**3GPP TSG-RAN WG4 Meeting # 104-e R4-2213968**

**Electronic Meeting, August 15 – 26, 2022**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.101-4** | **CR** | **draft** | **rev** | **0** | **Current version:** | **17.5.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network |  |

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|  | | | | | | | | | | |
| ***Title:*** | draftCR for RedCap UE CQI Fading Reporting Requirements | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Qualcomm Inc. | | | | | | | | | |
| ***Source to TSG:*** | RAN4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_redcap-Perf | | | | |  | ***Date:*** | | | 2022-08-09 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel.17 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Introduce new RedCap UE CQI Fading Reporting Requirements | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | New Sections for RedCap UE CQI Fading Reporting Requirements | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | No RedCap UE CQI Fading Reporting Requirements are introduced | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 6.2.1.1.2, 6.2.1.2.2, 6.2.2.1.2, 6.2.2.2.2; | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | | **X** |  | Test specifications | | | | TS38.521 | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

6.2 Reporting of Channel Quality Indicator (CQI)

This clause includes the requirements for the reporting of channel quality indicator (CQI).

6.2.1 1RX requirements

6.2.1.1 FDD

[…]

<Start of Change #1>

6.2.1.1.2 CQI reporting under fading conditions

6.2.1.1.2.1 Minimum requirement for wideband CQI reporting for RedCap

The purpose of the requirements is to verify that the RedCap UE is tracking the channel variations and selecting the largest transport format possible according to the prevailing channel state for the frequency non-selective scheduling.

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI. To account for sensitivity of the input SNR the wideband CQI reporting under frequency selective fading conditions is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.1.1.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least *α*% of the time where *α*% is specified in Table 6.2.1.1.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ *γ*, where *γ* is specified in Table 6.2.1.1.2.1-2;

c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

**Table 6.2.1.1.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | MHz | 10 | | | |
| Subcarrier spacing | | | kHz | 15 | | | |
| Duplex Mode | | |  | FDD | | | |
| SNR | | | dB | [9] | [10] | [15] | [16] |
| Propagation channel | | |  | TDLA30-5 | | | |
| Antenna configuration | | |  | 2×1 | | | |
| Correlation configuration | | |  | ULA high | | | |
| Beamforming Model | | |  | As specified in Annex B.4.1 | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | |  | 4 | | | |
| CDM Type | |  | FD-CDM2 | | | |
| Density (ρ) | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 9 | | | |
| CSI-RS  periodicity and offset | | slot | 10/1 | | | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | |  | 2 | | | |
| CDM Type | |  | FD-CDM2 | | | |
| Density (ρ) | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 3,(6) | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 13 | | | |
| NZP CSI-RS-timeConfig  periodicity and offset | | slot | 10/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | |  | Periodic | | | |
| CSI-IM RE pattern | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | slot | 10/1 | | | |
| ReportConfigType | | |  | Periodic | | | |
| CQI-table | | |  | Table 1 | | | |
| reportQuantity | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | |  | Not configured | | | |
| cqi-FormatIndicator | | |  | Wideband | | | |
| pmi-FormatIndicator | | |  | Wideband | | | |
| Sub-band Size | | | RB | 8 | | | |
| Csi-ReportingBand | | |  | 1111111 | | | |
| CSI-Report periodicity and offset | | | slot | 10/9 | | | |
| aperiodicTriggeringOffset | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type |  | typeI-SinglePanel | | | |
| Codebook Mode |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) |  | Not configured | | | |
| CodebookSubsetRestriction |  | 000001 | | | |
| RI Restriction |  | N/A | | | |
| Physical channel for CSI report | | |  | PUCCH | | | |
| CQI/RI/PMI delay | | | ms | [14] | | | |
| Maximum number of HARQ transmission | | |  | 1 | | | |
| Measurement channel | | |  | As specified in Table A.4-2, TBS.2-1 | | | |

**Table 6.2.1.1.2.1-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| ** [%] | 20 | 20 |
| ** | 1.05 | 1.05 |

<End of Change #1>

6.2.1.2 TDD

[…]

<Start of Change #2>

6.2.1.2.2 CQI reporting under fading conditions

6.2.1.2.2.1 Minimum requirement for wideband CQI reporting for RedCap

The purpose of the requirements is to verify that the RedCap UE is tracking the channel variations and selecting the largest transport format possible according to the prevailing channel state for the frequency non-selective scheduling.

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.1.2.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least *α*% of the time where *α*% is specified in Table 6.2.1.2.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ *γ*, where *γ* is specified in Table 6.2.1.2.2.1-2;

c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

**Table 6.2.1.2.2.1-1: Wideband CQI reporting test under frequency non-selective fading conditions**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Test 1** | | **Test 2** | |
| Bandwidth | | | MHz | 20 | | | |
| Subcarrier spacing | | | kHz | 30 | | | |
| Duplex Mode | | |  | TDD | | | |
| TDD UL-DL pattern | | |  | FR1.30-1 | | | |
| SNR | | | dB | [9] | [10] | [15] | [16] |
| Propagation channel | | |  | TDLA30-5 | | | |
| Antenna configuration | | |  | 2×1 | | | |
| Correlation configuration | | |  | ULA high | | | |
| Beamforming Model | | |  | As specified in Annex B.4.1 | | | |
| ZP CSI-RS configuration | CSI-RS resource Type | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | |  | 4 | | | |
| CDM Type | |  | FD-CDM2 | | | |
| Density (ρ) | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 5,4 | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 9 | | | |
| CSI-RS  periodicity and offset | | slot | 10/1 | | | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | |  | Periodic | | | |
| Number of CSI-RS ports (*X*) | |  | 2 | | | |
| CDM Type | |  | FD-CDM2 | | | |
| Density (ρ) | |  | 1 | | | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 3,(6) | | | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 13 | | | |
| NZP CSI-RS-timeConfig  periodicity and offset | | slot | 10/1 | | | |
| CSI-IM configuration | CSI-IM resource Type | |  | Periodic | | | |
| CSI-IM RE pattern | |  | 0 | | | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | |  | (4, 9) | | | |
| CSI-IM timeConfig  periodicity and offset | | slot | 10/1 | | | |
| ReportConfigType | | |  | Periodic | | | |
| CQI-table | | |  | Table 1 | | | |
| reportQuantity | | |  | cri-RI-PMI-CQI | | | |
| timeRestrictionForChannelMeasurements | | |  | Not configured | | | |
| timeRestrictionForInterferenceMeasurements | | |  | Not configured | | | |
| cqi-FormatIndicator | | |  | Wideband | | | |
| pmi-FormatIndicator | | |  | Wideband | | | |
| Sub-band Size | | | RB | 16 | | | |
| Csi-ReportingBand | | |  | 1111111 | | | |
| CSI-Report periodicity and offset | | | slot | 10/9 | | | |
| aperiodicTriggeringOffset | | |  | Not configured | | | |
| Codebook configuration | | Codebook Type |  | typeI-SinglePanel | | | |
| Codebook Mode |  | 1 | | | |
| (CodebookConfig-N1,CodebookConfig-N2) |  | Not configured | | | |
| CodebookSubsetRestriction |  | 000001 | | | |
| RI Restriction |  | N/A | | | |
| Physical channel for CSI report | | |  | PUCCH | | | |
| CQI/RI/PMI delay | | | ms | [14] | | | |
| Maximum number of HARQ transmission | | |  | 1 | | | |
| Measurement channel | | |  | As specified in Table A.4-2, TBS.2-3 | | | |

**Table 6.2.1.2.2.1-2: Minimum requirements**

|  |  |  |
| --- | --- | --- |
| **Parameters** | **Test 1** | **Test 2** |
| ** [%] | 20 | 20 |
| ** | 1.05 | 1.05 |

<End of Change #2>

6.2.2 2RX requirements

This sub-clause includes the requirements for reporting of CQI for UE equipped with 2 receiver antennas.

6.2.2.1 FDD

[…]

<Start of Change #3>

6.2.2.1.2.4 Minimum requirement for wideband CQI reporting for RedCap

The purpose of the requirements is to verify that the RedCap UE is tracking the channel variations and selecting the largest transport format possible according to the prevailing channel state for the frequency non-selective scheduling.

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI. To account for sensitivity of the input SNR the wideband CQI reporting under frequency selective fading conditions is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.1.1.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least *α*% of the time where *α*% is specified in Table 6.2.1.1.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ *γ*, where *γ* is specified in Table 6.2.1.1.2.1-2;

c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

**Table 6.2.2.1.2.4-1: Wideband CQI reporting test under frequency non-selective fading conditions**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Test 1** | |
| Bandwidth | | | MHz | 10 | |
| Subcarrier spacing | | | kHz | 15 | |
| Duplex Mode | | |  | FDD | |
| SNR | | | dB | [6] | [7] |
| Propagation channel | | |  | TDLA30-5 | |
| Antenna configuration | | |  | 2×2 | |
| Correlation configuration | | |  | ULA high | |
| Beamforming Model | | |  | As specified in Annex B.4.1 | |
| ZP CSI-RS configuration | CSI-RS resource Type | |  | Periodic | |
| Number of CSI-RS ports (*X*) | |  | 4 | |
| CDM Type | |  | FD-CDM2 | |
| Density (ρ) | |  | 1 | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 5,4 | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 9 | |
| CSI-RS  periodicity and offset | | slot | 10/1 | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | |  | Periodic | |
| Number of CSI-RS ports (*X*) | |  | 2 | |
| CDM Type | |  | FD-CDM2 | |
| Density (ρ) | |  | 1 | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 3,(6) | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 13 | |
| NZP CSI-RS-timeConfig  periodicity and offset | | slot | 10/1 | |
| CSI-IM configuration | CSI-IM resource Type | |  | Periodic | |
| CSI-IM RE pattern | |  | 0 | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | |  | (4, 9) | |
| CSI-IM timeConfig  periodicity and offset | | slot | 10/1 | |
| ReportConfigType | | |  | Periodic | |
| CQI-table | | |  | Table 1 | |
| reportQuantity | | |  | cri-RI-PMI-CQI | |
| timeRestrictionForChannelMeasurements | | |  | Not configured | |
| timeRestrictionForInterferenceMeasurements | | |  | Not configured | |
| cqi-FormatIndicator | | |  | Wideband | |
| pmi-FormatIndicator | | |  | Wideband | |
| Sub-band Size | | | RB | 8 | |
| Csi-ReportingBand | | |  | 1111111 | |
| CSI-Report periodicity and offset | | | slot | 10/9 | |
| aperiodicTriggeringOffset | | |  | Not configured | |
| Codebook configuration | | Codebook Type |  | typeI-SinglePanel | |
| Codebook Mode |  | 1 | |
| (CodebookConfig-N1,CodebookConfig-N2) |  | Not configured | |
| CodebookSubsetRestriction |  | 000001 | |
| RI Restriction |  | N/A | |
| Physical channel for CSI report | | |  | PUCCH | |
| CQI/RI/PMI delay | | | ms | [14] | |
| Maximum number of HARQ transmission | | |  | 1 | |
| Measurement channel | | |  | As specified in Table A.4-2, TBS.2-1 | |

**Table 6.2.2.1.2.4-2: Minimum requirements**

|  |  |
| --- | --- |
| **Parameters** | **Test 1** |
| ** [%] | 20 |
| ** | 1.05 |

<End of Change #3>

6.2.2.2 TDD

[…]

<Start of Change #4>

6.2.2.2.2.4 Minimum requirement for wideband CQI reporting for RedCap

The purpose of the requirements is to verify that the RedCap UE is tracking the channel variations and selecting the largest transport format possible according to the prevailing channel state for the frequency non-selective scheduling.

The reporting accuracy of CQI under frequency non-selective fading conditions is determined by the reporting variance, the relative increase of the throughput obtained when the transport format is indicated by the reported CQI compared to the throughput obtained when a fixed transport format is configured according to the reported median CQI, and a minimum BLER using the transport formats indicated by the reported CQI. To account for sensitivity of the input SNR the reporting definition is considered to be verified if the reporting accuracy is met for at least one of two SNR levels separated by an offset of 1 dB.

For the parameters specified in Table 6.2.1.2.2.1-1 and using the downlink physical channels specified in Annex C.3.1, the minimum requirements are specified by the following:

a) A CQI index not in the set {median CQI -1, median CQI, median CQI +1} shall be reported at least *α*% of the time where *α*% is specified in Table 6.2.1.2.2.1-2;

b) The ratio of the throughput obtained when transmitting the transport format indicated by each reported wideband CQI index and that obtained when transmitting a fixed transport format configured according to the wideband CQI median shall be ≥ *γ*, where *γ* is specified in Table 6.2.1.2.2.1-2;

c) When transmitting the transport format indicated by each reported wideband CQI index, the average BLER for the indicated transport formats shall be greater than or equal to 0.02.

**Table 6.2.2.2.2.4-1: Wideband CQI reporting test under frequency non-selective fading conditions**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Parameter** | | | **Unit** | **Test 1** | |
| Bandwidth | | | MHz | 20 | |
| Subcarrier spacing | | | kHz | 30 | |
| Duplex Mode | | |  | TDD | |
| TDD UL-DL pattern | | |  | FR1.30-1 | |
| SNR | | | dB | [6] | [7] |
| Propagation channel | | |  | TDLA30-5 | |
| Antenna configuration | | |  | 2×2 | |
| Correlation configuration | | |  | ULA high | |
| Beamforming Model | | |  | As specified in Annex B.4.1 | |
| ZP CSI-RS configuration | CSI-RS resource Type | |  | Periodic | |
| Number of CSI-RS ports (*X*) | |  | 4 | |
| CDM Type | |  | FD-CDM2 | |
| Density (ρ) | |  | 1 | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 5,4 | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 9 | |
| CSI-RS  periodicity and offset | | slot | 10/1 | |
| NZP CSI-RS for CSI acquisition | CSI-RS resource Type | |  | Periodic | |
| Number of CSI-RS ports (*X*) | |  | 2 | |
| CDM Type | |  | FD-CDM2 | |
| Density (ρ) | |  | 1 | |
| First subcarrier index in the PRB used for CSI-RS (k0) | |  | Row 3,(6) | |
| First OFDM symbol in the PRB used for CSI-RS (l0) | |  | 13 | |
| NZP CSI-RS-timeConfig  periodicity and offset | | slot | 10/1 | |
| CSI-IM configuration | CSI-IM resource Type | |  | Periodic | |
| CSI-IM RE pattern | |  | 0 | |
| CSI-IM Resource Mapping  (kCSI-IM,lCSI-IM) | |  | (4, 9) | |
| CSI-IM timeConfig  periodicity and offset | | slot | 10/1 | |
| ReportConfigType | | |  | Periodic | |
| CQI-table | | |  | Table 1 | |
| reportQuantity | | |  | cri-RI-PMI-CQI | |
| timeRestrictionForChannelMeasurements | | |  | Not configured | |
| timeRestrictionForInterferenceMeasurements | | |  | Not configured | |
| cqi-FormatIndicator | | |  | Wideband | |
| pmi-FormatIndicator | | |  | Wideband | |
| Sub-band Size | | | RB | 16 | |
| Csi-ReportingBand | | |  | 1111111 | |
| CSI-Report periodicity and offset | | | slot | 10/9 | |
| aperiodicTriggeringOffset | | |  | Not configured | |
| Codebook configuration | | Codebook Type |  | typeI-SinglePanel | |
| Codebook Mode |  | 1 | |
| (CodebookConfig-N1,CodebookConfig-N2) |  | Not configured | |
| CodebookSubsetRestriction |  | 000001 | |
| RI Restriction |  | N/A | |
| Physical channel for CSI report | | |  | PUCCH | |
| CQI/RI/PMI delay | | | ms | [14] | |
| Maximum number of HARQ transmission | | |  | 1 | |
| Measurement channel | | |  | As specified in Table A.4-2, TBS.2-3 | |

**Table 6.2.2.2.2.4-2: Minimum requirements**

|  |  |
| --- | --- |
| **Parameters** | **Test 1** |
| ** [%] | 20 |
| ** | 1.05 |

<End of Change #4>