**3GPP TSG- RAN4 Meeting #111R4-240x**

**Fukuoka City, Fukuoka, Japan, 20th – 24th May, 2024**

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| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
|  |
|  | **38.133** | **CR** | **DraftCR** | **rev** | **1** | **Current version:** | **18.5.0** |  |
|  |
| *For* [***HELP***](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:***  | Draft CR on TRP specific link recovery for multi-Rx |
|  |  |
| ***Source to WG:*** | vivo |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_FR2\_multiRX\_DL-Core |  | ***Date:*** | 2024-5-9 |
|  |  |  |  |  |
| ***Category:*** | F |  | ***Release:*** | Rel-18 |
|  | *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 canbe 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-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | In the RAN4#110b meeting and RAN4#110bis meeting, further agreements on fast beam sweeping and scheduling restriction were made, it should be captured in the spec.Measurement requirements for BFD need to be finalizedMeasurement restriction requirements for BFD need to be finalized.Meausrement restriction requirements for CBD should be removed. |
|  |  |
| ***Summary of change:*** | * Revised fast beam sweeping requirements for TRP specific SSB based beam failure detection.
* Revised measurement requirements and measurement restriction requirements for TRP specific CSI-RS based beam failure detection.
* Removed measurement restriction requirements for TRP specific CSI-RS based candidate beam detection.
* Revised scheduling availability during TRP specific CSI-RS based BFD for multi-Rx.
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| ***Consequences if not approved:*** | Requirements for TRP specific link recovery for multi-Rx in Rel-18 are not completed. |
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| ***Clauses affected:*** | 8.18.2, 8.18.3, 8.18.6, 8.18.8 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** | **X** |  |  Test specifications | TS 38.533  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

<Start of Change #1>

### 8.18.2 Requirements for TRP specific SSB based beam failure detection

#### 8.18.2.1 Introduction

The requirements in this clause apply for each SSB resource in the set two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1} $configured for a serving cell, provided that the SSB configured for beam failure detection is actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.18.2.2. The SSB(s) in set $\overbar{q}\_{0,1}$ can be associated with an additionalPCI other than serving cell PCI.

Table 8.18.2.1-1: PDCCH transmission parameters for beam failure instance

|  |  |
| --- | --- |
| Attribute | Value for BLER |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 8 |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy | 0dB |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 0dB |
| Bandwidth (PRBs) | 24 |
| Sub-carrier spacing (kHz) | Same as the SCS of RMSI CORESET |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.18.2.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured SSB resource in two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ estimated over the last TEvaluate\_BFD\_SSB ms period becomes worse than the threshold Qout\_LR\_SSB within TEvaluate\_BFD\_SSB ms period.

The value of TEvaluate\_BFD\_SSB is defined in Table 8.18.2.2-1 for FR1.

The value of TEvaluate\_BFD\_SSB is defined in Table 8.18.2.2-2 for FR2 with scaling factor N, where

N = 2, 4, or 6 in FR2-1 for UE supporting [TBD - multi-rx faster beam switching capability] according to the conditions in clause 3.6.x , and

N=8 for other cases in FR2.

<End of Change #1>

<Start of Change #2>

### 8.18.3 Requirements for CSI-RS based beam failure detection

#### 8.18.3.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$of resource configurations for a serving cell, provided that the CSI-RS resource(s) in two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$for beam failure detection are actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.18.3.2. UE is not expected to perform beam failure detection measurements on the CSI-RS configured for BFD if the CSI-RS is not QCL-ed, with QCL-TypeD when applicable, with the RS in the active TCI state of any CORESET configured in the UE active BWP.

Table 8.18.3.1-1: PDCCH transmission parameters for beam failure instance

|  |  |
| --- | --- |
| Attribute | Value for BLER |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 8 |
| Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy | 0dB |
| Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | 0dB |
| Bandwidth (PRBs) | 48 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

#### 8.18.3.2 Minimum requirement

**--- Unchanged texts omitted ---**

For FR2-1, for UE supporting [TBD - multi-rx capability] according to the conditions in clause 3.6.x, the value of PTRP in table 8.18.3.2-2 is defined as 1, when:

- CSI-RS resources in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ are not overlapped, or

- CSI-RS resources in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ are overlapped and the following conditions are met:

- Both CSI-RSs are not in any CSI-RS resource set with repetition ON

- The two CSI-RS resources in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ for beam failure detection [and both PDSCH] are overlapped on the same OFDM symbol.

- [The CSI-RS in set $\overbar{q}\_{0,0}$ has same QCL source as the active TCI state of one PDSCH, and the CSI-RS in set $\overbar{q}\_{0,1}$ has same QCL source as the active TCI state of the other PDSCH]

- Resources of the active TCI states for the two PDSCHs have been reported as a resource group in Rel-17 group-based RSRP report.

- [FFS how to capture UE is activated with multi-Rx operation]

- else, the value of PTRP is 2.

Table 8.18.2-1: Evaluation period TEvaluate\_BFD\_CSI-RS for FR1

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms)  |
| no DRX | Max(50, Ceil(MBFD × P × PBFD) × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × MBFD × P × PBFD) × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | Ceil(MBFD × P × PBFD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$. TDRX is the DRX cycle length. |

**Table 8.18.3.2-2: Evaluation period TEvaluate\_BFD\_CSI-RS for FR2**

|  |  |
| --- | --- |
| Configuration | TEvaluate\_BFD\_CSI-RS (ms)  |
| no DRX | Max(50, Ceil(MBFD × P × N × PBFD\*PTRP) × TCSI-RS) |
| DRX cycle ≤ 320ms | Max(50, Ceil(1.5 × MBFD × P × N × PBFD\*PTRP) × Max(TDRX, TCSI-RS)) |
| DRX cycle > 320ms | Ceil(MBFD × P × N × PBFD\*PTRP) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$. TDRX is the DRX cycle length. |

#### 8.18.3.3 Measurement restrictions for CSI-RS beam failure detection

The SSB mentioned in this clause can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

The UE is required to be capable of measuring CSI-RS for BFD without measurement gaps. The UE is required to perform the CSI-RS measurements with measurement restrictions as described in the following scenarios.

For both FR1 and FR2, when the CSI-RS for BFD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for BFD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for BFD measurement, the UE shall be able to perform CSI-RS measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS measurement without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for BFD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for BFD measurement without any restriction.

For FR2, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD or L1-RSRP measurement on the same CC or different CCs in the same band, or in the same symbol as SSB for CBD measurement on the same CC or different CCs in the same band when beam failure is detected, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

For UE incapable of [capability of measurement with RTD>CP] and for UE capable of [capability of measurement with RTD>CP],

- For both FR1 and FR2, when the CSI-RS for BFD measurement fully or partially overlaps with the OFDM symbol as SSB from candidate LTM neighbor cell for intra-frequency L1-RSRP measurement or inter-frequency L1-RSRP measurement without gap, UE is not required to receive CSI-RS for BFD measurement in the PRBs that overlap with an SSB.

- For FR1, when the CSI-RS for BFD measurement fully or partially overlaps with the OFDM symbol as SSB from candidate LTM neighbor cell for intra-frequency L1-RSRP measurement or inter-frequency L1-RSRP measurement without gap, if CSI-RS and SSB have different SCS and UE does not support simultaneousRxDataSSB-DiffNumerology, UE is required to measure one of but not both CSI-RS for BFD measurement and SSB. Longer measurement period for CSI-RS based BFD is expected, and no requirements are defined.

- For FR2, when the CSI-RS for BFD measurement on one CC fully or partially overlaps with the OFDM symbol as SSB from candidate LTM neighbor cell for intra-frequency L1-RSRP measurement or inter-frequency L1-RSRP measurement without gap in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer measurement period for CSI-RS based BFD is expected, and no requirements are defined.

For FR2, when the CSI-RS for BFD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band,

- In the following cases, UE is required to measure one of but not both CSI-RS for BFD measurement and the other CSI-RS. Longer measurement period for CSI-RS based BFD measurement is expected, and no requirements are defined.

- The CSI-RS for BFD measurement or the other CSI-RS in a resource set configured with repetition ON, or

- The other CSI-RS is configured in two sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ and beam failure is detected, or

- The two CSI-RS-es are not QCL-ed w.r.t. QCL-TypeD, or the QCL information is not known to UE,

- Otherwise, UE shall be able to measure the CSI-RS for BFD measurement without any restriction.

For FR2-1, there is no measurement restriction allowed for UE supporting [TBD - multi-rx capability] according to the conditions in clause 3.6.x, and the UE is required to measure both the CSI-RS for BFD and the other CSI-RS for RLM, BFD or L1-RSRP measurement, provided the following conditions are met:

- Both CSI-RSs are not in any CSI-RS resource set with repetition ON

- [FFS: The two CSI-RS resources are overlapped on the same OFDM symbol.]

- [The two CSI-RS resources and both PDSCH are overlapped on the same OFDM symbol.]

 Editor’s note: FFS whether CSI-RS need to overlap with PDSCH for measurement restriction

- The CSI-RS and both of the PDSCHs are on the same OFDM symbol(s).

- One CSI-RS has same QCL source as the active TCI state of one PDSCH, and the other CSI-RS has same QCL source as the active TCI state of the other PDSCH

- Resources of the active TCI states for the two PDSCHs have been reported as a resource group in Rel-17 group-based RSRP report.

- [FFS how to capture UE is activated with multi-Rx operation]

When two CSI-RSs for BFD measurements are from different sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$, UE shall be able to perform measure both CSI-RSs for BFD measurements.

<End of Change #2>

<Start of Change #3>

### 8.18.6 Requirements for CSI-RS based candidate beam detection

#### 8.18.6.1 Introduction

The requirements in this clause apply for each CSI-RS resource in the sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ configured for a serving cell, provided that the CSI-RS resources configured for candidate beam detection are actually transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.18.6.2.

**--- Unchanged texts/clauses omitted ---**

#### 8.18.6.3 Measurement restriction for CSI-RS based candidate beam detection

The SSB mentioned in this clause can be associated with either the serving cell PCI or a PCI different from serving cell PCI.

For both FR1 and FR2, when the CSI-RS for CBD measurement is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement, UE is not required to receive CSI-RS for CBD measurement in the PRBs that overlap with an SSB.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has same SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement without restrictions.

For FR1, when the SSB for RLM, BFD, CBD or L1-RSRP measurement is within the active BWP and has different SCS than CSI-RS for CBD measurement, the UE shall be able to perform CSI-RS based CBD measurement with restrictions according to its capabilities:

- If the UE supports *simultaneousRxDataSSB-DiffNumerology* the UE shall be able to perform CSI-RS based CBD measurement for without restrictions.

- If the UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer measurement period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR1, when the CSI-RS for CBD measurement is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement, UE shall be able to measure the CSI-RS for CBD measurement without any restriction.

For FR2, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as SSB for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined.

For FR2, when the CSI-RS for CBD measurement on one CC is in the same OFDM symbol as another CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and the other CSI-RS. Longer evaluation period for CSI-RS based CBD measurement is expected, and no requirements are defined. When two CSI-RSs for CBD measurements are from different sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$, UE shall be able to measure both CSI-RSs for CBD measurements.

For UE incapable of [capability of measurement with RTD>CP] and for UE capable of [capability of measurement with RTD>CP],

- For both FR1 and FR2, when the CSI-RS for CBD measurement fully or partially overlaps with the OFDM symbol as SSB from candidate LTM neighbor cell for intra-frequency L1-RSRP measurement or inter-frequency L1-RSRP measurement without gap, UE is not required to receive CSI-RS for CBD measurement in the PRBs that overlap with an SSB.

- For FR1, when the CSI-RS for CBD measurement fully or partially overlaps with the OFDM symbol as SSB from candidate LTM neighbor cell for intra-frequency L1-RSRP measurement or inter-frequency L1-RSRP measurement without gap, if CSI-RS and SSB have different SCS and UE does not support simultaneousRxDataSSB-DiffNumerology, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer measurement period for CSI-RS based CBD is expected, and no requirements are defined.

- For FR2, when the CSI-RS for CBD measurement on one CC fully or partially overlaps with the OFDM symbol as SSB from candidate LTM neighbor cell for intra-frequency L1-RSRP measurement or inter-frequency L1-RSRP measurement without gap in the same band, UE is required to measure one of but not both CSI-RS for CBD measurement and SSB. Longer measurement period for CSI-RS based CBD is expected, and no requirements are defined.

<End of Change #3>

<Start of Change #4>

### 8.18.8 Scheduling availability of UE during TRP specific beam failure detection

Scheduling availability restrictions when the UE is performing TRP specific beam failure detection are described in the following clauses.

#### 8.18.8.1 Scheduling availability of UE performing TRP specific beam failure detection with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to TRP specific beam failure detection performed on SSB and CSI-RS configured for BFD with the same SCS as PDSCH or PDCCH in FR1.

#### 8.18.8.2 Scheduling availability of UE performing TRP specific beam failure detection with a different subcarrier spacing than PDSCH/PDCCH on FR1

For UEs which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to TRP specific beam failure detection when SSB is configured as BFD. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to TRP specific beam failure detection when SSB is configured as BFD.

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for TRP specific beam failure detection.

When intra-band carrier aggregation in FR1 is configured, the scheduling restrictions on FR1 serving PCell or PSCell apply to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols. When inter-band carrier aggregation within FR1 is configured, there are no scheduling restrictions on FR1 serving cell(s) configured in other bands than the bands in which PCell or PSCell is configured.

#### 8.18.8.3 Scheduling availability of UE performing TRP specific beam failure detection on FR2

The following scheduling restriction applies due to TRP specific beam failure detection.

- For the case where no RSs are provided for BFD, or when CSI-RS is configured for BFD is explicitly configured and is type-D QCLed with active TCI state for PDCCH or PDSCH, and the CSI-RS is not in a CSI-RS resource set with repetition ON

- For FR2-1, for UE supporting [TBD - multi-rx capability] according to the conditions in clause 3.6.x, if CSI-RS for BFD and the other CSI-RS for tracking or for CQI in the same or overlapping OFDM symbol are configured with different QCL-TypeD in the PCell and the following conditions apply:

- The CSI-RS is not in a CSI-RS resource set with repetition ON, and

- The CSI-RS has same QCL source as the active TCI state of one of the PDSCHs and has different QCL-TypeD from the other PDSCH, and

- The CSI-RS and both of the PDSCHs are on the same OFDM symbol(s), or the CSI-RS and one of the PDSCHs with different QCL typeD are on the same OFDM symbol(s) when partially overlapping PDSCHs are scheduled, and

- Resources of the active TCI states for the two PDSCHs have been reported as a resource group in Rel-17 group-based RSRP report.

- Otherwise

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on BFD-RS resource symbols to be measured for TRP specific beam failure detection.

When intra-band carrier aggregation in FR2 is performed, the scheduling restrictions on FR2 serving PCell or PSCell apply to all serving cells in the same band on the symbols that fully or partially overlap with restricted symbols.

When inter-band carrier aggregation in FR2 is performed, there are no scheduling restrictions on FR2 serving cells in the bands due to beam failure detection performed on FR2 serving cell(s) in different band(s), provided that UE is capable of independent beam management on this FR2 band pair. Additionally, there is no scheduling restriction if the UE is configured with different numerology between SSB on one FR2 band and data on the other FR2 band provided the UE is configured for IBM operation for the band pair.

For FR2, if following conditions are met,

- UE has been notified about system information update through paging,

- The gap between UE’s reception of PDCCH that UE monitors in the Type2-PDCCH CSS set and that notifies system information update, and the PDCCH that UE monitors in the Type0-PDCCH CSS set, is greater than 2 slots,

For the SSB and CORESET for RMSI scheduling multiplexing patterns 3, UE is expected to receive the PDCCH that UE monitors in the Type0-PDCCH CSS set, and the corresponding PDSCH, on SSB symbols to be measured for BFD mesurement; and

For the SSB and CORESET for RMSI scheduling multiplexing patterns 2, UE is expected to receive PDSCH that corresponds to the PDCCH that UE monitors in the Type0-PDCCH CSS set, on SSB symbols to be measured for BFD mesurement.

<End of Change #4>