**3GPP TSG- Meeting #**

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

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| ***Title:***  |  |
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| ***Source to WG:*** |  |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** |  |  | ***Date:*** |  |
|  |  |  |  |  |
| ***Category:*** |  |  | ***Release:*** |  |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | Introducing requirements for measurement procedures when VSAT UEs are connected to Ku Band |
|  |  |
| ***Summary of change:*** | Introduces the said requirements |
|  |  |
| ***Consequences if not approved:*** | There will be no measurement procedure requirements for VSAT UEs operating in the KU Band. |
|  |  |
| ***Clauses affected:*** | 3.6.12, 9.2C.7, 9.2C.8, 9.3C.8, 9.3C.9, 9.3C.10 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

***<Start of change 1>***

3.6.12 Applicability of requirements for Satellite Access

The requirements for Satellite Access defined in clauses with suffix ‘C’ apply provided that UE indicates *nonTerrestrialNetwork* and is accessing a cell served by a Satellite Access Node (SAN). The requirements apply provided that serving and all neighbour satellites on the same layer are of same satellite type (LEO or GEO).

Unless otherwise stated, the requirements defined for FR2-NTN apply for VSAT working operating in cells with FR1-NTN numerology.

***<End of change 1>***

***<Start of change 2>***

#### 9.2C.3.1 Requirements for FR1-NTN

For each intra-frequency layer, during each layer 1 measurement period, the UE shall be capable of performing SS-RSRP, SS-RSRQ, and SS-SINR measurements for at least:

- 8 identified cells, and

- 8 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 not smaller than the number of configured RLM-RS SSB resources.

- 4 SSBs with different SSB index and/or PCI from neighbour cells in GEO deployment.

- In NGSO deployments: cells from 2 satellites including the satellite serving the PCell if UE does not support the capability *maxNumber-NGSO-SatellitesPerCarrier-r17*; or cells from 3 or 4 satellites satellites including the satellite serving the PCell, depending on the value indicated in *maxNumber-NGSO-SatellitesPerCarrier-r17*.

#### 9.2C.3.2 Requirements for FR2-NTN

For each intra-frequency layer, during each layer 1 measurement period, the UE shall be capable of performing SS-RSRP, SS-RSRQ, and SS-SINR measurements for at least:

- 8 identified cells, and

- 8 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 not smaller than the number of configured RLM-RS SSB resources.

- 4 SSBs with different SSB index and/or PCI from neighbour cells

- In case the UE supports [capability for soft-satellite switching], cells from 2 different satellites including the satellite associated to the current serving Cell.

***<End of change 2>***

***<Start of change 3>***

9.2C.7 Intra-frequency measurements without measurement gaps for NTN band above 10 GHz

The requirements in this clause are applicable for mobile VSAT UEs operating with FR1-NTN or FR2-NTN numerology.

9.2C.7.1 Intra-frequency cell identification

The UE shall be able to identify a new detectable intra-frequency cell within Tidentify\_intra\_without\_index if the UE is not indicated to report SSB based RRM measurement result with the associated SSB index(*reportQuantityRsIndexes* or *maxNrofRSIndexesToReport* is not configured), or the UE is indicated that the neighbour cell is synchronous with the serving cell (*deriveSSB-IndexFromCell* is enabled). 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\_intra + TSSB\_measurement\_period\_intra + TVSAT\_tracking\_margin) ms

 Tidentify\_intra\_with\_index = (TPSS/SSS\_sync\_intra + TSSB\_measurement\_period\_intra + TSSB\_time\_index\_intra + TVSAT\_tracking\_margin) ms

Where:

 TPSS/SSS\_sync\_intra: it is the time period used in PSS/SSS detection given in table 9.2C.7.1-1

 TSSB\_time\_index\_intra: it is the time period used to acquire the index of the SSB being measured given in table 9.2C.7.1-2

 TSSB\_measurement\_period\_intra: equal to a measurement period of SSB based measurement given in table 9.2C.7.2-1

TVSAT\_tracking\_margin : is a margin added for the VSAT antenna for the initial tracking of the target satellite based on ephemeris information given in Table 9.2C.7.1-3.

 CSSFintra: it is a carrier specific scaling factor and is determined

 according to CSSFoutside\_gap,i in clause 9.1.5.1 for measurement conducted outside measurement gaps, i.e. when intra-frequency SMTC is fully non overlapping or partially overlapping with measurement gaps, or according to CSSFwithin\_gap,i in clause 9.1.5.2 for measurement conducted within measurement gaps, i.e. when intra-frequency SMTC is fully overlapping with measurement gaps.

 if the high layer in TS 38.331 [2] signalling of *smtc2* is configured, the assumed periodicity of intra-frequency SMTC occasions corresponds to the value of higher layer parameter *smtc2*; Otherwise the assumed periodicity of intra-frequency SMTC occasions corresponds to the value of higher layer parameter *smtc1*.

Kp is the scaling factor for an SSB frequency layer to be measured without measurement gaps. Kp = Ntotal\_SAN / Navailable\_SAN, where Navailable\_SAN and Ntotal\_SAN are calculated as follows:

- For a window W of duration max(SMTC period, MGRP\_max), where

- If UE is configured with concurrent measurement gaps, MGRP max is the maximum MGRP across all configured per-UE measurement gap. Otherwise, MGRP max is the MGRP of configured measurement gap.

- Ntotal\_SAN is the total number of SMTC occasions within the window, including those overlapped and non-overlapped with measurement gap occasions within the window, and

- Navailable\_SAN is the number of SMTC occasions within the window W that do not collide with any non-dropped MG occasion within or outside the window W, after accounting for measurement gap collisions by applying the measurement gap collision rule in clause 9.1C.8.3. The collision rule between SMTC occasion and measurement gap occasion is defined in clause 9.1C.9.1

Kp = [1] when Navailable\_SAN = 0 and measurement gap sharing in clause 9.1.2.1a shall apply.

Kp = 1 when intra-frequency SMTC is fully non overlapping with measurement gaps.

 For calculation of Kp, if the high layer signalling (TS 38.331 [2]) of *smtc2* is configured, for cells indicated in the *pci-List* parameter in *smtc2*, the SMTC periodicity corresponds to the value of higher layer parameter *smtc2*; for the other cells, the SMTC periodicity corresponds to the value of higher layer parameter *smtc1.*

Klayer1\_measurement: it is scaling factor for sharing between L3 and L1 measurement, and Klayer1\_measurement =1

 If the above-mentioned reference signal configured for L1-RSRP measurement is aperiodic CSI-RS resource, longer cell identification delay would be expected.

 If the higher layer signaling in TS 38.331 [2] signalling of *smtc2* is present and *smtc1* is fully overlapping with measurement gaps and smtc2 is partially overlapping with measurement gaps, requirements are not specified for Tidentify\_intra\_without\_index or Tidentify\_intra\_with\_index

**Table 9.2C.7.1-1: Time period for PSS/SSS detection**

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync\_intra** |
| No DRX | max( 600 ms, ceil( 5 x Kp x Klayer1\_measurement) x SMTC period )Note 1 x CSSFintra |
| DRX cycle≤ 320 ms | max( 600 ms, ceil(1.5x 5 x Kp x Klayer1\_measurement) x max(SMTC period,DRX cycle)) x CSSFintra |
| DRX cycle>320 ms | ceil(5 x Kp x Klayer1\_measurement) x DRX cycle x CSSFintra |
| 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 9.2C.7.1-2: Time period for time index detection**

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index\_intra** |
| No DRX | max(120 ms, ceil( 3 x Kp x Klayer1\_measurement)x SMTC period)Note 1 x CSSFintra |
| DRX cycle≤ 320 ms | max(120 ms, ceil (1.5 x 3 x Kp x Klayer1\_measurement) x max(SMTC period,DRX cycle)) x CSSFintra |
| DRX cycle>320 ms | Ceil(3 x Kp x Klayer1\_measurement) x DRX cycle x CSSFintra |
| 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 9.2C.7.1-3: TVSAT\_tracking\_margin for cell detection**

|  |  |
| --- | --- |
| **DRX cycle** | **TVSAT\_tracking\_margin** |
| No DRX | max(120 ms, ceil( 1 x Kp x Klayer1\_measurement)x SMTC period)Note 1 x CSSFintra |
| DRX Cycle On | max(120 ms, ceil (1 x Kp x Klayer1\_measurement) x max(SMTC period,DRX cycle)) x CSSFintra |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified |

9.2C.7.2 Measurement period

The measurement period for intra-frequency measurements without gaps is as shown in table 9.2C.7.2-1.

If the higher layer signaling in TS 38.331 [2] signalling of *smtc2* is present and *smtc1* is fully overlapping with measurement gaps and *smtc2* is partially overlapping with measurement gaps, requirements are not specified for *TSSB\_measurement\_period\_intra*

**Table 9.2C.7.2-1: Measurement period for intra-frequency measurements without gaps**

|  |  |
| --- | --- |
| **DRX cycle** | **T SSB\_measurement\_period\_intra**  |
| No DRX | max(200 ms, ceil( 5 x Kp x Klayer1\_measurement) x SMTC period)Note 1 x CSSFintra |
| DRX cycle≤ 320 ms | max(200 ms, ceil(1.5x 5 x Kp x Klayer1\_measurement) x max(SMTC period,DRX cycle)) x CSSFintra |
| DRX cycle>320 ms | ceil( 5 x Kp x Klayer1\_measurement) x DRX cycle x CSSFintra |
| NOTE 1: If different SMTC periodicities are configured for different cells, the SMTC period in the requirement is the one used by the cell being identified |

9.2C.7.3 Scheduling availability of UE during intra-frequency measurements

When any of the conditions in the following clauses is met, there are restrictions on the scheduling availability; otherwise, there is no scheduling restriction. Note that the SSB symbols indicated by the union set of *SSB-ToMeasure* from all the configured measurement objects on the same serving carrier which can be merged[2], if it is configured; otherwise, all *L* SSB symbols within the SMTC window duration defined in clause 4.1 of TS 38.213 [3] are included. For UL, the scheduling restriction applies to UL symbols that fully or partially overlap with the restricted symbols as defined below.

9.2C.7.3.1 Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH on NTN bands above 10 GHz

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

- If *deriveSSB\_IndexFromCell* is enabled the UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on SSB symbols to be measured within SMTC window duration. If the high layer signalling of *smtc2*is configured(in TS 38.331 [2]), the SMTC periodicityfollows *smtc2*; Otherwise the SMTC periodicity follows *smtc1.*

- If *deriveSSB\_IndexFromCell* is not enabled the UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on all symbols within SMTC window duration. If the high layer signalling of *smtc2*is configured in TS 38.331 [2], the SMTC periodicityfollows *smtc2*; Otherwise the SMTC periodicity follows *smtc1.*

***<End of change 2>***

***<Start of change 3>***

9.2C.8 Intra-frequency measurements with measurement gaps for NTN band above 10 GHz

The requirements in this clause are applicable for mobile VSAT UEs operating with FR1-NTN or FR2-NTN numerology.

9.2C.8.1 Intra-frequency cell identification

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 (*reportQuantityRsIndexes* or *maxNrofRSIndexesToReport* is not configured), or the UE has been indicated that the neighbour cell is synchronous with the serving cell (*deriveSSB-IndexFromCell* is enabled). 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\_intra + TSSB\_measurement\_period\_intra +TVSAT\_tracking\_margin ms

 Tidentify\_intra\_with\_index = TPSS/SSS\_sync\_ntra + TSSB\_measurement\_period\_intra + TSSB\_time\_index\_intra + TVSAT\_tracking\_margin ms

Where:

 TPSS/SSS\_sync\_intra: it is the time period used in PSS/SSS detection given in table 9.2C.8.2-1.

 TSSB\_time\_index\_intra: it is the time period used to acquire the index of the SSB being measured given in table 9.2C.8.2-2.

 TSSB\_measurement\_period\_intra: equal to a measurement period of SSB based measurement given in table 9.2C.8.3-1.

TVSAT\_tracking\_margin : is a margin added for the VSAT antenna for the initial tracking of the target satellite based on ephemeris information given in Table 9.2C.8.1-3.

 Kgap is the scaling factor for a SSB frequency layer to be measured within an associated a measurement gap pattern. Kgap = 1 when the UE is not configured with concurrent measurement gaps. When the UE is configured with concurrent measurement gaps and the two measurement gaps are fully overlapping with MGRP=160ms, Kgap = 2. Otherwise, Kgap = Ntotal / Navailable, where Navailable and Ntotal are calculated as follows:

- For a window W of duration max(SMTC period, MGRP\_max), where

- If UE is configured with concurrent measurement gaps, MGRP max is the maximum MGRP across all configured per-UE measurement gap. Otherwise, MGRP max is the MGRP of configured measurement gap.

- Ntotal is the total number of SMTC occasions within the window, including those overlapped and non-overlapped with measurement gap occasions within the window, and

- Navailable is the number of SMTC occasions within the window W that do not collide with any non-dropped MG occasion within or outside the window W, after accounting for measurement gap collisions by applying the measurement gap collision rule in clause 9.1C.8.3. The collision rule between SMTC occasion and measurement gap occasion is defined in clause 9.1C.9.1

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

If the higher layer signaling in TS 38.331 [2] of *smtc2* is present and *smtc1* is fully overlapping with measurement gaps and *smtc2* is partially overlapping with measurement gaps, requirements are not specified for Tidentify\_intra\_without\_index or Tidentify\_intra\_with\_index.

**Table 9.2C.8.1-1: Time period for PSS/SSS detection**

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

**Table 9.2C.8.1-2: Time period for time index detection**

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

**Table 9.2C.8.1-3: TVSAT\_tracking\_margin for cell detection**

|  |  |
| --- | --- |
| **DRX cycle** | **TVSAT\_tracking\_margin** |
| No DRX | max(120 ms, 1 x Kgap x max(MGRP, SMTC period)) x CSSFintra |
| DRX cycle≤ 320 ms | max(120 ms, 1 x Kgap x max(MGRP, SMTC period,DRX cycle) x CSSFintra) |

9.2C.8.3 Intra-frequency Measurement Period

The measurement period for intra-frequency measurements with gaps is as shown in table 9.2C.8.3-1.

**Table 9.2C.8.3-1: Measurement period for intra-frequency measurements with gaps**

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_measurement\_period\_intra** |
| No DRX | max(200 ms, 5 x Kgap x max(MGRP, SMTC period)) x CSSFintra |
| DRX cycle≤ 320 ms | max(200 ms, ceil(1.5x 5) x Kgap x max(MGRP, SMTC period,DRX cycle))x CSSFintra |
| DRX cycle>320 ms | 5 x Kgap x max(MGRP, DRX cycle) x CSSFintra |

***<End of change 3>***

***<Start of change 4>***

9.3C.8 Inter-frequency measurement with measurement gaps for NTN band above 10 GHz

The requirements in this clause are applicable for mobile VSAT UEs operating with FR1-NTN or FR2-NTN numerology.

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

 Tidentify\_inter\_without\_index = (TPSS/SSS\_sync\_inter + TSSB\_measurement\_period\_inter +TVSAT\_tracking\_margin) ms

 Tidentify\_inter\_with\_index = (TPSS/SSS\_sync\_inter + TSSB\_measurement\_period\_inter + TSSB\_time\_index\_inter +TVSAT\_tracking\_margin) ms

Where:

 TPSS/SSS\_sync\_inter: it is the time period used in PSS/SSS detection given in table 9.3C.8-1.

 TSSB\_time\_index\_inter: it is the time period used to acquire the index of the SSB being measured given in table 9.3C.8-2.

 TSSB\_measurement\_period\_inter: equal to a measurement period of SSB based measurement given in table 9.3C.9-1.

TVSAT\_tracking\_margin : is a margin added for the VSAT antenna for the initial tracking of the target satellite based on ephemeris information given in Table 9.3C.8-3.

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

 Kgap is the scaling factor for a SSB frequency layer to be measured within an associated measurement gap pattern. Kgap = 1 when the UE is not configured with concurrent measurement gaps. When the UE is configured with concurrent measurement gaps and the two measurement gaps are fully overlapping with MGRP=160 ms, Kgap = 2. Otherwise, Kgap = Ntotal / Navailable, where Navailable and Ntotal are calculated as follows:

 For a window W of duration max(SMTC period, MGRP\_max), where MGRP max is the maximum MGRP across all configured per-UE measurement gap, and starting from the beginning of any SMTC occasion:

- Ntotal is the total number of SMTC occasions that are covered by instances of the associated measurement gap within the window W, including those overlapped with other measurement gap occasions within the window, and

- Navailable is the number of SMTC occasions that are covered by instances of the non-dropped associated measurement gap within the window W after accounting for measurement gap collisions by applying the measurement gap collision rule in clause 9.1.8.3.

 Kgap is only applicable for UE supporting *parallelMeasurementGap-r17*. When concurrent measurement gaps are configured, requirements in this clause do not apply if Navailable =0, or if one SMTC overlaps more than one MGs associated to the frequency layer.

**Table 9.3C.8-1: Time period for PSS/SSS detection**

|  |  |
| --- | --- |
| **Condition NOTE1** | **TPSS/SSS\_sync\_inter** |
| No DRX |  Max(600 ms, Ceil(8 x Kgap) × Max(MGRP, SMTC period **NOTE2**)) × CSSFinter |
| DRX cycle ≤ 320 ms | Max(600 ms, Ceil(8\*1.5 x Kgap) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter |
| DRX cycle > 320 ms | Ceil(8 x Kgap) × DRX cycle × CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: SMTC period is the SMTC period in SMTC configuration which is associated with the target cell to be measured configured in *SSB-MTC4List-r17*. |

**Table 9.3C.8-2: Time period for time index detection**

|  |  |
| --- | --- |
| **Condition NOTE1** | **TSSB\_time\_index\_inter** |
| No DRX | Max(120 ms, Ceil(3 x Kgap) × Max(MGRP, SMTC period **NOTE2**)) × CSSFinter |
| DRX cycle ≤ 320 ms | Max(120 ms, Ceil(3 × 1.5 x Kgap) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter |
| DRX cycle > 320 ms | Ceil(3 x Kgap) × DRX cycle × CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: SMTC period is the SMTC period in SMTC configuration which is associated with the target cell to be measured configured in *SSB-MTC4List-r17*. |

**Table 9.2C.8-3: TVSAT\_tracking\_margin for cell detection**

|  |  |
| --- | --- |
| **DRX cycle** | **TVSAT\_tracking\_margin** |
| No DRX | max(120 ms, 1 x Kgap x max(MGRP, SMTC period)) x CSSFinter |
| DRX cycle≤ 320 ms | max(120 ms, 1 x Kgap x max(MGRP, SMTC period,DRX cycle) x CSSFinter) |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: SMTC period is the SMTC period in SMTC configuration which is associated with the target cell to be measured configured in *SSB-MTC4List-r17*. |

***<End of change 4>***

***<Start of change 5>***

9.3C.9 Inter-frequency measurements for NTN band above 10 GHz

The requirements in this clause are applicable for mobile VSAT UEs operating with FR1-NTN or FR2-NTN numerology.

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 clauses 10.1.5C, 10.1.10C and 10.1.15C, respectively, as shown in table 9.3C.5-1.

**Table 9.3C.9-1: Measurement period for inter-frequency measurements with gaps**

|  |  |
| --- | --- |
| **Condition NOTE1** | **TSSB\_measurement\_period\_inter** |
| No DRX | Max(200 ms, Ceil(8 x Kgap) × Max(MGRP, SMTC period **NOTE2**)) × CSSFinter |
| DRX cycle ≤ 320 ms | Max(200 ms, Ceil(8 × 1.5 x Kgap) × Max(MGRP, SMTC period, DRX cycle)) × CSSFinter |
| DRX cycle > 320 ms | Ceil(8 x Kgap) × DRX cycle × CSSFinter |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: SMTC period is the SMTC period in SMTC configuration which is associated with the target cell to be measured configured in *SSB-MTC4List-r17*. |

***<End of change 5>***

***<Start of change 6>***

9.3C.10 Inter-frequency measurements without measurement gaps for NTN band above 10 GHz

The requirements in this clause are applicable for mobile VSAT UEs operating with FR1-NTN or FR2-NTN numerology.

9.3C.10.1 Inter-frequency Cell identification

If UE supports *interFrequencyMeas-NoGap-r16* and the flag *interFrequencyConfig-NoGap-r16* is configured by the Network, UE shall be able to identify a new detectable inter-frequency cell within Tidentify\_inter\_without\_index if UE is not indicated to report SSB based RRM measurement result with the associated SSB index (*reportQuantityRsIndexes* or *maxNrofRSIndexesToReport* is not configured). Otherwise UE shall be able to identify a new detectable inter-frequency cell within Tidentify\_inter\_with\_index. The UE shall be able to identify a new detectable inter frequency SS block of an already detected cell within Tidentify\_inter\_without\_index.

Tidentify\_inter\_without\_index = (TPSS/SSS\_sync\_inter + TSSB\_measurement\_period\_inter +TVSAT\_tracking\_margin) ms

Tidentify\_inter\_with\_index = (TPSS/SSS\_sync\_inter + TSSB\_measurement\_period\_inter + TSSB\_time\_index\_inter +TVSAT\_tracking\_margin) ms

Where:

 TPSS/SSS\_sync\_inter: it is the time period used in PSS/SSS detection given in table 9.3C.10.1-1.

 TSSB\_time\_index\_inter: it is the time period used to acquire the index of the SSB being measured given in table 9.3C.10.1-2.

 TSSB\_measurement\_period\_inter: equal to a measurement period of SSB based measurement given in table 9.3C.10.2-1.

TVSAT\_tracking\_margin : is a margin added for the VSAT antenna for the initial tracking of the target satellite based on ephemeris information given in Table 9.3C.10.1-3.

 CSSFinter: it is a carrier specific scaling factor and is determined according to CSSFoutside\_gap,i in clause 9.1.5.1 for measurement conducted outside measurement gaps, i.e. when inter-frequency SMTC is fully non overlapping or partially overlapping with measurement gaps or according to CSSFwithin\_gap,i in clause 9.1.5.2 for measurement conducted within measurement gaps, i.e. when inter-frequency SMTC is fully overlapping with measurement gaps.

Kp is the scaling factor for a SSB frequency layer to be measured without measurement gaps. Kp = Ntotal\_SAN / Navailable\_SAN, where Navailable\_SAN and Ntotal\_SAN are calculated as follows:

- For a window W of duration max(SMTC period, MGRP\_max), where

- If UE is configured with concurrent measurement gaps, MGRP\_max is the maximum MGRP across all configured per-UE measurement gap. Otherwise, MGRP\_max is the MGRP of configured measurement gap.

- Ntotal\_SAN is the total number of SMTC occasions within the window, including those overlapped and non-overlapped with measurement gap occasions within the window, and

- Navailable\_SAN is the number of SMTC occasions within the window W that do not collide with any non-dropped MG occasion within or outside the window W, after accounting for measurement gap collisions by applying the measurement gap collision rule in clause 9.1C.8.3. The collision rule between SMTC occasion and measurement gap occasion is defined in clause 9.1C.9.1

Kp = 1 when Navailable\_SAN = 0 and measurement gap sharing in clause 9.1.2.1a shall apply.

Kp = 1 when inter-frequency SMTC is fully non overlapping with measurement gaps.

**Table 9.3C.10.1-1: Time period for PSS/SSS detection**

|  |  |
| --- | --- |
| **DRX cycle** | **TPSS/SSS\_sync\_inter** |
| No DRX | max( 600 ms, ceil( 5 x Kp) x SMTC period )Note 1 x CSSFinter |
| DRX cycle≤ 320 ms | max( 600 ms, ceil(1.5x 5 x Kp) x max(SMTC period,DRX cycle)) x CSSFinter |
| DRX cycle>320 ms | ceil(5 x Kp) x DRX cycle x CSSFinter |
| NOTE 1: SMTC period is the SMTC period in SMTC configuration which is associated with the target cell to be measured configured in *SSB-MTC4List-r17*. |

**Table 9.3C.10.1-2: Time period for time index detection**

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_time\_index\_inter** |
| No DRX | max(120 ms, ceil( 3 x Kp )x SMTC period)Note 1 x CSSFinter |
| DRX cycle≤ 320 ms | max(120 ms, ceil (1.5 x 3 x Kp) x max(SMTC period,DRX cycle)) x CSSFinter |
| DRX cycle>320 ms | Ceil(3 x Kp) x DRX cycle x CSSFinter |
| NOTE 1: SMTC period is the SMTC period in SMTC configuration which is associated with the target cell to be measured configured in *SSB-MTC4List-r17*. |

**Table 9.2C.10-3: TVSAT\_tracking\_margin for cell detection**

|  |  |
| --- | --- |
| **DRX cycle** | **TVSAT\_tracking\_margin** |
| No DRX | max(120 ms, 1 x Kp x max(MGRP, SMTC period)) x CSSFinter |
| DRX cycle≤ 320 ms | max(120 ms, 1 x Kp x max(MGRP, SMTC period,DRX cycle) x CSSFinter) |
| NOTE 1: DRX or non DRX requirements apply according to the conditions described in clause 3.6.1NOTE 2: SMTC period is the SMTC period in SMTC configuration which is associated with the target cell to be measured configured in *SSB-MTC4List-r17*. |

9.3C.10.2 Measurement period

The UE physical layer shall be capable of reporting SS-RSRP, SS-RSRQ and SS-SINR measurements to higher layers with measurement accuracy as specified in clauses 10.1.5C, 10.1.10C and 10.1.15C, respectively, as shown in table 9.3C.7.2-1, if UE supports inter-frequency measurement without measurement gaps:

**Table 9.3C.10.2-1: Measurement period for inter-frequency measurements without gaps**

|  |  |
| --- | --- |
| **DRX cycle** | **TSSB\_measurement\_period\_inter** |
| No DRX | max(200 ms, ceil( 5 x Kp) x SMTC period)Note 1 x CSSFinter |
| DRX cycle≤ 320 ms | max(200 ms, ceil(1.5x 5 x Kp) x max(SMTC period,DRX cycle)) x CSSFinter |
| DRX cycle>320 ms | ceil( 5 x Kp ) x DRX cycle x CSSFinter |
| NOTE 1: SMTC period is the SMTC period in SMTC configuration which is associated with the target cell to be measured configured in *SSB-MTC4List-r17*. |

9.3C.10.3 Scheduling availability of UE during inter-frequency measurements

If UE supports *interFrequencyMeas-NoGap-r16* and the flag *interFrequencyConfig-NoGap-r16* is configured by the Network, UE is required to be capable of measuring without measurement gaps when the SSB is completely contained in the active bandwidth part of the UE. When any of the conditions in the following clauses is met, there are restrictions on the scheduling availability; otherwise, there is no scheduling restriction. Note that the SSB symbols to be measured in the following clauses are the SSB symbols indicated by *SSB-ToMeasure* [2], if it is configured; otherwise, all L SSB symbols within the SMTC window duration defined in clause 4.1 of TS 38.213 [3] are included. For UL, the scheduling restriction applies to UL symbols that fully or partially overlap with the restricted symbols as defined below.

9.3C.10.3.1 Scheduling availability of UE performing measurements with a different subcarrier spacing than PDSCH/PDCCH on NTN bands above 10 GHz

For UE which do not support *simultaneousRxDataSSB-DiffNumerology-Inter-r16* [14] the following restrictions apply due to SS-RSRP/RSRQ/SINR measurement

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

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

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

***<End of change 6>***

***<Start of change 7>***

#### 6.1C.1.3 NR SAN FR2-NTN – NR SAN FR2-NTN Handover

The requirements in this clause are applicable to both intra-frequency and inter-frequency handovers from NR SAN FR2-NTN cell to NR SAN FR2-NTN cell. The requirements in this clause apply provided that UE has the valid and applicable parameters of ephemeris information, common TA, DL and UL Polarization information, Koffset, and Kmac for target NR SAN cell during Dhandover, otherwise interruption time may be longer than the requirements in clause 6.1C.1.3.2.

##### 6.1C.1.3.1 Handover delay

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

Where:

- Dhandover equals the applicable RRC procedure delay defined in clause 12 in TS 38.331 [2] plus the interruption time stated in clause 6.1C.1.3.2.

##### 6.1C.1.3.2 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 to NR SAN cell is commanded, and if the target NR SAN cell is served by the same satellite as the serving cell, the interruption time shall be less than Tinterrupt\_intra\_sat, where Tinterrupt\_intra\_sat is same as Tinterrupt defined in clause 6.1C.1.2.2.

When intra-frequency or inter-frequency handover to NR SAN cell is commanded, and if the target NR SAN cell is served by a different satellite than the serving cell, the interruption time shall be less than Tinterrupt\_inter\_sat, where

 Tinterrupt\_inter\_sat = Tsearch + TIU + Tprocessing + Tsat\_beam + T∆ + Tmargin ms

Where:

- Tsearch is the time required to search the target NR SAN cell. If the target cell is an intra-frequency cell and the target cell Es/Iot ≥ -2 dB, then Tsearch = Trs ms. If the target cell is an inter-frequency cell and the target cell Es/Iot ≥ -2 dB, then Tsearch = 3\* Trs ms. If the target cell is already known by the UE and the UE supports [soft satellite switching capability], then Tsearch = 0 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∆ = Trs.

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

- Tmargin is time for SSB post-processing. Tmargin can be up to 2 ms.

- TIU is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. TIU can be up to the summation of SSB to PRACH occasion association period and 10 ms. SSB to PRACH occasion associated period is defined in the table 8.1-1 of TS 38.213 [3].

- Tsat\_beam is additional time for UE to steer the downlink spatial domain reception filter to the target cell.

- For UE indicating ‘*electronic’* via UE capability *ntn-VSAT-AntennaType-r18*, Tsat\_beam is 3\*Trs

- For UE indicating ‘*mechanical’* via UE capability *ntn-VSAT-AntennaType-r18*, Tsat\_beam is Oangle / 22.5 s, where Oangle is the angle offset observed from UE in degree between the satellite for the serving cell and the satellite for the target cell.

- If the VSAT UE supports [soft satellite switching capability] and the cell is already known, then, Tsat\_beam = 0.

- Trs is the SMTC periodicity of the target NR SAN cell if the UE has been provided with an SMTC configuration for the target cell in the handover command, otherwise Trs is the SMTC configured in the measObjectNR having the same SSB frequency and subcarrier spacing. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement in this clause is applied with Trs=5 ms assuming the SSB transmission periodicity is 5 ms. There is no requirement if the SSB transmission periodicity is not 5 ms. If the UE has been provided with higher layer in TS 38.331 [2] signalling of *smtc2*prior to the handover command, Trs follows *smtc1* or *smtc2* according to the physical cell ID of the target cell.

***<End of change 7>***

***<Start of change 8>***

#### 6.1C.2.4 NR SAN FR2-NTN – NR SAN FR2-NTN conditional handover

The requirements in this clause are applicable to both intra-frequency and inter-frequency conditional handover from NR SAN FR2-NTN cell to NR SAN FR2-NTN cell.

The requirements in this clause apply provided that UE has the valid and applicable parameters of ephemeris information, common TA, DL and UL Polarization information, Koffset, and Kmac for target NR SAN cell during DCHO, otherwise the measurement time, preparation time and interruption time may be longer than the requirements in clauses 6.1C.2.2.2, 6.1C.2.2.3 and 6.1C.2.2.4.

The requirements in this clause 6.1C.2.2 shall apply.

***<End of change 8>***

***<Start of change 9>***

#### 6.1C.2.5 NR SAN FR2-NTN – NR SAN FR2-NTN conditional handover without L3 measurement criteria

The requirements in this clause are applicable to both intra-frequency and inter-frequency conditional handover from NR SAN FR1 cell to NR SAN FR1 cell without L3 measurement criteria. The requirements in this clause apply provided that UE has the valid and applicable parameters of ephemeris information, common TA, DL and UL Polarization information, Koffset, and Kmac for target NR SAN cell during DCHO, otherwise preparation time and interruption time may be longer than the requirements in clauses 6.1C.2.5.2, 6.1C.2.5.3.

The requirements in this clause are applicable for UEs that support conditional handover without L3 measurement criteria.

##### 6.1C.2.5.1 Handover delay

Procedure delays for all procedures that can command a conditional handover are specified in TS 38.331 [2]. UE is allowed to execute time-based and location-based conditional handover without RRM measurement once the time or distance condition is met, the time/distance condition is defined in clause 5.5.4 in TS 38.331[2]

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

 DCHO = TRRC + TEvent\_DU + Tinterrupt + TCHO\_execution

Where:

- TRRC is the RRC procedure delay defined in clause 12 in TS 38.331 [2].

For time-based conditional handover:

- TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until condition T1-1 is fulfilled which will trigger the conditional handover

For location-based conditional handover:

- TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until both entering conditions are fulfilled which will trigger the conditional handover. If both source cell and target cell are quasi-Earth fixed cells, entering conditions correspond to condition D1-1 and condition D1-2. If both source cell and target cell are moving cells, entering conditions correspond to condition D2-1 and condition D2-2.

 - TCHO\_execution is the UE conditional execution preparation time for conditional handover in clause 6.1C.2.5.2.

- Tinterrupt is the interruption time stated in clause 6.1C.2.5.3.

##### 6.1C.2.5.2 Preparation time

TCHO\_execution is the UE execution preparation time for conditional handover, and starts after UE realizes the condition of CHO is met and identity of the target cell is determined. TCHO\_execution can be up to 10 ms.

##### 6.1C.2.5.3 Interruption time

The interruption time is the time between when the UE starts to execute the conditional handover to the target cell and the time the UE starts transmission of the new PRACH or PUSCH.

For intra-frequency or inter-frequency conditional handover, the measurement time shall be less than

 Tinterrupt = Tprocessing + Tsearch + TIU + T∆ + Tmargin + Tsat\_beam ms

Where:

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

- Tsearch is the time required to search the target cell when the target cell is not already known when the conditional 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 the target cell Es/Iot≥-2 dB, then Tsearch = Trs ms. If the target cell is an unknown inter-frequency cell and the target cell Es/Iot≥-2 dB, then Tsearch = 3\* Trs ms.

- TIU is the interruption uncertainty in acquiring the first available PRACH occasion in the new cell. TIU can be up to the summation of SSB to PRACH occasion association period and 10ms. SSB to PRACH occasion associated period is defined in the table 8.1-1 of TS 38.213 [3]. For combination of RACH-less handover with time-based conditional handover, TIU can be a configured grant based PUSCH, dynamic grant based PUSCH, SR on PUCCH, according to NW configuration and scheduling, or PRACH if no valid configured grant based PUSCH is selected.

- T∆ is time for fine time tracking and acquiring full timing information of the target cell. TΔ = Trs.

- Tsat\_beam is additional time for UE to steer the downlink spatial domain reception filter to the target cell.

- For UE indicating ‘*electronic’* via UE capability *ntn-VSAT-AntennaType-r18*, Tsat\_beam is 3\*Trs

- For UE indicating ‘*mechanical’* via UE capability *ntn-VSAT-AntennaType-r18*, Tsat\_beam is Oangle / 22.5 s, where Oangle is the angle offset observed from UE in degree between the satellite for the serving cell and the satellite for the target cell.

- If the VSAT UE supports [soft satellite switching capability] and the cell is already known, then, Tsat\_beam = 0.

- Tmargin is time for SSB post-processing. Tmargin can be up to 2 ms.

- Trs is the SMTC periodicity of the target NR SAN cell if the UE has been provided with an SMTC configuration for the target cellin the handover command, otherwise Trs is the SMTC configured in the *measObjectNR* having the same SSB frequency and subcarrier spacing. If the UE is not provided SMTC configuration or measurement object on this frequency, the requirement in this clause is applied with Trs=5 ms assuming the SSB transmission periodicity is 5 ms. There is no requirement if the SSB transmission periodicity is not 5 ms. If the UE has been provided with higher layer in TS 38.331 [2] signalling of *smtc2*prior to the handover command, Trs follows *smtc1* or *smtc2* according to the physical cell ID of the target cell.

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