FFS: Whether RI/PMI/(CRI) is transmitted in a report where only CQI is updated
	+ ~~FFS: how to report the updated CQI~~
	+ FFS: whether the CQI processing time can be ~~is~~ reduced compared to Rel-16 CSI processing delay

Final summary in R1-2103956

Agreements from RAN1#104-e

[**R1-2101811**](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104/Docs/R1-2101811.zip)

**Conclusion:** Continue evaluation of new reporting Case 1 and Case 2 for the schemes identified in Appendix B of [R1-2102131](file:///C%3A/Users/wanshic/OneDrive%20-%20Qualcomm/Documents/Standards/3GPP%20Standards/Meeting%20Documents/TSGR1_104/Docs/R1-2102131.zip).

* Companies are encouraged to provide their views on each scheme against each criterion in respective Tables in Appendix B.
* Companies are encouraged to provide additional evaluation results for as many schemes as possible, based on assumptions agreed in RAN1#102-e.
* Aim for down-selection at RAN1#104-b-e by taking into account evaluation results and assessment against criteria from Appendix B.

Agreements from RAN1#103-e:

Agreements

* No change of CSI processing time relative to Rel-16 CSI in this WI
* CSI processing time specific to a new CSI reporting quantity/type (if supported) can be studied

Agreement:

* For Case-2 new reporting, continue studying with focus on the new reporting type based on PDSCH decoding for OLLA performance enhancement for initial and re-transmissions of PDSCH.

Agreements:

For Case-1 New reporting, the following candidate schemes have been identified to address the fast interference change over time. Continue studying with focus on the identified schemes below for further study and evaluation.

* Scheme 1a: New reporting quantity based on CQI/SINR statistics, e.g.,
	+ CQI/SINR statistics (e.g., mean, variance, etc.)
	+ CSI prediction
* Scheme 1b: New reporting quantity of interference statistics (e.g., mean, variance, interference covariance matrix, etc.)
* Scheme 1c: New reporting quantity based on modifying existing reporting format, e.g.,
	+ CQI reporting considering the worst subbands
	+ Subband CQI granularity enhancement
* Scheme 1d: New reporting quantity related to CSI expiration time
* Scheme 1e: New reporting quantity with partial information update, e.g.,
	+ CSI reporting with interference update only

Companies are encouraged to investigate the above schemes, aiming for down-selection in RAN1#104-e

Agreements from RAN1#102-e:

Agreement:

* CSI feedback enhancement for Multi-TRP transmission is not to be discussed further under IIoT/URLLC enhancement WI

Agreements:

* Baseline assumptions are used as the required minimum to be simulated for the evaluation of candidate CSI enhancement schemes
	+ Reuse the assumptions in TR 38.824 and TR 38.901 as a starting point
	+ Companies shall report additional parameters (e.g., CSI measurement settings, CSI reporting schemes) used in their evaluation
	+ FFS details of baseline assumptions
* Companies can bring additional simulation results with other set(s) of assumptions

Agreements:

* Study/evaluate further on following CSI enhancement schemes in terms of technical benefit, specification and implementation impacts.
	+ New triggering methods for A-CSI and/or SRS
	+ New reporting based on one or more of the following:
		- Case 1: channel/interference measurement for new CSI reporting, considering aspects such as one or more of the following:
			* Reporting more accurate interference characteristics
			* Reduced CSI feedback overhead (e.g., reporting interference measurement only)
			* Enhanced CSI reporting such as WB/SB CQI
		- Case 2: other measurement (other than channel/interference) for additional information
			* E.g., PDCCH/PDSCH decoding, recommended HARQ RV sequence, etc.
		- It targets to help gNB scheduler for better link adaptation of (re)transmission
	+ [Reduced CSI computation time/complexity]
	+ [CSI feedback for PDCCH]
	+ Other CSI enhancement schemes that enable accurate MCS selection are not precluded
* Detailed assumptions of the proposed CSI enhancement schemes should be provided by the proponent, such as
	+ Reporting values
	+ Triggering conditions for the reporting
	+ Associated measurement resource
	+ Uplink resource to be used for the reporting
	+ How to use the reported information at the gNB scheduler
	+ CSI-RS overhead and CSI reporting frequency
	+ CSI reporting latency/timeline
	+ Etc.

Agreements:

* Consider Table 1 as baseline assumption for system level simulation for evaluating CSI enhancement schemes
	+ The uses cases in Table 1 is for simulation purposes and it does not preclude a CSI enhancement scheme which is beneficial for the other URLLC use cases
* No baseline assumption is used for link level simulation
	+ Companies are encouraged to use one of LLS assumption tables in Section A.3 in TR38.824 for any link level simulation

**Table 1. Baseline SLS assumption for CSI enhancement schemes in URLLC/IIoT**

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Performance metric | Option-1 (section 5.1 of TR 38.824)Additional metrics (it is up to company to bring results with additional metric):* MCS prediction error (e.g., difference of a scheduled MCS and an ideal MCS)
* DL/UL signaling overhead
* CCDF of latency samples from all UEs
* BLER of 1st transmission
* Resource utilization
* Spectral efficiency
 |
| Use cases | Following two use cases can be considered for new triggering method and new reporting. Companies are encouraged to evaluate the following cases in descending priority:* Rel-15 enabled use case (e.g. AR/VR) in TR 38.824
	+ Reliability: 99.999
	+ Latency: 4ms (200bytes)
	+ Traffic mode: FTP model 3 (100p/s)
* Factory automation in TR 38.824
	+ Reliability: 99.9999
	+ Latency: 1ms (32bytes)
	+ Traffic mode: Periodic deterministic traffic model with arrival interval 2ms
* Rel-15 enabled use case (e.g. AR/VR) in TR 38.824
	+ Reliability: 99.999
	+ Latency: 1ms (32bytes)
	+ Traffic mode: FTP model 3 (100p/s)
	+ Assumptions for eMBB and URLLC UEs sharing the same carrier is used (as in A2.5 of TR 38.824)
 |
| Simulation assumptions | Following simulation assumption is used based on the use case selected:* Rel-15 enabled use case with UMa (Table A.2.4-1 in TR 38.824)
* Factory automation at 4GHz (Table A.2.2-1 in TR38.824) with following update:
	+ Channel model is replaced with InF (InF-DH) in TR 38.901
		- Companies can bring results with other InF scenarios additionally
	+ Layout is replaced with BS deployment in Table 7.8-7 in TR 38.901
 |
| Transmission scheme | Multiple antenna ports Tx scheme* Companies report the details of Tx scheme used
 |