**3GPP TSG-RAN WG4 Meeting # 95-e R4-2008996**

**Electronic Meeting, 25 May – 5 June, 2020**

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| *CR-Form-v11.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.133** | **CR** | 0690 | **rev** | **1** | **Current version:** | **16.3.0** |  |
|  |
| *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 | **X** | Core Network |  |

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|  |
| ***Title:***  | CR on introducing inter-frequency measurements without measurement gap (9.1.5, 9.1.6, 9.3.1, 9.3.4, 9.3.5) |
|  |  |
| ***Source to WG:*** | CMCC |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_RRM\_Enh\_Core |  | ***Date:*** | 2020-05-15 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-16 |
|  | *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-12 (Release 12)**Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
|  |  |
| ***Reason for change:*** | Inter-frequency measurements without measurement gap is introduced in Rel-16. Corresponding requirements to support such feature are missing in TS38.133 . |
|  |  |
| ***Summary of change:*** | Clause 9.1.5 introduce carrier-specific scaling factor for inter-frequency measurement without gapClause 9.1.6 introduce inter-frequency measurement for transitions from outside gaps to within gaps or vice versaClause 9.3.1 introduce the definition of inter-frequency without measurement gapClause 9.3.4 change the clause title to “inter frequency measurements with measurement gaps”, and add sub cluase 9.3.4.1 and 9.3.4.2Clause 9.3.5 new clause for inter frequency measurements without measurement gaps, including cell identification, measurement period and scheduling availability of UE during inter-frequency measurements |
|  |  |
| ***Consequences if not approved:*** | Inter-frequency measurements without measurement gap is not supported |
|  |  |
| ***Clauses affected:*** | 9.1.5, 9.1.6, 9.3.1, 9.3.4, 9.3.5 |
|  |  |
|  | **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:*** |  |
|  |  |
|  |  |

=================Start of 1st change==================

9.1.2.1 EN-DC: Measurement Gap Sharing

For E-UTRA-NR dual connectivity UE configured with per-UE measurement gap, measurement gap sharing shall be applies when UE requires measurement gaps to identify and measure cells on intra-frequency carriers or when SMTC configured for intra-frequency measurement are fully overlapping with per-UE measurement gaps, and when UE requires measurement gaps to identify and measure cells on inter-frequency carriers or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps, E-UTRA gap-needed inter-frequency carriers and inter-RAT UTRAN carriers and/or inter-RAT GSM carriers.

For E-UTRA-NR dual connectivity UE configured with per-FR1 measurement gap, measurement gap sharing shall be applied when UE requires measurement gaps to identify and measure cells on FR1 intra-frequency carriers or when SMTC configured for FR1 intra-frequency measurement are fully overlapping with per-FR1 measurement gaps, and when UE requires measuremsnt gaps to identify and measure cells on FR1 inter-frequency carriers or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps, E-UTRA gap-needed inter-frequency carriers, inter-RAT UTRAN carriers and/or inter-RAT GSM carriers.

For E-UTRA-NR dual connectivity UE configured with per-FR2 measurement gap, measurement gap sharing shall be applied when UE requires measurement gaps to identify and measure cells on FR2 intra-frequency carriers or when SMTC configured for FR2 intra-frequency measurement are fully overlapping with per-FR2 measurement gaps, and when UE requires measuremsnt gapsto identify and measure cells on FR2 inter-frequency carriers, or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps.

When network signals “01”, “10” or “11” with RRC parameter *MeasGapSharingScheme* [2][16]and the value of X is defined as in Table 9.1.2.1-1, and

- Kintra = 1 / X \* 100,

- Kinter = 1 / (100 – X) \* 100,

When network signals “00” indicating equal splitting gap sharing, X is not applied.

The RRC parameter *MeasGapSharingScheme* shall be applied to the calculation of carrier specific scaling factor as specified in clause 9.1.5.2.1.

**Table 9.1.2.1-1: Value of parameter X for EN-DC measurement gap sharing**

|  |  |
| --- | --- |
| ***measGapSharingScheme*** | **Value of X (%)** |
| ‘00’ | Equal splitting |
| ‘01’ | 25 |
| ‘10’ | 50 |
| ‘11’ | 75 |
| Note: It is left to UE implementation to determine which measurement gap sharing scheme in the table *to be applied*, when *MeasGapSharingScheme is absent and there is* no stored value in the field. |

9.1.2.1a SA: Measurement Gap Sharing

For NR standalone UE without NR-DC operation and configured with per-UE measurement gap, measurement gap sharing shall be applies when UE requires measurement gaps to identify and measure cells on intra-frequency carriers or when SMTC configured for intra-frequency measurement are fully overlapping with per-UE measurement gaps, and when UE requires measurement gaps to identify and measure cells on inter-frequency carriers, or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps, and/or inter-RAT E-UTRAN carriers, and/or inter-RAT UTRAN carriers for SRVCC.

For NR standalone UE without NR-DC operation and configured with per-FR1 measurement gap, measurement gap sharing shall be applied when UE requires measurement gaps to identify and measure cells on FR1 intra-frequency carriers or when SMTC configured for FR1 intra-frequency measurement are fully overlapping with per-FR1 measurement gaps, and when UE requires measurement gaps to identify and measure cells on FR1 inter-frequency carriers and/or inter-RAT E-UTRAN carriers, or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps, and/or inter-RAT UTRAN carriers for SRVCC.

For NR standalone UE without NR-DC operation and configured with per-FR2 measurement gap, measurement gap sharing shall be applied when UE requires measurement gaps to identify and measure cells on FR2 intra-frequency carriers or when SMTC configured for FR2 intra-frequency measurement are fully overlapping with per-FR2 measurement gaps, and when UE requires measurement gaps to identify and measure cells on FR2 inter-frequency carriers, or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps.

When network signals “01”, “10” or “11” with RRC parameter *MeasGapSharingScheme* [2] and the value of X is defined as in Table 9.1.2.1a-1, and

- Kintra = 1 / X \* 100,

- Kinter = 1 / (100 – X) \* 100,

When network signals “00” indicating equal splitting gap sharing, X is not applied.

The RRC parameter *MeasGapSharingScheme* shall be applied to the calculation of carrier specific scaling factor as specified in clause 9.1.5.2.2.

**Table 9.1.2.1a-1: Value of parameter X for NR standalone measurement gap sharing**

|  |  |
| --- | --- |
| ***measGapSharingScheme*** | **Value of X (%)** |
| ‘00’ | Equal splitting |
| ‘01’ | 25 |
| ‘10’ | 50 |
| ‘11’ | 75 |
| Note: It is left to UE implementation to determine which measurement gap sharing scheme in the table *to be applied*, when *MeasGapSharingScheme is absent and there is* no stored value in the field. |

9.1.2.1b NE-DC: Measurement Gap Sharing

For NR-E-UTRA dual connectivity UE configured with per-UE measurement gap, measurement gap sharing shall be applied when UE requires measurement gaps to identify and measure cells on intra-frequency carriers or when SMTC configured for intra-frequency measurement are fully overlapping with per-UE measurement gaps, and when UE requires measurement gaps to identify and measure cells on inter-frequency carriers, E-UTRA gap-needed inter-frequency carriers, or when SMTC configured for intra-frequency measurement are fully overlapping with per-UE measurement gaps, and/or inter-RAT E-UTRA carriers, and/or inter-RAT UTRAN carriers for SRVCC.

For NR-E-UTRA dual connectivity UE configured with per-FR1 measurement gap, measurement gap sharing shall be applied when UE requires measurement gaps to identify and measure cells on FR1 intra-frequency carriers or when SMTC configured for FR1 intra-frequency measurement are fully overlapping with per-FR1 measurement gaps, and when UE requires measurement gaps to identify and measure cells on inter-frequency carriers, or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps, E-UTRA gap-needed inter-frequency carriers, and/or inter-RAT E-UTRA carriers, and/or inter-RAT UTRAN carriers for SRVCC.

For NR-E-UTRA dual connectivity UE configured with per-FR2 measurement gap, measurement gap sharing shall be applied when UE requires measurement gaps to identify and measure cells on FR2 intra-frequency carriers or when SMTC configured for FR2 intra-frequency measurement are fully overlapping with per-FR2 measurement gaps, and when UE requires measurement gaps to identify and measure cells on FR2 inter-frequency carriers, or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps.

When network signals “01”, “10” or “11” with RRC parameter *measGapSharingConfig* [2][16] and the value of X is defined as in Table 9.1.2.1b-1, and

- Kintra = 1 / X \* 100,

- Kinter = 1 / (100 – X) \* 100,

When network signals “00” indicating equal splitting gap sharing, X is not applied.

The RRC parameter *MeasGapSharingScheme* shall be applied to the calculation of carrier specific scaling factor as specified in clause 9.1.5.2.x.

**Table 9.1.2.1b-1: Value of parameter X for NE-DC measurement gap sharing**

|  |  |
| --- | --- |
| ***measGapSharingScheme*** | **Value of X (%)** |
| ‘00’ | Equal splitting |
| ‘01’ | 25 |
| ‘10’ | 50 |
| ‘11’ | 75 |
| Note: It is left to UE implementation to determine which measurement gap sharing scheme in the table *to be applied*, when *MeasGapSharingScheme is absent and there is* no stored value in the field. |

9.1.2.1c NR-DC: Measurement Gap Sharing

For UE with NR-DC operation and configured with per-UE measurement gap, measurement gap sharing shall be applies when UE requires measurement gaps to identify and measure cells on intra-frequency carriers or when SMTC configured for intra-frequency measurement are fully overlapping with per-UE measurement gaps, and when UE requires measurement gaps to identify and measure cells on inter-frequency carriers, and/or inter-RAT E-UTRAN carriers, or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps, and/or inter-RAT UTRAN carriers for SRVCC.

For UE with NR-DC operation and configured with per-FR1 measurement gap, measurement gap sharing shall be applied when UE requires measurement gaps to identify and measure cells on FR1 intra-frequency carriers or when SMTC configured for FR1 intra-frequency measurement are fully overlapping with per-FR1 measurement gaps, and when UE requires measurement gaps to identify and measure cells on FR1 inter-frequency carriers and/or inter-RAT E-UTRAN carriers, or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps, and/or inter-RAT UTRAN carriers for SRVCC.

For UE with NR-DC operation and configured with per-FR2 measurement gap, measurement gap sharing shall be applied when UE requires measurement gaps to identify and measure cells on FR2 intra-frequency carriers or when SMTC configured for FR2 intra-frequency measurement are fully overlapping with per-FR2 measurement gaps, and when UE requires measurement gapsto identify and measure cells on FR2 inter-frequency carriers, or when SMTC configured for inter-frequency measurement are fully overlapping with per-UE measurement gaps.

When network signals “01”, “10” or “11” with RRC parameter *measGapSharingConfig* [2] and the value of X is defined as in Table 9.1.2.1c-1, and

- Kintra = 1 / X \* 100,

- Kinter = 1 / (100 – X) \* 100,

When network signals “00” indicating equal splitting gap sharing, X is not applied.

The RRC parameter *MeasGapSharingScheme* shall be applied to the calculation of carrier specific scaling factor as specified in clause 9.1.5.2.x.

**Table 9.1.2.1c-1: Value of parameter X for NR-DC measurement gap sharing**

|  |  |
| --- | --- |
| ***measGapSharingConfig*** | **Value of X (%)** |
| ‘00’ | Equal splitting |
| ‘01’ | 25 |
| ‘10’ | 50 |
| ‘11’ | 75 |
| Note: It is left to UE implementation to determine which measurement gap sharing scheme in the table *to be applied*, when *MeasGapSharingScheme is absent and there is* no stored value in the field. |

=================End of 1st change==================

=================Start of 2nd change==================

9.1.5 Carrier-specific scaling factor

This clause specifies the derivation of carrier-specific scaling factor (CSSF) values, which scale the measurement delay requirements given in clause 9.2, 9.3 and 9.4 when UE is configured to monitor multiple measurement objects. The CSSF values are categorized into CSSFoutside\_gap,i andCSSFwithin\_gap,i, for the measurements conducted outside measurement gaps and within measurement gaps, respectively.

9.1.5.1 Monitoring of multiple layers outside gaps

The carrier-specific scaling factor CSSFoutside\_gap,i for measurement object *i* derived in this chapter is applied to following measurement types:

- Intra-frequency measurement with no measurement gap in clause 9.2.5, when none of the SMTC occasions of this intra-frequency measurement object are overlapped by the measurement gap.

- Intra-frequency measurement with no measurement gap in clause 9.2.5, when part of the SMTC occasions of this intra-frequency measurement object are overlapped by the measurement gap.

- Inter-frequency measurement with no measurement gap in clause 9.3.5, when none of the SMTC occasions of this inter-frequency measurement object are overlapped by the measurement gap.

- Inter-frequency measurement with no measurement gap in clause 9.3.5, when part of the SMTC occasions of this inter-frequency measurement object are overlapped by the measurement gap.

UE is expected to conduct the measurement of this measurement object *i* only outside the measurement gaps.

If the higher layer signaling in TS 38.331 [2] signaling of *smtc2* is present and *smtc1* is fully overlapping with measurement gaps and *smtc2* is partially overlapping with measurement gaps, CSSFoutside\_gap,i and requirements derivied from CSSFoutside\_gap,i are not specified.

The UE cell identification and measurement periods derived based on CSSFoutside\_gap,i in clauses 9.2.5.1, 9.2.5.2 may be extended for measurement objects of which the cell identification and measurement periods are overlapped with Tmeasure\_SFTD1 specified in clause 9.3.8 when no measurement gaps are provided.

9.1.5.1.1 EN-DC mode: carrier-specific scaling factor for SSB-based measurements performed outside gaps

For UE configured with the E-UTRA-NR dual connectivity operation, the carrier-specific scaling factor CSSFoutside\_gap,i for intra-frequency and inter-frequency SSB-based measurements performed outside measurements gaps will be as specified in Table 9.1.5.1.1-1.

**Table 9.1.5.1.1-1: CSSFoutside\_gap,i scaling factor for EN-DC mode**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | ***CSSF*outside\_gap,i for FR1 PSCC** | ***CSSF*outside\_gap,i for FR1 SCC** | ***CSSF*outside\_gap,i for FR2 PSCC** | ***CSSF*outside\_gap,i for FR2 SCC where neighbour cell measurement is required Note 2** | ***CSSF*outside\_gap,i for FR2 SCC where neighbour cell measurement is not required** | ***CSSF*outside\_gap,i for inter-frequency MO with no measurement gp** |
| **EN-DC with FR1 only CA**  | 1 | Number of configured FR1 SCell(s)+Y | N/A | N/A | N/A | Number of configured FR1 SCell(s)+Y |
| **EN-DC with****FR2 only intra band CA**  | N/A | N/A | 1 | N/A | Number of configured FR2 SCells+Y | Number of configured FR2 SCells+Y |
| **EN-DC with****FR1 +FR2 CA (FR1 PSCell) Note 1** | 1 | 2×(Number of configured SCell(s)+Y-1) | N/A | 2 | 2×(Number of configured SCell(s) +Y -1) | 2×(Number of configured SCell(s)+Y-1) |
| **EN-DC with****FR1 +FR2 CA (FR2 PSCell) Note 1** | N/A | Number of configured SCell(s)+Y | 1 | N/A | Number of configured SCell(s) +Y | Number of configured SCell(s)+Y |
| Note 1: Only one NR FR1 operating band and one NR FR2 operating band are included for FR1+FR2 inter-band EN-DC.Note 2: Selection of FR2 SCC where neighbour cell measurement is required follows clause 9.2.3.2.Note3: Y is the number of configured inter-frequency MOs without MG that are being measured outside of MG |

9.1.5.1.2 SA mode: carrier-specific scaling factor for SSB-based measurements performed outside gaps

For UE in SA operation mode, the carrier-specific scaling factor CSSFoutside\_gap,i for intra-frequency and inter-frequency SSB-based measurements performed outside measurements gaps will be as specified in Table 9.1.5.1.2-1, which shall also be applied for a UE configured with NE-DC operation.

**Table 9.1.5.1.2-1: CSSFoutside\_gap,i scaling factor for SA mode**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | ***CSSF*outside\_gap,i for FR1 PCC** | ***CSSF*outside\_gap,i for FR1 SCC** | ***CSSF*outside\_gap,i for FR2 PCC** | ***CSSF*outside\_gap,i for FR2 SCC where neighbour cell measurement is required** | ***CSSF*outside\_gap,i for FR2 SCC where neighbour cell measurement is not required** | ***CSSF*outside\_gap,i for inter-frequency MO with no measurement gap** |
| **FR1 only CA**  | 1 | Number of configured FR1 SCell(s)+Y | N/A | N/A | N/A | Number of configured FR1 SCell(s)+Y |
| **FR2 only intra band CA**  | N/A | N/A | 1 | N/A | Number of configured FR2 SCell(s)+Y | Number of configured FR2 SCell(s)+Y |
| **FR1 +FR2 CA (FR1 PCell) Note 1** | 1 | 2×(Number of configured SCell(s)+Y-1) | N/A | 2 | 2×(Number of configured SCell(s)+Y-1) | 2×(Number of configured SCell(s)+Y-1) |
| Note 1: Only one FR1 operating band and one FR2 operating band are included for FR1+FR2 inter-band CA.Note 2: Selection of FR2 SCC where neighbour cell measurement is required follows clause 9.2.3.2.Note3: Y is the number of configured inter-frequency MOs without MG that are being measured outside of MG |

9.1.5.1.3 NR-DC mode: carrier-specific scaling factor for SSB-based measurements performed outside gaps

For UE configured with NR-DC operation, the carrier-specific scaling factor CSSFoutside\_gap,i for intra-frequency and inter-frequency SSB-based measurements performed outside measurements gaps will be as specified in Table 9.1.5.1.3-1.

**Table 9.1.5.1.3-1: CSSFoutside\_gap,i scaling factor for NR-DC mode**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scenario** | ***CSSF*outside\_gap,i for FR1 PCC** | ***CSSF*outside\_gap,i for FR1 SCC** | ***CSSF*outside\_gap,i for FR2 PSCC** | ***CSSF*outside\_gap,i for FR2 SCC where neighbour cell measurement is not required** | ***CSSF*outside\_gap,i for inter-frequency MO with no measurement gap** |
| **FR1 + FR2 NR-DC (FR1 PCell and FR2 PScell) Note 1** | 1 | 2×(Number of configured SCell(s)+Y) | 2 | 2×(Number of configured SCell(s)+Y) | 2×(Number of configured SCell(s)+Y) |
| Note 1: NR-DC in Rel-15 only includes the scenarios where all serving cells in MCG in FR1 and all serving cells in SCG in FR2.Note 2: Y is the number of configured inter-frequency MOs without MG that are being measured outside of MG |

9.1.5.1.4 NE-DC mode: carrier-specific scaling factor for SSB-based measurements performed outside gaps

For UE configured with NE-DC operation, the carrier-specific scaling factor CSSFoutside\_gap,i for intra-frequency and inter-frequency SSB-based measurements performed outside measurements gaps will be as specified in Table 9.1.5.1.4-1.

**Table 9.1.5.1.4-1: CSSFoutside\_gap,i scaling factor for NE-DC mode**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | ***CSSF*outside\_gap,i for FR1 PCC** | ***CSSF*outside\_gap,i for FR1 SCC** | ***CSSF*outside\_gap,i for FR2 PCC** | ***CSSF*outside\_gap,i for FR2 SCC where neighbour cell measurement is required** | ***CSSF*outside\_gap,i for FR2 SCC where neighbour cell measurement is not required** | ***CSSF*outside\_gap,i for inter-frequency MO with no measurement gap** |
| **NE-DC with FR1 only CA**  | 1 | Number of configured FR1 SCell(s)+Y | N/A | N/A | N/A | Number of configured FR1 SCell(s)+Y |
| **NE-DC with FR2 only intra band CA**  | N/A | N/A | 1 | N/A | Number of configured FR2 SCell(s)+Y | Number of configured FR2 SCell(s)+Y |
| **NE-DC with FR1 +FR2 CA (FR1 PCell) Note 1** | 1 | 2×(Number of configured SCell(s)+Y-1) | N/A | 2 | 2×(Number of configured SCell(s)+Y-1) | 2×(Number of configured SCell(s)+Y-1) |
| Note 1: Only one FR1 operating band and one FR2 operating band are included for FR1+FR2 inter-band CA.Note 2: Selection of FR2 SCC where neighbour cell measurement is required follows clause 9.2.3.2.Note3: Y is the number of configured inter-frequency MOs without MG that are being measured outside of MG |

9.1.5.2 Monitoring of multiple layers within gaps

The carrier-specific scaling factor CSSFwithin\_gap,i for a measurement object *i* derived in this chapter is applied to following measurement types:

- Intra-frequency measurement object with no measurement gap in clause 9.2.5, when all of the SMTC occasions of this intra-frequency measurement object are overlapped by the measurement gap.

- Intra-frequency measurement object with measurement gap in clause 9.2.6.

- Inter-frequency measurement with no measurement gap in clause 9.3, when all of the SMTC occasions of this inter-frequency measurement object are overlapped by the measurement gap.

- Inter-frequency measurement object with measurement gap in clause 9.3.

- E-UTRA Inter-RAT measurement object in clauses 9.4.2 and 9.4.3.

- E-UTRA Inter-RAT RSTD and E-CID measurements in clauses 9.4.4 and 9.4.5.

- NR Inter-RAT measurement object configured by the E-UTRAN PCell (TS 36.133 [15] clause 8.17.4).

- E-UTRAN Inter-frequency measurement object configured by the E-UTRAN PCell (TS 36.133 [15] clause 8.17.3) and by the E-UTRAN PSCell (TS 36.133 [15] clause 8.19.3).

- E-UTRAN Inter-frequency RSTD measurement configured by the E-UTRAN PCell (TS 36.133 [15] clause 8.17.15).

- UTRA Inter-RAT measurement object configured by the E-UTRAN PCell (TS 36.133 [15] clauses 8.17.5 to 8.17.12).

- GSM Inter-RAT measurements configured by the E-UTRAN PCell (TS 36.133 [15] clauses 8.17.13 and 8.17.14).

UE is expected to conduct the measurement of this measurement object *i* only within the measurement gaps.

If the higher layer signaling in TS 38.331 [2] signaling of *smtc2* is present and *smtc1* is fully overlapping with measurement gaps and *smtc2* is partially overlapping with measurement gaps, CSSFwithin\_gap,i and requirements derivied from CSSFoutside\_gap,i are not specified.

=================End of 2nd change==================

=================Start of 3rd change==================

9.1.6 Minimum requirement at transitions

When the measurement on one intra-frequency measurement object or inter-frequency measurement object transitions from measurements performed outside gaps to measurements performed within gaps or vice versa during one measurement period, the cell identification and measurement period requirements with the longer delay apply.

The carrier-specific scaling factor specified in clause 9.1.5 that applies to the other impacted measurement objects will also apply based on the longer measurement or cell identification delay before or after the transition.

When the UE transitions between DRX and non-DRX or when DRX cycle periodicity changes, the cell identification and measurement period requirements apply based on the longer delay before or after the transition.

Subsequent to this measurement period, the cell identification and measurement period requirements on each measurement object are corresponding to the second mode after transition.

=================End of 3rd change==================

=================Start of 4th change==================

9.3.1 Introduction

A measurement is defined as an SSB based inter-frequency measurement provided it is not defined as an intra-frequency measurement according to clause 9.2.

The UE shall be able to identify new inter-frequency cells and perform SS-RSRP, SS-RSRQ, and SS-SINR measurements of identified inter-frequency cells if carrier frequency information is provided by PCell or PSCell, even if no explicit neighbour list with physical layer cell identities is provided.

The UE can perform inter-frequency SSB based measurements without measurement gaps if

- the SSB is completely contained in the active BWP of the UE.

For inter-frequency SSB based measurements without measurement gaps, UE may cause scheduling restriction as specified in section 9.3.5.3.

SSB based measurements are configured along with a measurement timing configuration (SMTC) per carrier, which provides periodicity, duration and offset information on a window of up to 5ms where the measurements on the configured inter-frequency carrier are to be performed. For inter-frequency connected mode measurements, one measurement window periodicity may be configured per inter-frequency measurement object.

When measurement gaps are needed, the UE is not expected to detect SSB on an inter-frequency measurement object which start earlier than the gap starting time + switching time, nor detect SSB which ends later than the gap end – switching time. When the inter-frequency cells are in FR2 and the per-FR gap is configured to the UE in EN-DC, SA NR, NE-DC and NR-DC, or the serving cells are in FR2, the inter-frequency cells are in FR2 and the per-UE gap is configured to the UE in SA NR and NR-DC, the switching time is 0.25ms. Otherwise the switching time is 0.5ms.

=================End of 4th change==================

=================Start of 5th change==================

9.3.4 Inter frequency measurement with measurement gaps

9.3.4.1 Inter frequency Cell identification

When measurement gaps are provided, or the UE supports capability of conducting such measurements without gaps, the UE shall be able to identify a new detectable inter frequency cell within Tidentify\_inter\_without\_index if UE is not indicated to report SSB based RRM measurement result with the associated SSB index (*reportQuantityRsIndexes* or *maxNrofRSIndexesToReport* is not configured). Otherwise UE shall be able to identify a new detectable inter frequency cell within Tidentify\_inter\_with\_index. The UE shall be able to identify a new detectable inter frequency SS block of an already detected cell within Tidentify\_inter\_without\_index.

Tidentify\_inter\_without\_index = (TPSS/SSS\_sync\_inter + T SSB\_measurement\_period\_inter) ms

Tidentify\_inter\_with\_index = (TPSS/SSS\_sync\_inter + T SSB\_measurement\_period\_inter + TSSB\_time\_index\_inter) ms

Where:

 TPSS/SSS\_sync\_inter: it is the time period used in PSS/SSS detection given in table 9.3.4-1 and table 9.3.4-2.

 TSSB\_time\_index\_inter: it is the time period used to acquire the index of the SSB being measured given in table 9.3.4-3 and table 9.3.4-4.

 TSSB\_measurement\_period\_inter: equal to a measurement period of SSB based measurement given in table 9.3.5-1 and table 9.3.5-2.

Mpss/sss\_sync\_inter: For a UE supporting FR2 power class 1, Mpss/sss\_sync\_inter = 64 samples. For a UE supporting FR2 power class 2, Mpss/sss\_sync\_inter = 40 samples. For a UE supporting FR2 power class 3, Mpss/sss\_sync\_inter = 40 samples. For a UE supporting FR2 power class 4, Mpss/sss\_sync\_inter = 40 samples.

MSSB\_index\_inter: For a UE supporting FR2 power class 1, MSSB\_index\_inter = 40 samples. For a UE supporting FR2 power class 2, MSSB\_index\_inter = 24 samples. For a UE supporting FR2 power class 3, MSSB\_index\_inter = 24 samples. For a UE supporting FR2 power class 4, MSSB\_index\_inter = 24 samples.

Mmeas\_period\_inter: For a UE supporting FR2 power class 1, Mmeas\_period\_inter =64 samples. For a UE supporting FR2 power class 2, Mmeas\_period\_inter=40 samples. For a UE supporting FR2 power class 3, Mmeas\_period\_inter =40 samples. For a UE supporting FR2 power class 4, Mmeas\_period\_inter = 40 samples.

 CSSFinter: it is a carrier specific scaling factor and is determined according to CSSFwithin\_gap,i in clause 9.1.5.2 for measurement conducted within measurement gaps.

**Table 9.3.4-1: Time period for PSS/SSS detection (Frequency range FR1)**

|  |  |
| --- | --- |
| **Condition NOTE1,2** | **TPSS/SSS\_sync\_inter** |
| No DRX |  Max(600ms, 8 × Max(MGRP, SMTC period)) × CSSFinter |
| DRX cycle ≤ 320ms | Max(600ms, Ceil(8\*1.5) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter |
| DRX cycle > 320ms | 8 × DRX cycle × CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: In EN-DC operation, the parameters, timers and scheduling requests referred to in clause 3.6.1 are for the secondary cell group. The DRX cycle is the DRX cycle of the secondary cell group. |

**Table 9.3.4-2: Time period for PSS/SSS detection, (Frequency range FR2)**

|  |  |
| --- | --- |
| **Condition NOTE1,2** | **TPSS/SSS\_sync\_inter** |
| No DRX | Max(600ms, Mpss/sss\_sync\_inter × Max(MGRP, SMTC period)) × CSSFinter |
| DRX cycle ≤ 320ms | Max(600ms, (1.5 × Mpss/sss\_sync\_inter) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter |
| DRX cycle > 320ms | Mpss/sss\_sync\_inter × DRX cycle × CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: In EN-DC operation, the parameters, timers and scheduling requests referred to in clause 3.6.1 are for the secondary cell group. The DRX cycle is the DRX cycle of the secondary cell group. |

**Table 9.3.4-3: Time period for time index detection (Frequency range FR1)**

|  |  |
| --- | --- |
| **Condition NOTE1,2** | **TSSB\_time\_index\_inter** |
| No DRX | Max(120ms, 3 × Max(MGRP, SMTC period)) × CSSFinter |
| DRX cycle ≤ 320ms | Max(120ms, Ceil(3 × 1.5) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter |
| DRX cycle > 320ms | 3 × DRX cycle × CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: In EN-DC operation, the parameters, timers and scheduling requests referred to in clause 3.6.1 are for the secondary cell group. The DRX cycle is the DRX cycle of the secondary cell group. |

**Table 9.3.4-4: Time period for time index detection (Frequency range FR2)**

|  |  |
| --- | --- |
| **Condition NOTE1,2** | **TSSB\_time\_index\_inter** |
| No DRX | Max(200ms, MSSB\_index\_inter × Max(MGRP, SMTC period)) × CSSFinter |
| DRX cycle ≤ 320ms | Max(200ms, (1.5 × MSSB\_index\_inter) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter |
| DRX cycle > 320ms | MSSB\_index\_inter × DRX cycle × CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: In EN-DC operation, the parameters, timers and scheduling requests referred to in clause 3.6.1 are for the secondary cell group. The DRX cycle is the DRX cycle of the secondary cell group. |

9.3.4.2 Measurement period

When measurement gaps are provided for inter frequency measurements, or the UE supports capability of conducting such measurements without gaps, the UE physical layer shall be capable of reporting SS-RSRP, SS-RSRQ and SS-SINR measurements to higher layers with measurement accuracy as specified in sub-clauses 10.1.4, 10.1.5, 10.1.9, 10.1.10, 10.1.14 and 10.1.15, respectively, as shown in table 9.3.5-1 and 9.3.5-2:

**Table 9.3.5-1: Measurement period for inter-frequency measurements with gaps (Frequency FR1)**

|  |  |
| --- | --- |
| **Condition NOTE1,2** | **T SSB\_measurement\_period\_inter** |
| No DRX | max(200ms, (8) x max(MGRP, SMTC period)) x CSSFinter |
| DRX cycle ≤ 320ms | max(200ms, ceil(8 x 1.5) x max(MGRP, SMTC period, DRX cycle)) x CSSFinter |
| DRX cycle > 320ms | (8) x DRX cycle x CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: In EN-DC operation, the parameters, timers and scheduling requests referred to in clause 3.6.1 are for the secondary cell group. The DRX cycle is the DRX cycle of the secondary cell group. |

**Table 9.3.5-2: Measurement period for inter-frequency measurements with gaps (Frequency FR2)**

|  |  |
| --- | --- |
| **Condition NOTE1,2** | **T SSB\_measurement\_period\_inter** |
| No DRX | max(400ms, Mmeas\_period\_inter x max(MGRP, SMTC period)) x CSSFinter |
| DRX cycle ≤ 320ms | max(400ms, (1.5 x Mmeas\_period\_inter) x max(MGRP, SMTC period, DRX cycle)) x CSSFinter |
| DRX cycle > 320ms | Mmeas\_period\_inter x DRX cycle x CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: In EN-DC operation, the parameters, timers and scheduling requests referred to in clause 3.6.1 are for the secondary cell group. The DRX cycle is the DRX cycle of the secondary cell group. |

9.3.5 Inter frequency measurements without measurement gaps

9.3.5.1 Inter frequency Cell identification

UE shall be able to identify a new detectable inter frequency cell within Tidentify\_inter\_without\_index if UE is not indicated to report SSB based RRM measurement result with the associated SSB index (*reportQuantityRsIndexes* or *maxNrofRSIndexesToReport* is not configured). Otherwise UE shall be able to identify a new detectable inter frequency cell within Tidentify\_inter\_with\_index. The UE shall be able to identify a new detectable inter frequency SS block of an already detected cell within Tidentify\_inter\_without\_index.

Tidentify\_inter\_without\_index = (TPSS/SSS\_sync\_inter + T SSB\_measurement\_period\_inter) ms

Tidentify\_inter\_with\_index = (TPSS/SSS\_sync\_inter + T SSB\_measurement\_period\_inter + TSSB\_time\_index\_inter) ms

Where:

 TPSS/SSS\_sync\_inter: it is the time period used in PSS/SSS detection given in table 9.3.4-1 and table 9.3.4-2.

 TSSB\_time\_index\_inter: it is the time period used to acquire the index of the SSB being measured given in table 9.3.4-3 and table 9.3.4-4.

 T SSB\_measurement\_period\_inter: equal to a measurement period of SSB based measurement given in table 9.3.5-1 and table 9.3.5-2.

 CSSFinter: it is a carrier specific scaling factor and is determined according to CSSFoutside\_gap,i in clause 9.1.5.1 for measurement conducted outside measurement gaps, i.e. when interfrequency SMTC is fully non overlapping or partially overlapping with measurement gaps.

Mpss/sss\_sync\_inter: For a UE supporting FR2 power class 1, Mpss/sss\_sync\_inter = 40 samples. For a UE supporting FR2 power class 2, Mpss/sss\_sync\_inter = 24 samples. For a UE supporting FR2 power class 3, Mpss/sss\_sync\_inter = 24 samples. For a UE supporting FR2 power class 4, Mpss/sss\_sync = 24 samples.

MSSB\_index\_inter: For a UE supporting power class 1, MSSB\_index\_inter = 40 samples. For a vehicle mounted UE supporting power class 2, Mpss/sss\_sync\_inter = 24 samples. For a UE supporting power class 3, MSSB\_index\_inter = 24 samples. For a UE supporting power class 4, Mmeas\_period\_inter = 24 samples.

Mmeas\_period\_inter: For a UE supporting FR2 power class 1, Mmeas\_period\_inter =40 samples. For a vehicle mounted UE supporting FR2 power class 2, Mpss/sss\_sync\_inter=24 samples. For a UE supporting FR2 power class 3, Mmeas\_period\_inter =24 samples. For a UE supporting FR2 power class 4, Mmeas\_period\_inter = 24 samples.

When interfrequency SMTC is fully non overlapping with measurement gaps or interfrequency SMTC is fully overlapping with MGs, Kp=1.

When interfrequency SMTC is partially overlapping with measurement gaps, Kp = 1/(1- (SMTC period /MGRP)), where SMTC period < MGRP.

**Table 9.3.4-1: Time period for PSS/SSS detection, (Frequency range FR1)**

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync\_inter** |
| No DRX | max( 600ms, ceil( 5 x Kp) x SMTC period )Note 1 x CSSFinter |
| DRX cycle≤ 320ms | max( 600ms, ceil(1.5x 5 x Kp) x max(SMTC period,DRX cycle)) x CSSFinter |
| DRX cycle>320ms | ceil(5 x Kp) x DRX cycle x CSSFinter |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified |

**Table 9.3.4-2: Time period for PSS/SSS detection, (Frequency range FR2)**

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync\_inter** |
| No DRX | max(600ms, ceil(Mpss/sss\_sync\_inter x Kp)x SMTC period)Note 1 x CSSFinter |
| DRX cycle≤ 320ms | max(600ms, ceil(1.5 x Mpss/sss\_sync\_inter x Kp)x max(SMTC period,DRX cycle)) x CSSFinter |
| DRX cycle>320ms | ceil(Mpss/sss\_sync\_inter x Kp) x DRX cycle x CSSFinter |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified |

**Table 9.3.4-3: Time period for time index detection (Frequency range FR1)**

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index\_intra** |
| No DRX | max(120ms, ceil( 3 x Kp )x SMTC period)Note 1 x CSSFinter |
| DRX cycle≤ 320ms | max(120ms, ceil (1.5 x 3 x Kp) x max(SMTC period,DRX cycle)) x CSSFinter |
| DRX cycle>320ms | Ceil(3 x Kp) x DRX cycle x CSSFinter |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified |

**Table 9.3.4-4: Time period for time index detection (Frequency range FR2)**

|  |  |
| --- | --- |
| **Condition NOTE1,2** | **TSSB\_time\_index\_inter** |
| No DRX | max(200ms, MSSB\_index\_inter x max(MGRP, SMTC period)) x CSSFinter |
| DRX cycle ≤ 320ms | max(200ms, (1.5 x MSSB\_index\_inter) x max(MGRP, SMTC period, DRX cycle)) x CSSFinter |
| DRX cycle > 320ms | MSSB\_index\_inter x DRX cycle x CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: In EN-DC operation, the parameters, timers and scheduling requests referred to in clause 3.6.1 are for the secondary cell group. The DRX cycle is the DRX cycle of the secondary cell group. |

9.3.5.2 Measurement period

The UE physical layer shall be capable of reporting SS-RSRP, SS-RSRQ and SS-SINR measurements to higher layers with measurement accuracy as specified in sub-clauses 10.1.4, 10.1.5, 10.1.9, 10.1.10, 10.1.14 and 10.1.15, respectively, as shown in table 9.3.5-1 and 9.3.5-2:

**Table 9.3.5-1: Measurement period for inter-frequency measurements with gaps (Frequency FR1)**

|  |  |
| --- | --- |
| **DRX cycle** | **T SSB\_measurement\_period\_intra**  |
| No DRX | max(200ms, ceil( 5 x Kp) x SMTC period)Note 1 x CSSFinter |
| DRX cycle≤ 320ms | max(200ms, ceil(1.5x 5 x Kp) x max(SMTC period,DRX cycle)) x CSSFinter |
| DRX cycle>320ms | ceil( 5 x Kp ) x DRX cycle x CSSFinter |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified |

**Table 9.3.5-2: Measurement period for inter-frequency measurements with gaps (Frequency FR2)**

|  |  |
| --- | --- |
| **DRX cycle** | **T SSB\_measurement\_period\_intra**  |
| No DRX | max(400ms, ceil(Mmeas\_period\_inter x Kp) x SMTC period)Note 1 x CSSFinter |
| DRX cycle≤ 320ms | max(400ms, ceil(1.5x Mmeas\_period\_inter x Kp) x max(SMTC period,DRX cycle)) x CSSFinter  |
| DRX cycle>320ms | ceil(Mmeas\_period\_inter xKp) x DRX cycle x CSSFinter |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified |

9.3.5.3 Scheduling availability of UE during inter-frequency measurements

UE are required to be capable of measuring without measurement gaps when the SSB is completely contained in the active bandwidth part of the UE. When any of the conditions in the following clauses is met, there are restrictions on the scheduling availability; otherwise, there is no scheduling restriction. Note that the SSB symbols to be measured in the following clauses are all *L* SSB symbols within SMTC window duration defined in clause 4.1 of TS 38.213 [3].

The scheduling availability requirements when UE performs inter-frequency measurements without measurement gaps in a TDD bands on FR1 and FR2 in clause 9.2.5.3.1~9.2.5.3.3 are valid under the following conditions:

 • SFN and frame boundary across serving cell and inter-frequency neighbor cells is aligned, and

 • the timing of SSBs across serving cell and inter-frequency neighbor cells are aligned

9.2.5.3.1 Scheduling availability of UE performing measurements in TDD bands on FR1

When UE performs inter-frequency measurements without measurement gaps in a TDD band, the following restrictions apply due to SS-RSRP or SS-SINR measurement

- UE is not expected to transmit PUCCH/PUSCH/SRS on SSB symbols to be measured, and on 1 data symbol before each consecutive SSB symbols to be measured and 1 data symbol after each consecutive SSB symbols to be measured within SMTC window duration.

When UE performs inter-frequency measurements without measurement gaps in a TDD band, the following restrictions apply due to SS-RSRQ measurement

- UE is not expected to transmit PUCCH/PUSCH/SRS on SSB symbols to be measured, RSSI measurement symbols, and on 1 data symbol before each consecutive SSB to be measured/RSSI symbols and 1 data symbol after each consecutive SSB to be measured/RSSI symbols within SMTC window duration.

When TDD intra-band carrier aggregation is performed, the scheduling restrictions due to one serving cell should also apply to all other serving cells in the same band on the symbols that fully or partially overlap with aforementioned restricted symbols.

9.2.5.3.2 Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH on FR1

For UE which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to SS-RSRP/RSRQ/SINR measurement

- If UE performs inter-frequency measurements without measurement gaps in a TDD band, UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on SSB symbols to be measured, and on 1 data symbol before each consecutive SSB symbols to be measured and 1 data symbol after each consecutive SSB symbols to be measured within SMTC window duration.

- If UE performs inter-frequency measurements without measurement gaps in a FDD band, UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on all symbols within SMTC window duration.

When intra-band carrier aggregation is performed, the scheduling restrictions due to a given serving cell should also apply to all other serving cells in the same band on the symbols that fully or partially overlap with aforementioned restricted symbols.

9.2.5.3.3 Scheduling availability of UE performing measurements on FR2

The following scheduling restriction applies due to SS-RSRP or SS-SINR measurement on an FR2 inter-frequency cell

 The UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on SSB symbols to be measured, and on 1 data symbol before each consecutive SSB symbols to be measured and 1 data symbol after each consecutive SSB symbols to be measured within SMTC window duration.

The following scheduling restriction applies to SS-RSRQ measurement on an FR2 inter-frequency cell

- The UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on SSB symbols to be measured, RSSI measurement symbols, and on 1 data symbol before each consecutive SSB to be measured/RSSI symbols and 1 data symbol after each consecutive SSB to be measured/RSSI symbols within SMTC window duration*.*

When intra-band carrier aggregation is performed, the scheduling restrictions due to a given serving cell should also apply to all other serving cells in the same band on the symbols that fully or partially overlap with aforementioned restricted symbols.

If following conditions are met:

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

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

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

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

9.2.5.3.4 Scheduling availability of UE performing measurements on FR1 or FR2 in case of FR1-FR2 inter-band CA

There are no scheduling restrictions on FR1 serving cell(s) due to measurements performed on FR2 serving cell frequency layer.

There are no scheduling restrictions on FR2 serving cell(s) due to measurements performed on FR1 serving cell frequency layer.

=================End of 5th change==================