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** 

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# Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

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x the first digit:

1 presented to TSG for information;

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

# 1 1 Scope

The present document specifies requirements for support of Radio Resource Management for the FDD and TDD modes of New Radio(NR). These requirements include requirements on measurements in NR and the UE as well as requirements on node dynamical behaviour and interaction, in terms of delay and response characteristics.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TS 38.304: "NR; User Equipment (UE) procedures in idle mode".

[2] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification".

[3] 3GPP TS 38.213: "NR; Physical layer procedures for control".

[4] 3GPP TS 38.215: "NR; Physical layer measurements".

[5] 3GPP TS 38.533: "NR; User Equipment (UE) conformance specification; Radio Resource Management (RRM)".

[6] 3GPP TS 38.211: "NR; Physical channels and modulation”.

[7] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[8] 3GPP TS 38. 212 "NR; Multiplexing and channel coding".

[9] 3GPP TS 38.202: "NR; Physical layer services provided by the physical layer".

[10] 3GPP TS 38.300: "NR; Overall description; Stage-2".

[11] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[12] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)".

[13] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception".

[14] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities".

[15] 3GPP TS 36.133: "Evolved Universal Terrestrial Radio Access (E-UTRA); Requirements for support of radio resource management".

[16] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC) protocol specification".

[17] 3GPP TS 37.340: “Evolved Universal Terrestrial Radio Access (E-UTRA) and NR; Multi-connectivity”, Stage 2.

[18] 3GPP TS 38.101-1: “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”.

[19] 3GPP TS 38.101-2: “NR; User Equipment (UE) radio transmission and reception; Part 2: Range 2 Standalone”.

[20] 3GPP TS 38.101-3: “NR; User Equipment (UE) radio transmission and reception; Part 3: Range 1 and Range 2 Interworking operation with other radios”.

[21] 3GPP TS 38.101-4: “NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements”.

[22] 3GPP TS 38.305: “NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN”.

[23] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation”.

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [11] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [11].

**Active DL BWP**: Active DL bandwidth part as defined in TS 38.213 [3].

**DL BWP**: DL bandwidth part as defined in TS 38.213 [3].

**EN-DC**: E-UTRA-NR Dual Connectivity as defined in TS 37.340 [17, Section 4.1.2].

**en-gNB**: As defined in TS 37.340 [17].

**FR1**: Frequency range 1 as defined in TS 38.104 [13, Section 5.1].

**FR2**: Frequency range 2 as defined in TS 38.104 [13, Section 5.1].

**gNB**: as defined in in TS 38.300 [10].

**Master Cell Group:** As defined in TS 38.331 [2].

**ng-eNB**: As defined in TS 38.300 [10].

**NSA operation mode**: EN-DC operation mode, where the UE is configured at least with PSCell and E-UTRA PCell.

**Primary Cell**: As defined in TS 38.331 [2].

**RLM-RS resource:** A resource out of the set of resources configured for RLM by higher layer parameter RLM-RS-List [2] as defined in TS 38.213 [3].

**SA operation mode**: Operation mode when the UE is configured with at least PCell.

**Secondary Cell**: As defined in TS 38.331 [2].

**Secondary Cell Group:** As defined in TS 38.331 [2].

**Serving Cell**: As defined in TS 38.331 [2].

**SMTC**: An SSB-based measurement timing configuration configured by *SSB-MeasurementTimingConfiguration* as specified in TS 38.331 [2].

**SSB:** SS/PBCH block as defined in TS 38.211 [6, section 7.8.3].

**Timing Advance Group**: As defined in TS 38.331 [2].

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

[…] Values included in square bracket must be considered for further studies, because it means that a decision about that value was not taken.

Tc Basic time unit, defined in TS 38.211 [6, Section 4.1].

Ts Reference time unit, defined in TS 38.211 [6, Section 4.1].

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [11] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [11].

BWP Bandwidth Part

CA Carrier Aggregation

CC Component Carrier

CP Cyclic Prefix

CSI Channel-State Information

CSI-RS CSI Reference Signal

DC Dual Connectivity

DL Downlink

DMRS Demodulation Reference Signal

DRX Discontinuous Reception

E-UTRA Evolved UTRA

E-UTRAN Evolved UTRAN

EN-DC E-UTRA-NR Dual Connectivity

FDD Frequency Division Duplex

FR Frequency Range

HARQ Hybrid Automatic Repeat Request

HO Handover

MAC Medium Access Control

MCG Master Cell Group

MGL Measurement Gap Length

MGRP Measurement Gap Repetition Period

MIB Master Information Block

NR New Radio

NSA Non-Standalone operation mode

OFDM Orthogonal Frequency Division Multiplexing

OFDMA Orthogonal Frequency Division Multiple Access

PBCH Physical Broadcast Channel

PCell Primary Cell

PLMN Public Land Mobile Network

PRACH Physical RACH

PSCell Primary SCell

PSS Primary Synchronization Signal

PUCCH Physical Uplink Control Channel

PUSCH Physical Uplink Shared Channel

RACH Random Access Channel

RAT Radio Access Technology

RLM Radio Link Monitoring

RLM-RS Reference Signal for RLM

RRC Radio Resource Control

RRM Radio Resource Management

RSSI Received Signal Strength Indicator

SA Standalone operation mode

SCell Secondary Cell

SCG Secondary Cell Group

SCS Subcarrier Spacing

SFN System Frame Number

SI System Information

SIB System Information Block

SMTC SSB-based Measurement Timing configuration

SRS Sounding Reference Signal

SS Synchronization Signal

SS-RSRP Synchronization Signal based Reference Signal Received Power

SS-RSRQ Synchronization Signal based Reference Signal Received Quality

SS-SINR Synchronization Signal based Signal to Noise and Interference Ratio

SSB Synchronization Signal Block

SSS Secondary Synchronization Signal

TA Timing Advance

TAG Timing Advance Group

TDD Time Division Duplex

TTI Transmission Time Interval

UE User Equipment

UL Uplink

## 3.4 Test tolerances

The requirements given in the present document make no allowance for measurement uncertainty. The test specification 38.5xx [x] defines the test tolerances.

*Editor’s note: intended to capture test tolerances. OTA test tolerance or margin will be captured in this section if needed.*

## 3.5 Notation for grouping

### 3.5.1 Groups of bands

The intention with the band grouping below is to increase the readability of the specification.

*Editor’s note: intended to capture band groups.*

### 3.5.2 Groups of numerologies

*Editor’s note: intended to capture numerologies groups. This section might be removed if unnecessary.*

## 3.6 Applicability of requirements in this specification version

In this specification,

- ‘cell’, ‘PCell’, ‘PSCell’ and ‘SCell’ refer to NR cell, NR PCell, NR PSCell and NR SCell,

- E-UTRA cells are referred to as ‘E-UTRA cell’, ‘E-UTRA PCell’ and ‘E-UTRA SCell’,

- E-UTRA-NR dual connectivity where E-UTRA is the master is referred to as ‘E-UTRA-NR dual connectivity’ or ‘EN-DC’.

For UE configured with supplementary UL, the requirements in section 7.1 and 7.3 shall also apply to uplink transmissions on supplementary UL.

### 3.6.1 RRC connected state requirements in DRX

For the requirements in RRC connected state specified in this version of the specification, the UE shall assume that no DRX is used provided the following conditions are met:

- DRX parameters are not configured or

- DRX parameters are configured and

- drx-InactivityTimer is running or

- drx-RetransmissionTimerDL is running or

- drx-RetransmissionTimerUL is running or

- ra-ContentionResolutionTimer is running or

- a Scheduling Request sent on PUCCH is pending or

- a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the preamble not selected by the MAC entity

Otherwise the UE shall assume that DRX is used.

# 4 SA: RRC\_IDLE state mobility

*Editor’s note: intended to capture the RRM requirements for RRC\_IDLE state in stand-alone operation.*

## 4.1 Cell Selection

After a UE has switched on and a PLMN has been selected, the Cell selection process takes place, as described in TS 38.304. This process allows the UE to select a suitable cell where to camp on in order to access available services. In this process, the UE can use stored information (*Stored information cell selection*) or not (*Initial cell selection*).

## 4.2 Cell Re-selection

### 4.2.1 Introduction

The cell reselection procedure allows the UE to select a more suitable cell and camp on it.

When the UE is in either *Camped* *Normally* state or *Camped on Any Cell* state on a cell, the UE shall attempt to detect, synchronise, and monitor intra-frequency, inter-frequency and inter-RAT cells indicated by the serving cell. For intra-frequency and inter-frequency cells the serving cell may not provide explicit neighbour list but carrier frequency information and bandwidth information only. UE measurement activity is also controlled by measurement rules defined in TS 38.304, allowing the UE to limit its measurement activity.

### 4.2.2 Requirements

#### 4.2.2.1 UE measurement capability

For idle mode cell re-selection purposes, the UE shall be capable of monitoring at least:

- Intra-frequency carrier, and

- Depending on UE capability, 7 NR inter-frequency carriers.

- Depending on UE capability, 7 FDD E-UTRA inter-RAT carriers, and

- Depending on UE capability, 7 TDD E-UTRA inter-RAT carriers, and

In addition to the requirements defined above, a UE supporting E-UTRA measurements in RRC\_IDLE state shall be capable of monitoring a total of at least 14 carrier frequency layers, which includes serving layer, comprising of any above defined combination of E-UTRA FDD, E-UTRA TDD and NR layers.

#### 4.2.2.2 Measurement and evaluation of serving cell

The UE shall measure the SS-RSRP and SS-RSRQ level of the serving cell and evaluate the cell selection criterion S defined in [1] for the serving cell at least every DRX cycle.

The UE shall filter the SS-RSRP and SS-RSRQ measurements of the serving cell using at least 2 measurements. Within the set of measurements used for the filtering, at least two measurements shall be spaced by, at least DRX cycle/2.

If the UE has evaluated according to Table 4.2.2.1-1 in Nserv consecutive DRX cycles that the serving cell does not fulfil the cell selection criterion S, the UE shall initiate the measurements of all neighbour cells indicated by the serving cell, regardless of the measurement rules currently limiting UE measurement activities.

If the UE in RRC\_IDLE has not found any new suitable cell based on searches and measurements using the intra-frequency, inter-frequency and inter-RAT information indicated in the system information for 10 s, the UE shall initiate cell selection procedures for the selected PLMN as defined in TS 38.304 [1].

Table 4.2.2.1-1: Nserv

|  |  |
| --- | --- |
| DRX cycle length [s] | Nserv [number of DRX cycles] |
| 0.32 | [4] |
| 0.64 | [4] |
| 1.28 | [2] |
| 2.56 | [2] |

#### 4.2.2.3 Measurements of intra-frequency NR cells

The UE shall be able to identify new intra-frequency cells and perform SS-RSRP and SS-RSRQ measurements of the identified intra-frequency cells without an explicit intra-frequency neighbour list containing physical layer cell identities.

The UE shall be able to evaluate whether a newly detectable intra-frequency cell meets the reselection criteria defined in TS38.304 within Tdetect,NR\_Intrawhen that Treselection= 0. An intra frequency cell is considered to be detectable according to SS-RSRP, SS-RSRP Ês/Iot defined in Annex XXX for a corresponding Band.

The UE shall measure SS-RSRP and SS-RSRQ at least every Tmeasure,NR\_Intra (see table 4.2.2.3-1) for intra-frequency cells that are identified and measured according to the measurement rules.

The UE shall filter SS-RSRP and SS-RSRQ measurements of each measured intra-frequency cell using at least 2 measurements. Within the set of measurements used for the filtering, at least two measurements shall be spaced by at least Tmeasure,NR\_Intra/2.

The UE shall not consider a NR neighbour cell in cell reselection, if it is indicated as not allowed in the measurement control system information of the serving cell.

For an intra-frequency cell that has been already detected, but that has not been reselected to, the filtering shall be such that the UE shall be capable of evaluating that the intra-frequency cell has met reselection criterion defined [1] within Tevaluate,NR\_intra when Treselection = 0as specified in table 4.2.2.3-1 provided that the cell is at least [3]dB better ranked. When evaluating cells for reselection, the side conditions for SS-RSRP apply to both serving and non-serving intra-frequency cells.

If Treselection timer has a non zero value and the intra-frequency cell is better ranked than the serving cell, the UE shall evaluate this intra-frequency cell for the Treselection time. If this cell remains better ranked within this duration, then the UE shall reselect that cell.

Table 4.2.2.3-1 : Tdetect,NR\_Intra, Tmeasure,NR\_Intra and Tevaluate, NR\_intra

|  |  |  |  |
| --- | --- | --- | --- |
| DRX cycle length [s] | Tdetect,NR\_Intra [s] (number of DRX cycles) | Tmeasure,NR\_Intra [s] (number of DRX cycles) | Tevaluate,NR\_intra  [s] (number of DRX cycles) |
| 0.32 | 11.52 x N1 [36 x N1] | 1.28 x N1 (4 x N1) | 5.12 x N1 (16 x N1) |
| 0.64 | 17.92 x N1 [28 x N1] | 1.28 x N1 (2 x N1) | 5.12 x N1 (8 x N1) |
| 1.28 | 32 x N1 [25 x N1] | 1.28 x N1 (1 x N1) | 6.4 x N1 (5 x N1) |
| 2.56 | 33.28 x N1 [23 x N1] | 2.56 x N1 (1 x N1) | 7.68 x N1 (3 x N1) |
| NOTE 1: N1=[TBD] for frequency range FR2, and N1=1 for frequency range FR1. | | | |

#### 4.2.2.4 Measurements of inter-frequency NR cells

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

If Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ then the UE shall search for inter-frequency layers of higher priority at least every Thigher\_priority\_search where Thigher\_priority\_search is described in clause 4.2.2.7.

If Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ then the UE shall search for and measure inter-frequency layers of higher, equal or lower priority in preparation for possible reselection. In this scenario, the minimum rate at which the UE is required to search for and measure higher priority layers shall be the same as that defined below.

The UE shall be able to evaluate whether a newly detectable inter-frequency cell meets the reselection criteria defined in TS38.304 within Kcarrier \* Tdetect,NR\_Inter if at least carrier frequency information is provided for inter-frequency neighbour cells by the serving cells when Treselection = 0 provided that the reselection criteria is met by a margin of at least [4.5] dB or reselections based on ranking or [4.5]dB for SSB-RSRP reselections based on absolute priorities or [TBD]dB for SSB-RSRQ reselections based on absolute priorities. The parameter Kcarrier is the number of NR inter-frequency carriers indicated by the serving cell. An inter-frequency cell is considered to be detectable according to SS-RSRP, SS-RSRP Ês/Iot defined in Annex XXX for a corresponding Band.

When higher priority cells are found by the higher priority search, they shall be measured at least every Tmeasure,NR\_Inter . If, after detecting a cell in a higher priority search, it is determined that reselection has not occurred then the UE is not required to continuously measure the detected cell to evaluate the ongoing possibility of reselection. However, the minimum measurement filtering requirements specified later in this section shall still be met by the UE before it makes any determination that it may stop measuring the cell. If the UE detects on a NR carrier a cell whose physical identity is indicated as not allowed for that carrier in the measurement control system information of the serving cell, the UE is not required to perform measurements on that cell.

The UE shall measure SS-RSRP or SS-RSRQ at least every Kcarrier \* Tmeasure,NR\_Inter (see table 4.2.2.4-1) for identified lower or equal priority inter-frequency cells. If the UE detects on a NR carrier a cell whose physical identity is indicated as not allowed for that carrier in the measurement control system information of the serving cell, the UE is not required to perform measurements on that cell.

The UE shall filter SS-RSRP or SS-RSRQ measurements of each measured higher, lower and equal priority inter-frequency cell using at least 2 measurements. Within the set of measurements used for the filtering, at least two measurements shall be spaced by at least Tmeasure,NR\_Inter/2.

The UE shall not consider a NR neighbour cell in cell reselection, if it is indicated as not allowed in the measurement control system information of the serving cell.

For an inter-frequency cell that has been already detected, but that has not been reselected to, the filtering shall be such that the UE shall be capable of evaluating that the inter-frequency cell has met reselection criterion defined TS 38.304 within Kcarrier \* Tevaluate,NR\_Inter when Treselection = 0as specified in table 4.2.2.4-1 provided that the reselection criteria is met by a margin of at least [4.5]dB for reselections based on ranking or [4.5]dB for SSB-RSRP reselections based on absolute priorities or [TBD]dB for SSB-RSRQ reselections based on absolute priorities. When evaluating cells for reselection, the side conditions for SS-RSRP apply to both serving and inter-frequency cells.

If Treselection timer has a non zero value and the inter-frequency cell is better ranked than the serving cell, the UE shall evaluate this inter-frequency cell for the Treselection time. If this cell remains better ranked within this duration, then the UE shall reselect that cell.

Table 4.2.2.4-1 : Tdetect,NR\_Inter, Tmeasure,NR\_Inter and Tevaluate,NR\_Inter

|  |  |  |  |
| --- | --- | --- | --- |
| DRX cycle length [s] | Tdetect,NR\_Intra [s] (number of DRX cycles) | Tmeasure,NR\_Intra [s] (number of DRX cycles) | Tevaluate,NR\_intra  [s] (number of DRX cycles) |
| 0.32 | 11.52 x N1 [36 x N1] | 1.28 x N1 (4 x N1) | 5.12 x N1 (16 x N1) |
| 0.64 | 17.92x N1 [28 x N1] | 1.28 x N1 (2 x N1) | 5.12 x N1 (8 x N1) |
| 1.28 | 32 x N1 [25 x N1] | 1.28 x N1 (1 x N1) | 6.4 x N1 (5 x N1) |
| 2.56 | 58.88 x N1 [23 x N1] | 2.56 x N1 (1 x N1) | 7.68 x N1 (3 x N1) |
| NOTE 1: N1=[TBD] for frequency range FR2, and N1=1 for frequency range FR1. | | | |

#### 4.2.2.5 Measurements of inter-RAT E-UTRAN cells

The requirements in this section apply for inter-RAT E-UTRAN FDD measurements and E-UTRA TDD measurements. When the measurement rules indicate that inter-RAT E-UTRAN cells are to be measured, the UE shall measure RSRP and RSRQ of detected EUTRA cells in the neighbour frequency list at the minimum measurement rate specified in this section. The parameter NEUTRA\_carrier is the number of carriers in the neighbour frequency list. The UE shall filterRSRP and RSRQ measurements of each measured EUTRA cell using at least 2 measurements. Within the set of measurements used for the filtering, at least two measurements shall be spaced by at least half the minimum specified measurement period.

The UE shall be able to evaluate whether a newly detectable inter-RAT E-UTRAN cell meets the reselection criteria defined in TS38.304 within (NEUTRA\_carrier) \* TdetectEUTRA when Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ when TreselectionRAT = 0 provided that the reselection criteria is met by a margin of at least 5dB for reselections based on ranking or 6dB for RSRP reselections based on absolute priorities or 4dB for RSRQ reselections based on absolute priorities.

Cells which have been detected shall be measured at least every (NEUTRA\_carrier) \* TmeasureEUTRA when Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ.

For a cell that has been already detected, but that has not been reselected to, the filtering shall be such that the UE shall be capable of evaluating that an already identified inter-RAT EUTRA cell has met reselection criterion defined in 3GPP TS 38.304 [1] within (NEUTRA\_carrier) \* TevaluateEUTRA when Treselection = 0as speficied in table 4.2.2.5-1 provided that the reselection criteria is met by a margin of at least 5dB for reselections based on ranking or 6dB for RSRP reselections based on absolute priorities or 4dB for RSRQ reselections based on absolute priorities.

If Treselection timer has a non zero value and the inter-RAT EUTRA cell is satisfied with the reselection criteria which are defined in [1], the UE shall evaluate this E-UTRA cell for the Treselection time. If this cell remains satisfied with the reselection criteria within this duration, then the UE shall reselect that cell.

Table 4.2.2.5-1: TdetectEUTRA, TmeasureEUTRA, and TevaluateEUTRA

|  |  |  |  |
| --- | --- | --- | --- |
| DRX cycle length [s] | Tdetect,EUTRAN [s] (number of DRX cycles) | Tmeasure,EUTRAN [s] (number of DRX cycles) | Tevaluate,E-UTRAN  [s] (number of DRX cycles) |
| 0.32 | 11.52 (36) | 1.28 (4) | 5.12 (16) |
| 0.64 | 17.92 (28) | 1.28 (2) | 5.12 (8) |
| 1.28 | 32(25) | 1.28 (1) | 6.4 (5) |
| 2.56 | 58.88 (23) | 2.56 (1) | 7.68 (3) |

4.2.2.6 Maximum interruption in paging reception

UE shall perform the cell re-selection with minimum interruption in monitoring downlink channels for paging reception.

At intra-frequency and inter-frequency cell re-selection, the UE shall monitor the downlink of serving cell for paging reception until the UE is capable to start monitoring downlink channels of the target intra-frequency and inter-frequency cell for paging reception. The interruption time shall not exceed TSI-NR + 2\*Ttarget\_cell\_SMTC\_periodms.

At inter-RAT cell re-selection, the UE shall monitor the downlink of serving cell for paging reception until the UE is capable to start monitoring downlink channels for paging reception of the target inter-RAT cell. For NR to E-UTRAN cell re-selection the interruption time must not exceed TSI-EUTRA + 55 ms.

TSI-NR is the time required for receiving all the relevant system information data according to the reception procedure and the RRC procedure delay of system information blocks defined in TS 38.331 [2] for an NR cell.

TSI-EUTRA is the time required for receiving all the relevant system information data according to the reception procedure and the RRC procedure delay of system information blocks defined in TS 36.331 [16] for an E-UTRAN cell.

These requirements assume sufficient radio conditions, so that decoding of system information can be made without errors and does not take into account cell re-selection failure.

#### 4.2.2.7 General requirements

The UE shall search every layer of higher priority at least every Thigher\_priority\_search = ([TBD] \* Nlayers) seconds, where Nlayers is the total number of higher priority NR and E-UTRA carrier frequencies broadcasted in system information.

# 5 SA: RRC\_INACTIVE state mobility

## 5.1 Cell Re-selection

### 5.1.1 Introduction

The cell reselection procedure allows the UE to select a more suitable cell and camp on it.

When the UE is in *Camped Normally* state on a cell, the UE shall attempt to detect, synchronise, and monitor intra-frequency, inter-frequency and inter-RAT cells indicated by the serving cell. For intra-frequency and inter-frequency cells the serving cell may not provide explicit neighbour list but carrier frequency information and bandwidth information only. UE measurement activity is also controlled by measurement rules defined in TS38.304, allowing the UE to limit its measurement activity.

### 5.1.2 Requirements

#### 5.1.2.1 UE measurement capability

The requirements in sub-clause 4.2.2.1 shall apply.

#### 5.1.2.2 Measurement and evaluation of serving cell

The requirements in sub-clause 4.2.2.2 shall apply.

#### 5.1.2.3 Measurements of intra-frequency NR cells

The requirements in sub-clause 4.2.2.3 shall apply.

#### 5.1.2.4 Measurements of inter-frequency NR cells

The requirements in sub-clause 4.2.2.4 shall apply.

#### 5.1.2.5 Measurements of inter-RAT E-UTRAN cells

The requirements in sub-clause 4.2.2.5 shall apply.

#### 5.1.2.6 Maximum interruption in paging reception

The requirements in sub-clause 4.2.2.6 shall apply.

#### 5.1.2.7 General requirements

The requirements in sub-clause 4.2.2.7 shall apply.

## 5.2 RRC\_INACTIVE Mobility Control

*Editor’s note: intended to capture requirements which applies for the transition between INACTIVE and IDLE state. This section might be removed if unnecessary.*

# 6 RRC\_CONNECTED state mobility

## 6.1 Handover

*Editor’s note: if handover requirements are differentiated by with beamforming and without beamforming, then two sets of requirements (with/without beamforming) could be specified in this section.*

### 6.1.1 NR Handover

#### 6.1.1.1 Introduction

#### 6.1.1.2 NR FR1 - NR FR1 Handover

The requirements in this clause are applicable to both intra-frequency and inter-frequency handovers from NR FR1 cell to NR FR1 cell.

##### 6.1.1.2.1 Handover delay

Procedure delays for all procedures that can command a handover are specified in TS 38.331 [2].

When the UE receives a RRC message implying handover the UE shall be ready to start the transmission of the new uplink PRACH channel within Dhandover seconds from the end of the last TTI containing the RRC command.

Where:

Dhandover equals the maximum RRC procedure delay to be defined in clause x.x in TS 38.331 [2] plus the interruption time stated in clause 6.1.1.2.2.

##### 6.1.1.2.2 Interruption time

The interruption time is the time between end of the last TTI containing the RRC command on the old PDSCH and the time the UE starts transmission of the new PRACH, excluding the RRC procedure delay.

When intra-frequency or inter-frequency handover is commanded, the interruption time shall be less than Tinterrupt

Tinterrupt = Tsearch + TIU + 20+ T∆ ms

Where:

Tsearch is the time required to search the target cell when the target cell is not already known when the handover command is received by the UE. If the target cell is known, then Tsearch = 0 ms. If the target cell is an unknown intra-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then Tsearch = SMTC periodicity + 5 ms. If the target cell is an unknown inter-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then Tsearch = [3\*SMTC periodicity + 5] ms. Regardless of whether DRX is in use by the UE, Tsearch shall still be based on non-DRX target cell search times.

T∆ is time for fine time tracking and acquiring full timing information of the target cell. T∆ = SMTC periodicity.

TIU is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. TIU can be up to x\*10 +10 ms. x is defined in the table 6.3.3.2-2 of [6].

NOTE 1: The actual value of TIU shall depend upon the PRACH configuration used in the target cell.

NOTE 2: if the SMTC periodicity is not configured, the term SMTC periodicity in Tsearch and T∆ shall be deemed to be replaced with SSB periodicity.

In the interruption requirement a cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds otherwise it is unknown. Relevant cell identification requirements are described in Clause 9.2.5 for intra-frequency handover and Clause 9.3.1 for inter-frequency handover.

#### 6.1.1.3 NR FR2- NR FR1 Handover

The requirements in this clause are applicable to inter-frequency handovers from NR FR2 cell to NR FR1 cell.

Requirements in clause 6.1.1.2 also apply for this section.

#### 6.1.1.4 NR FR2- NR FR2 Handover

The requirements in this clause are applicable to both intra-frequency and inter-frequency handovers from NR FR2 cell to NR FR2 cell.

##### 6.1.1.4.1 Handover delay

Procedure delays for all procedures that can command a handover are specified in TS 38.331 [2].

When the UE receives a RRC message implying handover the UE shall be ready to start the transmission of the new uplink PRACH channel within Dhandover seconds from the end of the last TTI containing the RRC command.

Where:

Dhandover equals the maximum RRC procedure delay to be defined in clause x.x in TS 38.331 [2] plus the interruption time stated in clause 6.1.1.4.2.

##### 6.1.1.4.2 Interruption time

The interruption time is the time between end of the last TTI containing the RRC command on the old PDSCH and the time the UE starts transmission of the new PRACH, excluding the RRC procedure delay.

When intra-frequency or inter-frequency handover is commanded, the interruption time shall be less than Tinterrupt

Tinterrupt = Tsearch + TIU + Tprocessing+ T∆ ms

Where:

Tsearch is the time required to search the target cell when the handover command is received by the UE. If the target cell is an intra-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then Tsearch = [N1\*SMTC periodicity + 5] ms. If the target cell is an inter-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then Tsearch = [N1\*(2 or 4)\* SMTC periodicity + 5] ms. Regardless of whether DRX is in use by the UE, Tsearch shall still be based on non-DRX target cell search times.

Tprocessing is time for UE processing. Tprocessing can be up 20ms.

T∆ is time for fine time tracking and acquiring full timing information of the target cell. T∆ = [TBD]\* SMTC periodicity.

TIU is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. TIU can be up to x\*10 +10 ms. x is defined in the table 6.3.3.2-2 of [6].

NOTE 1: The actual value of TIU shall depend upon the PRACH configuration used in the target cell.

NOTE 2: if the SMTC periodicity is not configured, the term SMTC periodicity in Tsearch and T∆ shall be deemed to be replaced with SSB periodicity.

#### 6.1.1.5 NR FR1- NR FR2 Handover

The requirements in this clause are applicable to inter-frequency handovers from NR FR1 cell to NR FR2 cell.

##### 6.1.1.5.1 Handover delay

Procedure delays for all procedures that can command a handover are specified in TS 38.331 [2].

When the UE receives a RRC message implying handover the UE shall be ready to start the transmission of the new uplink PRACH channel within Dhandover seconds from the end of the last TTI containing the RRC command.

Where:

Dhandover equals the maximum RRC procedure delay to be defined in clause x.x in TS 38.331 [2] plus the interruption time stated in clause 6.1.1.5.2.

##### 6.1.1.5.2 Interruption time

The interruption time is the time between end of the last TTI containing the RRC command on the old PDSCH and the time the UE starts transmission of the new PRACH, excluding the RRC procedure delay.

When intra-frequency or inter-frequency handover is commanded, the interruption time shall be less than Tinterrupt

Tinterrupt = Tsearch + TIU + Tprocessing+ T∆ ms

Where:

Tsearch is the time required to search the target cell when the handover command is received by the UE. If the target cell is an intra-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then Tsearch = [N1\*SMTC periodicity + 5] ms. If the target cell is an inter-frequency cell and signal quality is sufficient for successful cell detection on the first attempt, then Tsearch = [N1\*(2 or 4)\* SMTC periodicity + 5] ms. Regardless of whether DRX is in use by the UE, Tsearch shall still be based on non-DRX target cell search times.

Tprocessing is time for UE processing. Tprocessing can be up 20ms if UE provides the measurement report within the last [TBD] ms for the target cell before the handover command is received. Otherwise Tprocessing can be up 40ms.

T∆ is time for fine time tracking and acquiring full timing information of the target cell. T∆ = [TBD]\* SMTC periodicity.

TIU is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. TIU can be up to x\*10 +10 ms. x is defined in the table 6.3.3.2-2 of [6].

NOTE 1: The actual value of TIU shall depend upon the PRACH configuration used in the target cell.

NOTE 2: if the SMTC periodicity is not configured, the term SMTC periodicity in Tsearch and T∆ shall be deemed to be replaced with SSB periodicity.

### 6.1.2 NR Handover to other RATs

#### 6.1.2.1 NR – E-UTRAN Handover

##### 6.1.2.1.1 Introduction

The purpose of inter-RAT handover from NR to E-UTRAN is to change the radio access mode from NR to E-UTRAN. The handover procedure is initiated from NR with a RRC message that implies a handover as described in TS 38.331 [2].

##### 6.1.2.1.2 Handover delay

When the UE receives a RRC message implying handover to E-UTRAN the UE shall be ready to start the transmission of the uplink PRACH channel in E-UTRA within Dhandover seconds from the end of the last TTI containing the RRC command. Dhandover is defined as

Dhandover = TRRC\_procedure\_delay + Tinterruption

Where:

TRRC\_procedure\_delay: it is the RRC procedure delay, which is TBD ms

Tinterruption: it is the time between end of the last TTI containing the RRC command on the NR PDSCH and the time the UE starts transmission of the PRACH in E-UTRAN, excluding TRRC\_procedure\_delay. Tinterruption is defined in clause 6.1.1.3.

##### 6.1.2.1.3 Interruption time

When the inter-RAT handover to E-UTRAN is commanded, the interruption time shall be less than Tinterrupt

Tinterrupt = Tsearch + TIU + 20 ms

Where:

Tsearch is the time required to search the target cell when the target cell is not already known when the handover command is received by the UE. If the target cell is known, then Tsearch = 0 ms. If the target cell is unknown and signal quality is sufficient for successful cell detection on the first attempt, then Tsearch = 80 ms. Regardless of whether DRX is in use by the UE, Tsearch shall still be based on non-DRX target cell search times.

TIU is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. TIU can be up to 30 ms.

NOTE: The actual value of TIU shall depend upon the PRACH configuration used in the target cell.

In the interruption requirement a cell is known if it has been meeting the relevant cell identification requirement during the last 5 seconds otherwise it is unknown. Relevant E-UTRAN cell identification requirements are described in clause [9.4.1].

## 6.2 RRC Connection Mobility Control

### 6.2.1 SA: RRC Re-establishment

#### 6.2.1.1 Introduction

This clause contains requirements on the UE regarding RRC connection re-establishment procedure. RRC connection re-establishment is initiated when a UE in RRC\_CONNECTED state loses RRC connection due to any of failure cases, including radio link failure, handover failure, and RRC connection reconfiguration failure. The RRC connection re-establishment procedure is specified in clause 5.3.7 of TS 38.331 [2].

The requirements in this clause are applicable for RRC connection re-establishment to NR cell.

#### 6.2.1.2 Requirements

*Editor’s note: The current requirement assumes that UE still has correct SFN, frame and subframe level synchronization to the PCell during the whole procedure. In case UE has lost the SFN, frame or subframe level synchronization to the PCell, how to handle this case should be further studied.*

In RRC connected mode the UE shall be capable of sending *RRCConnectionReestablishmentRequest* message within Tre-establish\_delay seconds from the moment it detects a loss in RRC connection. The total RRC connection delay (Tre-establish\_delay) shall be less than:

TUL\_grant: It is the time required to acquire and process uplink grant from the target PCell. The uplink grant is required to transmit *RRCConnectionReestablishmentRequest* message.

The UE re-establishment delay (TUE\_re-establish\_delay) is specified in clause 6.2.1.2.1.

##### 6.2.1.2.1 UE Re-establishment delay requirement

The UE re-establishment delay (TUE\_re-establish\_delay) is the time between the moments when any of the conditions requiring RRC re-establishment as defined in clause 5.3.7 in TS 38.331 [2] is detected by the UE and when the UE sends PRACH to the target PCell. The UE re-establishment delay (TUE\_re-establish\_delay) requirement shall be less than:

The target NR cell shall be considered detectable when:

- SS-RSRP related side conditions given in Section 10.x are fulfilled for a corresponding NR Band,

- SCH\_RP and SCH Ês/Iot according to Annex TBD for a corresponding NR Band.

Tidentify\_intra\_NR: It is the time to identify the target intra-frequency NR cell and it depends on whether the target NR cell is known cell or unknown cell and on the frequency range (FR) of the target NR cell. If the UE is not configured with intra-frequency NR carrier for RRC re-establishment then Tidentify\_intra\_NR=0; otherwise Tidentify\_intra\_NR shall not exceed the values defined in table 6.2.1.2.1-1.

Tidentify\_inter\_NR,i: It is the time to identify the target inter-frequency NR cell on inter-frequency carrier *i* configured for RRC re-establishment and it depends on whether the target NR cell is known cell or unknown cell and on the frequency range (FR) of the target NR cell. Tidentify\_inter\_NR,i shall not exceed the values defined in table 6.2.1.2.1-2.

TSMTC,i: It is the periodicity of the SMTC occasion configured for the inter-frequency carrier *i*.

TSI-NR  = It is the time required for receiving all the relevant system information according to the reception procedure and the RRC procedure delay of system information blocks defined in TS 38.331 [2] for the target PCell.

TPRACH = It is the delay caused due to the random access procedure when sending random access to the target NR cell. The delay depends on the PRACH configuration defined in Table 6.3.3.2-2 [6] or Table 6.3.3.2-3 [6] for FR1 and in Table 6.3.3.2-4 [6] for FR2.

Nfreq: It is the total number of NR frequencies to be monitored for RRC re-establishment; Nfreq = 1 if the target PCell is known.

There is no requirement if the target cell does not contain the UE context.

Table 6.2.1.2.1-1: Time to identify target NR cell for RRC connection re-establishment to NR intra-frequency cell

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency range (FR) of target NR cell | Tidentify\_intra\_NR [ms] | | |
| Known NR cell | Unknown NR cell | |
| FR1 | MAX (200 ms, [5] x TSMTC) | MAX (800 ms, [10] x TSMTC) |
| FR2 | MAX (400 ms, K2 x [5] x TSMTC) | MAX (1000 ms, (K3 x [10]) x TSMTC)) |

*Editor’s note: K2 and K3 are FFS and is the number of receiver beam sweeps required to measure/detect NR cell in FR2*

Table 6.2.1.2.1-2: Time to identify target NR cell for RRC connection re-establishment to NR inter-frequency cell

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency range (FR) of target NR cell | Tidentify\_inter\_NR, i [ms] | | |
| Known NR cell | Unknown NR cell | |
| FR1 | MAX (200 ms, [6] x TSMTC, i) | MAX (800 ms, [13] x TSMTC, i) |
| FR2 | MAX (400 ms, K4 x [6] x TSMTC, i) | MAX (1000 ms, (K5 x [13]) x TSMTC, i)) |

*Editor’s note: K4 and K5 are FFS and is the number of receiver beam sweeps required to measure/detect NR cell in FR2*

### 6.2.2 Random access

#### 6.2.2.1 Introduction

This clause contains requirements on the UE regarding random access procedure. The random access procedure is initiated to establish uplink time synchronization for a UE which either has not acquired or has lost its uplink synchronization, or to convey UE’s request Other SI, or for beam failure recovery. The random access is specified in clause 8 of TS 38.213 [3] and the control of the RACH transmission is specified in clause 5.1 of TS 38.321 [7].

#### 6.2.2.2 Requirements

The UE shall have capability to calculate PRACH transmission power according to the PRACH power formula defined in TS 38.213 [3] and apply this power level at the first preamble or additional preambles. The absolute power applied to the first preamble shall have an accuracy as specified in Table 6.3.4.2-1 of TS 38.101-1 [18] for frequency range 1. The relative power applied to additional preambles shall have an accuracy as specified in Table 6.3.4.3-1 of TS 38.101-1 [18] for frequency range 1.

The UE shall indicate a Random Access problem to upper layers if the maximum number of preamble transmission counter has been reached for the random access procedure on PCell or PSCell as specified in clause 5.1.4 in TS 38.321 [7].

##### 6.2.2.2.1 Contention based random access

6.2.2.2.1.1 Correct behaviour when transmitting Random Access Preamble

With the UE selected SSB with SS-RSRP above *rsrp-ThresholdSSB*, UE shall have the capability to select a Random Access Preamble randomly with equal probability from the Random Access Preambles associated with the selected SSB if the association between Random Access Preambles and SS blocks is configured, as specified in clause 5.1.2 in TS 38.321 [7].

With the UE selected SSB with SS-RSRP above *rsrp-ThresholdSSB*, UE shall have the capability to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *ra-ssb-OccasionMaskIndex* if configured, if the association between PRACH occasions and SSBs is configured, and PRACH occasion shall be randomly selected with equal probability amongst the selected SSB associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [7].

6.2.2.2.1.2 Correct behaviour when receiving Random Access Response

The UE may stop monitoring for Random Access Response(s) and shall transmit the msg3 if the Random Access Response contains a Random Access Preamble identifier corresponding to the transmitted Random Access Preamble.

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7], and transmit with the calculated PRACH transmission power when the backoff time expires if all received Random Access Responses contain Random Access Preamble identifiers that do not match the transmitted Random Access Preamble.

6.2.2.2.1.3 Correct behaviour when not receiving Random Access Response

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7], and transmit with the calculated PRACH transmission power when the backoff time expires if no Random Access Response is received within the RA Response window defined in clause 5.1.4 in TS 38.321 [7].

6.2.2.2.1.4 Correct behaviour when receiving a NACK on msg3

The UE shall re-transmit the msg3 upon the reception of a NACK on msg3.

6.2.2.2.1.5 Correct behaviour when receiving a message over Temporary C-RNTI

The UE shall send ACK if the Contention Resolution is successful.

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7], and transmit with the calculated PRACH transmission power when the backoff time expires unless the received message includes a UE Contention Resolution Identity MAC control element and the UE Contention Resolution Identity included in the MAC control element matches the CCCH SDU transmitted in the uplink message.

6.2.2.2.1.6 Correct behaviour when contention Resolution timer expires

The UE shall re-select a preamble and transmit with the calculated PRACH transmission power when the backoff time expires if the Contention Resolution Timer expires.

##### 6.2.2.2.2 Non-Contention based random access

6.2.2.2.2.1 Correct behaviour when transmitting Random Access Preamble

If the contention-free Random Access Resources and the contention-free PRACH occasions associated with SSBs is configured, with the UE selected SSB with SS-RSRP above *rsrp-ThresholdSSB* amongst the associated SSBs, UE shall have the capability to select the Random Access Preamble corresponding to the selected SSB, and to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *ra-ssb-OccasionMaskIndex* if configured, and PRACH occasion shall be randomly selected with equal probability amongst the selected SSB associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [7].

If the contention-free Random Access Resources and the contention-free PRACH occasions associated with CSI-RSs is configured, with the UE selected CSI-RS with CSI-RSRP above *cfra-csirs-DedicatedRACH-Threshold* amongst the associated CSI-RSs, UE shall have the capability to select the Random Access Preamble corresponding to the selected CSI-RS, and to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions in *ra-OccasionList* corresponding to the selected CSI-RS, and PRACH occasion shall be randomly selected with equal probability amongst the selected CSI-RS associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [7].

If the random access procedure is initialized for beam failure recovery and if the contention-free Random Access Resources and the contention-free PRACH occasions for beam failure recovery request associated with any of the SSBs and/or CSI-RSs is configured, UE shall have the capability to select the Random Access Preamble corresponding to the selected SSB with SS-RSRP above *rsrp-ThresholdSSB* amongst the associated SSBs or the selected CSI-RS with CSI-RSRP above *cfra-csirs-DedicatedRACH-Threshold* amongst the associated CSI-RSs, and to transmit Random Access Preamble on the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *ra-ssb-OccasionMaskIndex* if configured, or from the PRACH occasions in *ra-OccasionList* corresponding to the selected CSI-RS, and PRACH occasion shall be randomly selected with equal probability amongst the selected SSB assocated PRACH occasions or the selected CSI-RS associated PRACH occasions occurring simultaneously but on different subcarriers, as specified in clause 5.1.2 in TS 38.321 [7].

6.2.2.2.2.2 Correct behaviour when receiving Random Access Response

The UE may stop monitoring for Random Access Response(s), if the Random Access Response contains a Random Access Preamble identifier corresponding to the transmitted Random Access Preamble, unless the random access procedure is initialized for Other SI request from UE.

The UE may stop monitoring for Random Access Response(s) and shall monitor the Other SI transmission if the Random Access Response only contains a Random Access Preamble identifier which is corresponding to the transmitted Random Access Preamble and the random access procedure is initialized for SI request from UE, as specified in clause 5.1.4 in TS 38.321 [7].

The UE may stop monitoring for Random Access Response(s), if the contention-free Random Access Preamble for beam failure recovery request was transmitted and if the PDCCH addressed to UE’s C-RNTI is received, as specified in clause 5.1.4 in TS 38.321 [7].

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7] for the next available PRACH occasion, and transmit the preamblewith the calculated PRACH transmission power if all received Random Access Responses contain Random Access Preamble identifiers that do not match the transmitted Random Access Preamble.

6.2.2.2.2.3 Correct behaviour when not receiving Random Access Response

The UE shall again perform the Random Access Resource selection procedure defined in clause 5.1.2 in TS 38.321 [7] for the next available PRACH occasion, and transmit the preamble with the calculated PRACH transmission power, if no Random Access Response is received within the RA Response window configured in *RACH-ConfigCommon* or if no PDCCH addressed to UE’s C-RNTI is received within the RA Response window configured in *BeamFailureRecoveryConfig*, as defined in clause 5.1.4 in TS 38.321 [7].

##### 6.2.2.2.3 UE behaviour when configured with supplementary UL

In addition to the requirements defined in clause 6.2.2.2.1 and 6.2.2.2.2, a UE configured with supplementary UL carrier shall use RACH configuration for the supplementary UL carrier contained in RMSI and RRC dedicated signalling. If the cell for the random access procedure is configured with supplementary UL, the UE shall transmit or re-transmit PRACH preamble on the supplementary UL carrier if the SS-RSRP measured by the UE on the DL carrier is lower than the *rsrp-ThresholdSSB-SUL* as defined in TS 38.331 [2].

### 6.2.3 SA: RRC Connection Release with Redirection

#### 6.2.3.1 Introduction

This clause contains requirements on the UE regarding RRC connection release with redirection procedure. RRC connection release with redirection is initiated by the *RRCConnectionRelease* message with redirection to E-UTRAN or NR-RAN from NR-RAN specified in TS 38.331 [2]. The RRC connection release with redirection procedure is specified in clause 5.3.8 of TS 38.331 [2].

#### 6.2.3.2 Requirements

##### 6.2.3.2.1 RRC connection release with redirection to NR

The UE shall be capable of performing the RRC connection release with redirection to the target NR cell within Tconnection\_release\_redirect\_NR.

The time delay (Tconnection\_release\_redirect\_NR) is the time between the end of the last slot containing the RRC command, “*RRCConnectionRelease*” (TS 38.331 [2]) on the NR PDSCH and the time the UE starts to send random access to the target NR cell. The time delay (Tconnection\_release\_redirect\_NR) shall be less than:

Tconnection\_release\_redirect\_NR = TRRC\_procedure\_delay + Tidentify-NR + TSI-NR + TRACH

The target NR cell shall be considered detectable when:

- SS-RSRP related side conditions given in Section 10.x are fulfilled for a corresponding NR Band,

- SCH\_RP and SCH Ês/Iot according to Annex TBD for a corresponding NR Band.

TRRC\_procedure\_delay: It is the RRC procedure delay for processing the received message “[*RRCConnectionRelease*]” as defined in clause 11.2 of TS 38.331 [2].

Tidentify-NR: It is the time to identify the target NR cell and depend on the frequency range (FR) of the target NR cell. It is defined in table 6.2.3.2.1-1. Note that Tidentify-NR = TPSS/SSS-sync + Tmeas, in which TPSS/SSS-sync is the cell search time and Tmeas is the measurement time due to cell selection criteria evaluation.

TSI-NR: It is the time required for acquiring all the relevant system information of the target NR cell. This time depends upon whether the UE is provided with the relevant system information of the target NR cell or not by the old NR cell before the RRC connection is released. TSI-NR = 0 provided the UE is provided with the SI (including MIB and all relevant SIBs) of the target NR cell before the RRC connection is released by the old NR cell.

TRACH: It is the delay caused due to the random access procedure when sending random access to the target NR cell. This delay depends on the PRACH configuration defined in Table 6.3.3.2-2 [6] or Table 6.3.3.2-3 [6] for FR1 and in Table 6.3.3.2-4 [6] for FR2.

Table 6.2.3.2.1-1: Time to identify target NR cell for RRC connection release with redirection to NR

|  |  |
| --- | --- |
| Frequency range (FR) of target NR cell | Tidentify-NR |
| FR1 | MAX (680 ms, [11] x SMTC period) |
| FR2 | MAX (880 ms, K1x[11] x SMTC period) |

*Editor’s note: K1 is FFS and is the number of receiver beam sweeps required to detect NR cell in FR2*

##### 6.2.3.2.2 RRC connection release with redirection to E-UTRAN

The UE shall be capable of performing the RRC connection release with redirection to the target E-UTRAN cell within Tconnection\_release\_redirect\_E-UTRA.

The time delay (Tconnection\_release\_redirect\_E-UTRA) is the time between the end of the last slot containing the RRC command, “[*RRCConnectionRelease*]” (TS 38.331 [2]) on the PDSCH and the time the UE starts to send random access to the target E-UTRA cell. The time delay (Tconnection\_release\_redirect\_E-UTRA) shall be less than:

Tconnection\_release\_redirect\_E-UTRA = TRRC\_procedure\_delay + Tidentify-E-UTRA + TSI-E-UTRA + TRACH

The target E-UTRA cell shall be considered detectable when:

- RSRP related side conditions given in Section 10.x are fulfilled for a corresponding E-UTRA Band,

- SCH\_RP and SCH Ês/Iot according to Annex TBD for a corresponding E-UTRA Band.

TRRC\_procedure\_delay: It is the RRC procedure delay for processing the received message “[*RRCConnectionRelease*]” as defined in clause 11.2 of TS 38.331 [2].

Tidentify-E-UTRA: It is the time to identify the target E-UTRA cell. It shall be less than [320] ms.

TSI-E-UTRA: It is the time required for acquiring all the relevant system information of the target E-UTRA cell. This time depends upon whether the UE is provided with the relevant system information (SI) of the target E-UTRA cell or not by the old NR cell before the RRC connection is released. TSI-E-UTRA = 0 provided the UE is provided with the SI (including MIB and all relevant SIBs) of the target E-UTRA cell before the RRC connection is released by the old NR cell.

TRACH: It is the delay caused due to the random access procedure when sending random access to the target E-UTRA cell.

# 7 Timing

## 7.1 UE transmit timing

### 7.1.1 Introduction

The UE shall have capability to follow the frame timing change of the connected gNB. The uplink frame transmission takes place before the reception of the first detected path (in time) of the corresponding downlink frame from the reference cell. The reference cell is PSCell in case of EN-DC. UE initial transmit timing accuracy, maximum amount of timing change in one adjustment, minimum and maximum adjustment rate are defined in the following requirements.

### 7.1.2 Requirements

The UE initial transmission timing error shall be less than or equal to ±Te where the timing error limit value Te is specified in Table 7.1.2-1. This requirement applies:

- when it is the first transmission in a DRX cycle for PUCCH, PUSCH and SRS or it is the PRACH transmission.

The UE shall meet the Te requirement for an initial transmission provided that at least one SSB is available at the UE during the last 160 ms. The reference point for the UE initial transmit timing control requirement shall be the downlink timing of the reference cell minus . The downlink timing is defined as the time when the first detected path (in time) of the corresponding downlink frame is received from the reference cell. *N*TA for PRACH is defined as 0.

 (in *Tc* units) for other channels is the difference between UE transmission timing and the downlink timing immediately after when the last timing advance in clause 7.3 was applied. *N*TA for other channels is not changed until next timing advance is received. The value ofdepends on the duplex mode of the cell in which the uplink transmission takes place and the frequency range (FR). is defined in Table 7.1.2-2.

Table 7.1.2-1: Te Timing Error Limit

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of SSB signals (KHz) | SCS of uplink signals s(KHz) | Te |
| 1 | 15 | 15 | [12]\*64\*Tc |
| 30 | [10]\*64\*Tc |
| 60 | [10]\*64\*Tc |
| 30 | 15 | [8]\*64\*Tc |
| 30 | [8]\*64\*Tc |
| 60 | [7]\*64\*Tc |
| 2 | 120 | 60 | [3.5]\*64\*Tc |
| 120 | [3.5]\*64\*Tc |
| 240 | 60 | [3]\*64\*Tc |
| 120 | [3]\*64\*Tc |
| NOTE 1: Tc is the basic timing unit defined in TS 38.211  *Editor’s note: The final values of Te for 120KHz SSB SCS are subject to further discussions in further meeting, and may not be outside 3\*64\*Tc to 3.5\*64\*Tc.* | | | |

Table 7.1.2-2: The Value of 

|  |  |
| --- | --- |
| **Frequency range and band of cell used for uplink transmission** | (Unit: TC) |
| FDD in FR1 | 0 |
| FR1 TDD band | 39936 or 25600 (Note 1) |
| FR2 | 13792 |
| NOTE 1: The UE identifies  based on the information [TBD] according to [TS38.331].  NOTE 2: The value of that applies to the supplementary UL carrier is determined from the non-supplementary UL carrier. | |

When it is not the first transmission in a DRX cycle or there is no DRX cycle, and when it is the transmission for PUCCH, PUSCH and SRS transmission, the UE shall be capable of changing the transmission timing according to the received downlink frame of the reference cell except when the timing advance in clause 7.3 is applied.

When the transmission timing error between the UE and the reference timing exceeds ±Te, the UE is required to adjust its timing to within ±Te. The reference timing shall be  before the downlink timing of the reference cell. All adjustments made to the UE uplink timing shall follow these rules:

1) The maximum amount of the magnitude of the timing change in one adjustment shall be Tq.

2) The minimum aggregate adjustment rate shall be Tp per second.

3) The maximum aggregate adjustment rate shall be Tq per [200]ms.

where the maximum autonomous time adjustment step Tq and the aggregate adjustment rate Tp are specified in Table 7.1.2-3.

Table 7.1.2-3: Tq Maximum Autonomous Time Adjustment Step and Tp Minimum Aggregate Adjustment rate

|  |  |  |  |
| --- | --- | --- | --- |
| Frequency Range | SCS of uplink signals (KHz) | Tq | Tp |
| 1 | 15 | [5.5]\*64\*Tc | [5.5]\*64\*Tc |
| 30 | [5.5]\*64\*Tc | [5.5]\*64\*Tc |
| 60 | [5.5]\*64\*Tc | [5.5]\*64\*Tc |
| 2 | 60 | [2.5]\*64\*Tc | [2.5]\*64\*Tc |
| 120 | [2.5]\*64\*Tc | [2.5]\*64\*Tc |
| NOTE 1: Tc is the basic timing unit defined in TS 38.211 | | | |

## 7.2 UE timer accuracy

### 7.2.1 Introduction

UE timers are used in different protocol entities to control the UE behaviour.

### 7.2.2 Requirements

For UE timers specified in TS 38.331 [TBD], the UE shall comply with the timer accuracies according to Table 7.2.2-1.

The requirements are only related to the actual timing measurements internally in the UE. They do not include the following:

- Inaccuracy in the start and stop conditions of a timer (e.g. UE reaction time to detect that start and stop conditions of a timer is fulfilled), or

- Inaccuracies due to restrictions in observability of start and stop conditions of a UE timer (e.g. slot alignment when UE sends messages at timer expiry).

Table 7.2.2-1

|  |  |
| --- | --- |
| **Timer value [s]** | **Accuracy** |
| timer value < 4 | ± 0.1s |
| timer value ≥ 4 | ± 2.5% |

## 7.3 Timing advance

### 7.3.1 Introduction

The timing advance is initiated from gNB with MAC message that implies and adjustment of the timing advance, see TS 38.321 clause 5.2.

### 7.3.2 Requirements

#### 7.3.2.1 Timing Advance adjustment delay

UE shall adjust the timing of its uplink transmission timing at time slot *n*+[6] for a timing advance command received in time slot *n*. The same requirement applies also when the UE is not able to transmit a configured uplink transmission due to the channel assessment procedure.

#### 7.3.2.2 Timing Advance adjustment accuracy

The UE shall adjust the timing of its transmissions with a relative accuracy better than or equal to the UE Timing Advance adjustment accuracy requirement in Table 7.3.2.2-1, to the signalled timing advance value compared to the timing of preceding uplink transmission. The timing advance command step is defined in TS38.213.

Table 7.3.2.2-1: UE Timing Advance adjustment accuracy

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sub Carrier Spacing, SCS kHz | 15 | 30 | 60 | 120 |
| UE Timing Advance adjustment accuracy | ±256 Tc | ±256 Tc | ±128 Tc | ±32 Tc |

## 7.4 Cell phase synchronization accuracy

### 7.4.1 Definition

Cell phase synchronization accuracy for TDD is defined as the maximum absolute deviation in frame start timing between any pair of cells on the same frequency that have overlapping coverage areas.

### 7.4.2 Minimum requirements

The cell phase synchronization accuracy measured at BS antenna connectors shall be better than 3 µs.

## 7.5 Maximum Transmission Timing Difference

### 7.5.1 Introduction

A UE shall be capable of handling a relative transmission timing difference between subframe timing boundary of E-UTRA PCell and slot timing boundaries of PSCell to be aggregated EN-DC

### 7.5.2 Minimum Requirements for inter-band EN-DC

The UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in Table 7.5.2-1. The requirements for asynchronous EN-DC are applicable for E-UTRA TDD- NR TDD, E-UTRA FDD- NR FDD, E-UTRA FDD-NR TDD and E-UTRA TDD-NR FDD inter-band asynchronous EN-DC.

Table 7.5.2-1 Maximum uplink transmission timing difference requirement for asynchronous EN-DC

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing in E-UTRA PCell (kHz) | UL Sub-carrier spacing for data in PSCell (kHz) | Maximum uplink transmission timing difference (µs) |
| 15 | 15 | 500 |
| 15 | 30 | 250 |
| 15 | 60 | 125 |
| 15 | 120Note1 | 62.5 |
| NOTE 1: For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied. | | |

The UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in Table 7.5.2-2 provided that the UE indicates that it is capable of synchronous EN-DC [16]. The requirements for synchronous EN-DC are applicable for E-UTRA TDD-NR TDD, E-UTRA TDD-NR FDD and E-UTRA FDD-NR TDD inter-band EN-DC.

Table 7.5.2-2 Maximum uplink transmission timing difference requirement for inter-band synchronous EN-DC

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing in E-UTRA PCell (kHz) | UL Sub-carrier spacing for data in PSCell (kHz) | Maximum uplink transmission timing difference (µs) |
| 15 | 15 | 35.21 |
| 15 | 30 | 35.21 |
| 15 | 60 | 35.21 |
| 15 | 120 Note1 | 35.21 |
| NOTE 1: For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied. | | |

### 7.5.3 Minimum Requirements for intra-band EN-DC

For intra-band EN-DC, only collocated deployment is applied.

The UE shall be capable of handling a maximum uplink transmission timing difference between E-UTRA PCell and PSCell as shown in Table 7.5.2-1 provided the UE indicates that it is capable of asynchronous EN-DC [16]. The requirements for asynchronous EN-DC are applicable for E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band asynchronous EN-DC.

No uplink transmission timing difference is applicable for synchronous EN-DC.

### 7.5.4 Minimum Requirements for NR Carrier Aggregation

For inter-band carrier aggregation, the UE shall be capable of handling at least a relative transmission timing difference between slot timing of different carriers to be aggregated as shown in Table 7.5.4-1 below:

Table 7.5.4-1: Maximum transmission timing difference requirement for inter-band NR carrier aggregation

|  |  |
| --- | --- |
| Frequency Range | Maximum transmission timing difference (µs) |
| FR1 | 35.21 |
| FR2 | 8.5 |
| Between FR1 and FR2 | [TBD] |

## 7.6 Maximum Receive Timing Difference

### 7.6.1 Introduction

A UE shall be capable of handling a relative receive timing difference between subframe timing boundary of E-UTRA PCell and slot timing boundaries of PSCell to be aggregated for EN-DC.

A UE shall be capable of handling a relative receive timing difference between slot timing boundary of different carriers to be aggregated NR carrier aggregation.

### 7.6.2 Minimum Requirements for inter-band EN-DC

The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell at the UE receiver as shown in Table 7.6.2-1. The requirements for asynchronous EN-DC are applicable for E-UTRA TDD- NR TDD, E-UTRA FDD- NR FDD, E-UTRA FDD- NR TDD and E-UTRA TDD- NR FDD inter-band EN-DC.

Table 7.6.2-1: Maximum receive timing difference requirement for asynchronous EN-DC

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing in E-UTRA PCell (kHz) | DL Sub-carrier spacing in PSCell (kHz) (Note 1) | Maximum receive timing difference (µs) |
| 15 | 15 | 500 |
| 15 | 30 | 250 |
| 15 | 60 | 125 |
| 15 | 120 | 62.5 |
| NOTE 1 : DL Sub-carrier spacing is min{SCSSS, SCSDATA}.  NOTE 2 : For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied. | | |

The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell at the UE receiver as shown in Table 7.6.2-2 provided that the UE indicates that it is capable of synchronous EN-DC[16]. The requirements for synchronous EN-DC are applicable for E-UTRA TDD- NR TDD, E-UTRA TDD- NR FDD and E-UTRA FDD- NR TDD inter-band EN-DC.

Table 7.6.2-2: Maximum receive timing difference requirement for inter-band synchronous EN-DC

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing in E-UTRA PCell (kHz) | DL Sub-carrier spacing in PSCell (kHz) (Note1) | Maximum receive timing difference (µs) |
| 15 | 15 | 33 |
| 15 | 30 |
| 15 | 60 |
| 15 | 120 |
| NOTE 1: DL Sub-carrier spacing is min{SCSSS, SCSDATA}.  NOTE 2: For E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC, 120kHz is not applied. | | |

Table 7.6.2-3 Void

### 7.6.3 Minimum Requirements for intra-band EN-DC

For intra-band EN-DC, only collocated deployment is applied.

The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell as shown in Table 7.6.2-1 provided the UE indicates that it is capable of asynchronous EN-DC [16]. The requirements for asynchronous EN-DC are applicable for E-UTRA FDD- NR FDD and E-UTRA TDD- NR TDD intra-band EN-DC.

The UE shall be capable of handling at least a relative receive timing difference between subframe timing of signal from E-UTRA PCell and slot timing of signal from PSCell as shown in Table 7.6.3-1 provided the UE indicates that it is only capable of synchronous EN-DC [16]. The requirements for synchronous EN-DC are applicable for E-UTRA TDD- NR TDD and E-UTRA FDD- NR FDD intra-band EN-DC.

Table 7.6.3-1 Maximum receive timing difference requirement for intra-band synchronous EN-DC

|  |  |  |
| --- | --- | --- |
| Sub-carrier spacing in E-UTRA PCell (kHz) | DL Sub-carrier spacing in PSCell (kHz) Note1 | Maximum receive timing difference (µs) |
| 15 | 15 | 3 |
| 15 | 30 | 3 |
| 15 | 60 | 3 |
| NOTE 1: DL Sub-carrier spacing is min{SCSSS, SCSDATA}. | | |

Table 7.6.3-2 Void

### 7.6.4 Minimum Requirements for NR Carrier Aggregation

For intra-band CA, only collocated deployment is applied. For intra-band non-contiguous NR carrier aggregation, the UE shall be capable of handling at least a relative receive timing difference between slot timing of different carriers to be aggregated at the UE receiver as shown in Table 7.6.4-1 below.

Table 7.6.4-1: Maximum receive timing difference requirement for intra-band non-contiguous NR carrier aggregation

|  |  |
| --- | --- |
| Frequency Range | Maximum receive timing difference (µs) |
| FR1 | 3 |
| FR2 | 3 |

For inter-band NR carrier aggregation, the UE shall be capable of handling at least a relative receive timing difference between slot timing of different carriers to be aggregated at the UE receiver as shown in Table 7.6.4-2 below.

Table 7.6.4-2: Maximum receive timing difference requirement for inter-band NR carrier aggregation

|  |  |
| --- | --- |
| Frequency Range | Maximum receive timing difference (µs) |
| FR1 | 33 |
| FR2 | 8 |
| Between FR1 and FR2 | [TBD] |

# 8 Signalling characteristics

8.1 Radio Link Monitoring

8.1.1 Introduction

The UE shall monitor the downlink link quality based on the reference signal in the configured RLM-RS resource(s) in order to detect the downlink radio link quality of the PCell and PSCell as specified in [3]. The configured RLM-RS resources can be all SSBs, or all CSI-RSs, or a mix of SSBs and CSI-RSs. UE is not required to perform RLM outside the active DL BWP.

On each RLM-RS resource, the UE shall estimate the downlink radio link quality and compare it to the thresholds Qout and Qin for the purpose of monitoring downlink radio link quality of the cell.

The threshold Qout is defined as the level at which the downlink radio link cannot be reliably received and shall correspond to the out-of-sync block error rate (BLERout) as defined in Table 8.1.1-1. For SSB based radio link monitoring, Qout\_SSB is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1.2.1-1. For CSI-RS based radio link monitoring, Qout\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1.3.1-1.

The threshold Qin is defined as the level at which the downlink radio link quality can be significantly more reliably received than at Qout and shall correspond to the in-sync block error rate (BLERin) as defined in Table 8.1.1-1. For SSB based radio link monitoring, Qin\_SSB is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1.2.1-2. For CSI-RS based radio link monitoring, Qin\_CSI-RS is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1.3.1-2.

The out-of-sync block error rate (BLERout) and in-sync block error rate (BLERin) are determined from the network configuration via parameter *RLM-IS-OOS-thresholdConfig* signalled by higher layers. The network can configure one of the two pairs of out-of-sync and in-sync block error rates which are shown in Table 8.1.1-1. When UE is not configured with *RLM-IS-OOS-thresholdConfig* from the network, UE determines out-of-sync and in-sync block error rates from Configuration #0 in Table 8.1.1-1 as default.

Table 8.1.1-1: Out-of-sync and in-sync block error rates

|  |  |  |
| --- | --- | --- |
| **Configuration** | **BLERout** | **BLERin** |
| 0 | 10% | 2% |
| 1 | TBD | TBD |

UE shall be able to monitor up to XRLM-RS RLM-RS resources of the same or different types in each corresponding carrier frequency range, where XRLM-RS is specified in Table 8.1.1-2, and meet the requirements as specified in section 8.1.

Table 8.1.1-2: Maximum number of RLM-RS resources XRLM-RS

|  |  |
| --- | --- |
| **Maximum number of RLM-RS resources, XRLM-RS** | **Carrier frequency range of PCell/PSCell** |
| 2 | FR1, ≤ 3 GHz |
| 4 | FR1, > 3 GHz |
| 8 | FR2 |

### 8.1.2 Requirements for SSB based radio link monitoring

#### 8.1.2.1 Introduction

The requirements in this section apply for each SSB based RLM-RS resource configured for PCell or PSCell, provided that the SSB configured for RLM are actually transmitted within UE active DL BWP during the entire evaluation period specified in section 8.1.2.2.

Table 8.1.2.1-1: PDCCH transmission parameters for out-of-sync

|  |  |  |
| --- | --- | --- |
| **Attribute** | **Value for BLER pair#0** | **Value for BLER pair#1** |
| DCI format | 1-0 | TBD |
| Number of control OFDM symbols | Same as the number of symbols of RMSI CORESET |
| Aggregation level (CCE) | 8 |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy | 4dB |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 4dB |
| Bandwidth (MHz) | Same as the number of PRBs of RMSI CORESET |
| Sub-carrier spacing (kHz) | Same as the SCS of RMSI CORESET |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Same as the CP length of RMSI CORESET |
| Mapping from REG to CCE | Distributed |

Table 8.1.2.1-2: PDCCH transmission parameters for in-sync

|  |  |  |
| --- | --- | --- |
| **Attribute** | **Value for BLER pair#0** | **Value for BLER pair#1** |
| DCI payload size | 1-0 | TBD |
| Number of control OFDM symbols | Same as the number of symbols of RMSI CORESET |
| Aggregation level (CCE) | 4 |
| 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 (MHz) | Same as the number of PRBs of RMSI CORESET |
| Sub-carrier spacing (kHz) | Same as the SCS of RMSI CORESET |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Same as the CP length of RMSI CORESET |
| Mapping from REG to CCE | Distributed |

#### 8.1.2.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last TEvaluate\_out\_SSB [ms] period becomes worse than the threshold Qout\_SSB within TEvaluate\_out\_SSB [ms] evaluation period.

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last TEvaluate\_in\_SSB [ms] period becomes better than the threshold Qin\_SSB within TEvaluate\_in\_SSB [ms] evaluation period.

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 8.1.2.2-1 for FR1.

TEvaluate\_out\_SSB and TEvaluate\_in\_SSB are defined in Table 8.1.2.2-2 for FR2 with

- N=1, if the SSB configured for RLM is spatially QCLed and TDMed to CSI-RS resources configured for BM, and the QCL association is known to UE;

- N=FFS, otherwise.

For FR1,

- P=1/(1 – TSSB/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; and

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

For FR2,

- P=1/(1 – TSSB/TSMTCperiod), when RLM-RS is not overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod).

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

- P is 1/(1- TSSB/MGRP - TSSB/TSMTCperiod), when RLM-RS is partially overlapped with measurement gap and RLM-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 is 1/(1- TSSB /MGRP)\* Psharing factor, when RLM-RS is partially overlapped with measurement gap and RLM-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 is 1/{1- TSSB /min (TSMTCperiod ,MGRP)}, when RLM-RS is partially overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion (TSSB < TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- P is 1/(1- TSSB /MGRP)\* Psharing factor, when RLM-RS is partially overlapped with measurement gap and RLM-RS is fully overlapped with SMTC occasion (TSSB = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor is FFS

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

Table 8.1.2.2-1: Evaluation period TEvaluate\_out and TEvaluate\_in for FR1

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out (ms) | TEvaluate\_in (ms) |
| non-DRX | max(200,ceil(10\*P)\*TSSB) | max(100,ceil(5\*P)\*TSSB) |
| DRX cycle≤320 | max(200,ceil(15\*P)\*max(TDRX,TSSB)) | max(100,ceil(7.5\*P)\*max(TDRX,TSSB)) |
| DRX cycle>320 | ceil(10\*P)\*TDRX | ceil(5\*P)\*TDRX |
| NOTE: TSSB is the periodicity of SSB configured for RLM. TDRX is the DRX cycle length. | | |

Table 8.1.2.2-2: Evaluation period TEvaluate\_out and TEvaluate\_in for FR2

|  |  |  |
| --- | --- | --- |
| Configuration | TEvaluate\_out (ms) | TEvaluate\_in (ms) |
| non-DRX | max(200,ceil(10\*P\*N)\*TSSB) | max(100,ceil(5\*P\*N)\*TSSB) |
| DRX cycle≤320 | max(200,ceil(15\*P\*N)\*max(TDRX,TSSB)) | max(100,ceil(7.5\*P\*N)\*max(TDRX,TSSB)) |
| DRX cycle>320 | ceil(10\*P\*N)\*TDRX | ceil(5\*P\*N)\*TDRX |
| NOTE: TSSB is the periodicity of SSB configured for RLM. TDRX is the DRX cycle length. | | |

### 8.1.3 Requirements for CSI-RS based radio link monitoring

#### 8.1.3.1 Introduction

The requirements in this section apply for each CSI-RS based RLM-RS resource configured for PCell or PSCell, provided that the CSI-RS configured for RLM are actually transmitted within UE active DL BWP during the entire evaluation period specified in section 8.1.3.2.

Table 8.1.3.1-1: PDCCH transmission parameters for out-of-sync

|  |  |  |
| --- | --- | --- |
| **Attribute** | **Value for BLER pair#0** | **Value for BLER pair#1** |
| DCI format | 1-0 | TBD |
| Number of control OFDM symbols | Same as the number of symbols of CORESET QCLed with respective CSI-RS for RLM |
| Aggregation level (CCE) | [8] |
| Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy | [4]dB |
| Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | [4]dB |
| Bandwidth (MHz) | Same as the number of PRBs of CORESET QCLed with respective CSI-RS for RLM |
| Sub-carrier spacing (kHz) | Same as the SCS of CORESET QCLed with respective CSI-RS for RLM |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Same as the CP length of CORESET QCLed with respective CSI-RS for RLM |
| Mapping from REG to CCE | Distributed |

Table 8.1.3.1-2: PDCCH transmission parameters for in-sync

|  |  |  |
| --- | --- | --- |
| **Attribute** | **Value for BLER pair#0** | **Value for BLER pair#1** |
| DCI payload size | [1-0] | TBD |
| Number of control OFDM symbols | Same as the number of symbols of CORESET QCLed with respective CSI-RS for RLM |
| Aggregation level (CCE) | [4] |
| Ratio of hypothetical PDCCH RE energy to average CSI-RS RE energy | [0]dB |
| Ratio of hypothetical PDCCH DMRS energy to average CSI-RS RE energy | [0]dB |
| Bandwidth (MHz) | Same as the number of PRBs of CORESET QCLed with respective CSI-RS for RLM |
| Sub-carrier spacing (kHz) | Same as the SCS of CORESET QCLed with respective CSI-RS for RLM |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Same as the CP length of CORESET QCLed with respective CSI-RS for RLM |
| Mapping from REG to CCE | Distributed |

#### 8.1.3.2 Minimum requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last TEvaluate\_out\_CSI-RS [ms] period becomes worse than the threshold Qout\_CSI-RS within TEvaluate\_out\_CSI-RS [ms] evaluation period.

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last TEvaluate\_in\_CSI-RS [ms] period becomes better than the threshold Qin\_CSI-RS within TEvaluate\_in\_CSI-RS [ms] evaluation period.

- TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS are defined in Table 8.1.3.2-1 for FR1.

- TEvaluate\_out\_CSI-RS and TEvaluate\_in\_CSI-RS are defined in Table 8.1.3.2-2 for FR2, where

- N=1, if the CSI-RS resource configured for RLM is spatially QCLed and TDMed to CSI-RS resources configured for BM or SSBs configured for BM, and the QCL association is known to UE;

- N=FFS, otherwise.

For FR1,

- P=1/(1 – TCSI-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 RLM-RS is not overlapped with measurement gap and also not overlapped with SMTC occasion.

- P=1/(1 – TCSI-RS/MGRP) , when RLM-RS is partially overlapped with measurement gap and RLM-RS is not overlapped with SMTC occasion (TCSI-RS < MGRP)

- P=1/(1 – TCSI-RS /TSMTCperiod), when RLM-RS is not overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod).

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

- P is 1/(1- TCSI-RS /MGRP - TCSI-RS /TSMTCperiod), when RLM-RS is partially overlapped with measurement gap and RLM-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 is 1/(1- TCSI-RS /MGRP)\* Psharing factor, when RLM-RS is partially overlapped with measurement gap and RLM-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 is 1/{1- TCSI-RS /min (TSMTCperiod ,MGRP)}, when RLM-RS is partially overlapped with measurement gap and RLM-RS is partially overlapped with SMTC occasion (TCSI-RS < TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- P is 1/(1- TCSI-RS /MGRP)\* Psharing factor, when RLM-RS is partially overlapped with measurement gap and RLM-RS is fully overlapped with SMTC occasion (TCSI-RS = TSMTCperiod) and SMTC occasion is partially overlapped with measurement gap (TSMTCperiod < MGRP)

- Psharing factor is FFS

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

The values of Mout and Min used in Table 8.1.3.2-1 and Table 8.1.3.2-2 are defined as:

- Mout = 20 and Min = 10, if the CSI-RS resource configured for RLM is transmitted with Density =3.

Table 8.1.3.2-1: Evaluation period TEvaluate\_out and TEvaluate\_in for FR1

|  |  |  |
| --- | --- | --- |
| **Configuration** | **TEvaluate\_out (ms)** | **TEvaluate\_in (ms)** |
| non-DRX | max(200, ceil(Mout×P)×TCSI-RS) | max(100, ceil(Min×P) × TCSI-RS) |
| DRX ≤ 320ms | max(200, ceil(1.5×Mout×P)× max(TDRX, TCSI-RS)) | max(100, ceil(1.5×Min×P)× max(TDRX, TCSI-RS)) |
| DRX > 320ms | ceil(Mout×P) × TDRX | ceil(Min×P) × TDRX |
| NOTE: TCSI-RS is the periodicity of CSI-RS resource configured for RLM. TDRX is the DRX cycle length. | | |

Table 8.1.3.2-2: Evaluation period TEvaluate\_out and TEvaluate\_in for FR2

|  |  |  |
| --- | --- | --- |
| **Configuration** | **TEvaluate\_out (ms)** | **TEvaluate\_in (ms)** |
| non-DRX | max(200, ceil(Mout×P×N)×TCSI-RS) | max(100, ceil(Min×P×N) × TCSI-RS) |
| DRX ≤ 320ms | max(200, ceil(1.5×Mout×P×N)× max(TDRX, TCSI-RS)) | max(100, ceil(1.5×Min×P×N)× max(TDRX, TCSI-RS)) |
| DRX > 320ms | ceil(Mout×P×N) × TDRX | ceil(Min×P×N) × TDRX |
| NOTE: TCSI-RS is the periodicity of CSI-RS resource configured for RLM. TDRX is the DRX cycle length. | | |

### 8.1.4 Void

### 8.1.5 Void

8.1.6 Minimum requirement for L1 indication

When the downlink radio link quality on all the configured RLM-RS resources is worse than Qout, Layer 1 of the UE shall send an out-of-sync indication for the cell to the higher layers. A Layer 3 filter shall be applied to the out-of-sync indications as specified in TS 38.331 [2].

When the downlink radio link quality on at least one of the configured RLM-RS resources is better than Qin, Layer 1 of the UE shall send an in-sync indication for the cell to the higher layers. A Layer 3 filter shall be applied to the in-sync indications as specified in TS 38.331 [2].

The out-of-sync and in-sync evaluations for the configured RLM-RS resources shall be performed as specified in clause 5 in TS 38.213 [3]. Two successive indications from Layer 1 shall be separated by at least TIndication\_interval.

When DRX is not used TIndication\_interval is max(10ms, TRLM-RS,M), where

TRLM,M is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to TSSB specified in section 8.1.2 if the RLM-RS resource is SSB, or TCSI-RS specified in section 8.1.3 if the RLM-RS resource is CSI-RS.

In case DRX is used, upon start of T310 timer as specified in TS 38.331 [2], the UE shall monitor the configured RLM-RS resources for recovery using the evaluation period and Layer 1 indication interval corresponding to the non-DRX mode until the expiry or stop of T310 timer.

*Editor’s note: FFS whether the DRX requirements are scaled by 1.5 if DRX on-duration and RLM-RS are not aligned.*

### 8.1.7 Scheduling availability of UE during radio link monitoring

When the reference signal to be measured for RLM has different subcarrier spacing than PDSCH/PDCCH and on frequency range FR2, there are restrictions on the scheduling availability as described in the following clauses.

#### 8.1.7.1 Scheduling availability of UE performing radio link monitoring with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to radio link monitoring performed with a same subcarrier spacing as PDSCH/PDCCH on FR1.

#### 8.1.7.2 Scheduling availability of UE performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH on FR1

For UE which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to radio link monitoring based on SSB as RLM-RS. For UE which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to radio link monitoring based on SSB as RLM-RS.

- The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured for radio link monitoring.

When intra-band carrier aggregation is performed, the scheduling restrictions apply to all serving cells on the band due to radio link monitoring performed on FR1 serving PCell or PSCell in the same band. When inter-band carrier aggregation within FR1 is performed, there are no scheduling restrictions on FR1 serving cell(s) in the bands due to radio link monitoring performed on FR1 serving PCell or PSCell in different bands.

#### 8.1.7.3 Scheduling availability of UE performing radio link monitoring on FR2

The following scheduling restriction applies due to radio link monitoring on an FR2 serving PCell and/or PSCell.

- The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on RLM-RS symbols to be measured for radio link monitoring, except for RMSI PDCCH/PDSCH and PDCCH/PDSCH which is not required to be received by RRC\_CONNECTED mode UE.

*Editor’s Note: FFS when intra-band carrier aggregation is performed, whether the scheduling restrictions apply to all serving cells on the band due to radio link monitoring performed on FR2 serving PCell or PSCell in the same band or not.*

*Editor’s Note: FFS scheduling restrictions for inter-band carrier aggregation will be defined depending on band combination in future.*

#### 8.1.7.4 Scheduling availability of UE performing radio link monitoring on FR1 or FR2 in case of FR1-FR2 inter-band CA

There are no scheduling restrictions on FR1 serving cell(s) due to radio link monitoring performed on FR2 serving PCell and/or PSCell.

There are no scheduling restrictions on FR2 serving cell(s) due to radio link monitoring performed on FR1 serving PCell and/or PSCell.

## 8.2 Interruption

*Editor’s note: intended to capture requirements for interruption due to SCell configuration/de-configuration/activation/deactivation, and PSCell addition/release and so on.*

### 8.2.1 NSA: Interruptions with EN-DC

#### 8.2.1.1 Introduction

This section contains the requirements related to the interruptions on PSCell, and SCell, when

E-UTRA PCell transitions between active and non-active during DRX, or

E-UTRA PCell transitions from non-DRX to DRX, or

E-UTRA SCell in MCG or SCell in SCG is added or released, or

E-UTRA SCell in MCG or SCell in SCG is activated or deactivated, or

measurements on SCC with deactivated SCell in either E-UTRA MCG or NR SCG

The requirements shall apply for E-UTRA-NR DC with an E-UTRA PCell.

This section contains interruptions where victim cell is PSCell or SCell belonging to SCG. Requirements for interruptions requirements when the victim cell is E-UTRA PCell or E-UTRA SCell belonging to MCG are specified in [TS 36.133].

#### 8.2.1.2 Requirements

##### 8.2.1.2.1 Interruptions at transitions between active and non-active during DRX

Interruption on PSCell and the activated SCell if configured due to E-UTRA PCell transitions between active and non-active druing DRX when PSCell or SCell is in non-DRX are allowed with up to [1%] probability of missed ACK/NACK when the configured PSCell DRX cycle is less than [640] ms, and [0.625%] probability of missed ACK/NACK is allowed when the configured PSCell DRX cycle is [640] ms or longer. Each interruption shall not exceed [X] slot as defined in table 8.2.1.2.1-1.

Each interruption shall not exceed X slot as defined in table 8.2.1.2.1-1.

Table 8.2.1.2.1-1 Interruption length X at transition between active and non-active during DRX

|  |  |  |  |
| --- | --- | --- | --- |
|  | NR Slot length (ms) | Interruption length X | |
| Sync | Async |
| 0 | 1 | 1 | 2 |
| 1 | 0.5 | 1 | 2 |
| 2 | 0.25 | 3 | |
| 3 | 0.125 | 5 | |

When both PCell and PSCell are in DRX, no interruption is allowed.

##### 8.2.1.2.2 Interruptions at transitions from non-DRX to DRX

Interruption on PSCell and the activated SCell if configured due to E-UTRA PCell transitions from non-DRX to DRX when PSCell or SCell is in non-DRX shall not exceed [X] slot as defined in table 8.2.1.2.1-1.

##### 8.2.1.2.3 Interruptions at SCell addition/release

The requirements in this clause shall apply for the UE configured with PSCell.

When one E-UTRA SCell is added or released:

- an interruption on PSCell:

- of up to X1 slot, if the PSCell is not in the same band as any of the E-UTRA SCells being added or released, or

- of up to max{Y1 slot + SMTC duration, 5ms} if the PSCell is in the same band as any of the E-UTRA SCells being added or released, provided the cell specific reference signals from the PSCell and the E-UTRA SCells being added or released are available in the same slot;

- an interruption on any activated SCell in SCG:

- of up to X1 slot, if the activated SCell is not in the same band as any of the E-UTRA SCells being added or released, or

- of up to max{Y1 slot + SMTC duration, 5ms} if the activated SCell is in the same band as any of the E-UTRA SCells being added or released, provided the cell specific reference signals from the activated SCell and the E-UTRA SCells being added or released are available in the same slot.

When one SCell is added or released:

- an interruption on PSCell:

- of up to X1 slot, if the PSCell is not in the same band as any of the SCells being added or released, or

- of up to Y1 slot + SMTC duration if the PSCell is in the same band as any of the SCells being added or released, provided the cell specific reference signals from the PSCell and the SCells being added or released are available in the same slot;

- an interruption on any activated SCell in SCG:

- of up to X1 slot, if the activated SCell is not in the same band as any of the SCells being added or released, or

- of up to Y1 slot + SMTC duration if the activated SCell is in the same band as any of the SCells being added or released, provided the cell specific reference signals from the activated SCell and the SCells being added or released are available in the same slot.

Table 8.2.1.2.3-1 Interruption length X1 and Y1 at SCell addition/Release

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) | Interruption length X1 slot | | Interruption length Y1 slotNote 1 |
| Sync | Async |
| 0 | 1 | 1 | 2 | 1 |
| 1 | 0.5 | 2 | 3 | 2 |
| 2 | 0.25 | 5 | | 4 |
| 3 | 0.125 | 9 | | 8 |

##### 8.2.1.2.4 Interruptions at SCell activation/deactivation

The requirements in this clause shall apply for the UE configured with PSCell and one SCell.

When one E-UTRA SCell is activated or deactivated:

- an interruption on PSCell:

- of up to X2 slot, if the PSCell is not in the same band as any of the E-UTRA SCells being activated or deactivated, or

- of up to max{Y2 slot + SMTC duration, 5ms} if the PSCell is in the same band as any of the E-UTRA SCells being activated or deactivated, provided the cell specific reference signals from the PSCell and the SCells being activated or deactivated are available in the same slot;

- an interruption on any activated SCell in SCG:

- of up to X2 slot, if the activated SCell is not in the same band as any of the E-UTRA SCells being activated or deactivated, or

- of up to max{Y2 slot + SMTC duration, 5ms} if the activated SCell is in the same band as any of the E-UTRA SCells being activated or deactivated, provided the cell specific reference signals from the activated SCell and the SCells being activated or deactivated are available in the same slot.

When one SCell is activated or deactivated:

- an interruption on PSCell:

- of up to X2 slot, if the PSCell is not in the same band as any of the SCells being activated or deactivated, or

- of up to Y2 slot + SMTC duration if the PSCell is in the same band as any of the SCells being activated or deactivated, provided the cell specific reference signals from the PSCell and the SCells being activated or deactivated are available in the same slot;

- an interruption on any activated SCell in SCG:

- of up to X2 slot, if the activated SCell is not in the same band as any of the SCells being activated or deactivated, or

- of up to Y2 slot + SMTC duration if the activated SCell is in the same band as any of the SCells being activated or deactivated, provided the cell specific reference signals from the deactivated SCell and the SCells being activated or deactivated are available in the same slot.

Table 8.2.1.2.4-1 Interruption length X2 and Y2 at SCell activation/deactivation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NR Slot length (ms) | Interruption length X2 slot | | Interruption length Y2 slot |
| Sync | Async |
| 0 | 1 | 1 | 2 | 1 |
| 1 | 0.5 | 1 | 2 | 1 |
| 2 | 0.25 | 3 | | 2 |
| 3 | 0.125 | 5 | | 4 |

##### 8.2.1.2.5 Interruptions during measurements on SCC

##### 8.2.1.2.5.1 Interruptions during measurements on deactivated NR SCC

Interruption on PSCell and other active NR SCell(s) during measurement on the deactivated NR SCC shall meet requirements in clause 8.2.2.2.3, where the term PCell in clause 8.2.2.2.3 shall be deemed to be replaced with PSCell.

##### 8.2.1.2.5.2 Interruptions during measurements on deactivated E-UTRAN SCC

When one E-UTRA SCell in MCG is deactivated, the UE is allowed due to measurements on the E-UTRA SCC with the deactivated E-UTRA SCell:

- an interruption on PSCell or any activated SCell with up to 0.5% probability of missed ACK/NACK when any of the configured *measCycleSCell* [2] for the deactivated E-UTRA SCellsis 640 ms or longer.

- an interruption on PSCell or any activated SCell with up to 0.5% probability of missed ACK/NACK regardless of the configured *measCycleSCell* [2]for the deactivated E-UTRA SCells if indicated by the network using IE *allowInterruptions* [2].

Each interruption shall not exceed

- X3 slot, if the PSCell or activated SCell is not in the same band as the E-UTRA deactivated SCC being measured, or

- Y3 slot + SMTC duration, if the PSCell or activated SCell is in the same band as the E-UTRA deactivated SCC being measured, provided the cell specific reference signals from the PSCell or activated SCell and the E-UTRA deactivated SCC being measured are available in the same slot.

Table 8.2.1.2.5-1 Interruption length X3 and Y3 at measurements on deactivated E-UTRA SCC

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **NR Slot length (ms)** | **Interruption length X3 slot** | | **Interruption length Y3 slot** |
| **Sync** | **Async** |
| 0 | 1 | 1 | 2 | 1 |
| 1 | 0.5 | 1 | 2 | 1 |
| 2 | 0.25 | 3 | | 2 |
| 3 | 0.125 | 5 | | 4 |

##### 8.2.1.2.6 Interruptions at UL carrier RRC reconfiguration

The requirements in this clause shall apply when a supplementary UL carrier or an UL carrier is configured or de-configured in NR non-standalone operation as defined in [2].

When an UL carrier or supplementary UL carrier is configured or deconfigured, an interruption on LTE PCell, all activated LTE SCells, PSCell and all activated SCells within the same FR as the reconfigured uplink carrier of up to [1] slot, is allowed immediately after the RRC reconfiguration procedure [2]. The interruption is for both uplink and downlink of LTE PCell, all LTE activated SCells, PSCell and all activated SCells within the same FR as the configured or de-configured UL.

### 8.2.2 SA: Interruptions with Standalone NR Carrier Aggregation

#### 8.2.2.1 Introduction

This section contains the requirements related to the interruptions on PCell and activated SCell if configured, when up to TBD SCells are configured, deconfigured, activated or deactivated.

NOTE: interruptions at SCell addition/release, activation/deactivation and during measurements on SCC may not be required by all UEs.

*Editor’s Note: The interruptions shall not interrupt RRC signalling or ACK/NACKs related to RRC reconfiguration procedure [2] for SCell addition/release or MAC control signalling [17] for SCell activation/deactivation command. How to specify this is FFS.*

#### 8.2.2.2 Requirements

##### 8.2.2.2.1 Interruptions at SCell addition/release

When any number of SCells between one and TBD is added or released using the same *RRCConnectionReconfiguration* message as defined in [2], the UE is allowed an interruption on PCell and on any activated SCell during the RRC reconfiguration procedure as follows:

- an interruption on PCell:

- of up to the duration shown in table 8.2.2.2.1-1, if the PCell is not in the same band as any of the SCells being added or released, or

- of up to the duration shown in table 8.2.2.2.1-2, if the PCell is in the same band as any of the SCells being added or released, provided the cell specific reference signals from the PCell and the SCells being added or released are available in the same slot;

- an interruption on any activated SCell:

- of up to to the duration shown in table 8.2.2.2.1-1, if the activated SCell is not in the same band as any of the SCells being added or released, or

- of up to the duration shown in table 8.2.2.2.1-2, if the activated SCell is in the same band as any of the SCells being added or released, provided the cell specific reference signals from the activated SCell and the SCells being added or released are available in the same slot.

Table 8.2.2.2.1-1: Interruption duration for SCell addition/release for inter-band CA

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length  (slot) |
| 0 | 1 | 1 |
| 1 | 0.5 | 2 |
| 2 | 0.25 | 4 |
| 3 | 0.125 | 8 |

Table 8.2.2.2.1-2: Interruption duration for SCell addition/release for intra-band CA

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length (slot) |
| 0 | 1 | 1 + SMTC duration |
| 1 | 0.5 | 2 + SMTC duration |
| 2 | 0.25 | 4 + SMTC duration |
| 3 | 0.125 | 8 + SMTC duration |

##### 8.2.2.2.2 Interruptions at SCell activation/deactivation

When an intra-band SCell is activated or deactivated as defined in [17] the UE is allowed

- an interruption on PCell:

- of up to the duration shown in table 8.2.2.2.2-1, if the PCell is not in the same band as any of the SCells being activated or deactivated, or

- of up to the duration shown in table 8.2.2.2.2-2 if the PCell is in the same band as any of the SCells being activated or deactivated provided the cell specific reference signals from the PCell and the SCells being activated or deactivated are available in the same slot;

- an interruption on any activated SCell:

- of up to the duration shown in table 8.2.2.2.2-1, if the activated SCell is not in the same band as any of the SCells being activated or deactivated, or

- of up to the duration shown in table 8.2.2.2.2-2, if the activated SCell is in the same band as any of the SCells being activated or deactivated provided the cell specific reference signals from the PCell and the SCells being activated or deactivated are available in the same slot.

Table 8.2.2.2.2-1: Interruption duration for SCell activation/deactivation for inter-band CA

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length |
| 0 | 1 | 1 |
| 1 | 0.5 | 1 |
| 2 | 0.25 | 2 |
| 3 | 0.125 | 4 |

Table 8.2.2.2.2-2: Interruption duration for SCell activation/deactivation for intra-band CA

|  |  |  |
| --- | --- | --- |
|  | NR Slot length (ms) | Interruption length |
| 0 | 1 | 1 + SMTC duration |
| 1 | 0.5 | 2 + SMTC duration |
| 2 | 0.25 | 4 + SMTC duration |
| 3 | 0.125 | 8 + SMTC duration |

##### 8.2.2.2.3 Interruptions during measurements on SCC for intra-band CA

*Editors note : Interruption requirements to PCell and active Sells due to measuements on the carrier with deactivated SCell are for futher study*

##### 8.2.2.2.4 Interruptions at UL carrier RRC reconfiguration

The requirements in this clause shall apply when a supplementary UL carrier or an UL carrier is configured or de-configured in NR standalone carrier aggregation as defined in [2].

When an UL carrier or supplementary UL carrier is configured or deconfigured, an interruption on PCell and all activated SCells within the same FR as the reconfigured uplink carrier of up to [1] slot, is allowed immediately after the RRC reconfiguration procedure [2]. The interruption is for both uplink and downlink of PCell and all the activated SCells within the same FR as the configured or de-configured UL.

## 8.3 SCell Activation and Deactivation Delay

### 8.3.1 Introduction

This section defines requirements for the delay within which the UE shall be able to activate a deactivated SCell in SCG and deactivate an activated SCell in SCG in E-UTRA-NR DC.

The requirements shall apply for E-UTRA-NR DC where the E-UTRA is the master (Option 3/3a/3x in TR 38.801[1] section 10.1.2)

### 8.3.2 SCell Activation Delay Requirement for Deactivated SCell

The requirements in this section shall apply for the UE configured with one downlink SCell in SCG.

The delay within which the UE shall be able to activate the deactivated SCell in SCG depends upon the specified conditions.

Upon receiving SCG SCell activation command in slot *n*, the UE shall be capable to transmit valid CSI report and apply actions related to the activation command for the SCell being activated no later than in slot *n*+ [THARQ + Tactivation\_time + TCSI\_Reporting ]

Where:

THARQ is the timing between DL data transmission and acknowledgement as specified in [7].

Tactivation\_time is the SCell activation delay. If the SCell is known and belongs to FR1, Tactivation\_time is:

- [3ms+ 1\*SMTC periodicity+4\*OFDM symbol], if the SCell measurement cycle is equal to or smaller than [160ms].

- [3ms+2\*SMTC periodicity+4\*OFDM symbol], if the SCell measurement cycle is larger than [160ms].

If the SCell is unknown and belongs to FR1, Tactivation\_time is:

- [3ms+ 4\*SMTC periodicity+4\*OFDM symbol] provided the SCell can be successfully detected on the first attempt.

If the SCell being activated is known and belongs to FR2,Tactivation\_time is [TBD]. If the SCell being activated is unknown and belongs to FR2, Tactivation\_time is [TBD].

TCSI\_reporting is the delay uncertainty in acquiring the first available CSI reporting resources as specified in [2].

SCell in FR1 is known if it has been meeting the following conditions:

- During the period equal to max([5] measCycleSCell,  [5] DRX cycles) for FR1 before the reception of the SCell activation command:

- the UE has sent a valid measurement report for the SCell being activated and

- the SSB measured remains detectable according to the cell identification conditions specified in section 9.2 and 9.3.

- the SSB measured during the period equal to max([5] measCycleSCell, [5] DRX cycles) also remains detectable during the SCell activation delay according to the cell identification conditions specified in section 9.2 and 9.3.

Otherwise SCell in FR1 is unknown.

The condition for SCell in FR2 is FFS

In addition to CSI reporting defined above, UE shall also apply other actions related to the activation command specified in [2] for an SCG SCell at the first opportunities for the corresponding actions once the SCell is activated.

The PSCell interruption specified in section 8.2 shall not occur before slot n+[THARQ] and not occur after slot *n+*[ THARQ +3ms ].

Starting from the slot specified in section 4.3 of [3] (timing for secondary Cell activation/deactivation) and until the UE has completed the SCell activation, the UE shall report out of range if the UE has available uplink resources to report CQI for the SCell.

### 8.3.3 SCell Deactivation Delay Requirement for Activated SCell

The requirements in this section shall apply for the UE configured with one downlink SCell in SCG

Upon receiving SCG SCell deactivation command or upon expiry of the *sCellDeactivationTimer* in slot *n*, the UE shall accomplish the deactivation actions for the SCell being deactivated no later than in slot *n+*[ THARQ +3ms ].

The PSCell interruption specified in section 8.2 shall not occur before slot n+[THARQ] and not occur after slot *n+*[ THARQ +3ms ].

## 8.4 UE UL carrier RRC reconfiguration Delay

### 8.4.1 Introduction

The requirements in this section apply for a UE being configured or deconfigured with a supplementary UL carrier or NR UL carrier.

### 8.4.2 UE UL carrier configuration Delay Requirement

When the UE receives a RRC message implying NR UL or Supplementary UL carrier configuration, the UE shall be ready to start transmission on the newly configured carrier within TUL\_carrier\_config from the end of the last slot containing the RRC command.

TUL\_carrier\_config equals the maximum RRC procedure delay defined in clause x.y in TS 38.331 [2] plus the interruption time specified in section 8.2.1.2.6.

### 8.4.3 UE UL carrier deconfiguration Delay Requirement

When the UE receives a RRC message implying NR UL or Supplementary UL carrier deconfiguration RRC signalling, the UE shall stop UL signalling on the deconfigured UL carrier within TUL\_carrier\_deconfig from the end of the last slot containing the RRC command.

TUL\_carrier\_deconfig equals the maximum RRC procedure delay defined in clause x.y in TS 38.331 [2].

# 9 Measurement Procedure

## 9.1 General measurement requirement

### 9.1.1 Introduction

This clause contains general requirements on the UE regarding measurement reporting in RRC\_CONNECTED state. The requirements are split in intra-frequency, inter-frequency, inter-RAT E-UTRAN FDD, and inter-RAT E-UTRAN TDD requirements. These measurements may be used by the NG-RAN. The measurement quantities are defined in [TS38.215], the measurement model is defined in TS38.300[10], TS37.340[17] and measurement accuracies are specified in clause 10. Control of measurement reporting is specified in [16].

9.1.2 Measurement gap

If the UE requires measurement gaps to identify and measure intra-frequency cells and/or inter-frequency cells and/or inter-RAT E-UTRAN cells, and the UE does not support independent measurement gap patterns for different frequency ranges as specified in Table 5.1-1 in [41], in order for the requirements in the following subsections to apply the [network] must provide a single per-UE measurement gap pattern for concurrent monitoring of all frequency layers.

If the UE requires measurement gaps to identify and measure intra-frequency cells and/or inter-frequency cells and/or inter-RAT E-UTRAN cells, and the UE supports independent measurement gap patterns for different frequency ranges as specified in Table 5.1-1 in [41], in order for the requirements in the following subsections to apply the [network] must provide either per-FR measurement gap patterns for frequency range where UE requires per-FR measurement gap for concurrent monitoring of all frequency layers of each frequency range independently, or a single per-UE measurement gap pattern for concurrent monitoring of all frequency layers of all frequency ranges.

During the per-UE measurement gaps the UE:

- shall not transmit any data

- [is not required to receive data from the corresponding E-UTRAN PCell, E-UTRAN SCell(s) and NR serving cells for NSA]

- [is not required to receive data from the corresponding NR serving cells for SA]

*Editor note: whether or not UE can receive signal for measurement from the corresponding serving cells within some of measurement gaps is FFS.*

During the per-FR measurement gaps the UE:

- shall not transmit any data on serving cells in the corresponding frequency range

- [is not required to receive data from the corresponding E-UTRAN PCell, E-UTRAN SCell(s) and NR serving cells for NSA]

- [is not required to receive data from the corresponding NR serving cells for SA]

*Editor note: whether or not UE can receive signal for measurement from the corresponding serving cells within some of measurement gaps is FFS.*

UEs shall support the measurement gap patterns listed in Table 9.1.2-1 based on the applicability specified in table 9.1.2-2 and 9.1.2-3. UE determines measurement gap timing based on gap offset configuration and measurement gap timing advance configuration provided by higher layer signalling as specified in [2] and [16].

Table 9.1.2-1: Gap Pattern Configurations

|  |  |  |
| --- | --- | --- |
| **Gap Pattern Id** | **Measurement Gap Length (MGL, ms)** | **Measurement Gap Repetition Period**  **(MGRP, ms)** |
| 0 | 6 | 40 |
| 1 | 6 | 80 |
| 2 | 3 | 40 |
| 3 | 3 | 80 |
| 4 | 6 | 20 |
| 5 | 6 | 160 |
| 6 | 4 | 20 |
| 7 | 4 | 40 |
| 8 | 4 | 80 |
| 9 | 4 | 160 |
| 10 | 3 | 20 |
| 11 | 3 | 160 |
| 12 | 5.5 | 20 |
| 13 | 5.5 | 40 |
| 14 | 5.5 | 80 |
| 15 | 5.5 | 160 |
| 16 | 3.5 | 20 |
| 17 | 3.5 | 40 |
| 18 | 3.5 | 80 |
| 19 | 3.5 | 160 |
| 20 | 1.5 | 20 |
| 21 | 1.5 | 40 |
| 22 | 1.5 | 80 |
| 23 | 1.5 | 160 |

Table 9.1.2-2: Applicability for Gap Pattern Configurations supported by the E-UTRA-NR dual connectivity UE

|  |  |  |  |
| --- | --- | --- | --- |
| **Measurement gap pattern configuration** | **Serving cell** | **Measurement Purpose** | **Applicable Gap Pattern Id** |
| Per-UE measurement gap | E-UTRA + FR1, or  E-UTRA + FR2, or  E-UTRA + FR1 + FR2 | non-NR RAT Note1,2 | 0,1,2,3 |
| FR1 and/or FR2 | 0-11 |
| non-NR RATNote1,2 and FR1 and/or FR2 | 0,1,2,3 |
| Per FR measurement gap | E-UTRA and, FR1 if configured | non-NR RAT Note1,2 | 0,1,2,3 |
| FR2 if configured | No gap |
| E-UTRA and, FR1 if configured | FR1 only | 0-11 |
| FR2 if configured | No gap |
| E-UTRA and, FR1 if configured | FR2 only | No gap |
| FR2 if configured | 12-23 |
| E-UTRA and, FR1 if configured | non-NR RAT Note1,2 and FR1 | 0,1,2,3 |
| FR2 if configured | No gap |
| E-UTRA and, FR1 if configured | FR1 and FR2 | 0-11 |
| FR2 if configured | 12-23 |
| E-UTRA and, FR1 if configured | non-NR RAT Note1,2 and FR2 | 0,1,2,3 |
| FR2 if configured | 12-23 |
| E-UTRA and, FR1 if configured | non-NR RAT Note1,2 and FR1 and FR2 | 0,1,2,3 |
| FR2 if configured | 12-23 |
| *Note: if GSM or UTRA TDD or UTRA FDD inter-RAT frequency layer is configured to be monitered, only measurement gap pattern #0 and #1 can be used for per-FR gap in E-UTRA and FR1 if configured, or for per-UE gap.*  NOTE 1: Non-NR RAT includes E-UTRA, UTRA and/or GSM.  NOTE 2: The gap pattern 2 and 3 are supported by UEs which support shortMeasurementGap-r14.  NOTE 3: When E-UTRA inter-frequency RSTD measurements are configured and the UE requires measurement gaps for performing such measurements, only Gap Pattern #0 can be used. | | | |

For E-UTRA-NR dual connectivity, when serving cells are on E-UTRA and FR1, measurement objects are in both E-UTRA /FR1 and FR2,

- If MN indicates UE that the measurement gap from MN applies to E-UTRA/FR1/FR2 serving cells, UE fulfils the per-UE measurement requirements for both E-UTRA/FR1 and FR2 measurement objects based on the measurement gap pattern configured by MN;

- If MN indicates UE that the measurement gap from MN applies to only LTE/FR1 serving cell(s),

- UE fulfils the measurement requirements for FR1/LTE measurement objects based on the configured measurement gap pattern;

- UE fulfils the requirements for FR2 measurement objects based on effective MGRP=20ms;

When serving cells are in E-UTRA, FR1 and FR2, Measurement objects are in both E-UTRA /FR1 and FR2,

- If MN indicates UE that the measurement gap from MN applies to E-UTRA/FR1/FR2 serving cells, UE fulfils the per-UE measurement requirements for both E-UTRA/FR1 and FR2 measurement objects based on the measurement gap pattern configured by MN.

Table 9.1.2-3: Applicability for Gap Pattern Configurations supported by the UE with NR standalone operation

|  |  |  |  |
| --- | --- | --- | --- |
| **Measurement gap pattern configuration** | **Serving cell** | **Measurement Purpose** NOTE 2 | **Applicable Gap Pattern Id** |
| Per-UE measurement gap | FR1, or  FR1 + FR2 | E-UTRA only | 0,1,2,3 |
| FR1 and/or FR2 | 0-11 |
| E-UTRAN and FR1 and/or FR2 | 0,1,2,3 |
| FR2 | E-UTRA only | 0,1,2,3 |
| FR1 only | 0-11 |
| FR1 and FR2 | 0-11 |
| E-UTRAN and FR1 and/or FR2 | 0,1,2,3 |
| FR2 only | 12-23 |
| Per FR measurement gap | FR1 if configured | E-UTRA only | 0,1,2,3 |
| FR2 if configured | No gap |
| FR1 if configured | FR1 only | 0-11 |
| FR2 if configured | No gap |
| FR1 if configured | FR2 only | No gap |
| FR2 if configured | 12-23 |
| FR1 if configured | E-UTRA and FR1 | 0,1,2,3 |
| FR2 if configured | No gap |
| FR1 if configured | FR1 and FR2 | 0-11 |
| FR2 if configured | 12-23 |
| FR1 if configured | E-UTRA and FR2 | 0,1,2,3 |
| FR2 if configured | 12-23 |
| FR1 if configured | E-UTRA and FR1 and FR2 | 0,1,2,3 |
| FR2 if configured | 12-23 |
| NOTE 1: When E-UTRA inter-RAT RSTD measurements are configured and the UE requires measurement gaps for performing such measurements, only Gap Pattern #0 can be used.  NOTE 2: Measurement purpose which includes E-UTRA measurements includes also inter-RAT E-UTRA RSRP and RSRQ measurements for E-CID | | | |

In NR standalone operation, for per-FR gap based measurement,when there is no serving cell in a particular FR, where measurements objects are configured, regardless if explicit per-FR measurement gap is configured in this FR, the effective MGRP in this FR used to determine requirements;

- 20ms for FR2 NR measurements

- 40ms for FR1 NR measurements

- 40ms for LTE measurements

- 40ms for FR1+LTE measurements

If measurement gap is configured in one FR but measurement object is not configured in the FR, the scheduling opportunity in the FR depends on the configured measurement gap pattern.

For E-UTRA-NR dual connectivity, if UE is not capable of per-FR-gap, total interruption time on SCG during MGL is defined only when MGL(N) = 6ms, 4ms and 3ms. And if the UE supporting EN-DC is configured with PSCell, during the total interruption time as shown in Figure 9.1.2-1, the UE shall not transmit and receive any data in SCG.



(a) Measurement gap with MGL = N(ms) with MG timing advance of 0ms for synchronous EN-DC



(b) Measurement gap with MGL = N(ms) with MG timing advance of 0.5ms for synchronous EN-DC



(c) Measurement gap with MGL = N(ms) with MG timing advance of 0ms for asynchronous EN-DC



(d) Measurement gap with MGL = N(ms) with MG timing advance of 0.5ms for asynchronous EN-DC

Figure 9.1.2-1: Measurement GAP and total interruption time on MCG and SCG

The corresponding total number of interrupted slots on SCG during MGL is listed in Table9.1.2-4 and Table9.1.2-4a for synchronous EN-DC and asynchronous EN-DC respectively.

Table 9.1.2-4: Total number of interrupted slots on SCG during MGL for Synchronous EN-DC with per-UE measurement gap or per-FR measurement gap for FR1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **NR SCS (kHz)** | **Total number of interrupted slots on SCG** | | | | | |
| **When MG timing advance of 0ms is applied** | | | **When MG timing advance of 0.5ms is applied** | | |
| **MGL=6ms** | **MGL=4ms** | **MGL=3ms** | **MGL=6ms** | **MGL=4ms** | **MGL=3ms** |
| 15 | 6 | 4 | 3 | 7 | 5 | 4 |
| 30 | [12] | [8] | [6] | [12] | [8] | [6] |
| 60 | [24] | [16] | [12] | [24] | [16] | [12] |
| 120 | [48] | [32] | [24] | [48] | [32] | [24] |
| NOTE 1: For Gap Pattern ID 0, 1, 2 and 3, total number of interrupted subframes on MCG is MGL subframes when MG timing advance of 0ms is applied, and (MGL+1) subframes when MG timing advance of 0.5ms is applied.  NOTE 2: NR SCS of 120 kHz is only applicable to the case with per-UE measurement gap. | | | | | | |

Table 9.1.2-4a: Total number of interrupted slots on SCG during MGL for Asynchronous EN-DC with per-UE measurement gap or per-FR measurement gap for FR1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **NR SCS (kHz)** | **Total number of interrupted slots on SCG** | | | | | |
| **When MG timing advance of 0ms is applied** | | | **When MG timing advance of 0.5ms is applied** | | |
| **MGL=6ms** | **MGL=4ms** | **MGL=3ms** | **MGL=6ms** | **MGL=4ms** | **MGL=3ms** |
| 15 | 7 | 5 | 4 | 7 | 5 | 4 |
| 30 | 13 | 9 | 7 | 13 | 9 | 7 |
| 60 | 25 | 17 | 13 | 25 | 17 | 13 |
| 120 | 49 | 33 | 25 | 49 | 33 | 25 |
| NOTE 1: For Gap Pattern ID 0, 1, 2 and 3, total number of interrupted subframes on MCG is MGL subframes when MG timing advance of 0ms is applied, and (MGL+1) subframes when MG timing advance of 0.5ms is applied.  NOTE 2: NR SCS of 120 kHz is only applicable to the case with per-UE measurement gap. | | | | | | |

In case that UE capable of per-FR measurement gap is configured with per-FR measurement gap for FR2 serving cells, total number of interrupted slots on FR2 serving cells during MGL is listed in Table9.1.2-4b.

Table 9.1.2-4b: Total number of interrupted slots on FR2 serving cells during MGL in case with per-FR measurement gap for FR2

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **NR SCS (kHz)** | **Total number of interrupted slots on FR2 serving cells** | | | | | |
| **When MG timing advance of 0ms is applied** | | | **When MG timing advance of 0.25ms is applied** | | |
| **MGL=5.5ms** | **MGL=3.5ms** | **MGL=1.5ms** | **MGL=5.5ms** | **MGL=3.5ms** | **MGL=1.5ms** |
| 60 | [22] | [14] | [6] | [22] | [14] | [6] |
| 120 | [44] | [28] | [12] | [44] | [28] | [12] |

Measurement gap sharing shall be applies when UE requires measurement gaps to identify and measure intra-frequency cells or when SMTC configured for intra-frequency measurement are fully overlapping with measurement gaps, and when UE is configured to identify and measure cells on inter-frequency carriers and inter-RAT carriers.When network signals “01”, “10” or “11”, where X is a signalled RRC parameter TBD and is defined as in Table 9.1.2-5,

- the performance of intra-frequency measurements with no measurement gaps as specified in section 9.2.5, when SMTC configured for intra-frequency measurement are fully overlapping with measurement gaps, shall consider the factor Kintra = 1 / X \* 100,

- the performance of intra-frequency measurements with measurement gaps as specified in section 9.2.6 shall consider the factor Kintra = 1 / X \* 100,

- the performance of inter-frequency measurement as specified in section 9.3 and the performance of inter-RAT measurement as specified in section 9.4 shall consider the factor Kinter = 1 / (100 – X) \* 100,

When network signals “00” indicating equal splitting gap sharing, X is not applied and the performance of intra-frequency measurements as specified in section 9.2.5 and section 9.2.6, the performance of inter-frequency measurement as specified in section 9.3 and the performance of inter-RAT measurement as specified in section 9.4 are FFS.

Table 9.1.2-5: Value of parameter X

|  |  |
| --- | --- |
| Network signaling ParameterName (to be determined by RAN2) | Value of X (%) |
| ‘00’ | Equal splitting |
| ‘01’ | [25] |
| ‘10’ | [50] |
| ‘11’ | [75] |

### 9.1.3 UE Measurement capability

#### 9.1.3.1 NSA: Monitoring of multiple layers using gaps

The requirements in this section are applicable for UE capable of E-UTRA-NR dual connectivity operation with E-UTRA PCell.

When monitoring of multiple inter-frequency E-UTRAN, inter-RAT NR, GSM, UTRA FDD and UTRA TDD carriers as configured by E-UTRA PCell, and inter-frequency NR carriers as configured by PSCell using gaps (or without using gaps provided the UE supports such capability) is configured, the UE shall be capable of performing one measurement of the configured measurement type (SS-RSRP, SS-RSRQ, SS-SINR, SFTD, E-UTRAN RSRP, E-UTRAN RSRQ, E-UTRAN RS-SINR measurements, UTRAN TDD P-CCPCH RSCP, UTRAN FDD CPICH measurements, GSM carrier RSSI, etc.) of detected cells on all the layers.

For UE configured with the E-UTRA-NR dual connectivity operation, the effective total number of frequencies excluding the frequencies of the PSCell, SCells, E-UTRA PCell, and E-UTRA SCells being monitored is Nfreq, NSA, which is defined as:

Nfreq, NSA = Nfreq, NSA, NR + Nfreq, NSA, E-UTRA+ Nfreq, NSA, UTRA + MNSA, GSM,

where

Nfreq, NSA, E-UTRA is the number of E-UTRA inter-frequency carriers being monitored (FDD and TDD) as configured by E-UTRA PCell.

Nfreq, NSA, NR ≤ Nfreq, NSA, NR, inter-RAT + Nfreq, NSA, NR, inter-freq

where

Nfreq, NSA, NR, inter-RAT is the number of NR inter-RAT carriers being monitored as configured by E-UTRA PCell [15]

Nfreq, NSA, NR, inter-freq is the number of NR inter-frequency carriers being monitored as configured by PSCell

Nfreq, NSA, UTRA is the number of UTRA inter-RAT carriers being monitored as configured by E-UTRA PCell (FDD and TDD)

MNSA, GSM is an integer which is a function of the number of GSM inter-RAT carriers as configured by E-UTRA PCell on which measurements are being performed. MNSA, GSM is equal to 0 if no GSM carrier is being monitored. For a MGRP of 40 ms, MNSA, GSM is equal to 1 if cells on up to 32 GSM carriers are being measured. For a MGRP of 80 ms, MNSA, GSM is equal to ceil(Ncarriers,GSM /20) where Ncarriers,GSM is the number of GSM carriers on which cells are being measured.

9.1.3.1a SA: Monitoring of multiple layers using gaps

The requirements in this section are applicable for UE configured with at least a PCell.

When monitoring of multiple inter-RAT E-UTRAN carriers and inter-frequency NR carriers using gaps (or without using gaps provided the UE supports such capability) is configured by PCell, the UE shall be capable of performing one measurement of the configured measurement type (SS-RSRP, SS-RSRQ, SS-SINR, E-UTRAN RSRP, E-UTRAN RSRQ, E-UTRAN RS-SINR measurements, etc.) of detected cells on all the layers.

For UE configured with the NR SA operation, the effective total number of frequencies, excluding the frequencies of the PCell, PSCell and SCells being monitored, is Nfreq, SA, which is defined as:

Nfreq, SA = Nfreq, SA, NR + Nfreq, SA, E-UTRA,

where

Nfreq, SA, E-UTRA is the number of E-UTRA inter-RAT carriers being monitored (FDD and TDD) as configured by PCell.

Nfreq, SA, NR is the number of NR inter-frequency carriers being monitored as configured by PCell.

#### 9.1.3.2 NSA: Maximum allowed layers for multiple monitoring

If a UE is configured with E-UTRA-NR dual connectivity operation, the UE shall be capable of monitoring at least:

- Depending on UE capability, 7 NR inter-frequency carriers configured by PScell, and

- Depending on UE capability, 7 NR inter-RAT carriers configured by E-UTRA PCell [15], and

- Depending on UE capability, 6 E-UTRA TDD inter-frequency carriers configured by E-UTRA PCell [15], and

- Depending on UE capability, 6 E-UTRA FDD inter-frequency carriers configured by E-UTRA PCell [15], and

- Depending on UE capability, 3 FDD UTRA carriers, and

- Depending on UE capability, 3 TDD UTRA carriers, and

- Depending on UE capability, 32 GSM carriers (one GSM layer corresponds to 32 carriers)

In addition to the requirements defined above, the UE shall be capable of monitoring a total of at least 13 effective carrier frequency layers comprising of any above defined combination of NR, E-UTRA FDD, E-UTRA TDD, UTRA FDD, UTRA TDD and GSM (one GSM layer corresponds to 32 carriers) layers. The UE shall be capable of monitoring a total of at least 7 effective NR carrier frequency layers configured by E-UTRA PCell and/or PSCell.

NOTE 1: The E-UTRA-NR dual connectivity capable UE configured with PSCell shall fulfil the requirements defined in only one of Section 9.1.3.2 and Section 8.2.1.1b.1 of [15].

NOTE 2: When the E-UTRA PCell and PSCell configure the same NR carrier frequency layer to be monitored by the UE, this layer shall be counted only once to the total number of effective carrier frequency layers, unless the configured NR carrier frequency layers to be monitored have different subcarrier spacing or different RSSI measurement resources.

*Editor’s note: FFS when the E-UTRA PCell and PSCell configure the same NR carrier frequency layer to be monitored, whether this layer shall be counted only once under the condition that the UE is configured with differences in SMTC configurations or different useServingCellTimingForSync indications.*

#### 9.1.3.2a SA: Maximum allowed layers for multiple monitoring

If a UE is configured with at least a PCell, the UE shall be capable of monitoring at least:

- Depending on UE capability, 7 NR inter-frequency carriers configured by PCell, and

- Depending on UE capability, 7 E-UTRA TDD inter-RAT carriers configured by PCell, and

- Depending on UE capability, 7 E-UTRA FDD inter-RAT carriers configured by PCell

In addition to the requirements defined above, the UE shall be capable of monitoring a total of at least [13] effective carrier frequency layers comprising of any above defined combination of NR, E-UTRA FDD and E-UTRA TDD layers.

### 9.1.4 Capabilities for Support of Event Triggering and Reporting Criteria

#### 9.1.4.1 Introduction

This clause contains requirements on UE capabilities for support of event triggering and reporting criteria. As long as the measurement configuration does not exceed the requirements stated in Section 9.1.4.2, the UE shall meet all other performance requirements defined in Section 9 and Section 10.

The UE can be requested to make measurements under different measurement identities defined in TS 38.331 [2]. Each measurement identity corresponds to either event based reporting, periodic reporting, or no reporting. In case of event based reporting, each measurement identity is associated with an event triggering criterion. In case of periodic reporting, a measurement identity is associated with one periodic reporting criterion. In case of no reporting, a measurement identity is associated with one no reporting criterion.

The purpose of this clause is to set some limits on the number of different event triggering, periodic, and no reporting criteria the UE may be requested to track in parallel.

#### 9.1.4.2 Requirements

In this section a reporting criterion corresponds to either one event (in the case of event based reporting), or one periodic reporting criterion (in case of periodic reporting), or one no reporting criterion (in case of no reporting). For event based reporting, each instance of event, with the same or different event identities, is counted as separate reporting criterion in Table 9.1.4.2-1.

The UE shall be able to support in parallel per category up to Ecat reporting criteria according to Table 9.1.4.2-1. For the measurement categories belonging to intra-frequency, inter-frequency, and inter-RAT measurements (i.e. without counting other categories that the UE shall always support in parallel), the UE need not support more than the total number of reporting criteria as follows:

- For UE configured with EN-DC: , where

 is the total number of NR reporting criteriaapplicable for UE configured with EN-DC according to Table 9.1.4.2-1, and  is the number of configured NR serving frequencies, including PSCell and SCells carrier frequencies,

 is the total number of reporting criteria for E-UTRA PCell as specified in TS 36.133 [15] for UE configured with EN-DC,

- For UE not configured of EN-DC: , where

 is the total number of NR reporting criteria according to Table 9.1.4.2-1, and  is the number of configured NR serving frequencies, including PCell and SCells carrier frequencies,

 is the total number of E-UTRA inter-RAT reporting criteria according to Table 9.1.4.2-1.

Table 9.1.4.2-1: Requirements for reporting criteria per measurement category

|  |  |  |  |
| --- | --- | --- | --- |
| Measurement category | Ecat | Note | |
| Intra-frequency Note 1 | 9 | Events for any one or a combination of intra-frequency SS-RSRP, SS-RSRQ, and SS-SINR for NG-RAN intra-frequency cells | |
| Inter-frequency | 10 | Events for any one or a combination of inter-frequency SS-RSRP, SS-RSRQ, and SS-SINR for NG-RAN inter-frequency cells | |
| Inter-RAT (E-UTRA FDD, E-UTRA TDD) | 10 | Only applicable for UE with this (inter-RAT) capability when the UE is not configured with EN-DC operation. | |
| Inter-RAT (E-UTRA FDD, E-UTRA TDD) RSTD | 1 | Inter-RAT RSTD measurement reporting for UE supporting OTDOA; 1 report capable of minimum 16 inter-RAT cell measurements.  Only applicable for UE with this (inter-RAT RSTD via LPP [22]) capability and when the UE is not configured with EN-DC operation. | |
| Inter-RAT (E-UTRA FDD, E-UTRA TDD) RSRP and RSRQ measurements for E-CID | 1 | Inter-RAT RSRP and RSRQ measurements for E-CID reported to E-SMLC via LPP [22]. One report capable of at least in total 10 inter-RAT RSRP and RSRQ measurements. Applicable to UE capable of reporting inter-RAT RSRP and RSRQ to E-SMLC via LPP and when the UE is not configured with EN-DC operation. | |
| NOTE 1: When the UE is configured with PSCell and SCell carrier frequencies, Ecat for Intra-frequency is applied per serving frequency. | | | |

## 9.2 NR intra-frequency measurements

### 9.2.1 Introduction

A measurement is defined as a SSB based intra-frequency measurement provided the centre frequency of the SSB of the serving cell indicated for measurement and the centre frequency of the SSB of the neighbour cell are the same, and the subcarrier spacing of the two SSB are also the same

The UE can perform intra-frequency SSB based measurements without measurement gaps under the following conditions:

- the SSB is completely contained in the downlink operating bandwidth of the UE, and;

- the SSB has the same subcarrier spacing as the downlink data transmission to the UE, and;

- the UE is measuring on FR1;

- the serving cell data transmissions to the UE have the same subcarrier spacing as the SSB to be measured

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

When measurement gaps are needed, the UE is not expected to detect SSB which start earlier than the gap starting time + switching time, nor detect SSB which end later than the gap end – switching time. Switching time is 0.5ms for frequency range FR1 and 0.25ms for frequency range FR2.

### 9.2.2 Requirements applicability

The requirements in this section apply if

- SCH\_RP and SCH Ês/Iot according to Annex TBD for a corresponding Band.

### 9.2.3 Number of cells and number of SSB

#### 9.2.3.1 Requirements for FR1

For each intra-frequency layer, the UE shall be capable of monitoring at least 8 cells.

For each intra-frequency layer, during each layer 1 measurement period, the UE shall be capable of monitoring at least [14] SSBs with different SSB index and/or PCI on the intra-frequency layer, where the number of SSBs in the serving cell (except for the SCell) is no smaller than the number of configured RLM-RS SSB resources.

#### 9.2.3.2 Requirements for FR2

For each intra-frequency layer the UE shall be capable of monitoring at least [6] cells on a single serving carrier (PCC or PSCC or 1 SCC if PCC/PSCC is in a band different from SCC) out of all the serving carriers configured in the same band.

For each intra-frequency layer, during each layer 1 measurement period, the UE shall be capable of monitoring at least [24] SSB with different SSB index and/or PCI on a single serving carrier (PCC or PSCC or 1 SCC if PCC/PSCC is in a band different from SCC) out of all the serving carriers configured in the same band. UE shall be capable of monitoring [1~ 4] SSB(s) on serving cell for each of the other serving carrier(s) in the same band. UE shall be capable of performing RSRP and RSRQ on all above-mentioned SSBs

### 9.2.4 Measurement Reporting Requirements

#### 9.2.4.1 Periodic Reporting

Reported RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in sections 10.x,10.y and 10.z, respectively.

#### 9.2.4.2 Event-triggered Periodic Reporting

Reported RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in sections 10.x,10.y and 10.z, respectively.

The first report in event triggered periodic measurement reporting shall meet the requirements specified in clause 9.2.4.3.

#### 9.2.4.3 Event Triggered Reporting

Reported RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in sections 10.x,10.y and 10.z, respectively.

The UE shall not send any event triggered measurement reports, as long as no reporting criteria are fulfilled.

The measurement reporting delay is defined as the time between an event that will trigger a measurement report and the point when the UE starts to transmit the measurement report over the air interface. This requirement assumes that the measurement report is not delayed by other RRC signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTIDCCH.This measurement reporting delay excludes a delay which caused by no UL resoureces for UE to send the measurement report.

The event triggered measurement reporting delay, measured without L3 filtering shall be less than T identify intra with index or T identify intra without index defined in clause 9.2.5.1 or clause 9.2.6.2.When L3 filtering is used an additional delay can be expected.

If a cell which has been detectable at least for the time period than T identify intra without index or T identify intra with index defined in clause 9.2.5.1 or clause 9.2.6.2 becomes undetectable for a period ≤ TBD seconds and then the cell becomes detectable again and triggers an event, the event triggered measurement reporting delay shall be less than TMeasurement\_Period, Intra provided the timing to that cell has not changed more than ± TBD Ts and the L3 filter has not been used. When L3 filtering is used, an additional delay can be expected.

### 9.2.5 Intrafrequency measurements with no measurement gaps

#### 9.2.5.1 Intrafrequency cell identification

*Editor’s Note :The requirements below have been derived without considering gap sharing when all SMTC occasion are fully overlapping with measurement gaps.*

The UE shall be able to identify a new detectable intra frequency cell within Tidentify\_intra\_without\_index if UE is not indicated to report SSB based RRM measurement result with the associated SSB index, or the UE has been indicated that the neighbour cell is synchronous with the serving cell. Otherwise UE shall be able to identify a new detectable intra frequency cell within Tidentify\_intra\_with\_index. The UE shall be able to identify a new detectable intra frequency SS block of an already detected cell within Tidentify\_intra\_without\_index.

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

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

Where:

TPSS/SSS\_sync: it is the time period used in PSS/SSS detection given in table 9.2.5.1-1, 9.2.5.1-2, 9.2.5.1-5 (deactivated Scell) or 9.2.5.1-6 (deactivated SCell)

TSSB\_time\_index: it is the time period used to acquire the index of the SSB being measured given in table 9.2.5.1-3 or 9.2.5.1-4 or 9.2.5.1-7 (deactivated SCell) or 9.2.5.1-8 (deactivated SCell)

T SSB\_measurement\_period: equal to a measurement period of SSB based measurement given in table 9.2.5.2-1, table 9.2.5.2-2 table 9.2.5.2-3 (deactivated Scell) or 9.2.5.2-4(deactivated SCell)

Kca: For FR1, Kca =1 for measurements on frequencies corresponding to PCell or PSCell, and Kca =number of configured SCells for measurements on frequencies corresponding to FR1 only SCells

*Editor’s note : Kca for SCells on FR1 assumes that all Scell SMTC are overlapping(definition FFS). Kca definition may be revised for non overlapping Scell SMTCs.*

*Editor’s note:Kca is FFS if any FR2 serving cells are configured*

When intrafrequency SMTC is fully non overlapping with measurement gaps, Kp=1

When intrafrequency is partially overlapping with measurent gaps, Kp = 1/(1- (SMTC period /MGRP)), where SMTC period < MGRP

*Editor’s note : It is FFS how requirements are defined for the case that SMTC are fully overlapping with measurement gap*

*Editor’s note: It is FFS if the same scaling factor can be applied for FR2 in case of partial overlap between SMTC and measurement gap*

Table 9.2.5.1-1: Time period for PSS/SSS detection, (Frequency range FR1)

|  |  |
| --- | --- |
| DRX cycle | TPSS/SSS\_sync |
| No DRX | max[ 600ms, ceil( [5] x Kp) x SMTC period ]Note 1 |
| DRX cycle≤ 320ms | max[ 600ms, ceil(1.5x [5] x Kp) x max(SMTC period,DRX cycle) ] |
| DRX cycle>320ms | Ceil([5] x Kp) x DRX cycle |
| 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 9.2.5.1-2: Time period for PSS/SSS detection, (Frequency range FR2)

|  |  |
| --- | --- |
| DRX cycle | TPSS/SSS\_sync |
| No DRX | max[ 600ms, ceil( [5] x Kp)x N1 x SMTC period ]Note 1 |
| DRX cycle≤ 320ms | max[ 600ms, ceil(1.5 x [5] x Kp) x N1 x max(SMTC period,DRX cycle) ] |
| DRX cycle>320ms | Ceil( [5] x Kp) x N1 x DRX cycle |
| **…** | **…** |
| 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 9.2.5.1-3: Time period for time index detection (Frequency range FR1)

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index** |
| No DRX | max[120ms, ceil( 3 x Kp )x SMTC period ]Note 1 |
| DRX cycle≤ 320ms | max[120ms, ceil (1.5 x 3 x Kp) x max(SMTC period,DRX cycle) ] |
| DRX cycle>320ms | Ceil(3 x Kp) x DRX cycle |
| 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 9.2.5.1-4: Time period for time index detection (Frequency range FR2)

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index** |
| No DRX | max[ 200ms, ceil( [5] x Kp) x N2 x SMTC period ]Note 1 |
| DRX cycle≤ 320ms | max[ 200ms, ceil (1.5 x[5] x Kp) x N2 x max(SMTC period,DRX cycle) ] |
| DRX cycle>320ms | Ceil( [5] x Kp) x N2 x DRX cycle |
| **…** | **…** |
| 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 9.2.5.1-5: Time period for PSS/SSS detection, deactivated SCell (Frequency range FR1)

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync** |
| No DRX | [5] x measCycleSCell |
| DRX cycle≤ 320ms | [5] x max(measCycleSCell, 1.5xDRX cycle) |
| DRX cycle> 320ms | [5] x max(measCycleSCell, DRX cycle) |

Table 9.2.5.1-6: Time period for PSS/SSS detection, deactivated SCell (Frequency range FR2)

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync** |
| No DRX | TBD |
| DRX | TBD |

Table 9.2.5.1-7: Time period for time index detection, deactivated SCell (Frequency range FR1)

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index** |
| No DRX | [3] x measCycleSCell |
| DRX cycle≤ 320ms | [3] x max(measCycleSCell, 1.5xDRX cycle) |
| DRX cycle> 320ms | [3] x max(measCycleSCell, DRX cycle) |

Table 9.2.5.1-8: Time period for time index detection, deactivated SCell (Frequency range FR2)

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index** |
| No DRX | TBD |
| DRX | TBD |

#### 9.2.5.2 Measurement period

*Editor’s Note : The requirements below have been derived so far assuming no configured Scell or E-UTRA SCell. The requirements when one or more SCells or E-UTRA SCells are configured is for further study. The requirements below have been derived without considering gap sharing when all SMTC occasion are fully overlapping with measurement gaps.*

The measurement period for intrafrequency measurements without gaps is as shown in table 9.2.5.2-1, 9.2.5.2-2, 9.2.5.2-3 (deactivated SCell) or 9.2.5.2-4(deactivated SCell).

Table 9.2.5.2-1: Measurement period for intrafrequency measurements without gaps(Frequency FR1)

|  |  |
| --- | --- |
| **DRX cycle** | **T SSB\_measurement\_period** |
| No DRX | max[ 200ms, ceil( 5 x Kp) x SMTC period ]Note 1 |
| DRX cycle≤ 320ms | max[ 200ms, ceil(1.5x 5 x Kp) x max(SMTC period,DRX cycle) ] |
| DRX cycle>320ms | ceil( 5 x Kp ) x DRX cycle |
| 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 9.2.5.2-2: Measurement period for intrafrequency measurements without gaps(Frequency FR2)

|  |  |
| --- | --- |
| **DRX cycle** | **T SSB\_measurement\_period** |
| No DRX | max[ 400ms, ceil( 5 x Kp) x N3 x SMTC period ]Note 1 |
| DRX cycle≤ 320ms | max[ 400ms, ceil(1.5x 5 x Kp) x N3 x max(SMTC period,DRX cycle) ] |
| DRX cycle>320ms | ceil(5 xKp ) x N3 x DRX cycle |
| 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 9.2.5.2-3: Measurement period for intrafrequency measurements without gaps (deactivated SCell) (Frequency range FR1)

|  |  |
| --- | --- |
| DRX cycle | T SSB\_measurement\_period |
| No DRX | [5] x measCycleSCell |
| DRX cycle≤ 320ms | [5] x max(measCycleSCell, 1.5xDRX cycle) |
| DRX cycle> 320ms | [5] x max(measCycleSCell, DRX cycle) |

Table 9.2.5.2-4: Measurement period for intrafrequency measurements without gaps (deactivated SCell) (Frequency range FR2)

|  |  |
| --- | --- |
| DRX cycle | T SSB\_measurement\_period |
| No DRX | TBD |
| DRX | TBD |

#### 9.2.5.3 Scheduling availability of UE during intra-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 the measurement signal has different subcarrier spacing than PDSCH/PDCCH and on frequency range FR2, there are restrictions on the scheduling availability as described in the following clauses.

##### 9.2.5.3.1 Scheduling availability of UE performing measurements with a same subcarrier spacing as PDSCH/PDCCH on FR1

There are no scheduling restrictions due to measurements performed with a same subcarrier spacing as PDSCH/PDCCH on FR1.

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

For UE which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to measurements. For UE which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to SS-RSRP/RSRQ/SINR measurement

- If *useServingCellTimingForSync* is enabled the UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured, and on 1 data symbol before each consecutive SSB symbols and 1 data symbol after each consecutive SSB symbols within SMTC window duration

- If *useServingCellTimingForSync* is not enabled the UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on all symbols within SMTC window duration

When intra-band carrier aggregation is performed, the scheduling restrictions apply to all serving cells on the band. When inter-band carrier aggregation within FR1 is performed, there are no scheduling restrictions on FR1 serving cell(s) in the bands due to measurements performed on FR1 serving cell frequency layer in different bands.

##### 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 intra-frequency cell

- The UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured, 1 symbol before each consecutive SSB symbols and 1 data symbol after each consecutive SSB symbols within SMTC window duration (it is assumed that *useServingCellTimingForSync* is always enabled for FR2)

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

- UE is not expected to transmit PUCCH/PUSCH or receive PDCCH/PDSCH on SSB symbols to be measured, RSSI measurement symbols, 1 data symbol before each consecutive SSB/RSSI symbols and 1 data symbol after each consecutive SSB/RSSI symbols within SMTC window duration (it is assumed that *useServingCellTimingForSync* is always enabled for FR2)

When intra-band carrier aggregation is performed, the scheduling restrictions apply to all serving cells on the band. When inter-band carrier aggregation within FR2 is performed, the scheduling restrictions apply to all serving cells on the bands.

*Editor’s Note: FFS scheduling restrictions for inter-band carrier aggregation will be defined depending on band combination in future.*

##### 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.

### 9.2.6 Intrafrequency measurements with measurement gaps

#### 9.2.6.1 Intra gap sharing

*[Editor’s note : This is being studied]*

#### 9.2.6.2 Intrafrequency cell identification

*Editor’s Note : The impact of gap sharing between intrafrequency and interfrequency measurements has not been include in the requirements below.*

The UE shall be able to identify a new detectable intra frequency cell within Tidentify\_intra\_without\_index if UE is not indicated to report SSB based RRM measurement result with the associated SSB index, or the UE has been indicated that the neighbour cell is synchronous with the serving cell.. Otherwise UE shall be able to identify a new detectable intra frequency cell within Tidentify\_intra\_with\_index. The UE shall be able to identify a new detectable intra frequency SS block of an already detected cell within Tidentify\_intra\_without\_index.

Tidentify\_intra\_without\_index = TPSS/SSS\_sync + T SSB\_measurement\_period ms

Tidentify\_intra\_with\_index = TPSS/SSS\_sync + T SSB\_measurement\_period + TSSB\_time\_index

Where:

TPSS/SSS\_sync: it is the time period used in PSS/SSS detection given in table 9.2.6.2-1, 9.2.6.2-2, or 9.2.6.2-1(deactivated SCell)

TSSB\_time\_index: it is the time period used to acquire the index of the SSB being measured given in table 9.2.6.2-3 or 9.2.6.2-5 or 9.2.6.2-7(deactivated SCell) or or 9.2.6.2-8(deactivated SCell).

T SSB\_measurement\_period: equal to a measurement period of SSB based measurement given in table 9.2.6.2-1, 9.2.6.2-2, 9.2.6.2-3 (deactivated Scell) or 9.2.6.2-4(deactivated SCell)

Table 9.2.6.2-1: Time period for PSS/SSS detection (Frequency range FR1)

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync** |
| No DRX | max[ 600ms, [5] x max(MGRP, SMTC period) ] |
| DRX cycle≤ 320ms | max[ 600ms, ceil(1.5x [5]) x max(MGRP, SMTC period,DRX cycle) ] |
| DRX cycle>320ms | [5] x max(MGRP, DRX cycle) |

Table 9.2.6.2-2: Time period for PSS/SSS detection (Frequency range FR2)

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync** |
| No DRX | max[ 600ms, [5] x N1 x max(MGRP, SMTC period) ] |
| DRX cycle≤ 320ms | max[ 600ms, ceil(1.5x [5]) x N1 x max(MGRP, SMTC period, DRX cycle) ] |
| DRX cycle>320ms | [5] x N1 x max(MGRP, DRX cycle) |
| **…** | **…** |
| *Editor’s note: The values of N1 in the following tables are to be updated.* | |

Table 9.2.6.2-3: Time period for time index detection (Frequency range FR1)

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index** |
| No DRX | max[ 120ms, 3 x max(MGRP, SMTC period) ] |
| DRX cycle≤ 320ms | max[ 120ms, ceil(1.5x 3) x max(MGRP, SMTC period,DRX cycle) ] |
| DRX cycle>320ms | 3 x max(MGRP, DRX cycle) |

Table 9.2.6.2-4: Time period for time index detection (Frequency range FR2)

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index** |
| No DRX | max[ 200ms, [5] x N2 x max(MGRP, SMTC period) ] |
| DRX cycle≤ 320ms | max[ 200ms, ceil(1.5x [5]) x N2 x max(MGRP, SMTC period, DRX cycle) ] Note 1 |
| DRX cycle>320ms | [5] x N2 x max(MGRP, DRX cycle) |
| **…** | **…** |
| *Editor’s note: The values of N2 in the following tables are to be updated.* | |

Table 9.2.6.2-5: Time period for PSS/SSS detection, deactivated SCell (Frequency range FR1)

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync** |
| No DRX | [5] x measCycleSCell |
| DRX cycle≤ 320ms | [5] x max(measCycleSCell, 1.5xDRX cycle) |
| DRX cycle>320ms | [5] x max(measCycleSCell, DRX cycle) |

Table 9.2.6.2-6: Time period for PSS/SSS detection, deactivated SCell (Frequency range FR2)

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync** |
| No DRX | TBD |
| DRX | TBD |

Table 9.2.6.2-7: Time period for time index detection (Frequency range FR1), deactivated SCell

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index** |
| No DRX | [3] x measCycleSCell |
| DRX cycle≤ 320ms | [3] x max(measCycleSCell, 1.5xDRX cycle) |
| DRX cycle>320ms | [3] x max(measCycleSCell, DRX cycle) |

Table 9.2.6.2-8: Time period for time index detection (Frequency range FR2), deactivated SCell

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index** |
| No DRX | TBD |
| DRX | TBD |

9.2.6.3 Intrafrequency Measurement Period

*Editor’s Note : The requirements below have been derived so far assuming no configured Scell or E-UTRA SCell. The requirements when one or more SCells or E-UTRA SCells are configured is for further study. . The impact of gap sharing between intrafrequency and interfrequency measurements has not been include in the requirements below.*

The measurement period for FR1 intrafrequency measurements with gaps is as shown in table 9.2.6.3-1 or 9.2.6.3-3(deactivated Scell)

The measurement period for FR2 intrafrequency measurements with gaps is as shown in table 9.2.6.3-2 or 9.2.6.3-4(deactivated Scell)

*Editor’s note: The values of X, Y and N in the following tables are to be updated.*

Table 9.2.6.3-1: Measurement period for intrafrequency measurements with gaps(Frequency Range FR1)

|  |  |
| --- | --- |
| **DRX cycle** | **T SSB\_measurement\_period** |
| No DRX | max[ 200ms, 5 x max(MGRP, SMTC period) ] |
| DRX cycle≤ 320ms | max[ 200ms, ceil(1.5x 5) x max(MGRP, SMTC period,DRX cycle) ] |
| DRX cycle>320ms | 5 x max(MGRP, DRX cycle) |

Table 9.2.6.3-2: Measurement period for intrafrequency measurements with gaps(Frequency Range FR2)

|  |  |
| --- | --- |
| **DRX cycle** | **T SSB\_measurement\_period** |
| No DRX | max[ 400ms, 5 x N3 x max(MGRP, SMTC period) ] |
| DRX cycle≤ 320ms | max[ 400ms, ceil(1.5 x 5) x N3 x max(MGRP, SMTC period, DRX cycle) ] Note 1 |
| DRX cycle>320ms | 5 x N3 x max(MGRP, DRX cycle) |
| **…** | **…** |
| *Editor’s note: The values N3 in the following tables are to be updated.* | |

Table 9.2.6.3-3: Measurement period for intrafrequency measurements with gaps, deactivated SCell (Frequency Range FR1)

|  |  |
| --- | --- |
| **DRX cycle** | **T SSB\_measurement\_period** |
| No DRX | [5] x measCycleSCell |
| DRX cycle≤ 320ms | [5] x max(measCycleSCell, 1.5xDRX cycle) |
| DRX cycle>320ms | [5] x max(measCycleSCell, DRX cycle) |

Table 9.2.6.3-4: Measurement period for intrafrequency measurements with gaps, deactivated SCell (Frequency Range FR2)

|  |  |
| --- | --- |
| **DRX cycle** | **T SSB\_measurement\_period** |
| No DRX | TBD |
| DRX | TBD |

## 9.3 NR inter-frequency measurements

*Editor’s note: DRX and non DRX requirement might be separately defined in this section. The numerology and BW combinations might be reflected in the requirement table.*

### 9.3.1 Introduction

A measurement is defined as a SSB based inter-frequency measurement provided it is not defined as in intra-frequency measurement according to section 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 the PSCell, even if no explicit neighbour list with physical layer cell identities is provided.

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 end 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, the switching time is 0,25ms Otherwise the switching time is 0.5ms.

### 9.3.2 Requirements applicability

A cell shall be considered detectable when:

- [SS-RSRP] related side conditions given in Section [TBD] are fulfilled for a corresponding Band,

- [SS-RSRQ] related side conditions given in Clause [TBD] are fulfilled for a corresponding Band,

- [SS-SINR] related side conditions given in Section [TBD] are fulfilled for a corresponding Band,

- [SCH\_RP] and [SCH Ês/Iot] according to Annex [TBD] for a corresponding Band.

*Editors note: requirements for both per UE measurement gap and per-FR measurement gap will be captured in this section.*

#### 9.3.2.1 Void

#### 9.3.2.2 Void

### 9.3.3 Number of cells and number of SSB

#### 9.3.3.1 Requirements for FR1

For each inter-frequency layer, the UE shall be capable of monitoring at least 4 cells.

For each inter-frequency layer, during each layer 1 measurement period, the UE shall be capable of monitoring at least [7] SSBs with different SSB index and/or PCI on the inter-frequency layer.

#### 9.3.3.2 Requirements for FR2

For each inter-frequency layer, the UE shall be capable of monitoring at least 4 cells.

For each inter-frequency layer, during each layer 1 measurement period, the UE shall be capable of monitoring at least [10] SSBs with different SSB index and/or PCI on the inter-frequency layer. The UE shall be capable of monitoring at least one SSB per cell.

### 9.3.4 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. 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 TSSB\_time\_index\_inter.

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.

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

|  |  |
| --- | --- |
| Condition | TPSS/SSS\_sync\_inter |
| No DRX | max[ [TBD]ms, [TBD] x max[MGRP, SMTC period] x CSFinter] Note 1, Note 2 |
| DRX cycle ≤ [320]ms | max[ [TBD]ms, [TBD] x max(MGRP, SMTC period, DRX cycle) x CSFinter] Note 1, Note 2 |
| DRX cycle > [320]ms | [TBD] x DRX cycle x CSFinter Note 2 |
| NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being identified  NOTE 2: CSFinter is a carrier specific scaling factor and is determined according to section [9.3.6] | |

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

|  |  |
| --- | --- |
| **Condition** | **TPSS/SSS\_sync\_inter** |
| No DRX | max[ [TBD]ms, [TBD] x N4 x max[MGRP, SMTC period] x CSFinter]  Note 1, Note 2 |
| DRX cycle ≤ [320]ms | max[ [TBD]ms, [TBD] x N4 x max(MGRP, SMTC period, DRX cycle) x CSFinter] Note 1, Note 2 |
| DRX cycle > [320]ms | [TBD] x N4 x DRX cycle x CSFinter Note 2 |
| NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being identified  NOTE 2: CSFinter is a carrier specific scaling factor and is determined according to section [9.3.6] | |

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

|  |  |
| --- | --- |
| **Condition** | **TSSB\_time\_index\_inter** |
| No DRX | max[ [TBD]ms, [TBD] x max[MGRP, SMTC period] x CSFinter]  Note 1, Note 2 |
| DRX cycle ≤ [320]ms | max[ [TBD]ms, [TBD] x max(MGRP, SMTC period, DRX cycle) x CSFinter] Note 1, Note 2 |
| DRX cycle > [320]ms | [TBD] x DRX cycle x CSFinter Note 2 |
| NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being identified  NOTE 2: CSFinter is a carrier specific scaling factor and is determined according to section [9.3.6] | |

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

|  |  |
| --- | --- |
| **Condition** | **TSSB\_time\_index\_inter** |
| No DRX | max[ [TBD]ms, [TBD] x N5 x max[MGRP, SMTC period] x CSFinter]  Note 1, Note 2 |
| DRX cycle ≤ [320]ms | max[ [TBD]ms, [TBD] x N5 x max(MGRP, SMTC period, DRX cycle) x CSFinter] Note 1, Note 2 |
| DRX cycle > [320]ms | [TBD] x N4 x DRX cycle x CSFinter Note 2 |
| NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being identified  NOTE 2: CSFinter is a carrier specific scaling factor and is determined according to section [9.3.6] | |

#### 9.3.4.1 Void

#### 9.3.4.2 Void

### 9.3.5 Inter frequency measurements

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 [TBD], [TBD], and [TBD], 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 | T SSB\_measurement\_period\_inter |
| No DRX | max[ [TBD]ms, [TBD] x max[MGRP, SMTC period] x CSFinter]  Note 1, Note 2 |
| DRX cycle ≤ [320]ms | max[ [TBD]ms, [TBD] x max(MGRP, SMTC period, DRX cycle) x CSFinter] Note 1, Note 2 |
| DRX cycle > [320]ms | [TBD] x DRX cycle x CSFinter Note 2 |
| **…** | **…** |
| NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being measured  NOTE 2: CSFinter is a carrier specific scaling factor and is determined according to section [9.3.6] | |

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

|  |  |
| --- | --- |
| Condition | T SSB\_measurement\_period\_inter |
| No DRX | max[ [TBD]ms, [TBD] x N6 x max[MGRP, SMTC period] x CSFinter]  Note 1, Note 2 |
| DRX cycle ≤ [320]ms | max[ [TBD]ms, [TBD] x N6 x max(MGRP, SMTC period, DRX cycle) x CSFinter] Note 1, Note 2 |
| DRX cycle > [320]ms | [TBD] x N4 x DRX cycle x CSFinter Note 2 |
| **…** | **…** |
| NOTE 1: If different SMTC periodicities are configured for different inter-frequency carriers, the SMTC period in the requirement is the SMTC period of the inter-frequency carrier being measured  NOTE 2: CSFinter is a carrier specific scaling factor and is determined according to section [9.3.6] | |

TBD [*Editor’s note: Physical layer measurement period for both non-DRX and DRX*]

#### 9.3.5.1 Void

#### 9.3.5.2 Void

#### 9.3.5.3 Void

9.3.6 NR Inter frequency measurements reporting requirements

9.3.6.1 Periodic Reporting

Reported SS-RSRP, SS-RSRQ, and SS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in sections [TBD], respectively.

9.3.6.2 Event-triggered Periodic Reporting

Reported SS-RSRP, SS-RSRQ, and SS-SINR measurements contained in event triggered periodic measurement reports shall meet the requirements in sections [TBD], respectively.

The first report in event triggered periodic measurement reporting shall meet the requirements specified in clause [TBD].

9.3.6.3 Event-triggered Reporting

Reported SS-RSRP, SS-RSRQ, and SS-SINR measurements contained in event triggered measurement reports shall meet the requirements in sections [TBD], respectively.

The UE shall not send any event triggered measurement reports, as long as no reporting criteria are fulfilled.

The measurement reporting delay is defined as the time between an event that will trigger a measurement report and the point when the UE starts to transmit the measurement report over the air interface. This requirement assumes that that the measurement report is not delayed by other RRC signalling on the [DCCH]. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the [TTI] of the uplink [DCCH]. The delay uncertainty is: [2 x TTIDCCH.] This measurement reporting delay excludes a delay which caused by no UL resources for UE to send the measurement report.

The event triggered measurement reporting delay, measured without L3 filtering shall be less than [T identify -inter ] defined in clause [TBD].When L3 filtering is used an additional delay can be expected.

If a cell which has been detectable at least for the time period [Tidentify\_inter ] defined in clause [TBD] and then triggers the measurement report as per TS 38.331 [TBD], the event triggered measurement reporting delay shall be less than [TMeasurement\_Period\_Inter\_FDD ]defined in clause [TBD] provided the timing to that cell has not changed more than [± 50 Ts] while measurement gap has not been available and the L3 filter has not been used. When L3 filtering is used an additional delay can be expected.

*Editor’s note: To be captured once the RAN2 work progresses.*

### 9.3.7 Derivation of CSFinter

*Editors note: this section includes how to determine the scaling factor used in determining the UE cell detection, Index detection and measurement requirements.*

## 9.4 Inter-RAT measurements

### 9.4.1 Introduction

The requirements in this section are specified for NR−E-UTRAN FDD and NR−E-UTRAN TDD measurements and are applicable without an explicit E-UTRAN neighbour cell list containing physical layer cell identities, for a UE:

- in RRC\_CONNECTED state, and

- configured with at least PCell, and

- configured with an appropriate measurement gap pattern according to Table 9.1.2-3.

Parameter TInter1 used in inter-RAT requirements in Section 9.4 is specified in Table 9.4.1-1.

Table 9.4.1-1: Minimum available time for inter-RAT measurements

|  |  |  |  |
| --- | --- | --- | --- |
| Gap Pattern Id | MeasurementGap Length (MGL, ms) | Measurement Gap Repetition Period  (MGRP, ms) | Minimum available time for inter-frequency and inter-RAT measurements during 480ms period  (Tinter1, ms) |
| 0 | 6 | 40 | 60 |
| 1 | 6 | 80 | 30 |
| 2 | 3 | 40 | 24NOTE 1 |
| 3 | 3 | 80 | 12NOTE 1 |
| NOTE 1: When determing UE requirements using Tinter1 for GP2 and GP3, Tinter1 = [60] for GP2 and Tinter1 = [30] for GP3 shall be used.  NOTE 2: Measurement gaps pattern configurations applicability are as specified in Table 9.1.2-1. | | | |

*Editor’s note: a note to be added in Table 9.4.1-1 on that measurement gap patterns #2 and #3 are supported only by the UEs which have a corresponding capability once RAN2 specifies the capability.*

### 9.4.2 SA: NR − E-UTRAN FDD measurements

#### 9.4.2.1 Introduction

The requirements are applicable for NR−E-UTRAN FDD RSRP, RSRQ, and RS-SINR measuements.

In the requirements, an E-UTRAN FDD cell is considered to be detectable when:

- RSRP related side conditions given in Section 10.x are fulfilled for a corresponding Band,

- RSRQ related side conditions given in Section 10.y are fulfilled for a corresponding Band,

- RS-SINR related side conditions given in Section 10.z are fulfilled for a corresponding Band,

- SCH\_RP and SCH Ês/Iot according to Annex TBD for a corresponding Band.

#### 9.4.2.2 Requirements when no DRX is used

When the UE requires measurement gaps to idenitify and measurement inter-RAT cells and an appropriate measurement gap pattern is scheduled, the UE shall be able to identify a new detectable FDD cell within TIdentify, E-UTRAN FDD according to the following expression:

,

where:

TBasicIdentify = 480 ms,

TInter1 is defined in Section 9.4.1,

K=TBD and depends at least on Nfreq, SA defined in Section 9.1.3.3 and whether and how gaps are shared.

Identification of a cell shall include detection of the cell and additionally performing a single measurement with measurement period of TMeasure, E-UTRAN FDD defined in Table 9.4.2.2-1.

Table 9.4.2.2-1: Measurement period and measurement bandwidth

|  |  |  |
| --- | --- | --- |
| Configuration | Physical Layer Measurement period: TMeasure, E-UTRAN FDD [ms] | Measurement bandwidth [RB] |
| 0 | 480 x TBD | 6 |
| 1 (Note 1) | 240 x TBD | 50 |
| NOTE 1: This configuration is optional. | | |

The UE shall be capable of identifying and performing NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements of at least 4 E-UTRAN FDD cells per E-UTRA FDD carrier frequency layer for up to 7 E-UTRA FDD carrier frequency layers.

If higher layer filtering is used, an additional cell identification delay can be expected.

The NR – E-UTRAN FDD RSRP measurement accuracy for all measured cells shall be as specified in Section 10.x. The NR – E-UTRAN FDD RSRQ measurement accuracy for all measured cells shall be as specified in Section 10.y. The NR – E-UTRAN FDD RS-SINR measurement accuracy for all measured cells shall be as specified in Section 10.z.

#### 9.4.2.3 Requirements when DRX is used

When DRX is in use and measurement gaps are configured, the UE shall be able to identify a new detectable E-UTRAN FDD cell within TIdentify, E-UTRAN FDD specified in Table 9.4.2.3-1.

Table 9.4.2.3-1: Requirement to identify a newly detectable E-UTRAN FDD cell

|  |  |  |
| --- | --- | --- |
| DRX cycle length (s) | TIdentify, E-UTRAN FDD (s) (DRX cycles) | |
|  | Gap period = 40 ms | Gap period = 80 ms |
| ≤0.16 | Non-DRX requirements in Section 9.4.2.2 apply | Non-DRX requirements in Section 9.4.2.2 apply |
| 0.256 | 5.12\*K (20\*K) | 7.68\*K (30\*K) |
| 0.32 | 6.4\*K (20\*K) | 7.68\*K (24\*K) |
| 0.32< DRX-cycle ≤10.24 | Note1 (20\*K) | Note1 (20\*K) |
| NOTE1: The time depends on the DRX cycle length.  NOTE2: K=TBD and depends at least on Nfreq, SA defined in Section 9.1.3.3. | | |

When DRX is in use, the UE shall be capable of performing NR – E-UTRAN FDD RSRP and RSRQ measurements of at least 4 E-UTRAN FDD cells per E-UTRA FDD frequency layer for up to 7 E-UTRA FDD carrier frequency layers, and the UE physical layer shall be capable of reporting NR – E-UTRAN FDD RSRP and RSRQ measurements to higher layers with the measurement period Tmeasure, E-UTRAN FDD specified in Table 9.4.2.3-2.

Table 9.4.2.3-2: Requirement to measure E-UTRAN FDD cells

|  |  |
| --- | --- |
| DRX cycle length (s) | Tmeasure, E-UTRAN FDD (s) (DRX cycles) |
| ≤0.08 | Non-DRX requirements in Section 9.4.2.2 apply |
| 0< DRX-cycle ≤10.24 | Note1 (5\*K) |
| NOTE1: The time depends on the DRX cycle length.  NOTE2: K=TBD and depends at least on Nfreq, SA defined in Section 9.1.3.3. | |

If higher layer filtering is used, an additional cell identification delay can be expected.

The NR – E-UTRAN FDD RSRP measurement accuracy for all measured cells shall be as specified in Section 10.x. The NR – E-UTRAN FDD RSRQ measurement accuracy for all measured cells shall be as specified in Section 10.y. The NR – E-UTRAN FDD RS-SINR measurement accuracy for all measured cells shall be as specified in Section 10.z.

*Editor’s note: gap sharing to be accounted for.*

#### 9.4.2.4 Measurement reporting requirements

##### 9.4.2.4.1 Periodic Reporting

The reported NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in Sections 10.2.x, 10.2.y, and 10.2.z, respectively.

##### 9.4.2.4.2 Event-Triggered Periodic Reporting

The reported NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements contained in event-triggered periodic measurement reports shall meet the requirements in Sections 10.2.x, 10.2.y, and 10.2.z, respectively.

The first report in event-triggered periodic measurement reporting shall meet the requirements specified in Section 9.4.2.4.3.

##### 9.4.2.4.3 Event-Triggered Reporting

The reported NR – E-UTRAN FDD RSRP, RSRQ, and RS-SINR measurements contained in event-triggered measurement reports shall meet the requirements in Sections 10.2.x, 10.2.y, and 10.2.z, respectively.

The UE shall not send any event-triggered measurement reports, as long as no reporting criteria are fulfilled.

The measurement reporting delay is defined as the time between an event that will trigger a measurement report and the point when the UE starts to transmit the measurement report over the air interface. This requirement assumes that that the measurement report is not delayed by other RRC signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTIDCCH where TTIDCCH is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes a delay which caused by no UL resources for UE to send the measurement report.

The event triggered measurement reporting delay, measured without L3 filtering shall be less than T Identify, E-UTRAN FDD defined in Sections 9.4.2.2 and 9.4.2.3 without DRX and with DRX, respectively.When L3 filtering is used, an additional delay can be expected.

If a cell which has been detectable at least for the time period TIdentify, E-UTRAN FDD becomes undetectable for a period ≤ TBD seconds and then the cell becomes detectable again and triggers an event as per TS 38.331 [2], the event triggered measurement reporting delay shall be less than TMeasure, E-UTRAN FDD provided the timing to that cell has not changed more than ± 50 Ts while measurement gap has not been available and the L3 filter has not been used.

### 9.4.3 SA: NR − E-UTRAN TDD measurements

#### 9.4.3.1 Introduction

The requirements are applicable for NR−E-UTRAN TDD RSRP, RSRQ, and RS-SINR measuements.

In the requirements, an E-UTRAN TDD cell is considered to be detectable when:

- RSRP related side conditions given in Section 10.x are fulfilled for a corresponding Band,

- RSRQ related side conditions given in Section 10.y are fulfilled for a corresponding Band,

- RS-SINR related side conditions given in Section 10.z are fulfilled for a corresponding Band,

- SCH\_RP and SCH Ês/Iot according to Annex TBD for a corresponding Band.

#### 9.4.3.2 Requirements when no DRX is used

When the UE requires measurement gaps to idenitify and measurement inter-RAT cells and an appropriate measurement gap pattern is scheduled, the UE shall be able to identify a new detectable FDD cell within TIdentify, E-UTRAN TDD according to the following expression:

- When configuration 0 or configuration 1 in Table 9.4.3.2-1 is applied,

,

- When configuration 2 or configuration 3 in Table 9.4.3.2-1 is applied,

,

where:

TBasicIdentify = 480 ms,

TInter1 is defined in Section 9.4.1,

K=TBD and depends at least on Nfreq, SA defined in Section 9.1.3.3 and whether and how gaps are shared.

Identification of a cell shall include detection of the cell and additionally performing a single measurement with measurement period of TMeasure, E-UTRAN TDD defined in Table 9.4.3.2-1.

Table 9.4.3.2-1: TMeasure, E-UTRAN TDD for different configurations

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Configuration | Measurement bandwidth [RB] | Number of UL/DL sub-frames per half frame (5 ms) | | DwPTS | | TMeasure, E-UTRAN TDD [ms] |
|  | DL | UL | Normal CP | Extended CP |  |
| 0 | 6 | 2 | 2 |  |  | 480 x K |
| 1 (Note 1) | 50 | 2 | 2 |  |  | 240 x K |
| NOTE 1: This configuration is optional.  NOTE 2: K=TBD and depends at least on Nfreq, SA defined in Section 9.1.3.3. | | | | | | |

The UE shall be capable of identifying and performing NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements of at least 4 E-UTRAN TDD cells per E-UTRA TDD carrier frequency layer for up to 7 E-UTRA TDD carrier frequency layers.

If higher layer filtering is used, an additional cell identification delay can be expected.

The NR – E-UTRAN TDD RSRP measurement accuracy for all measured cells shall be as specified in Section 10.x. The NR – E-UTRAN TDD RSRQ measurement accuracy for all measured cells shall be as specified in Section 10.y. The NR – E-UTRAN TDD RS-SINR measurement accuracy for all measured cells shall be as specified in Section 10.z.

#### 9.4.3.3 Requirements when DRX is used

When DRX is in use and measurement gaps are configured, the UE shall be able to identify a new detectable E-UTRAN TDD cell within TIdentify, E-UTRAN TDD specified in Table 9.4.3.3-1.

Table 9.4.3.3-1: Requirement to identify a newly detectable E-UTRAN TDD cell

|  |  |  |
| --- | --- | --- |
| DRX cycle length (s) | TIdentify, E-UTRAN TDD (s) (DRX cycles) | |
|  | Gap period = 40 ms | Gap period = 80 ms |
| ≤0.16 | Non-DRX requirements in Section 9.4.3.2 apply | Non-DRX requirements in Section 9.4.3.2 apply |
| 0.256 | 5.12\*K (20\*K) | 7.68\*K (30\*K) |
| 0.32 | 6.4\*K (20\*K) | 7.68\*K (24\*K) |
| 0.32< DRX-cycle ≤10.24 | Note1 (20\*K) | Note1 (20\*K) |
| NOTE 1: The time depends on the DRX cycle length.  NOTE 2: K=TBD and depends at least on Nfreq, SA defined in Section 9.1.3.3. | | |

When DRX is in use, the UE shall be capable of performing NR – E-UTRAN TDD RSRP and RSRQ measurements of at least 4 E-UTRAN TDD cells per E-UTRA TDD frequency layer for up to 7 E-UTRA TDD carrier frequency layers, and the UE physical layer shall be capable of reporting NR – E-UTRAN TDD RSRP and RSRQ measurements to higher layers with the measurement period Tmeasure, E-UTRAN TDD specified in Table 9.4.3.3-2.

Table 9.4.3.3-2: Requirement to measure E-UTRAN TDD cells

|  |  |
| --- | --- |
| DRX cycle length (s) | Tmeasure, E-UTRAN TDD (s) (DRX cycles) |
| ≤0.08 | Non-DRX Requirements in Section 9.4.3.2 apply |
| 0.128 | For configuration 2, non-DRX requirements in section 9.4.3.2 apply,  Otherwise: Note1 (5\*K) |
| 0.128<DRX-cycle≤10.24 | Note1 (5\*K) |
| NOTE 1: The time depends on the DRX cycle length.  NOTE 2: K=TBD and depends at least on Nfreq, SA defined in Section 9.1.3.3. | |

If higher layer filtering is used, an additional cell identification delay can be expected.

The NR – E-UTRAN TDD RSRP measurement accuracy for all measured cells shall be as specified in Section 10.x. The NR – E-UTRAN TDD RSRQ measurement accuracy for all measured cells shall be as specified in Section 10.y. The NR – E-UTRAN TDD RS-SINR measurement accuracy for all measured cells shall be as specified in Section 10.z.

*Editor’s note: gap sharing to be accounted for.*

#### 9.4.3.4 Measurement reporting requirements

##### 9.4.3.4.1 Periodic Reporting

The reported NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements contained in periodically triggered measurement reports shall meet the requirements in Sections 10.2.x, 10.2.y, and 10.2.z, respectively.

##### 9.4.3.4.2 Event-Triggered Periodic Reporting

The reported NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements contained in event-triggered periodic measurement reports shall meet the requirements in Sections 10.2.x, 10.2.y, and 10.2.z, respectively.

The first report in event-triggered periodic measurement reporting shall meet the requirements specified in Section 9.4.3.4.3.

##### 9.4.3.4.3 Event-Triggered Reporting

The reported NR – E-UTRAN TDD RSRP, RSRQ, and RS-SINR measurements contained in event-triggered measurement reports shall meet the requirements in Sections 10.2.x, 10.2.y, and 10.2.z, respectively.

The UE shall not send any event-triggered measurement reports, as long as no reporting criteria are fulfilled.

The measurement reporting delay is defined as the time between an event that will trigger a measurement report and the point when the UE starts to transmit the measurement report over the air interface. This requirement assumes that that the measurement report is not delayed by other RRC signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTIDCCH where TTIDCCH is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes a delay which caused by no UL resources for UE to send the measurement report.

The event triggered measurement reporting delay, measured without L3 filtering shall be less than T Identify, E-UTRAN TDD defined in Sections 9.4.3.2 and 9.4.3.3 without DRX and with DRX, respectively.When L3 filtering is used, an additional delay can be expected.

If a cell which has been detectable at least for the time period TIdentify, E-UTRAN TDD becomes undetectable for a period ≤ TBD seconds and then the cell becomes detectable again and triggers an event as per TS 38.331 [2], the event triggered measurement reporting delay shall be less than TMeasure, E-UTRAN TDD provided the timing to that cell has not changed more than ± 50 Ts while measurement gap has not been available and the L3 filter has not been used.

### 9.4.4 SA: Inter-RAT RSTD measurements

#### 9.4.4.1 SA: NR − E-UTRAN FDD RSTD measurements

##### 9.4.4.1.1 Introduction

The requirements are applicable for NR−E-UTRAN FDD RSTD measuements requested via LPP [22].

##### 9.4.4.1.2 Requirements

*Editor’s note: sharing factor is not yet taken into account in this section.*

When the physical layer cell identities of neighbour cells together with the OTDOA assistance data are provided, the UE shall be able to detect and measure inter-RAT E-UTRAN FDD RSTD, specified in TS 38.215 [4], for at least *n*=16 cells, including the reference cell, within  ms as given below:

 ,

where

 is the total time for detecting and measuring at least *n* cells,

 is the the largest value of the cell-specific positioning subframe configuration period, defined in TS 36.211 [23], among the measured *n* cells including the reference cell,

 is the number of PRS positioning occasions as defined in Table 9.4.4.1.2-1, where each PRS positioning occasion comprises of  (1≤≤6) consecutive downlink positioning subframes defined in TS 36.211 [23],

 =  ms is the measurement time for a single PRS positioning occasion which includes the sampling time and the processing time, and

the *n* cells are distributed on up to two E-UTRAN FDD carrier frequencies.

Table 9.4.4.1.2-1: Number of PRS positioning occasions within 

|  |  |  |
| --- | --- | --- |
| Positioning subframe configuration period | Number of PRS positioning occasions | |
| f2 Note1 | f1 and f2 Note2 |
| 160 ms | 16 | 32 |
| >160 ms | 8 | 16 |
| NOTE 1: When inter-RAT E-UTRAN FDD RSTD measurements are performed over the reference cell and neighbour cells, which belong to the E-UTRAN FDD carrier frequency f2.  NOTE 2: When inter-RAT E-UTRAN FDD RSTD measurements are performed over the reference cell and the neighbour cells, which belong to the E-UTRAN FDD carrier frequency f1 and the E-UTRAN FDD carrier frequency f2 respectively. | | |

The UE physical layer shall be capable of reporting RSTD for the reference cell and all the neighbor cells *i* out of at least (*n*-1) neighbor cells within  provided:

≥-6 dB for all Frequency Bands for the reference cell,

≥-13 dB for all Frequency Bands for neighbour cell *i*,

 and  conditions apply for all subframes of at least  PRS positioning occasions,

PRP 1,2|dBm according to Annex TBD for a corresponding Band

 is defined as the ratio of the average received energy per PRS RE during the useful part of the symbol to the average received power spectral density of the total noise and interference for this RE, where the ratio is measured over all REs which carry PRS.

The time  starts from the first subframe of the PRS positioning occasion closest in time after both the [OTDOA-RequestLocationInformation] message and the OTDOA assistance data in the [OTDOA-ProvideAssistanceData] message as specified in [TS 38.355], are delivered to the physical layer of the UE.

The RSTD measurement accuracy for all measured neighbor cells *i* shall be fulfilled according to the accuracy as specified in Section TBD.

###### 9.4.4.1.2.1 RSTD Measurement Reporting Delay

This requirement assumes that the measurement report is not delayed by other LPP signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTIDCCH where TTIDCCH is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes any delay caused by no UL resources for UE to send the measurement report.

#### 9.4.4.2 SA: NR − E-UTRAN TDD RSTD measurements

##### 9.4.4.2.1 Introduction

The requirements are applicable for NR−E-UTRAN TDD RSTD measuements requested via LPP [22].

##### 9.4.4.2.2 Requirements

*Editor’s note: sharing factor is not yet taken into account in this section.*

When the physical layer cell identities of neighbour cells together with the OTDOA assistance data are provided, the UE shall be able to detect and measure inter-RAT -UTRAN TDD RSTD, specified in TS 38.215 [4], for at least *n*=16 cells, including the reference cell, within  ms as given below:

 ,

where

is the total time for detecting and measuring at least *n* cells,

 is the largest value of the cell-specific positioning subframe configuration period, defined in TS 36.211 [16], among the measured *n* cells including the reference cell,

 is the number of PRS positioning occasions as defined in Table 9.4.4.2.2-1, where a PRS positioning occasion is as defined in clause 9.4.4.1.2,

 =  ms is the measurement time for a single PRS positioning occasion which includes the sampling time and the processing time, and

the *n* cells are distributed on up to two E-UTRAN TDD carrier frequencies.

Table 9.4.4.2.2-1: Number of PRS positioning occasions within 

|  |  |  |
| --- | --- | --- |
| Positioning subframe configuration period | Number of PRS positioning occasions | |
| f2 Note1 | f1 and f2 Note2 |
| 160 ms | 16 | 32 |
| >160 ms | 8 | 16 |
| NOTE 1: When inter-RAT E-UTRAN TDD RSTD measurements are performed over the reference cell and neighbour cells, which belong to the E-UTRAN TDD carrier frequency f2.  NOTE 2: When inter-RAT E-UTRAN TDD RSTD measurements are performed over the reference cell and the neighbour cells, which belong to the E-UTRAN TDD carrier frequency f1 and the E-UTRAN TDD carrier frequency f2 respectively. | | |

The requirements in this section shall apply for all TDD special subframe configurations specified in TS 36.211 [23] and for the TDD uplink-downlink configurations as specified in Table 9.4.4.2.2-2 for UE requiring measurement gaps for these measurements. For UEs capable of performing inter-RAT RSTD measurements without measurement gaps, TDD uplink-downlink subframe configurations as specified in Table 9.4.4.2.2-3 shall apply.

Table 9.4.4.2.2-2: TDD uplink-downlink subframe configurations applicable for inter-RAT RSTD requirements

|  |  |
| --- | --- |
| PRS Transmission Bandwidth [RB] | Applicable TDD uplink-downlink configurations |
| 6, 15 | 3, 4 and 5 |
| 25 | 1, 2, 3, 4, 5 and 6 |
| 50, 75, 100 | 0, 1, 2, 3, 4, 5 and 6 |
| NOTE 1: Uplink-downlink configurations are specified in Table 4.2-2 in TS 36.211 [23]. | |

Table 9.4.4.2.2-3: TDD uplink-downlink subframe configurations applicable for inter-RAT RSTD requirements without gaps

|  |  |
| --- | --- |
| PRS Transmission Bandwidth [RB] | Applicable TDD uplink-downlink configurations |
| 6, 15 | 1, 2, 3, 4 and 5 |
| 25, 50, 75, 100 | 0, 1, 2, 3, 4, 5 and 6 |
| Note: Uplink-downlink configurations are specified in Table 4.2-2 in TS 36.211 [23]. | |

The UE physical layer shall be capable of reporting RSTD for the reference cell and all the neighbor cells *i* out of at least (*n*-1) neighbor cells within  provided:

≥-6 dB for all Frequency Bands for the reference cell,

≥-13 dB for all Frequency Bands for neighbour cell *i*,

 and  conditions apply for all subframes of at least  PRS positioning occasions,

PRP 1,2|dBm according to Annex TBD for a corresponding Band

 is as defined in Section 9.4.4.1.2.

The time  starts from the first subframe of the PRS positioning occasion closest in time after both the [OTDOA-RequestLocationInformation] message and the OTDOA assistance data in the [OTDOA-ProvideAssistanceData] message as specified in [TS 38.355], are delivered to the physical layer of the UE.

The RSTD measurement accuracy for all measured neighbor cells *i* shall be fulfilled according to the accuracy as specified in Section TBD.

###### 9.4.4.2.2.1 RSTD Measurement Reporting Delay

This requirement assumes that that the measurement report is not delayed by other LPP signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTIDCCH where TTIDCCH is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes any delay caused by no UL resources for UE to send the measurement report.

### 9.4.5 SA: Inter-RAT E-CID measurements

#### 9.4.5.1 NR−E-UTRAN FDD E-CID RSRP and RSRQ measurements

##### 9.4.5.1.1 Introduction

The requirements in Section 9.4.5.1. shall apply provided the UE has received [ECID-RequestLocationInformation] message from LMF via LPP requesting the UE to report inter-RAT E-UTRAN FDD E-CID RSRP and RSRQ measurements [22].

##### 9.4.5.1.2 Requirements

The requirements in Section 9.4.2 also apply for this section except the measurement reporting requirements. The measurement reporting requirements for E-CID RSRP and RSRQ are defined in Section 9.4.5.1.3.

*Editor’s note: sharing factor is not yet taken into account in this section.*

##### 9.4.5.1.3 Measurement Reporting Delay

This requirement assumes that that the measurement report is not delayed by other LPP signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTIDCCH where TTIDCCH is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes any delay caused by no UL resources for UE to send the measurement report.

Reported RSRP and RSRQ measurements contained in periodically triggered measurement reports shall meet the requirements in Sections TBD1 and TBD2, respectively.

#### 9.4.5.2 NR−E-UTRAN TDD E-CID RSRP and RSRQ measurements

##### 9.4.5.2.1 Introduction

The requirements in Section 9.4.5.2. shall apply provided the UE has received [ECID-RequestLocationInformation] message from LMF via LPP requesting the UE to report inter-RAT E-UTRAN TDD E-CID RSRP and RSRQ measurements [22].

##### 9.4.5.2.2 Requirements

The requirements in Section 9.4.3 also apply for this section except the measurement reporting requirements. The measurement reporting requirements for E-CID RSRP and RSRQ are defined in Section 9.4.5.2.3.

*Editor’s note: sharing factor is not yet taken into account in this section.*

##### 9.4.5.2.3 Measurement Reporting Delay

This requirement assumes that that the measurement report is not delayed by other LPP signalling on the DCCH. This measurement reporting delay excludes a delay uncertainty resulted when inserting the measurement report to the TTI of the uplink DCCH. The delay uncertainty is: 2 x TTIDCCH where TTIDCCH is the duration of subframe or slot or subslot when the measurement report is transmitted on the PUSCH with subframe or slot or subslot duration. This measurement reporting delay excludes any delay caused by no UL resources for UE to send the measurement report.

Reported RSRP and RSRQ measurements contained in periodically triggered measurement reports shall meet the requirements in Sections TBD3 and TBD4, respectively.

# 10 Measurement Performance requirements

*Editor’s note: Accuracy requirement might be an individual top-level chapter to maintain since it is the performance part.*

## 10.1 NR measurements

### 10.1.1 Introduction

*Editor’s note: new measurement metrics may be added according to the RAN4 discussion. Absolute/relative accuracy requirement, mapping table of RSRP/RSRQ may be specified in this section. The numerology and BW combinations might be reflected in the accuracy requirement table.*

### 10.1.2 Intra-frequency RSRP accuracy requirements for FR1

#### 10.1.2.1 Intra-frequency SS RSRP accuracy requirements

##### 10.1.2.1.1 Absolute SS RSRP Accuracy

Unless otherwise specified, the requirements for absolute accuracy of SS RSRP in this clause apply to a cell on the same frequency as that of the serving cell.

The accuracy requirements in Table 10.1.2.1.1-1 are valid under the following conditions:

[TBD]

Table 10.1.2.1.1-1: SS RSRP Intra frequency absolute accuracy

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Accuracy | | Conditions | | | | |
| Normal condition | Extreme condition | Ês/Iot | Io Note 1 range | | | |
| NR operating band groups | Minimum Io | | Maximum Io |
| dB | dB | dB |  | dBm/SSB sub carrier spacing | dBm/BWChannel | dBm/BWChannel |
| ±[4.5] | ±[9] | ≥[-6] dB | TBD | TBD | N/A | -70 |
| TBD | TBD | N/A | -70 |
| TBD | TBD | N/A | -70 |
| TBD | TBD | N/A | -70 |
| ±[8] | ±[11] | ≥[-6] dB | All | N/A | -70 | -50 |
| NOTE 1: Io is assumed to have constant EPRE across the bandwidth. | | | | | | |

##### 10.1.2.1.2 Relative SS RSRP Accuracy

The relative accuracy of SS RSRP is defined as the SS RSRP measured from one cell compared to the SS RSRP measured from another cell on the same frequency.

The accuracy requirements in Table 10.1.2.1.2-1 are valid under the following conditions:

[TBD]

Table 10.1.2.1.2-1: SS RSRP Intra frequency relative accuracy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Accuracy | | Conditions | | | |
| Normal condition | Extreme condition | Ês/Iot Note 2 | Io Note 1 range | | |
| NR operating band groups | Minimum Io | Maximum Io |
| dB | dB | dB |  | dBm/SSB sub carrier spacing | dBm/BWChannel |
| [±2] | [±3] | ≥[-3] dB | TBD | TBD | -50 |
| TBD | TBD | -50 |
| TBD | TBD | -50 |
| TBD | TBD | -50 |
| ±[3] | ±[3] | ≥[-6] dB | Note 3 | Note 3 | Note 3 |
| NOTE 1: Io is assumed to have constant EPRE across the bandwidth.  NOTE 2: The parameter Ês/Iot is the minimum Ês/Iot of the pair of cells to which the requirement applies.  NOTE 3: The same bands and the same Io conditions for each band apply for this requirement as for the corresponding highest accuracy requirement. | | | | | |

#### 10.1.2.2 Intra-frequency [CSI-RS RSRP] accuracy requirements

### 10.1.3 Intra-frequency RSRP accuracy requirements for FR2

#### 10.1.3.1 Intra-frequency SS RSRP accuracy requirements

#### 10.1.3.2 Intra-frequency [CSI-RS RSRP] accuracy requirements

### 10.1.4 Inter-frequency RSRP accuracy requirements for FR1

#### 10.1.4.1 Inter-frequency SS RSRP accuracy requirements

##### 10.1.4.1.1 Aboslute Accuracy of SS RSRP

The requirements for absolute accuracy of SS RSRP in this clause apply to a cell that has different carrier frequency from the serving cell.

The accuracy requirements in Table 10.1.4.1.1-1 are valid under the following conditions:

[TBD]

Table 10.1.4.1.1-1: SS RSRP Inter frequency absolute accuracy

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Accuracy | | Conditions | | | | |
| Normal condition | Extreme condition | Ês/Iot | Io Note 1 range | | | |
| E-UTRA operating band groups | Minimum Io | | Maximum Io |
| dB | dB | dB |  | dBm/SSB sub carrier spacing | dBm/BWChannel | dBm/BWChannel |
| ±[4.5] | ±[9] | ≥[-6] dB | TBD | TBD | N/A | -70 |
| TBD | TBD | N/A | -70 |
| TBD | TBD | N/A | -70 |
| TBD | TBD | N/A | -70 |
| ±[8] | ±[11] | ≥[-6] dB | All | N/A | -70 | -50 |
| NOTE 1: Io is assumed to have constant EPRE across the bandwidth. | | | | | | |

##### 10.1.4.1.2 Relative Accuracy of SS RSRP

The relative accuracy of SS RSRP in inter frequency case is defined as the RSRP measured from one cell compared to the RSRP measured from another cell on a different frequency.

The accuracy requirements in Table 10.1.4.1.2-1 are valid under the following conditions:

[TBD]

Table 10.1.4.1.2-1: SS RSRP Inter frequency relative accuracy

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Accuracy | | Conditions | | | |
| Normal condition | Extreme condition | Ês/Iot Note 2 | Io Note 1 range | | |
| E-UTRA operating band groups | Minimum Io | Maximum Io |
| dB | dB | dB |  | dBm/SSB sub carrier spacing | dBm/BWChannel |
| ±[4.5] | ±[6] | ≥[-6] dB | TBD | TBD | -50 |
| TBD | TBD | -50 |
| TBD | TBD | -50 |
| TBD | TBD | -50 |
| NOTE 1: Io is assumed to have constant EPRE across the bandwidth.  NOTE 2: The parameter Ês/Iot is the minimum Ês/Iot of the pair of cells to which the requirement applies. | | | | | |

#### 10.1.4.2 Inter-frequency [CSI-RS RSRP] accuracy requirements

### 10.1.5 Inter-frequency RSRP accuracy requirementsfor FR2

#### 10.1.5.1 Inter-frequency SS RSRP accuracy requirements

#### 10.1.5.2 Inter-frequency [CSI-RS RSRP] accuracy requirements

### 10.1.6 Intra-frequency RSRQ accuracy requirements for FR1

### 10.1.7 Intra-frequency RSRQ accuracy requirements for FR2

### 10.1.8 Inter-frequency RSRQ accuracy requirements for FR1

### 10.1.9 Inter-frequency RSRQ accuracy requirements for FR2

### 10.1.10 Power Headroom

## 10.2 E-UTRAN measurements

### 10.2.1 E-UTRAN RSRP measurements

### 10.2.2 E-UTRAN RSRQ measurements

# 11 Measurements Performance Requirements for NR network

*Editor’s note: network side measurement and mapping tables may be specified in this section. If RAN4 decides to move NR network requirements to gNodeB specification, this section might be removed.*

Annex A (normative):  
Test Cases

*Editor’s note: TBD in the performance part of NR WID. The conducted and OTA testing criteria might be specified in the annex A before test cases configuration*

Annex B (normative):  
Conditions for RRM requirements applicability for operating bands

*Editor’s note: intended to capture the condition for RRM requirements for different operating bands. FFS if the conditions for RRM requirements applicability for numerologies shall be specified.*

Annex C (informative):  
Change history

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Change history** | | | | | | | |
| **Date** | **Meeting** | **TDoc** | **CR** | **Rev** | **Cat** | **Subject/Comment** | **New version** |
| 2017-05 | RAN4#83 | R4-1706324 |  |  |  | Specification skeleton | 0.0.1 |
| 2017-09 |  |  |  |  |  | Email approved | 0.1.0 |
| 2017-09 | RAN4-NR AH #3 | R4-1709413 |  |  |  | Capture TPs approved in the meeting | 0.2.0 |
| 2017-10 | RAN4#84-Bis | R4-1711985 |  |  |  | Capture TPs approved in the meeting | 0.3.0 |
| 2017-12 | RAN4#85 | R4-1714546 |  |  |  | Capture TPs approved in RAN4#85 | 0.4.0 |
| 2017-12 | RAN#78 | RP-172407 |  |  |  | v1.0.0 submitted for plenary approval | 1.0.0 |
| 2017-12 | RAN#78 |  |  |  |  | Approved by plenary – Rel-15 spec under change control | 15.0.0 |
| 2018-03 | RAN#79 | RP-180264 | 0032 |  | B | CR to TS38.133 | 15.1.0 |
| 2018-06 | RAN#80 | RP-181075 | 0037 |  | B | CR to TS 38.133: Implementation of endorsed draft CRs from RAN4 #86bis and RAN4 #87 | 15.2.0 |