3GPP TSG-RAN WG4 Meeting # 109 R4-2319491

Chicago, US, November 13 – 17, 2023

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.133** | **CR** | **DraftCR** | **rev** | **-** | **Current version:** | **18.3.0** |  |
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| *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:***  | [NR\_DualTxRx\_MUSIM-Core] CR on TRP specific Link Recovery Procedures due to MUSIM gaps |
|  |  |
| ***Source to WG:*** | OPPO  |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_DualTxRx\_MUSIM-Core |  | ***Date:*** | 2023-11-03 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***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-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | With the introduction of MUSIM gaps, the existing core requirements for both L1 and L3 measurements will be impacted due to collision with MUSIM gaps. Based on the CR split, the TRP specific link recovery procedures will be updated in the draft CR. |
|  |  |
| ***Summary of change:*** | Update the evaluation period requirements for TRP specific BFD and CBD procedures due to MUSIM gaps. |
|  |  |
| ***Consequences if not approved:*** | The core requirements for for TRP specific BFD and CBD procedure will be incorrect when MUSIM gaps are configured. |
|  |  |
| ***Clauses affected:*** | 8.18 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ... |
| ***(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=8

For UE supporting *musim-GapPreference-r17* and is configured with one or more per-UE periodic MUSIM gaps,

- P value for an BFD SSB resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TSSB, SMTC period, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE periodic MUSIM gaps, per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any configured BFD SSB resource occasion:

- Ntotal is the total number of configured BFD SSB resource occasions within the window, including those overlapped with MUSIM gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of configured BFD SSB resource occasions that are not overlapped with any MUSIM gap occasions within the window W

- Navailable is the number of configured BFD SSB resource occasions that are not overlapped with any non-dropped MUSIM gap occasions nor any SMTC occasion within the window W

- TSSB is periodicity of the target SSB resource for BFD.

Requirements in this clause do not apply when Noutside MG = 0 due to fully overlapping between target SSB resource for BFD and MUSIM gap occasions within the window W.

Otherwise, when UE is not configured with periodic MUSIM gap(s) or not supporting MUSIM gap capability,

For FR1,

- $P=\frac{1}{1-\frac{T\_{SSB}}{MGRP}}$, when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the SSB.

- P=1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the SSB.

For FR2,

- $P=\frac{1}{1-\frac{T\_{SSB}}{T\_{SMTCperiod}}}$, when BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P = Psharing factor, when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- $P=\frac{1}{1-\frac{T\_{SSB}}{MGRP} - \frac{T\_{SSB}}{T\_{SMTCperiod}}}$, when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5\*TSMTCperiod

- $P=\frac{P\_{sharing factor}}{1-\frac{T\_{SSB}}{MGRP}}$, when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5\*TSMTCperiod

- $P=\frac{1}{1-\frac{T\_{SSB}}{T\_{SMTCperiod}}}$, when the BFD-RS resource is partially overlapped with measurement gap (TSSB <MGRP) and the BFD-RS resource is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap.

- $P=\frac{P\_{sharing factor}}{1-\frac{T\_{SSB}}{MGRP}}$, when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the BFD-RS resource outside measurement gap is

- not overlapped with the SSB symbols indicated by SSB-ToMeasure and 1 data symbol before each consecutive SSB symbols indicated by SSB-ToMeasure and 1 data symbol after each consecutive SSB symbols indicated by SSB-ToMeasure, given that SSB-ToMeasure is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by ss-RSSI-Measurement and 1 data symbol before each RSSI symbol indicated by ss-RSSI-Measurement and 1 data symbol after each RSSI symbol indicated by ss-RSSI-Measurement, given that ss-RSSI-Measurement is configured.

- Psharing factor = 3, otherwise.

where,

If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, TSMTCperiod corresponds to the value of higher layer parameter *smtc2*; Otherwise TSMTCperiod corresponds to the value of higher layer parameter *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, given the SMTC offset of all CCs in FR2 provided the same offset.

Longer evaluation period would be expected if the combination of BFD-RS resource, SMTC occasion and measurement gap configurations does not meet pervious conditions.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of PTRP defined in table 8.18.2.2-2 is defined as 2, if SSB/CSI-RS resource in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ are overlapped, else it is 1.

**Table 8.18.2.2-1: Evaluation period TEvaluate\_BFD\_SSB for FR1**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_BFD\_SSB (ms)**  |
| no DRX | Max(50, Ceil(5 × P) × TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 × P) × Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 × P) × TDRX |
| Note: TSSB is the periodicity of SSB in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$. TDRX is the DRX cycle length. |

**Table 8.18.2.2-2: Evaluation period TEvaluate\_BFD\_SSB for FR2**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_BFD\_SSB (ms)**  |
| no DRX | Max(50, Ceil(5 × P × N\*PTRP) × TSSB) |
| DRX cycle ≤ 320ms | Max(50, Ceil(7.5 × P × N\*PTRP) × Max(TDRX,TSSB)) |
| DRX cycle > 320ms | Ceil(5 × P × N\*PTRP) × TDRX |
| Note: TSSB is the periodicity of SSB in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$. TDRX is the DRX cycle length. |

<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

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

The value of TEvaluate\_BFD\_CSI-RS is defined in Table 8.18.3.2-1 for FR1.

The value of TEvaluate\_BFD\_CSI-RS is defined in Table 8.18.3.2-2 for FR2 with N=1. The requirements of TEvaluate\_BFD\_CSI-RS apply provided that the CSI-RS for BFD is not in a resource set configured with repetition ON. The requirements shall not apply when the CSI-RS resource in the active TCI state of CORESET is the same CSI-RS resource for BFD and the TCI state information of the CSI-RS resource is not given, wherein the TCI state information means QCL Type-D to SSB for L1-RSRP or CSI-RS with repetition ON.

For UE supporting *musim-GapPreference-r17* and is configured with one or more per-UE periodic MUSIM gaps,

- P value for an BFD CSI-RS resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TCSI-RS, SMTC period, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE periodic MUSIM gaps, per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any configured BFD CSI-RS resource occasion:

- Ntotal is the total number of configured BFD CSI-RS resource occasions within the window, including those overlapped with MUSIM gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of configured BFD CSI-RS resource occasions that are not overlapped with any MUSIM gap occasions within the window W

- Navailable is the number of configured BFD CSI-RS resource occasions that are not overlapped with any non-dropped MUSIM gap occasions nor any SMTC occasion within the window W

- TCSI-RS is periodicity of the target CSI-RS resource for BFD.

Requirements in this clause do not apply when Noutside MG = 0 due to fully overlapping between target CSI-RS resource for BFD and MUSIM gap occasions within the window W.

Otherwise, when UE is not configured with MUSIM gap,

For FR1,

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{MGRP}}$, when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the CSI-RS.

- P = 1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the CSI-RS.

For FR2,

- P = 1, when the BFD-RS resource is not overlapped with measurement gap and also not overlapped with SMTC occasion.

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{MGRP}}$, when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is not overlapped with SMTC occasion (TCSI-RS < MGRP)

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{T\_{SMTCperiod}}}$, when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P = Psharing factor, when the BFD-RS resource is not overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{MGRP} - \frac{T\_{CSI-RS}}{T\_{SMTCperiod}}}$, when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TCSI-RS < 0.5 × TSMTCperiod

- $P=\frac{P\_{sharing factor}}{1-\frac{T\_{CSI-RS}}{MGRP}}$, when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TCSI-RS = 0.5 × TSMTCperiod

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{T\_{SMTCperiod}}}$, when the BFD-RS resource is partially overlapped with measurement gap (TCSI-RS < MGRP) and the BFD-RS resource is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap.

- $P=\frac{P\_{sharing factor}}{1-\frac{T\_{CSI-RS}}{MGRP}}$, when the BFD-RS resource is partially overlapped with measurement gap and the BFD-RS resource is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the BFD-RS resource outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured,

- Psharing factor = 3, otherwise.

where,

 If the high layer in TS 38.331 [2] signaling of *smtc2* is configured, TSMTCperiod corresponds to the value of higher layer parameter *smtc2*; Otherwise TSMTCperiod corresponds to the value of higher layer parameter *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

Note: The overlap between CSI-RS for BFD and SMTC means that CSI-RS for BFD is within the SMTC window duration.

Longer evaluation period would be expected if the combination of the BFD-RS resource, SMTC occasion and measurement gap configurations does not meet pervious conditions.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer BFD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of MBFD used in Table 8.18.3.2-1 and Table 8.18.3.2-2 are defined as

- MBFD = 10, if the CSI-RS resource(s) in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ used for BFD is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PBFD used in Table 8.18.3.2-1 and Table 8.18.3.2-2 are defined as

 For each CSI-RS resource in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ configured for PCell or PSCell in EN-DC or NE-DC or SA; or PCell in NR-DC

- PBFD = 1.

For each CSI-RS resource in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ configured for PSCell in NR-DC

PBFD = 2 if UE is configured for beam failure detection on SCell, 1 otherwise.

 For each CSI-RS resource in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ configured for a SCell

- PBFD = Z in EN-DC or NE-DC or SA.

- PBFD = 2\* Z in NR-DC.

Where Z is the number of band(s) on which UE is performing beam failure detection only for SCell.

The values of PTRP define in table 8.518.3.2-2 is defined as 2,if SSB/CSI-RS resource in the two sets $\overbar{q}\_{0,0}$ and $\overbar{q}\_{0,1}$ are overalapped, else it is 1.

**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. |

<End of Change 2>

<Start of Change 3>

8.18.5 Requirements for SSB based candidate beam detection

8.18.5.1 Introduction

The requirements in this clause apply for each SSB resource in the sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$configured for a serving cell, provided that the SSBs configured for candidate beam detection (CBD) are actually transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.18.5.2. The SSB(s) in set $\overbar{q}\_{1,1}$ can be associated with an additional PCI other than serving PCI.

8.18.5.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured SSB resource in the two sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$,estimated over the last TEvaluate\_CBD\_SSB ms period becomes better than the threshold Qin\_LR provided SSB\_RP and SSB Ês/Iot are according to Annex Table B.2.4.1 for a corresponding band.

The UE shall monitor the configured SSB resources using the evaluation period in table 8.18.5.2-1 and 8.18.5.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_SSB is defined in Table 8.18.5.2-1 for FR1.

The value of TEvaluate\_CBD\_SSB is defined in Table 8.18.5.2-2 for FR2 with scaling factor N=8.

For UE supporting *musim-GapPreference-r17* and is configured with one or more per-UE periodic MUSIM gaps,

- P value for an CBD SSB resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TSSB, SMTC period, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE periodic MUSIM gaps, per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any configured CBD SSB resource occasion:

- Ntotal is the total number of configured CBD SSB resource occasions within the window, including those overlapped with MUSIM gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of configured CBD SSB resource occasions that are not overlapped with any MUSIM gap occasions within the window W

- Navailable is the number of configured CBD SSB resource occasions that are not overlapped with any non-dropped MUSIM gap occasions nor any SMTC occasion within the window W

- TSSB is periodicity of the target SSB resource for CBD.

Requirements in this clause do not apply when Noutside MG = 0 due to fully overlapping between target SSB resource for CBD and MUSIM gap occasions within the window W.

Otherwise, when UE is not configured with MUSIM gap,

For FR1,

- $P=\frac{1}{1-\frac{T\_{SSB}}{MGRP}}$, when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the SSB,

- P = 1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the SSB.

For FR2,

- $P=\frac{1}{1-\frac{T\_{SSB}}{T\_{SMTCperiod}}}$, when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

- P is Psharing factor, when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC period (TSSB = TSMTCperiod).

- $P=\frac{1}{1-\frac{T\_{SSB}}{MGRP} - \frac{T\_{SSB}}{T\_{SMTCperiod}}}$, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TSSB < 0.5 × TSMTCperiod

- $P=\frac{P\_{sharing factor}}{1-\frac{T\_{SSB}}{MGRP}}$, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TSSB = 0.5 × TSMTCperiod

- $P=\frac{1}{1-\frac{T\_{SSB}}{Min(MGRP,T\_{SMTCperiod})}}$, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- $P=\frac{P\_{sharing factor}}{1-\frac{T\_{SSB}}{MGRP}}$, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the candidate beam detection RS outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured

- Psharing factor = 3, otherwise.

where,

 If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.* TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

Longer evaluation period would be expected if the combination of the CBD-RS resource, SMTC occasion and measurement gap configurations does not meet pervious conditions.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer CBD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of PCBD used in Table 8.18.5.2-1 and Table 8.18.5.2-2 are defined as

 For each SSB resource in the sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ configured for PCell or PSCell in EN-DC or NE-DC or SA; or PCell in NR-DC

- PCBD = 1.

For each SSB resource in the sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ configured for PSCell in NR-DC

- PCBD = 2 if UE is configured for candidate beam detection on SCell, 1 otherwise.

 For each SSB resource in the sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ configured for a SCell

- PCBD = Z in EN-DC or NE-DC or SA.

- PCBD = 2\* Z in NR-DC.

 Where Z is the number of band(s) on which UE is performing beam failure detection only for SCell

- PCBD is the number of band(s) on which UE is performing candidate beam detection only for SCell.

The values of PTRP defined in table 8.18.5.2-2 is defined as 2, if SSB/CSI-RS resource in the two sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ are overlapped, else it is 1.

**Table 8.18.5.2-1: Evaluation period TEvaluate\_CBD\_SSB for FR1**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB (ms)**  |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 × P × PCBD) × TSSB) |
| DRX cycle > 320ms | Ceil(3 × P × PCBD) × TDRX |
| Note: TSSB is the periodicity of SSB in the two sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$. TDRX is the DRX cycle length. |

**Table 8.18.5.2-2: Evaluation period TEvaluate\_CBD\_SSB for FR2**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_SSB (ms)**  |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(3 × P × N × PCBD × PTRP) × TSSB) |
| DRX cycle > 320ms | Ceil(3 × P × N × PCBD × PTRP) × TDRX |
| Note: TSSB is the periodicity of SSB in the two sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$. TDRX is the DRX cycle length. |

<End of Change 3>

<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.

8.18.6.2 Minimum requirement

Upon request the UE shall be able to evaluate whether the L1-RSRP measured on the configured CSI-RS resource in sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ estimated over the last TEvaluate\_CBD\_CSI-RS [ms] period becomes better than the threshold Qin\_LR within TEvaluate\_CBD\_CSI-RS [ms] period provided CSI-RS Ês/Iot is according to Annex Table B.2.4.2 for a corresponding band.

The UE shall monitor the configured CSI-RS resources using the evaluation period in table 8.18.6.2-1 and 8.18.6.2-2 corresponding to the non-DRX mode, if the configured DRX cycle ≤ 320ms.

The value of TEvaluate\_CBD\_CSI-RS is defined in Table 8.18.6.2-1 for FR1.

The value of TEvaluate\_CBD\_CSI-RS is defined in Table 8.18.6.2-2 for FR2 with scaling factor N=8.

For UE supporting *musim-GapPreference-r17* and is configured with one or more per-UE periodic MUSIM gaps,

- P value for an CBD CSI-RS resource to be measured is defined as

- Ntotal / Noutside\_MG in FR1

- Psharing factor \* Ntotal / Noutside\_MG in FR2 with Navailable = 0

- Ntotal / Navailable in FR2 with Navailable > 0

- For a window W of duration max(TCSI-RS, SMTC period, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE periodic MUSIM gaps, per-UE measurement gaps and per-FR measurement gaps within the same FR as serving cell, and starting at the beginning of any configured CBD CSI-RS resource occasion:

- Ntotal is the total number of configured CBD CSI-RS resource occasions within the window, including those overlapped with MUSIM gap occasions or SMTC occasions within the window, and

- Noutside\_MG is the number of configured CBD CSI-RS resource occasions that are not overlapped with any MUSIM gap occasions within the window W

- Navailable is the number of configured CBD CSI-RS resource occasions that are not overlapped with any non-dropped MUSIM gap occasions nor any SMTC occasion within the window W

- TCSI-RS is periodicity of the target CSI-RS resource for CBD.

Requirements in this clause do not apply when Noutside MG = 0 due to fully overlapping between target CSI-RS resource for CBD and MUSIM gap occasions within the window W.

Otherwise, when UE is not configured with MUSIM gap,

For FR1,

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{MGRP}}$, when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, which are overlapping with some but not all occasions of the CSI-RS; and

- P = 1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the CSI-RS.

For FR2,

- P = 1, when candidate beam detection RS is not overlapped with measurement gap and also not overlapped with SMTC occasion.

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{MGRP}}$ when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is not overlapped with SMTC occasion (TCSI-RS < MGRP)

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{T\_{SMTCperiod}}}$, when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

- P =Psharing factor, when candidate beam detection RS is not overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod).

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{MGRP} - \frac{T\_{CSI-RS}}{T\_{SMTCperiod}}}$,, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and

- TSMTCperiod ≠ MGRP or

- TSMTCperiod = MGRP and TCSI-RS < 0.5 × TSMTCperiod

- $P=\frac{P\_{sharing factor}}{1-\frac{T\_{CSI-RS}}{MGRP}}$, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is not overlapped with measurement gap and TSMTCperiod = MGRP and TCSI-RS = 0.5 × TSMTCperiod

- $P=\frac{1}{1-\frac{T\_{CSI-RS}}{Min(MGRP, T\_{SMTCperiod})}}$, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially or fully overlapped with measurement gap

- $P=\frac{3}{1-\frac{T\_{CSI-RS}}{MGRP}}$,, when candidate beam detection RS is partially overlapped with measurement gap and candidate beam detection RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor = 1, if the candidate beam detection RS outside measurement gap is

- not overlapped with the SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol before each consecutive SSB symbols indicated by *SSB-ToMeasure* and 1 data symbol after each consecutive SSB symbols indicated by *SSB-ToMeasure*, given that *SSB-ToMeasure* is configured, where the *SSB-ToMeasure* is the union set of *SSB-ToMeasure* from all the configured measurement objects merged on the same serving carrier, and;

- not overlapped with the RSSI symbols indicated by *ss-RSSI-Measurement* and 1 data symbol before each RSSI symbol indicated by *ss-RSSI-Measurement* and 1 data symbol after each RSSI symbol indicated by *ss-RSSI-Measurement*, given that *ss-RSSI-Measurement* is configured.

- Psharing factor = 3, otherwise.

where,

 If the high layer in TS 38.331 [2] signaling of *smtc2* is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1*. TSMTCperiod is the shortest SMTC period among all CCs in the same FR2 band, provided the SMTC offset of all CCs in FR2 have the same offset.

Note: The overlap between CSI-RS for CBD and SMTC means that CSI-RS for CBD is within the SMTC window duration.

Longer evaluation period would be expected if the combination of the CBD-RS resource, SMTC occasion and measurement gap configurations does not meet pervious conditions.

Longer evaluation period would be expected if the CSI-RS is on the same OFDM symbols with RLM, BFD, BM-RS, or other CBD-RS, according to the measurement restrictions defined in clause 8.18.6.3.

For either an FR1 or FR2 serving cell, longer evaluation period would be expected during the period Tidentify\_CGI when the UE is requested to decode an NR CGI.

For either an FR1 or FR2 serving cell, longer CBD evaluation period would be expected during the period Tidentify\_CGI,E-UTRAN when the UE is requested to decode an LTE CGI.

The values of MCBD used in Table 8.18.6.2-1 and Table 8.18.6.2-2 are defined as

- MCBD = 3, if the CSI-RS resource configured in the sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ is transmitted with Density = 3 and over the bandwidth ≥ 24 PRBs.

The values of PCBD used in Table 8.18.6.2-1 and Table 8.18.6.2-2 are defined as

 For each CSI-RS resource in the sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ configured for PCell or PSCell in EN-DC or NE-DC or SA; or PCell in NR-DC

- PCBD = 1.

For each CSI-RS resource in the sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ configured for PSCell in NR-DC

- PCBD = 2 if UE configured for candidate beam detection on SCell, 1 otherwise.

 For each CSI-RS resource in the sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ configured for a SCell

- PCBD = Z in EN-DC or NE-DC or SA.

- PCBD = 2\* Z in NR-DC.

 Where Z is the number of band(s) on which UE is performing beam failure detection only for SCell

- PCBD is the number of band(s) on which UE is performing candidate beam detection only for SCell.

The values of PTRP defined in table 8.18.6.2-2 is defined as 2, if SSB/CSI-RS resource in the two sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$ are overlapped, else it is 1.

**Table 8.18.6.2-1: Evaluation period TEvaluate\_CBD\_CSI-RS for FR1**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluateC\_CBD\_CSI-RS (ms)**  |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × PCBD) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × PCBD) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the two sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$. TDRX is the DRX cycle length. |

**Table 8.18.6.2-2: Evaluation period TEvaluate\_CBD\_CSI-RS for FR2**

|  |  |
| --- | --- |
| **Configuration** | **TEvaluate\_CBD\_CSI-RS (ms)**  |
| non-DRX, DRX cycle ≤ 320ms | Max(25, Ceil(MCBD × P × N × PCBD × PTRP) × TCSI-RS) |
| DRX cycle > 320ms | Ceil(MCBD × P × N × PCBD × PTRP) × TDRX |
| Note: TCSI-RS is the periodicity of CSI-RS resource in the two sets $\overbar{q}\_{1,0}$ and $\overbar{q}\_{1,1}$. TDRX is the DRX cycle length. |

<End of Change 4>