**3GPP TSG-RAN2 Meeting #116-e *R2-211XXXX***

**Online, 2021-11-01 - 2021-11-12**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.304** | **CR** | **CRNum** | **rev** | **-** | **Current version:** | **15.13.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
|  | | | | | | | | |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | | | |
| ***Title:*** | Running CR for the RedCap WI | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Ericsson | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_redcap-Core | | | | |  | ***Date:*** | | | 2021-11-15 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | B |  | | | | | ***Release:*** | | | Rel-17 |
|  | *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 can be 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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | This is a draft of the running 38.304 CR for the RedCap WI. To be updated as the work progresses. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | FYI: Agreements and if/how they have been captured (to be removed when finalizing the CR).   |  |  | | --- | --- | | **RAN2#116:** | | | RAN2 will not further discuss L2 buffer size reduction for RedCap UEs in Rel-17 (this does not prevent future discussion in future releases) | No impact | | In MAC perspective, a RedCap UE uses Msg1 early identification whenever transmitting preamble for CBRA, as long as the Msg1 early identification is configured for RedCap by NW. | No impact | | For Msg1 early identification, RAN2 confirm both dedicated ROs and dedicated PRACH preamble can be supported from signalling point of view | No impact | | For RedCap, Msg1 early identification is enabled/disabled implicitly by the presence of dedicate RACH configuration for Msg1 early identification. | No impact | | At least the dedicated LCID (i.e. the Msg3 early identification solution) can be supported for MsgA early identification. It is up to RAN1 on the need of dedicated preamble and/or dedicated PUSCH resource configuration. | No impact | | Do not support the RedCap specific UAC parameters. | No impact | | In MAC perspective, RedCap UE uses the dedicated LCID for Msg3 early identification, when the Msg3 includes the CCCH data. FFS on whether it requires no other precondition, or precondition as “when Msg1 early identification is not configured”, or precondition as “when Msg3 early identification is enabled by NW”. | No impact | | Two reserved LCIDs are used for CCCH and CCCH1 cases respectively for Msg3 early identification | No impact | | The max eDRX cycle length for RRC Inactive is 10.24s in Rel-17 | No impact | | PO determination for non-overlapping CN/RN case is applicable to eDRX | Impact captured in CR#0224, relevant part included in 7.1 for reference. | | When IDLE eDRX and INACTIVE eDRX are configured and both cycles are no longer than 10.24s, PO is determined by IDLE eDRX. | Impact captured in 7.1 | | When IDLE eDRX is configured and is no longer than 10.24s, INACITVE eDRX cycle is not configured, PO is determined by IDLE eDRX. | Impact captured in 7.1 | | During CN PTW when IDLE eDRX is configured and longer than 10.24s, and INACTIVE eDRX is configured, PO is determined by the shortest value of default paging cycle and UE specific DRX cycle if configured by upper layer. | Impact captured in 7.1. | | During CN PTW when IDLE eDRX is configure and is longer than 10.24s, INACTIVE eDRX cycle is not configured, PO is determined by the shortest value of default paging cycle and UE specific DRX cycle if configured by upper layer. | Impact captured in 7.1. | | eDRX supporting UEs are assumed to also support the UE capability on PO determination for non overlapping CN/RN case (Further discuss on the reporting of eDRX capability) | No impact / FFS. | | The below working agreement is now changed to an agreement.  When IDLE eDRX cycle is longer than 10.24s, CN PTW\_start calculation formula defined in LTE is re-used as the baseline, as below. FFS whether CN PTW\_start position could be configurable by network and in case which node decides the N value. Note: this formula would be revisited if INACTIVE eDRX cycle can be above 10.24s  PTW\_start denotes the first radio frame of the PH that is part of the PTW and has SFN satisfying the following equation:  SFN = 1024/N\* ieDRX, where  ieDRX = floor(UE\_ID\_H /TeDRX,H) mod N  FFS N = 4 or 8, FFS if N can take other values | Impact captured in 7.x | | The same LTE hashed UE\_ID calculation is used for UE\_ID\_H for NR. | Impact captured in 7.x | | eDRX feature can be supported by non RedCap UEs. | No impact | | A UE in idle mode requests eDRX configuration via NAS signalling. FFS if capability signalling in RAN, as part of the UE capability message, is also needed. | No impact | | eDRX support is optional for the RedCap UE. | No impact | | the UE\_ID for eDRX is defined by 5G-S-TMSI mod 4096. | Impact captured in 7.1 | | the eDRX acquisition period is the maximum configurable value of the eDRX cycle | No impact | | No eDRX specific on-demand SI enhancements are considered for Rel-17 | No impact | | For the eDRX PTW start calculation, agree to N=8. No signalling needed to CN. | Impact captured in 7.x | | The eDRX acquisition period is the same for IDLE and INACTIVE. | No impact | | A) For RRC\_INACTIVE UE, when IDLE eDRX cycle is no longer than 10.24s and INACTIVE eDRX cycle is not configured, T is determined by the shortest of RAN paging cycle and IDLE eDRX cycle.  B) For RRC\_INACTIVE UE, when IDLE eDRX cycle is longer than 10.24s and INACTIVE eDRX cycle is not configured, outside CN PTW, T is determined by RAN paging cycle. | A) Impact captured in 7.1  B) Already captured in 7.1 | | UE is not allowed to relax its RRM measurements if both stationarity criterion and R17 not-at-cell-edge criterion are configured but UE meets only the R17 not-at-cell-edge criterion. | No impact (already covered by 5.2.4.9.0) | | UE reports to network when it no longer meets relaxation criteria. | No impact | | No additional signaling is introduced for network to tell UE whether and which criteria for RRM relaxation is considered satisfied when leaving RRC\_CONNECTED state. | No impact | | No need for UE to send UE Assistance Information to request network configuring it with relaxation criteria. | No impact | | UE does not report its history/state of RRM relaxation when transitioning from RRC Idle/Inactive to RRC Connected. | No impact | | Relaxation criteria for UEs in RRC Connected are configured by only dedicated signaling. | No impact | | RAN2 assume that the existing RRM measurement framework can be used as baseline for enabling and disabling RRM relaxations for UEs in RRC Connected. Other methods can be considered too based on relaxation methods agreed by RAN4. | No impact | | RAN2 understands that no prohibit timer is needed, if legacy measurement reporting framework is reused by UE to report its relaxation status | No impact | | The granularity of RRM measurement relaxations (i.e. whether it should be specified per beam, per cell or per frequency) should be handled by RAN4 | No impact | |  |  | | **RAN2#115:** | | | The number of DRBs supported by RedCap UEs is less than legacy value (which is 16). There will be a single mandatory value (FFS if 4 or 8). FFS if it will be possible to have an optional capability | No impact | | “RRC processing delay” is not relaxed for RedCap UE | No impact | | PDCP/RLC AM 12 bits SN is mandatory for RedCap UE, and PDCP/RLC AM 18bits SN is optional supported by RedCap UE; FFS on how to capture this in specification | No impact | | NE-DC, and (NG)EN-DC are not supported by RedCap UE; FFS on how to capture it in the specification | No impact | | DAPS and CAPC related capabilities are not applicable for RedCap UE; [8/20] FFS on CHO. FFS on how to capture this in the specification; | No impact | | Maximum 8 DRBs is mandatory supported by RedCap UEs. | No impact | | From RAN2 perspective, inter RAT mobility related capabilities are applicable for RedCap UE; | No impact | | From RAN2 perspective, measurement related capabilities are applicable for RedCap UE; | No impact | | From RAN2 perspective, URLLC related capabilities are applicable for RedCap UE except those affected by CA/DC; | No impact | | From RAN2 perspective, IAB related capabilities are not applicable for RedCap UE, i.e. the RedCap UE is not expected to act as IAB node; | No impact | | Do not introduce capability signalling on the supported Rx number for RedCap UE since the number of Rx branches for RedCap is implicitly indicated by the corresponding capability parameter maxNumberMIMO-LayersPDSCH in the existing UE capability framework; | No impact | | Msg1 identification which can be configured to be enabled/disabled can be specified from RAN2 point of view. | No impact | | Solution for early identification for 2-step RACH will be specified. | No impact | | Specify separate indications in SIB1 for barring RedCap UEs with 1 Rx chain and 2 Rx chains. | Impact captured in 5.3.1 | | Specify a RedCap specific IFRI in SIB1. | Impact captured in 5.3.1 | | IFRI for RedCap UEs in SIB1 is common for UEs with 1 Rx or 2 Rx branches. | No impact | | If RedCap-specific IFRI is absent from broadcast SI, the UE considers the cell does not support RedCap. | Impact in 38.304 is TBD. Perhaps sufficient to capture this in 38.331. | | A Msg3 early identification based on dedicated LCID is supported (if SA3 confirms there is no problem) | No impact | | RedCap UE applies the existing cellBarred field in MIB | No impact | | When IDLE eDRX cycle is longer than 10.24s, PH calculation formula defined in LTE is re-used, i.e.  PH\_CN: H-SFN mod TeDRX,\_CN,H= (UE\_ID\_H mod TeDRX\_CN,H)  - where TeDRX\_CN,H is equal to IDLE eDRX cycle. | Impact captured in 7.x | | When IDLE eDRX cycle is longer than 10.24s, CN PTW\_end calculation formula defined in LTE is re-used, i.e.  PTW\_end is radio frame satisfying SFN = (PTW\_start + L\*100 - 1) mod 1024,  - where L is PTW length configured by upper layers. | Impact captured in 7.x | | For RRC\_IDLE UE, when eDRX cycle is no longer than 10.24s, T is determined by IDLE eDRX cycle. When eDRX cycle is longer than 10.24s, during the CN PTW, T is determined by the shortest of UE specific DRX cycle, if configured by upper layer, and default paging cycle. | Impact captured in 7.1 | | For RRC\_INACTIVE UE, when IDLE eDRX cycle is longer than 10.24s and Inactive eDRX cycle is not configured, during CN PTW, T is determined by the shortest of UE specific DRX cycle, if configured by upper layer, RAN paging cycle and default paging cycle. | Impact captured in 7.1 | | For RRC\_INACTIVE UE, when IDLE eDRX cycle is longer than 10.24s and Inactive eDRX cycle is no longer than 10.24s, outside CN PTW, T is determined by INACTIVE eDRX cycle. | Impact captured in 7.1 | | RAN2 considers the configuration as an invalid case, where INACTIVE eDRX cycle is configured but IDLE eDRX cycle is not configured. FFS whether to capture this restriction in RAN2 spec. | No Impact | | RAN2 considers the configuration as invalid case, where INACTIVE eDRX cycle is longer than IDLE eDRX cycle. FFS whether to capture this restriction in RAN2 spec. | No Impact | | The maximum PTW length is 40.96s when IDLE eDRX cycle is longer than 10.24s. | No Impact | | The minimum PTW length is 1.28s and the step length/granularity of PTW length is 1.28 when IDLE eDRX cycle is longer than 10.24s. | No Impact | | Introduce an additional new IE for INACTIVE eDRX to contain all values of INACTIVE eDRX cycles (also include values >10.24, if agreed in future). | No Impact | | For RRC\_INACTIVE UE, when IDLE eDRX cycle is no longer than 10.24s and INACTIVE eDRX cycle is no longer than 10.24s, T is determined by the shortest of IDLE eDRX cycle and INACTIVE eDRX cycle. | Impact captured in 7.1 | | For RRC\_INACTIVE UE, when IDLE eDRX cycle is longer than 10.24s and INACTIVE eDRX cycle is no longer than 10.24s, during CN PTW, T is determined by the shortest of UE specific DRX cycle, if configured by upper layer, INACTIVE eDRX cycle and default paging cycle. | Impact captured in 7.1 | | eDRX feature is optional for any UE (including RedCap and non-RedCap UEs). | No Impact | | eDRX is optional for any gNB (either supporting RedCap or not), which means it is up to gNB implementation whether to support eDRX | No Impact | | When IDLE eDRX cycle is longer than 10.24s, CN PTW\_start calculation formula defined in LTE is re-used as the baseline, as below. FFS whether CN PTW\_start position could be configurable by network and in case which node decides the N value. Note: this formula would be revisited if INACTIVE eDRX cycle can be above 10.24s  PTW\_start denotes the first radio frame of the PH that is part of the PTW and has SFN satisfying the following equation:  SFN = 1024/N\* ieDRX, where  ieDRX = floor(UE\_ID\_H /TeDRX,H) mod N  FFS N = 4 or 8, FFS if N can take other values | Impact captured in 7.1 and 7.x | | For RRC\_INACTIVE UE, when IDLE eDRX cycle is no longer than 10.24s and INACTIVE eDRX cycle is not configured, FFS which option below is adopted for paging monitoring:  Option 1: T is determined by the shortest of RAN paging cycle, IDLE eDRX cycle, and default paging cycle.  Option 2: T is determined by the shortest of RAN paging cycle and IDLE eDRX cycle | No Impact | | For RRC\_INACTIVE UE, when IDLE eDRX cycle is longer than 10.24s and INACTIVE eDRX cycle is not configured, outside CN PTW, FFS which option below is adopted for paging monitoring:  Option 1: T is determined by the shortest of RAN paging cycle and default paging cycle.  Option 2: T is determined by RAN paging cycle. | No Impact yet due to FFS. | | Do not introduce nor reuse not-at-cell-edge threshold for R17 RRC\_CONNECTED UEs. | No impact | | Do not introduce beam change based criterion in Rel-17. | No impact | | The network provides the configuration of stationarity criterion to the UE via dedicated signalling (e.g. RRCReconfiguration message) in RRC\_CONNECTED. | No impact | | Send LS to RAN4 to inform RAN2 conclusions for RRM relaxation. | No impact | | The LS to RAN4 includes the agreed RAN2 conclusions and “For RRC\_IDLE/INACTIVE, RAN4 is asked to study and define corresponding R17 RRM relaxation method” . | No impact | | Introduce separate Rel-17 not-at-cell-edge threshold, and the new threshold is only associated with Rel-17 stationary criterion (if configured). If configured with a not-at-cell-edge criterion, the R17 stationary criterion can only be configured together with the R17 not-at-cell-edge criterion, not with the R16 one | Impact captured in 5.2.4.9 | | **RAN2#114:** | | | Working assumption:  1. Extend UE-NR-Capability using NCE to capture RedCap capabilities | No impact | | 2. We will continue the discussion on which capability are applicable to RedCap UE (FFS if we need to have an exhaustive check) | No impact | | 3. At least for early identification there will be only one RedCap UE (no need to define separate RedCap UE types for FR1 and FR2) | No impact | | 4. It is up to the network how to prevent RedCap UEs from using radio capabilities not intended for RedCap UEs (no specification impact is foreseen at least in RAN2. FFS whether something is needed from SA2/CT1) | No impact | | 1. RAN2 Working Assumption: by default, all non-RedCap UE capabilities are applicable for RedCap UE, and therefore only for non-RedCap capabilities that are not appliable for RedCap UE, we clarify in the definitions for parameters in TS38.306, the value or feature is not applicable for RedCap UE | No impact | | 2. We will have an email discussion until the next meeting to discuss which higher layer capabilities are not applicable for RedCap UEs (it could result in a draft 38.306 CR) and how to reflect the handling of RedCap specific capabilities (e.g. Maximum BW, Max Rx, MIMO-Layer, 256QAM, CA/DC, HD-FDD, etc) | No impact | | 3. The network needs to know if the UE is a RedCap UE or not in order to at least correctly identify the set of mandatory features (i.e. baseline capabilities) that the UE supports, including Handover case | No impact | | 4. The network needs to unambiguously know whether the UE is a RedCap or a non-RedCap UE from its reported UE capability information. | No impact | | 1. SIB1 (not MIB) indicates cell barring for 1 Rx branch and 2 Rx branches separately for RedCap UEs. Further details of the solution are FFS | No impact | | 2. The cell barring for RedCap UE is per cell (not per PLMN). | No impact | | 3. RedCap UE supports the Intra Frequency Reselection Indicator. | No impact | | 4. Either Msg1 and/or Msg3 early identification will be supported | No impact | | 1. There is no need to support Rx branches specific early identification from RAN2 perceptive (final decision up to RAN1). | No impact | | 2. Send LS to ask RAN3 to consider the coordination between gNBs on whether a neighbour/target gNB supports RedCap UEs, if needed, to avoid handover RedCap to a target cell that it can’t access. We can come back in the next meeting with discussions on other restrictions, e.g. related to number of RX | No impact | | 1. Lower bound for eDRX configuration in RRC\_IDLE and RRC\_INACTIVE is 2.56 seconds. Inform SA2/CT1 and check if there is any concern. | No impact | | 2. It is up to RAN to configure the length for PTW for RAN paging, the RAN PTW length can be different from the CN PTW length. | No impact | | 3. When RAN and CN paging coincide in the same PH, the PTW starting locations are the same. FFS how to calculate the PTW starting location so that it is the same for RAN and CN PTW. | No impact (yet) | | 1. Continue in the next meeting the discussion on how UE is expected to monitor RAN and CN PTW, e.g. whether UE in RRC\_INACTIVE monitors for only RAN PTW or both CN and RAN PTW when they overlap | No impact (yet) | | 1. An RSRP/RSRQ based stationarity criterion (Working Assumption: the same as in idle/inactive) can be configured for UEs in RRC Connected. If the criterion is met, this is reported to the network (FFS how/when). It is FFS whether, based on this, besides possibly reconfiguring RRM measurements (up to network implementation), the network can enable RRM measurement relaxation (FFS whether same method as in Idle/Inactive) | No impact | | 1. Subscription based relaxation criteria will not be considered in Rel-17 RRM relaxation | No impact | | 1. Reuse R16 low mobility criterion, as part or whole of Rel-17 stationary criterion in RRC\_IDLE/INACTIVE. When NW configures both Rel-17 stationary criterion and Rel-16 low mobility criterion, NW configures different Rel-17 thresholds (i.e., SSearchDeltaP\_stationary/TSearchDeltaP\_stationary) from Rel-16 (SSearchDeltaP / TSearchDeltaP). How to configure the criterion (e.g. more stringent) is left to NW implementation (i.e. no specification impact to RAN2). | Captured in 5.2.4.9 | | 2. Postpone the following discussion until RAN4 defines RRM relaxation method for Rel-17:  When NW configures both R16/R17 relaxation criteria and the UE fulfills both, UE performs:  - Option 1) UE performs Rel-17 RRM relaxation method  - Option 2) It is up to UE implementation to select either Rel-16 or Rel-17 relaxation operation | No impact | | 1. Working Assumption: If beam-level criterion is adopted for Rel-17 stationary criterion in RRC\_IDLE/INACTIVE, it is configured separately with Rel-16 low mobility criterion reused | No impact. | | 2. When NW configures Rel-17 RRM relaxation for RRC\_IDLE/INACTIVE, Rel-17 stationary criterion is mandatory, and Rel-17 not-at-cell-edge criterion is optional configuration. FFS whether the same applies to RRC Connected | No impact | | 3. Continue discussion on Rel-17 not-at-cell-edge criterion in RRC\_IDLE/INACTIVE within two options:  - Option 1) Reuse Rel-16 not-at-cell-edge criterion with the same thresholds (i.e., SSearchThresholdP / SSearchThresholdQ)  - Option 2) Reuse Rel-16 not-at-cell-edge criterion with the different thresholds | No impact | | **RAN2#113bis** | | | 1. RAN decides and configures eDRX via RRC for RRC\_INACTIVE (FFS on the need and details of coordination with the CN) | No impact | | 2. At least for eDRX cycle, the configurations of the eDRX for RRC\_IDLE and RRC\_INACTIVE can be different (FFS for PTW, e.g. length and starting point, when eDRX cycles are longer than 10.24s) | Partly captured in 7.x. | | 1. RAN2 assumes that CN provides necessary assistance information on eDRX config. for RRC\_IDLE to RAN (e.g. reusing eDRX config. defined in “CN Assistance Information for RRC INACTIVE IE” for E-UTRA/5GC). | No impact | | 2. eDRX feature, including the related parameters (i.e. PH, PTW. H-SFN) and corresponding paging operation defined for E-UTRA/5GC is used as baseline to enable eDRX >10.24sec for both RRC\_IDLE and RRC\_INACTIVE in NR/5GC | Partly captured in 7.x, further details to be discussed and agreed. | | 3. RAN2 confirms that CN paging and RAN paging use the same paging frame offset and first PDCCH monitoring occasion in PO, which are configured by RAN without involvement of CN. | Not yet captured. | | 4. RAN2 confirms that SI modification mechanism from LTE is used as a baseline for SI change (other than ETWS and CMAS), i.e. by using an eDRX acquisition period and a flag to indicate SI modification for eDRX in Short Message (e.g. systemInfoModification-eDRX) | No impact | | 1. Assuming there will be a stationary property based on subscription (which is FFS), we will not restrict to this and will continue to assume that a UE can use some RSRP/RSRQ based criteria (FFS whether reuse R16 thresholds or new ones. FFS also on the use of a beam based criteria) | Captured in 5.2.4.9 | | At least for RRC idle/inactive, a measurement-based R17 stationarity criterion can be configured separately from R16 low-mobility criterion for R17 UEs supporting the feature. FFS how the configuration is provided. FFS whether this stationarity criterion is based on:  - the same algorithm used in R16 low-mobility criterion but with its own specific set of thresholds; and/or  - a combination of R16 low-mobility criterion and/or beam-change based criterion. Exact details of beam change criterion are FFS. | Captured in 5.2.4.9 | | 1. Network can configure R17 stationarity criterion/criteria together with a not-at-cell-edge criterion, to trigger RRM relaxations in RRC Idle/Inactive for R17 UEs supporting the feature. FFS whether the R16 not-at-cell-edge thresholds can be reused or separate R17 not-at-cell-edge thresholds are needed. | Captured in 5.2.4.9 | | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | RedCap is not supported in 38.304 | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | TBD | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | TS TODO CR TODO | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | | This CR should be lifted to the latest version of the specification. | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

# 1 Scope

The present document specifies the Access Stratum (AS) part of the UE procedures in RRC\_IDLE state (also called Idle mode) and RRC\_INACTIVE state. The non-access stratum (NAS) part of Idle mode procedures and processes is specified in TS 23.122 [9].

The present document specifies the model for the functional division between the NAS and AS in a UE.

The present document applies to all UEs that support at least NR Radio Access, including multi-RAT UEs as described in 3GPP specifications, in the following cases:

- When the UE is camped on a NR cell;

- When the UE is searching for a cell to camp on;

NOTE: When the UE is camped on or searching for a cell to camp on belonging to other RATs, the UE behaviour is described in the specifications of the other RATs.

# 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 TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 38.300: "NR Overall Description; Stage 2".

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

[4] 3GPP TS 38.213: "NR; Physical layer procedures for control ".

[5] Void

[6] 3GPP TS 36.331: "E-UTRA; Radio Resource Control (RRC) - Protocol Specification".

[7] 3GPP TS 36.304: "E-UTRA; User Equipment (UE) procedures in RRC\_IDLE state ".

[8] 3GPP TS 38.133: "NR; Requirements for Support of Radio Resource Management".

[9] 3GPP TS 23.122: "NAS functions related to Mobile Station (MS) in RRC\_IDLE state".

[10] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[11] 3GPP TS 38.215: "NR; Physical layer measurements".

[12] 3GPP TS 22.261: "Service requirements for the 5G system".

[13] 3GPP TS 24.890: "5G System – Phase 1; CT WG1 Aspects".

[14] 3GPP TS 24.501: "Non-Access-Stratum (NAS) protocol for 5G System (5GS); Stage 3".

[15] 3GPP TS 38.101-1: "NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone".

[16] 3GPP TS 23.287: "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services".

[17] 3GPP TS 23.285: "Technical Specification Group Services and System Aspects; Architecture enhancements for V2X services".

[18] 3GPP TS 22.011: "Service accessibility".

[19] 3GPP TS 23.003: "Numbering, addressing and identification".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

**Acceptable Cell:** A cell that satisfies certain conditions as specified in 4.5.

**Allowed CAG list:** A per-PLMN list of CAG Identifiers the UE is allowed to access (see TS 23.501 [10])**.**

**Available PLMN(s):** One or more PLMN(s) for which the UE has found at least one cell and read its PLMN identity(ies).

**Barred Cell**: A cell a UE is not allowed to camp on.

**CAG cell**: A cell broadcasting at least one Closed Access Group Identifier.

**Camped on a cell:** UE has completed the cell selection/reselection process and has chosen a cell. The UE monitors system information and (in most cases) paging information.

**Camped on any cell**: UE is in idle mode and has completed the cell selection/reselection process and has chosen a cell irrespective of PLMN identity.

**Closed Access Group Identifier**: Identifier of a CAG within a PLMN.

**Commercial Mobile Alert System:** Public Warning System that delivers *Warning Notifications* provided by *Warning Notification Providers* to CMAS capable UEs.

**eCall Only Mode:** A UE configuration option that allows the UE to register at 5GC and register in IMS to perform only eCall Over IMS, and a non-emergencyIMS call for test and/or terminal reconfiguration services.

**EHPLMN:** Any of the PLMN entries contained in the Equivalent HPLMN list TS 23.122 [9].

**Equivalent PLMN list:** List of PLMNs considered as equivalent by the UE for cell selection, cell reselection, and handover according to the information provided by the NAS.

**Home PLMN:** A PLMN where the Mobile Country Code (MCC) and Mobile Network Code (MNC) of the PLMN identity are the same as the MCC and MNC of the IMSI.

**Network Identifier**: Identifier of an SNPN in combination with a PLMN ID (TS 23.501 [10]).

**Non-Public Network:** A network deployed for non-public use, as defined in TS 22.261 [12].

**NR sidelink communication**: AS functionality enabling at least V2X Communication as defined in TS 23.287 [16], between two or more nearby UEs, using NR technology but not traversing any network node.

**Process:** A local action in the UE invoked by an RRC procedure or an RRC\_IDLE or RRC\_INACTIVE state procedure.

**Radio Access Technology:** Type of technology used for radio access, for instance NR or E-UTRA.

**RedCap UE: TBD**

**Registration Area**: (NAS) registration area is an area in which the UE may roam without a need to perform location registration, which is a NAS procedure.

**Registered PLMN:** This is the PLMN on which certain Location Registration outcomes have occurred, as specified in TS 23.122 [9].

**Registered SNPN**: This is the SNPN on which certain Location Registration outcomes have occurred, as specified in TS 23.122 [9].

**Reserved Cell**: A cell on which camping is not allowed, except for particular UEs, if so indicated in the system information.

**Selected PLMN:** This is the PLMN that has been selected by the NAS, either manually or automatically.

**Selected SNPN**: This is the SNPN that has been selected by the NAS, either manually or automatically.

**Serving cell:** The cell on which the UE is camped.

**Sidelink:** UE to UE interface for V2X sidelink communication defined in TS 23.287[16].

**SNPN Access Mode:** Mode of operation wherein UE only selects SNPNs (as defined in TS 23.501 [10]).

**SNPN identity**: An identifier of an SNPN comprising of a PLMN ID and an NID combination.

**Strongest cell:** The cell on a particular frequency that is considered strongest according to the layer 1 cell search procedure (TS 38.213 [4], TS 38.215 [11]).

**Suitable Cell:** This is a cell on which a UE may camp. For NR cell, the criteria are defined in clause 4.5, for E-UTRA cell in TS 36.304 [7].

**V2X sidelink communication**: AS functionality enabling V2X Communication as defined in TS 23.285 [17], between nearby UEs, using E-UTRA technology but not traversing any network node.

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] 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 [1].

AS Access Stratum

CAG Closed Access Group

CAG-ID Closed Access Group Identifier

CMAS Commercial Mobile Alert System

CN Core Network

DCI Downlink Control Information

DRX Discontinuous Reception

eDRX Extended DRX

ETWS Earthquake and Tsunami Warning System

E-UTRA Evolved UMTS Terrestrial Radio Access

E-UTRAN Evolved UMTS Terrestrial Radio Access Network

H-SFN Hyper System Frame Number

HRNN Human-Readable Network Name

IAB Integrated Access and Backhaul

IMSI International Mobile Subscriber Identity

MCC Mobile Country Code

MICO Mobile Initiated Connection Only

NAS Non-Access Stratum

NID Network Identifier

NPN Non-Public Network

NR NR Radio Access

PH Paging Hyperframe

PLMN Public Land Mobile Network

PTW Paging Time Window

RAT Radio Access Technology

RNA RAN-based Notification Area

RNAU RAN-based Notification Area Update

RRC Radio Resource Control

SNPN Stand-alone Non-Public Network

UAC Unified Access Control

UE User Equipment

UMTS Universal Mobile Telecommunications System

V2X Vehicle to Everything

# 4 General description of RRC\_IDLE state and RRC\_INACTIVE state

## 4.1 Overview

The RRC\_IDLE state and RRC\_INACTIVE state tasks can be subdivided into three processes:

- PLMN selection (for UE not operating in SNPN access mode) or SNPN selection (for UE operating in SNPN access mode);

- Cell selection and reselection;

- Location registration and RNA update.

PLMN selection, SNPN selection, cell reselection procedures, and location registration are common for both RRC\_IDLE state and RRC\_INACTIVE state. RNA update is only applicable for RRC\_INACTIVE state. When UE selects a new PLMN or SNPN, UE transitions from RRC\_INACTIVE to RRC\_IDLE, as specified in TS 24.501 [14].

When a UE is switched on, a public land mobile network (PLMN) or a SNPN is selected by NAS. For the selected PLMN/SNPN, associated RAT(s) may be set, as specified in TS 23.122 [9]. The NAS shall provide a list of equivalent PLMNs, if available, that the AS shall use for cell selection and cell reselection.

With cell selection, the UE searches for a suitable cell of the selected PLMN or selected SNPN, chooses that cell to provide available services, and monitors its control channel. This procedure is defined as "camping on the cell".

The UE shall, if necessary, then register its presence, by means of a NAS registration procedure, in the tracking area of the chosen cell. As an outcome of a successful Location Registration, the selected PLMN/SNPN then becomes the registered PLMN/SNPN, as specified in TS 23.122 [9].

If the UE finds a more suitable cell, according to the cell reselection criteria, it reselects onto that cell and camps on it. If the new cell does not belong to at least one tracking area to which the UE is registered, location registration is performed. In RRC\_INACTIVE state, if the new cell does not belong to the configured RNA, an RNA update procedure is performed.

If necessary, the UE shall search for higher priority PLMNs at regular time intervals as described in TS 23.122 [9] and search for a suitable cell if another PLMN has been selected by NAS.

For UE not operating in SNPN access mode, search of available CAGs may be triggered by NAS to support manual CAG selection. The AS shall report available CAG-ID(s) together with their HRNN (if broadcast) and PLMN(s) to the NAS.

If the UE loses coverage of the registered PLMN/SNPN, either a new PLMN/SNPN is selected automatically (automatic mode), or an indication of available PLMNs/SNPNs is given to the user so that a manual selection can be performed (manual mode). As part of manual SNPN selection, the AS shall report available SNPN identifiers together with their HRNN (if broadcast) to the NAS.

Registration is not performed by UEs only capable of services that need no registration.

The UE may perform NR sidelink communication and/or V2X sidelink communication while in-coverage or out-of-coverage for sidelink, as specified in clause 8.

The purpose of camping on a cell in RRC\_IDLE state and RRC\_INACTIVE state is fourfold:

a) It enables the UE to receive system information from the PLMN or the SNPN.

b) When registered and if the UE wishes to establish an RRC connection or resume a suspended RRC connection, it can do this by initially accessing the network on the control channel of the cell on which it is camped.

c) If the network needs to send a message or deliver data to the registered UE, it knows (in most cases) the set of tracking areas (in RRC\_IDLE state) or RNA (in RRC\_INACTIVE state) in which the UE is camped. It can then send a "paging" message for the UE on the control channels of all the cells in the corresponding set of areas. The UE will then receive the paging message and can respond.

d) It enables the UE to receive ETWS and CMAS notifications.

When the UE is in RRC\_IDLE state, upper layers may deactivate AS layer when MICO mode is activated as specified in TS 24.501 [14]. When MICO mode is activated, the AS configuration (e.g. priorities provided by dedicated signalling) is kept and all running timers continue to run but the UE need not perform any idle mode tasks. If a timer expires while MICO mode is activated it is up to the UE implementation whether it performs the corresponding action immediately or the latest when MICO mode is deactivated. When MICO mode is deactivated, the UE shall perform all idle mode tasks.

## 4.2 Functional division between AS and NAS in RRC\_IDLE state and RRC\_INACTIVE state

Table 4.2-1 presents the functional division between UE non-access stratum (NAS) and UE access stratum (AS) in RRC\_IDLE state and RRC\_INACTIVE states. The NAS part is specified in TS 23.122 [9] and the AS part in the present document.

Table 4.2-1: Functional division between AS and NAS in RRC\_IDLE state and RRC\_INACTIVE state

| RRC\_IDLE and RRC\_INACTIVE state Process | UE Non-Access Stratum | UE Access Stratum |
| --- | --- | --- |
| PLMN Selection | **For a UE not operating in SNPN access mode, perform the following:**  Maintain a list of PLMNs in priority order according to TS 23.122 [9]. Select a PLMN using automatic or manual mode as specified in TS 23.122 [9] and request AS to select a cell belonging to this PLMN. For each PLMN, associated RAT(s) may be set.  Evaluate reports of available PLMNs and any associated CAG-IDs from AS for PLMN selection.  Maintain a list of equivalent PLMN identities.  To support manual CAG selection, provide request to search for available CAGs and evaluate reports of available CAGs from AS for CAG selection.  **For a UE operating in SNPN access mode, perform the following:**  Maintain a list of SNPNs according to TS 23.122 [9]. Select a SNPN using automatic or manual mode as specified in TS 23.122 [9] and request AS to select a cell belonging to this SNPN.  Evaluate reports of available SNPNs from AS for SNPN selection. | For a UE not operating in SNPN access mode, search for available PLMNs.  If associated RAT(s) is (are) set for the PLMN, search in this (these) RAT(s) and other RAT(s) for that PLMN as specified in TS 23.122 [9].  For a UE operating in SNPN access mode, search for available SNPNs only consider NR cells.  Perform measurements to support PLMN/SNPN selection.  Synchronise to a broadcast channel to identify found PLMNs/SNPNs.  Report available PLMNs and any associated CAG-IDs with associated RAT(s) to NAS on request from NAS or autonomously.  For a UE operating in SNPN access mode, report available SNPNs to NAS autonomously.  **To support manual CAG selection, perform the following:**  Search for cells broadcasting a CAG-ID.  Read the HRNN (if broadcast) for each CAG-ID if a cell broadcasting a CAG-ID is found.  Report CAG-ID(s) of found cell(s) broadcasting a CAG-ID together with the associated manual CAG selection allowed indicator, HRNN and PLMNto NAS.  On selection of a CAG by NAS, select any acceptable or suitable cell belonging to the selected CAG and give an indication to NAS that access is possible (for the registration procedure)  To support manual SNPN selection, report available SNPNs together with associated HRNNs (if available) to NAS on request from NAS. |
| Cell  Selection | Control cell selection for example by indicating RAT(s) associated with the selected PLMN to be used initially in the search of a cell in the cell selection.  Maintain a list of "Forbidden Tracking Areas" and provide the list to AS.  For a UE not operating in SNPN access mode: Maintain Allowed CAG list and optional CAG-only indication along with associated PLMN ID(s) on which the UE is allowed access and provide these lists to AS. To support manual CAG selection, select a CAG and request AS to select a cell belonging to this CAG. | Perform measurements needed to support cell selection.  Detect and synchronise to a broadcast channel. Receive and handle broadcast information. Forward NAS system information to NAS.  Search for a suitable cell. The cells broadcast one or more 'PLMN identity' or 'SNPN identity' (for a UE operating in SNPN access mode) in the system information. Respond to NAS whether such cell is found or not.  If associated RATs is (are) set for the PLMN, perform the search in this (these) RAT(s) and other RATs for that PLMN as specified in TS 23.122 [9].  If a cell is found which satisfies cell selection criteria, camp on that cell. |
| Cell  Reselection | For a UE not operating in SNPN access mode,  maintain a list of equivalent PLMN identities and provide the list to AS.  Maintain a list of "Forbidden Tracking Areas" and provide the list to AS.  For a UE not operating in SNPN access mode, maintain Allowed CAG list and optional CAG-only indication along with associated PLMN ID(s) on which the UE is allowed access and provide these lists to AS. | Perform measurements needed to support cell reselection.  Detect and synchronise to a broadcast channel. Receive and handle broadcast information. Forward NAS system information to NAS.  Change cell if a more suitable cell is found. |
| Location registration | Register the UE as active after power on.  Register the UE's presence in a registration area, for instance regularly or when entering a new tracking area.  Deregister UE when shutting down.  Maintain a list of "Forbidden Tracking Areas".  Control and restrict location registration for a UE in eCall Only Mode. | Report registration area information to NAS. |
| RAN Notification Area Update | Not applicable. | Register the UE's presence in a RAN-based notification area (RNA), periodically or when entering a new RNA. |

## 4.3 Service types in RRC\_IDLE state

This clause defines the level of service that may be provided by the network to a UE in RRC\_IDLE state. The following three levels of services are provided while a UE is in RRC\_IDLE state:

- Limited service (emergency calls, ETWS and CMAS on an acceptable cell);

- Normal service (for public use or non-public use on a suitable cell);

- Operator service (for operators only on a reserved cell).

## 4.4 Service types in RRC\_INACTIVE state

This clause defines the level of service that may be provided by the network to a UE in RRC\_INACTIVE state. The following two levels of services are provided while a UE is in RRC\_INACTIVE state:

- Normal service (for public use or non-public use on a suitable cell);

- Operator service (for operators only on a reserved cell).

## 4.5 Cell Categories

The cells are categorised according to which services they offer:

**acceptable cell:**

An "acceptable cell" is a cell on which the UE may camp to obtain limited service (originate emergency calls and receive ETWS and CMAS notifications). Such a cell shall fulfil the following requirements, which is the minimum set of requirements to initiate an emergency call and to receive ETWS and CMAS notification in an NR network:

- The cell is not barred, see clause 5.3.1;

- The cell selection criteria are fulfilled, see clause 5.2.3.2.

**suitable cell:**

For UE not operating in SNPN Access Mode, a cell is considered as suitable if the following conditions are fulfilled:

- The cell is part of either the selected PLMN or the registered PLMN or PLMN of the Equivalent PLMN list, and for that PLMN either:

- The PLMN-ID of that PLMN is broadcast by the cell with no associated CAG-IDs and CAG-only indication in the UE for that PLMN (TS 23.501 [10]) is absent or false;

- Allowed CAG list in the UE for that PLMN (TS 23.501 [10]) includes a CAG-ID broadcast by the cell for that PLMN;

- The cell selection criteria are fulfilled, see clause 5.2.3.2.

According to the latest information provided by NAS:

- The cell is not barred, see clause 5.3.1;

- The cell is part of at least one TA that is not part of the list of "Forbidden Tracking Areas for Roaming" (TS 22.011 [18]), which belongs to a PLMN that fulfils the first bullet above.

For UE operating in SNPN Access Mode, a cell is considered as suitable if the following conditions are fulfilled:

- The cell is part of either the selected SNPN or the registered SNPN of the UE;

- The cell selection criteria are fulfilled, see clause 5.2.3.2;

According to the latest information provided by NAS:

- The cell is not barred, see clause 5.3.1;

- The cell is part of at least one TA that is not part of the list of "Forbidden Tracking Areas for Roaming" which belongs to either the selected SNPN or the registered SNPN of the UE.

**barred cell:**

A cell is barred if it is so indicated in the system information, as specified in TS 38.331 [3].

**reserved cell:**

A cell is reserved if it is so indicated in system information, as specified in TS 38.331 [3].

Following exception to these definitions are applicable for UEs:

- if a UE has an ongoing emergency call, all acceptable cells of that PLMN are treated as suitable for the duration of the emergency call.

- camped on a cell that belongs to a tracking area that is forbidden for regional provision of service; a cell that belongs to a tracking area that is forbidden for regional provision service (TS 23.122 [9], TS 24.501 [14]) is suitable but provides only limited service.

- if the UE in RRC\_IDLE fulfils the conditions to support NR sidelink communication or V2X sidelink communication in limited service state as specified in TS23.287 [16] clause 5.7, the UE may perform NR sidelink communication or V2X sidelink communication.

NOTE: UE is not required to support manual search and selection of PLMN or CAG or SNPN while in RRC CONNECTED state. The UE may use local release of RRC connection to perform manual search if it is not possible to perform the search while RRC connected.

# 5 Process and procedure descriptions

## 5.1 PLMN selection and SNPN selection

In the UE not operating in SNPN access mode, the AS shall report available PLMNs and any associated CAG-IDs to the NAS on request from the NAS or autonomously. In the UE operating in SNPN access mode, the AS shall report available SNPNs to the NAS on request from the NAS or autonomously.

During PLMN selection, based on the list of PLMN identities in priority order, the particular PLMN may be selected either automatically or manually. Each PLMN in the list of PLMN identities is identified by a 'PLMN identity'. In the system information on the broadcast channel, the UE can receive one or multiple 'PLMN identity' in a given cell. The result of the PLMN selection performed by NAS (see TS 23.122 [9]) is an identifier of the selected PLMN.

During SNPN selection, based on the list of SNPN identities, the particular SNPN may be selected either automatically or manually. Each SNPN in the list of SNPN identities is identified by a 'SNPN identity'. In the system information on the broadcast channel, the UE can receive one or multiple 'SNPN identity' in a given cell and optionally may receive associated HRNNs. The result of the SNPN selection performed by NAS (see TS 23.122 [9]) is an identifier of the selected SNPN.

### 5.1.1 Support for PLMN selection

#### 5.1.1.1 General

On request of the NAS, the AS shall perform a search for available PLMNs and report them to NAS.

#### 5.1.1.2 NR case

The UE shall scan all RF channels in the NR bands according to its capabilities to find available PLMNs and available CAGs. On each carrier, the UE shall search for the strongest cell and read its system information, in order to find out which PLMN(s) the cell belongs to and any associated CAG(s). For operation with shared spectrum channel access, the UE may also read the system information of multiple strongest cell(s). If the UE can read one or several PLMN identities in the strongest cell or the multiple strongest cell(s) in case of operation with shared spectrum channel access, each found PLMN (see the PLMN reading in TS 38.331 [3]) shall be reported to the NAS as a high quality PLMN (but without the RSRP value) and any associated CAG-ID, provided that the following high-quality criterion is fulfilled:

1. For an NR cell, the measured RSRP value shall be greater than or equal to -110 dBm.

Found PLMNs that do not satisfy the high-quality criterion but for which the UE has been able to read the PLMN identities are reported to the NAS together with their corresponding RSRP values and any associated CAG-ID. The quality measure reported by the UE to NAS shall be the same for each PLMN found in one cell.

The search for PLMNs may be stopped on request from the NAS. The UE may optimise PLMN search by using stored information e.g. frequencies and optionally also information on cell parameters from previously received measurement control information elements.

Once the UE has selected a PLMN, the cell selection procedure shall be performed in order to select a suitable cell of that PLMN to camp on.

To support manual CAG selection, the UE shall upon request by NAS report available CAG-ID(s) together with their manual CAG selection allowed indicator (if broadcast), HRNN (if broadcast) and PLMN(s) to the NAS. If NAS has selected a CAG and provided this selection to AS, the UE shall search for an acceptable or suitable cell belonging to the selected CAG to camp on.

#### 5.1.1.3 E-UTRA case

Support for PLMN selection in E-UTRA is described in TS 36.304 [7].

### 5.1.2 Support for SNPN selection

#### 5.1.2.1 General

On request of the NAS, the AS shall perform a search for available SNPNs on only NR cells and report them to NAS.

#### 5.1.2.2 NR case

The UE shall scan all RF channels in the NR bands according to its capabilities to find available SNPNs. On each carrier, the UE shall search for the strongest cell and read its system information, in order to find out which SNPN(s) the cell belongs to. For operation with shared spectrum channel access, the UE may also read the system information of multiple strongest cell(s). If the UE can read one or several SNPN identities in the strongest cell, each found SNPN (see the SNPN reading in TS 38.331 [3]) shall be reported to the NAS. For manual selection, UE shall upon request by NAS report available SNPN identifiers together with their HRNN (if broadcast) to the NAS and the search for available SNPNs may be stopped on request of the NAS.

The search for SNPNs may be stopped on request from the NAS. The UE may optimise SNPN search by using stored information e.g. frequencies and optionally also information on cell parameters from previously received measurement control information elements.

Once the UE has selected a SNPN, the cell selection procedure shall be performed in order to select a suitable cell of that SNPN to camp on.

## 5.2 Cell selection and reselection

### 5.2.1 Introduction

UE shall perform measurements for cell selection and reselection purposes as specified in TS 38.133 [8].

When evaluating Srxlev and Squal of non-serving cells for reselection evaluation purposes, the UE shall use parameters provided by the serving cell and for the final check on cell selection criterion, the UE shall use parameters provided by the target cell for cell reselection.

The NAS can control the RAT(s) in which the cell selection should be performed, for instance by indicating RAT(s) associated with the selected PLMN, and by maintaining a list of forbidden registration area(s) and a list of equivalent PLMNs. The UE shall select a suitable cell based on RRC\_IDLE or RRC\_INACTIVE state measurements and cell selection criteria.

In order to expedite the cell selection process, stored information for several RATs, if available, may be used by the UE.

When camped on a cell, the UE shall regularly search for a better cell according to the cell reselection criteria. If a better cell is found, that cell is selected. The change of cell may imply a change of RAT. Details on performance requirements for cell reselection can be found in TS 38.133 [8].

The NAS is informed if the cell selection and reselection result in changes in the received system information relevant for NAS.

For normal service, the UE shall camp on a suitable cell, monitor control channel(s) of that cell so that the UE can:

- receive system information from the PLMN or SNPN; and

- receive registration area information from the PLMN or SNPN, e.g., tracking area information; and

- receive other AS and NAS Information; and

- if registered:

- receive paging and notification messages from the PLMN or SNPN; and

- initiate transfer to Connected mode.

For cell selection in multi-beam operations, measurement quantity of a cell is up to UE implementation.

For cell reselection in multi-beam operations, including inter-RAT reselection from E-UTRA to NR, the measurement quantity of this cell is derived amongst the beams corresponding to the same cell based on SS/PBCH block as follows:

- if *nrofSS-BlocksToAverage* (*maxRS-IndexCellQual* in E-UTRA) is not configured in *SIB2/SIB4* (*SIB24* in E-UTRA); or

- if *absThreshSS-BlocksConsolidation* (*threshRS-Index* in E-UTRA)is not configured in *SIB2/SIB4* (*SIB24* in E-UTRA); or

- if the highest beam measurement quantity value is below or equal to *absThreshSS-BlocksConsolidation* (*threshRS-Index* in E-UTRA):

- derive a cell measurement quantity as the highest beam measurement quantity value, where each beam measurement quantity is described in TS 38.215 [11].

- else:

- derive a cell measurement quantity as the linear average of the power values of up to *nrofSS-BlocksToAverage* (*maxRS-IndexCellQual* in E-UTRA) of highest beam measurement quantity values above *absThreshSS-BlocksConsolidation* (*threshRS-Index* in E-UTRA).

### 5.2.2 States and state transitions in RRC\_IDLE state and RRC\_INACTIVE state

Figure 5.2.2-1 shows the states and state transitions and procedures in RRC\_IDLE and RRC\_INACTIVE. Whenever a new PLMN selection or new SNPN selection is performed, it causes an exit to number 1.



Figure 5.2.2-1: RRC\_IDLE and RRC\_INACTIVE Cell Selection and Reselection

### 5.2.3 Cell Selection process

#### 5.2.3.1 Description

Cell selection is performed by one of the following two procedures:

a) Initial cell selection (no prior knowledge of which RF channels are NR frequencies):

1. The UE shall scan all RF channels in the NR bands according to its capabilities to find a suitable cell.

2. On each frequency, the UE need only search for the strongest cell, except for operation with shared spectrum channel access where the UE may search for the next strongest cell(s).

3. Once a suitable cell is found, this cell shall be selected.

b) Cell selection by leveraging stored information:

1. This procedure requires stored information of frequencies and optionally also information on cell parameters from previously received measurement control information elements or from previously detected cells.

2. Once the UE has found a suitable cell, the UE shall select it.

3. If no suitable cell is found, the initial cell selection procedure in a) shall be started.

NOTE: Priorities between different frequencies or RATs provided to the UE by system information or dedicated signalling are not used in the cell selection process.

#### 5.2.3.2 Cell Selection Criterion

The cell selection criterion S is fulfilled when:

|  |
| --- |
| Srxlev > 0 AND Squal > 0 |

where:

|  |
| --- |
| Srxlev = Qrxlevmeas – (Qrxlevmin + Qrxlevminoffset )– Pcompensation - Qoffsettemp  Squal = Qqualmeas – (Qqualmin + Qqualminoffset) - Qoffsettemp |

where:

|  |  |
| --- | --- |
| Srxlev | Cell selection RX level value (dB) |
| Squal | Cell selection quality value (dB) |
| Qoffsettemp | Offset temporarily applied to a cell as specified in TS 38.331 [3] (dB) |
| Qrxlevmeas | Measured cell RX level value (RSRP) |
| Qqualmeas | Measured cell quality value (RSRQ) |
| Qrxlevmin | Minimum required RX level in the cell (dBm). If the UE supports SUL frequency for this cell, Qrxlevmin is obtained from *q-RxLevMinSUL*, if present,in *SIB1*, *SIB2* and *SIB4*, additionally, if QrxlevminoffsetcellSUL is present in *SIB3* and *SIB4* for the concerned cell, this cell specific offset is added to the corresponding Qrxlevmin to achieve the required minimum RX level in the concerned cell;  else Qrxlevmin is obtained from *q-RxLevMin* in *SIB1, SIB2* and *SIB4*, additionally, if Qrxlevminoffsetcell is present in *SIB3* and *SIB4* for the concerned cell, this cell specific offset is added to the corresponding Qrxlevmin to achieve the required minimum RX level in the concerned cell. |
| Qqualmin | Minimum required quality level in the cell (dB). Additionally, if Qqualminoffsetcell is signalled for the concerned cell, this cell specific offset is added to achieve the required minimum quality level in the concerned cell. |
| Qrxlevminoffset | Offset to the signalled Qrxlevmin taken into account in the Srxlev evaluation as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN, as specified in TS 23.122 [9]. |
| Qqualminoffset | Offset to the signalled Qqualmin taken into account in the Squal evaluation as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN, as specified in TS 23.122 [9]. |
| Pcompensation | For FR1, if the UE supports the *additionalPmax* in the *NR-NS-PmaxList*, if present, in *SIB1, SIB2* and *SIB4:*  *max(PEMAX1 –PPowerClass, 0) – (min(PEMAX2, PPowerClass) – min(PEMAX1, PPowerClass)) (dB);*  *else:*  *max(PEMAX1 –PPowerClass, 0) (dB)*  For FR2, Pcompensation is set to 0. |
| PEMAX1, PEMAX2 | Maximum TX power level of a UE may use when transmitting on the uplink in the cell (dBm) defined as PEMAX in TS 38.101 [15]. If UE supports SUL frequency for this cell, PEMAX1 and PEMAX2 are obtained from the *p-Max* for SUL in *SIB1* and *NR-NS-PmaxList* for SUL respectively in *SIB1, SIB2* and *SIB4* as specified in TS 38.331 [3], else PEMAX1 and PEMAX2 are obtained from the *p-Max* and *NR-NS-PmaxList* respectively in *SIB1*, *SIB2* and *SIB4* for normal UL as specified in TS 38.331 [3]. |
| PPowerClass | Maximum RF output power of the UE (dBm) according to the UE power class as defined in TS 38.101-1 [15]. |

The signalled values Qrxlevminoffset and Qqualminoffset are only applied when a cell is evaluated for cell selection as a result of a periodic search for a higher priority PLMN while camped normally in a VPLMN (TS 23.122 [9]). During this periodic search for higher priority PLMN, the UE may check the S criteria of a cell using parameter values stored from a different cell of this higher priority PLMN.

#### 5.2.3.3 E-UTRAN case in Cell Selection

The cell selection criteria and procedures in E-UTRAN are specified in TS 36.304 [7].

### 5.2.4 Cell Reselection evaluation process

#### 5.2.4.1 Reselection priorities handling

Absolute priorities of different NR frequencies or inter-RAT frequencies may be provided to the UE in the system information, in the *RRCRelease* message, or by inheriting from another RAT at inter-RAT cell (re)selection. In the case of system information, an NR frequency or inter-RAT frequency may be listed without providing a priority (i.e. the field *cellReselectionPriority* is absent for that frequency). If priorities are provided in dedicated signalling, the UE shall ignore all the priorities provided in system information. If UE is in *camped on any cell* state, UE shall only apply the priorities provided by system information from current cell, and the UE preserves priorities provided by dedicated signalling and *deprioritisationReq* received in *RRCRelease* unless specified otherwise. When the UE in camped normally state, has only dedicated priorities other than for the current frequency, the UE shall consider the current frequency to be the lowest priority frequency (i.e. lower than any of the network configured values). If the UE is configured to perform both NR sidelink communication and V2X sidelink communication, the UE may consider the frequency providing both NR sidelink communication configuration and V2X sidelink communication configuration to be the highest priority. If the UE is configured to perform NR sidelink communication and not perform V2X communication, the UE may consider the frequency providing NR sidelink communication configuration to be the highest priority. If the UE is configured to perform V2X sidelink communication and not perform NR sidelink communication, the UE may consider the frequency providing V2X sidelink communication configuration to be the highest priority.

NOTE 1: The frequency only providing the anchor frequency configuration should not be prioritized for V2X service during cell reselection, as specified in TS 38.331[3].

NOTE 2: When UE is configured to perform NR sidelink communication or V2X sidelink communication performs cell reselection, it may consider the frequencies providing the intra-carrier and inter-carrier configuration have equal priority in cell reselection.

NOTE 3: The prioritization among the frequencies which UE considers to be the highest priority frequency is left to UE implementation.

NOTE 4: The UE is configured to perform V2X sidelink communication or NR sidelink communication, if it has the capability and is authorized for the corresponding sidelink operation.

NOTE 5: When UE is configured to perform both NR sidelink communication and V2X sidelink communication, but cannot find a frequency which can provide both NR sidelink communication configuration and V2X sidelink communication configuration, UE may consider the frequency providing either NR sidelink communication configuration or V2X sidelink communication configuration to be the highest priority.

The UE shall only perform cell reselection evaluation for NR frequencies and inter-RAT frequencies that are given in system information and for which the UE has a priority provided.

In case UE receives *RRCRelease* with *deprioritisationReq*, UE shall consider current frequency and stored frequencies due to the previously received *RRCRelease* with *deprioritisationReq* or all the frequencies of NR to be the lowest priority frequency (i.e. lower than any of the network configured values) while T325 is running irrespective of camped RAT. The UE shall delete the stored deprioritisation request(s) when a PLMN selection or SNPN selection is performed on request by NAS (TS 23.122 [9]).

NOTE: UE should search for a higher priority layer for cell reselection as soon as possible after the change of priority. The minimum related performance requirements specified in TS 38.133 [8] are still applicable.

The UE shall delete priorities provided by dedicated signalling when:

- the UE enters a different RRC state; or

- the optional validity time of dedicated priorities (T320) expires; or

- the UE receives an *RRCRelease* message with the field *cellReselectionPriorities* absent; or

- a PLMN selection or SNPN selection is performed on request by NAS (TS 23.122 [9]).

NOTE 2: Equal priorities between RATs are not supported.

The UE shall not consider any black listed cells as candidate for cell reselection.

The UE shall consider only the white listed cells, if configured, as candidates for cell reselection.

The UE in RRC\_IDLE state shall inherit the priorities provided by dedicated signalling and the remaining validity time (i.e. T320 in NR and E-UTRA), if configured, at inter-RAT cell (re)selection.

NOTE 3: The network may assign dedicated cell reselection priorities for frequencies not configured by system information.

#### 5.2.4.2 Measurement rules for cell re-selection

Following rules are used by the UE to limit needed measurements:

- If the serving cell fulfils Srxlev> SIntraSearchP and Squal > SIntraSearchQ, the UE may choose not to perform intra-frequency measurements.

- Otherwise, the UE shall perform intra-frequency measurements.

- The UE shall apply the following rules for NR inter-frequencies and inter-RAT frequencies which are indicated in system information and for which the UE has priority provided as defined in 5.2.4.1:

- For a NR inter-frequency or inter-RAT frequency with a reselection priority higher than the reselection priority of the current NR frequency, the UE shall perform measurements of higher priority NR inter-frequency or inter-RAT frequencies according to TS 38.133 [8].

- For a NR inter-frequency with an equal or lower reselection priority than the reselection priority of the current NR frequency and for inter-RAT frequency with lower reselection priority than the reselection priority of the current NR frequency:

- If the serving cell fulfils Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, the UE may choose not to perform measurements of NR inter-frequency cells of equal or lower priority, or inter-RAT frequency cells of lower priority;

- Otherwise,the UE shall perform measurements of NR inter-frequency cells of equal or lower priority, or inter-RAT frequency cells of lower priority according to TS 38.133 [8].

- If the UE supports relaxed measurement and *relaxedMeasurement* is present in *SIB2*, the UE may further relax the needed measurements, as specified in clause 5.2.4.9.

#### 5.2.4.3 Mobility states of a UE

##### 5.2.4.3.0 Introduction

The UE mobility state is determined if the parameters (TCRmax, NCR\_H, NCR\_M and TCRmaxHyst) are broadcasted in system information for the serving cell.

**State detection criteria:**

Normal-mobility state criteria:

- If number of cell reselections during time period TCRmax is less than NCR\_M.

Medium-mobility state criteria:

- If number of cell reselections during time period TCRmax is greater than or equal to NCR\_M but less than or equal to NCR\_H.

High-mobility state criteria:

- If number of cell reselections during time period TCRmax is greater than NCR\_H.

The UE shall not consider consecutive reselections where a cell is reselected again right after one reselection for mobility state detection criteria.

**State transitions:**

The UE shall:

- if the criteria for High-mobility state is detected:

- enter High-mobility state.

- else if the criteria for Medium-mobility state is detected:

- enter Medium-mobility state.

- else if criteria for either Medium- or High-mobility state is not detected during time period TCRmaxHys**t**:

- enter Normal-mobility state.

If the UE is in High- or Medium-mobility state, the UE shall apply the speed dependent scaling rules as defined in clause 5.2.4.3.1.

##### 5.2.4.3.1 Scaling rules

UE shall apply the following scaling rules:

- If neither Medium- nor High-mobility state is detected:

- no scaling is applied.

- If High-mobility state is detected:

- Add the *sf-High* of "Speed dependent ScalingFactor for Qhyst" to Qhyst if broadcasted in system information;

- For NR cells, multiply TreselectionNR by the *sf-High* of "Speed dependent ScalingFactor for TreselectionNR" if broadcasted in system information;

- For EUTRA cells, multiply TreselectionEUTRA by the *sf-High* of "Speed dependent ScalingFactor for TreselectionEUTRA" if broadcasted in system information.

- If Medium-mobility state is detected:

- Add the *sf-Medium* of "Speed dependent ScalingFactor for Qhyst" to Qhyst if broadcasted in system information;

- For NR cells, multiply TreselectionNR by the *sf-Medium* of "Speed dependent ScalingFactor for TreselectionNR" if broadcasted in system information;

- For EUTRA cells, multiply TreselectionEUTRA by the *sf-Medium* of "Speed dependent ScalingFactor for TreselectionEUTRA" if broadcasted in system information.

In case scaling is applied to any TreselectionRAT parameter, the UE shall round up the result after all scalings to the nearest second.

#### 5.2.4.4 Cells with cell reservations, access restrictions or unsuitable for normal camping

For the highest ranked cell (including serving cell) according to cell reselection criteria specified in clause 5.2.4.6, for the best cell according to absolute priority reselection criteria specified in clause 5.2.4.5, the UE shall check if the access is restricted according to the rules in clause 5.3.1.

If that cell and other cells have to be excluded from the candidate list, as stated in clause 5.3.1, the UE shall not consider these as candidates for cell reselection. This limitation shall be removed when the highest ranked cell changes.

If the highest ranked cell or best cell according to absolute priority reselection rules is an intra-frequency or inter-frequency cell which is not suitable due to one or more of the following reasons:

- this cell belongs to a PLMN which is not indicated as being equivalent to the registered PLMN, or

- this cell is a CAG cell that belongs to a PLMN which is equivalent to the registered PLMN but with no CAG-ID that is present in the UE's allowed CAG list being broadcasted, or

- this cell is not a CAG cell and the CAG-only indication in the UE is set, or

- this cell does not belong to a SNPN that is equal to the registered or selected SNPN of the UE in SNPN access mode,

the UE shall not consider this cell and, for operation in licensed spectrum, other cells on the same frequency as candidates for reselection for a maximum of 300 seconds.

For operation with shared spectrum channel access, when the highest ranked cell or best cell is not a candidate for reselection per the previous paragraph, the UE should continue to consider other cells on the same frequency for cell reselection, however if the second highest ranked cell on this frequency is also not suitable due to one or more of the above reasons, the UE may consider this frequency to be the lowest priority for a maximum of 300 seconds.

If the highest ranked cell or best cell according to absolute priority reselection rules is an intra-frequency or inter-frequency cell which is not suitable due to being part of the "list of 5GS forbidden TAs for roaming", the UE shall not consider this cell and other cells on the same frequency as candidates for reselection for a maximum of 300 seconds.

If the UE enters into state *any cell selection*, any limitation shall be removed.

If the highest ranked cell or best cell according to absolute priority reselection rules is an inter-RAT cell which is not suitable due to being part of the "list of forbidden TAs for roaming" or belonging to a PLMN which is not indicated as being equivalent to the registered PLMN, the UE shall not consider this cell and other cells on the same frequency, as candidates for reselection for a maximum of 300 seconds. If the UE enters into state *any cell selection*, any limitation shall be removed. If the UE is redirected under NR control to a frequency for which the timer is running, any limitation on that frequency shall be removed.

#### 5.2.4.5 NR Inter-frequency and inter-RAT Cell Reselection criteria

If *threshServingLowQ* is broadcast in system information and more than 1 second has elapsed since the UE camped on the current serving cell, cell reselection to a cell on a higher priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if:

- A cell of a higher priority NR or EUTRAN RAT/frequency fulfils Squal > ThreshX, HighQ during a time interval TreselectionRAT

Otherwise, cell reselection to a cell on a higher priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if:

- A cell of a higher priority RAT/ frequency fulfils Srxlev > ThreshX, HighP during a time interval TreselectionRAT; and

- More than 1 second has elapsed since the UE camped on the current serving cell.

Cell reselection to a cell on an equal priority NR frequency shall be based on ranking for intra-frequency cell reselection as defined in clause 5.2.4.6.

If *threshServingLowQ* is broadcast in system information and more than 1 second has elapsed since the UE camped on the current serving cell, cell reselection to a cell on a lower priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if:

- The serving cell fulfils Squal < ThreshServing, LowQ and a cell of a lower priority NR or E-UTRAN RAT/ frequency fulfils Squal > ThreshX, LowQ during a time interval TreselectionRAT.

Otherwise, cell reselection to a cell on a lower priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if:

- The serving cell fulfils Srxlev < ThreshServing, LowP and a cell of a lower priority RAT/ frequency fulfils Srxlev > ThreshX, LowP during a time interval TreselectionRAT; and

- More than 1 second has elapsed since the UE camped on the current serving cell.

Cell reselection to a higher priority RAT/frequency shall take precedence over a lower priority RAT/frequency if multiple cells of different priorities fulfil the cell reselection criteria.

If more than one cell meets the above criteria, the UE shall reselect a cell as follows:

- If the highest-priority frequency is an NR frequency, the highest ranked cell among the cells on the highest priority frequency(ies) meeting the criteria according to clause 5.2.4.6;

- If the highest-priority frequency is from another RAT, the strongest cell among the cells on the highest priority frequency(ies) meeting the criteria of that RAT.

#### 5.2.4.6 Intra-frequency and equal priority inter-frequency Cell Reselection criteria

The cell-ranking criterion Rs for serving cell and Rn for neighbouring cells is defined by:

|  |
| --- |
| Rs = Qmeas,s +Qhyst - Qoffsettemp  Rn = Qmeas,n -Qoffset - Qoffsettemp |

where:

|  |  |
| --- | --- |
| Qmeas | RSRP measurement quantity used in cell reselections. |
| Qoffset | For intra-frequency: Equals to Qoffsets,n, if Qoffsets,n is valid, otherwise this equals to zero.  For inter-frequency: Equals to Qoffsets,n plus Qoffsetfrequency, if Qoffsets,n is valid, otherwise this equals to Qoffsetfrequency. |
| Qoffsettemp | Offset temporarily applied to a cell as specified in TS 38.331 [3]. |

The UE shall perform ranking of all cells that fulfil the cell selection criterion S, which is defined in 5.2.3.2.

The cells shall be ranked according to the R criteria specified above by deriving Qmeas,n and Qmeas,s and calculating the R values using averaged RSRP results.

If *rangeToBestCell* is not configured, the UE shall perform cell reselection to the highest ranked cell. If this cell is found to be not-suitable, the UE shall behave according to clause 5.2.4.4.

If *rangeToBestCell* is configured*,* then the UE shall perform cell reselection to the cell with the highest number of beams above the threshold (i.e. *absThreshSS-BlocksConsolidation*) among the cells whose R value is within *rangeToBestCell* of the R value of the highest ranked cell. If there are multiple such cells, the UE shall perform cell reselection to the highest ranked cell among them. If this cell is found to be not-suitable, the UE shall behave according to clause 5.2.4.4.

In all cases, the UE shall reselect the new cell, only if the following conditions are met:

- the new cell is better than the serving cell according to the cell reselection criteria specified above during a time interval TreselectionRAT;

- more than 1 second has elapsed since the UE camped on the current serving cell.

NOTE: If *rangeToBestCell* is configured but *absThreshSS-BlocksConsolidation* is not configured on an NR frequency, the UE considers that there is one beam above the threshold for each cell on that frequency.

#### 5.2.4.7 Cell reselection parameters in system information broadcasts

##### 5.2.4.7.0 General reselection parameters

Cell reselection parameters are broadcast in system information and are read from the serving cell as follows:

**absThreshSS-BlocksConsolidation**

This specifies the minimum threshold for beams which can be used for selection of the highest ranked cells, if *rangeToBestCell* is configured, and for beams used for derivation of cell measurement quantity. The parameter in *SIB2* applies to the current serving frequency and the parameter in *SIB4* applies to the corresponding inter-frequency.

**cellReselectionPriority**

This specifies the absolute priority for NR frequency or E-UTRAN frequency.

**cellReselectionSubPriority**

This specifies the fractional priority value added to cellReselectionPriority for NR frequency or E-UTRAN frequency.

**combineRelaxedMeasCondition**

This indicates when the UE needs to fulfil both low mobility criterion and not-at-cell-edge criterion to determine whether to relax measurement requirements.

**highPriorityMeasRelax**

This indicates whether measurement on higher priority frequency is allowed to be relaxed as specified in clause 5.2.4.9.0.

**nrofSS-BlocksToAverage**

This specifies the number of beams which can be used for selection of the highest ranked cell, if *rangeToBestCell* is configured, and the number of beams used for derivation of cell measurement quantity. The parameter in *SIB2* applies to the current serving frequency and the parameter in *SIB4* applies to the corresponding inter-frequency.

**Qoffsets,n**

This specifies the offsetbetween the two cells.

**Qoffsetfrequency**

Frequency specific offset for equal priority NR frequencies.

**Qhyst**

This specifies the hysteresis value for ranking criteria.

**Qoffsettemp**

This specifies the additional offset to be used for cell selection and re-selection. It is temporarily used in case the RRC Connection Establishment fails on the cell as specified in TS 38.331 [3].

**Qqualmin**

This specifies the minimum required quality level in the cell in dB.

**Qrxlevmin**

This specifies the minimum required Rx level in the cell in dBm.

**Qrxlevminoffsetcell**

This specifies the cell specific Rx level offset in dB to Qrxlevmin.

**Qqualminoffsetcell**

This specifies the cell specific quality level offset in dB to Qqualmin.

**rangeToBestCell**

This specifies the R value range which the cells whose R value is within the range can be a candidate for the highest ranked cell. It is configured in SIB2 and used for intra-frequency and equal priority inter-frequency cell reselection and among the cells on the highest priority frequency(ies) for inter-frequency cell reselection within NR.

**SIntraSearchP**

This specifies the Srxlev threshold (in dB) for intra-frequency measurements.

**SIntraSearchQ**

This specifies the Squal threshold (in dB) for intra-frequency measurements.

**SnonIntraSearchP**

This specifies the Srxlev threshold (in dB) for NR inter-frequency and inter-RAT measurements.

**SnonIntraSearchQ**

This specifies the Squal threshold (in dB) for NR inter-frequency and inter-RAT measurements.

**SSearchDeltaP**

This specifies the threshold (in dB) on Srxlev variation for relaxed measurement.

**SSearchThresholdP**

This specifies the Srxlev threshold (in dB) for relaxed measurement.

**SSearchThresholdQ**

This specifies the Squal threshold (in dB) for relaxed measurement.

**TreselectionRAT**

This specifies the cell reselection timer value. For each target NR frequency and for each RAT other than NR, a specific value for the cell reselection timer is defined, which is applicable when evaluating reselection within NR or towards other RAT (i.e. TreselectionRAT for NR is TreselectionNR, for E-UTRAN TreselectionEUTRA).

NOTE: TreselectionRAT is not broadcast in system information but used in reselection rules by the UE for each RAT.

**TreselectionNR**

This specifies the cell reselection timer value TreselectionRAT for NR. The parameter can be set per NR frequency as specified in TS 38.331 [3].

**TreselectionEUTRA**

This specifies the cell reselection timer value TreselectionRAT for E-UTRAN.

**ThreshX, HighP**

This specifies the Srxlev threshold (in dB) used by the UE when reselecting towards a higher priority RAT/ frequency than the current serving frequency. Each frequency of NR and E-UTRAN might have a specific threshold.

**ThreshX, HighQ**

This specifies the Squal threshold (in dB) used by the UE when reselecting towards a higher priority RAT/ frequency than the current serving frequency. Each frequency of NR and E-UTRAN might have a specific threshold.

**ThreshX, LowP**

This specifies the Srxlev threshold (in dB) used by the UE when reselecting towards a lower priority RAT/ frequency than the current serving frequency. Each frequency of NR and E-UTRAN might have a specific threshold.

**ThreshX, LowQ**

This specifies the Squal threshold (in dB) used by the UE when reselecting towards a lower priority RAT/ frequency than the current serving frequency. Each frequency of NR and E-UTRAN might have a specific threshold.

**ThreshServing, LowP**

This specifies the Srxlev threshold (in dB) used by the UE on the serving cell when reselecting towards a lower priority RAT/ frequency.

**ThreshServing, LowQ**

This specifies the Squal threshold (in dB) used by the UE on the serving cell when reselecting towards a lower priority RAT/ frequency.

**TSearchDeltaP**

This specifies the time period over which the Srxlev variation is evaluated forrelaxed measurement.

##### 5.2.4.7.1 Speed dependent reselection parameters

Speed dependent reselection parameters are broadcast in system information and are read from the serving cell as follows:

**TCRmax**

This specifies the duration for evaluating allowed amount of cell reselection(s).

**NCR\_M**

This specifies the maximum number of cell reselections to enter Medium-mobility state.

**NCR\_H**

This specifies the maximum number of cell reselections to enter High-mobility state.

**TCRmaxHyst**

This specifies the additional time period before the UE can enter Normal-mobility state.

**Speed dependent ScalingFactor for Qhyst**

This specifies scaling factor for Qhyst in *sf-High* for High-mobility state and *sf-Medium* for Medium-mobility state.

**Speed dependent ScalingFactor for TreselectionNR**

This specifies scaling factor for TreselectionNR in *sf-High* for High-mobility state and *sf-Medium* for Medium-mobility state.

**Speed dependent ScalingFactor for TreselectionEUTRA**

This specifies scaling factor for TreselectionEUTRA in *sf-High* for High-mobility state and *sf-Medium* for Medium-mobility state.

#### 5.2.4.8 Inter-RAT Cell reselection in RRC\_INACTIVE state

For UE in the RRC\_INACTIVE state, upon cell reselection to another RAT, UE transitions from RRC\_INACTIVE to RRC\_IDLE and performs­ actions as specified in TS 38.331 [3].

#### 5.2.4.9 Relaxed measurement

##### 5.2.4.9.0 Relaxed measurement rules

When the UE is required to perform measurements of intra-frequency cells or NR inter-frequency cells or inter-RAT frequency cells according to the measurement rules in clause 5.2.4.2:

- if *lowMobilityEvaluation* is configured and *cellEdgeEvaluation* is not configured; and

- if the UE has performed normal intra-frequency, NR inter-frequency, or inter-RAT frequency measurements for at least TSearchDeltaP after (re-)selecting a new cell; and

- if the relaxed measurement criterion in clause 5.2.4.9.1 is fulfilled for a period of TSearchDeltaP:

- the UE may choose to perform relaxed measurements for intra-frequency cells according to relaxation methods in clauses 4.2.2.9 in TS 38.133 [8];

- if the serving cell fulfils Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ:

- for any NR inter-frequency or inter-RAT frequency of higher priority, if less than 1 hour has passed since measurements of corresponding frequency cell(s) for cell reselection were last performed; and,

- if *highPriorityMeasRelax* is configured with value *true*:

- the UE may choose not to perform measurement on this frequency cell(s);

- else (i.e. the serving cell fulfils Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ):

- the UE may choose to perform relaxed measurements for NR inter-frequency cells or inter-RAT frequency cells according to relaxation methods in clauses 4.2.2.10, and 4.2.2.11 in TS 38.133 [8];

- if *cellEdgeEvaluation* is configured and *lowMobilityEvaluation* is not configured; and

- if the relaxed measurement criterion in clause 5.2.4.9.2 is fulfilled:

- the UE may choose to perform relaxed measurements for intra-frequency cells according to relaxation methods in clauses 4.2.2.9 in TS 38.133 [8];

- if the serving cell fulfils Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ:

- the UE may choose to perform relaxed measurements for NR inter-frequency cells or inter-RAT frequency cells according to relaxation methods in clauses 4.2.2.10, and 4.2.2.11 in TS 38.133 [8];

- if both *lowMobilityEvaluation* and *cellEdgeEvaluation* are configured:

- if the UE has performed normal intra-frequency, NR inter-frequency, or inter-RAT frequency measurements for at least TSearchDeltaP after (re-)selecting a new cell; and

- if the relaxed measurement criterion in clause 5.2.4.9.1 is fulfilled for a period of TSearchDeltaP; and

- if the relaxed measurement criterion in clause 5.2.4.9.2 is fulfilled:

- for any intra-frequency, NR inter-frequency, or inter-RAT frequency, if less than 1 hour has passed since measurements of corresponding frequency cell(s) for cell reselection were last performed:

- the UE may choose not to perform measurement for measurements on this frequency cell(s);

- else:

- if the UE has performed normal intra-frequency, NR inter-frequency, or inter-RAT frequency measurements for at least TSearchDeltaP after (re-)selecting a new cell, and the relaxed measurement criterion in clause 5.2.4.9.1 is fulfilled for a period of TSearchDeltaP; or,

- if the relaxed measurement criterion in clause 5.2.4.9.2 is fulfilled:

- if *combineRelaxedMeasCondition* is not configured:

- the UE may choose to perform relaxed measurements for intra-frequency cells, NR inter-frequency cells of equal or lower priority, or inter-RAT frequency cells of lower priority according to relaxation methods in clauses 4.2.2.9, 4.2.2.10, and 4.2.2.11 in TS 38.133 [8];

- if the serving cell fulfils Srxlev ≤ SnonIntraSearchP or Squal ≤ SnonIntraSearchQ:

- the UE may choose to perform relaxed measurement for NR inter-frequency cells of higher priority, or inter-RAT frequency cells of higher priority according to relaxation methods in clauses 4.2.2.10, and 4.2.2.11 in TS 38.133 [8];

- if *stationaryMobilityEvaluation* is configured and *cellEdgeEvaluationWhileStationary* is not configured; and

- if the UE has performed normal intra-frequency, NR inter-frequency, or inter-RAT frequency measurements for at least TSearchDeltaP after (re-)selecting a new cell; and

- if the relaxed measurement criterion in clause 5.2.4.9.X is fulfilled for a period of TSearchDeltaP-Stationary:

- the UE may choose to perform relaxed measurements for [TBD] according to relaxation methods in clauses [TBD];

Editor's note: It is TBD if/what type of relaxation the UE shall be allowed to do in case both stationary and not-at-cell-edge criteria are configured but only stationary criterion is fulfilled.

- if both *stationaryMobilityEvaluation* and *cellEdgeEvaluationWhileStationary* are configured; and

- if the relaxed measurement criterion in clause 5.2.4.9.Y is fulfilled:

- the UE may choose to perform relaxed measurements for [TBD] according to relaxation methods in clauses [TBD];

Editor's note: When the network configures both R16/R17 relaxation criteria and the UE fulfils both, it is TBD if the UE performs Rel-17 RRM relaxation method or it is up to UE implementation to select either Rel-16 or Rel-17 relaxation operation.

The above relaxed measurements and no measurement are not applicable for frequencies that are included in *VarMeasIdleConfig*, if configured and for which the UE supports dual connectivity or carrier aggregation between those frequencies and the frequency of the current serving cell.

##### 5.2.4.9.1 Relaxed measurement criterion for UE with low mobility

The relaxed measurement criterion for UE with low mobility is fulfilled when:

- (SrxlevRef – Srxlev) < SSearchDeltaP,

Where:

- Srxlev = current Srxlev value of the serving cell (dB).

- SrxlevRef = reference Srxlev value of the serving cell (dB), set as follows:

- After selecting or reselecting a new cell, or

- If (Srxlev - SrxlevRef) > 0, or

- If the relaxed measurement criterion has not been met for TSearchDeltaP:

- The UE shall set the value of SrxlevRef to the current Srxlev value of the serving cell.

##### 5.2.4.9.2 Relaxed measurement criterion for UE not at cell edge

The relaxed measurement criterion for UE not at cell edge is fulfilled when:

- Srxlev > SSearchThresholdP, and,

- Squal > SSearchThresholdQ, if SSearchThresholdQ is configured,

Where:

- Srxlev = current Srxlev value of the serving cell (dB).

- Squal = current Squal value of the serving cell (dB).

##### 5.2.4.9.X Relaxed measurement criterion for a stationary UE

The relaxed measurement criterion for a stationary UE is fulfilled when:

- (SrxlevRef – Srxlev) < SSearchDeltaP-Stationary,

Where:

- Srxlev = current Srxlev value of the serving cell (dB).

- SrxlevRef = reference Srxlev value of the serving cell (dB), set as follows:

- After selecting or reselecting a new cell, or

- If (Srxlev - SrxlevRef) > 0, or

- If the relaxed measurement criterion has not been met for TSearchDeltaP-Stationary:

- The UE shall set the value of SrxlevRef to the current Srxlev value of the serving cell.

##### 5.2.4.9.Y Relaxed measurement criterion for a stationary UE not at cell edge

The relaxed measurement criterion for a stationary UE not at cell edge is fulfilled when:

- the relaxed measurement criterion in clause 5.2.4.9.X is fulfilled for a period of TSearchDeltaP-Stationary,

- Srxlev > SSearchThresholdP2, and,

- Squal > SSearchThresholdQ2, if SSearchThresholdQ2 is configured,

Where:

- Srxlev = current Srxlev value of the serving cell (dB).

- Squal = current Squal value of the serving cell (dB).

#### 5.2.4.10 Cell reselection with CAG cells

In addition to normal cell reselection, a UE may optionally use an autonomous search function to detect CAG cells on serving and non-serving frequencies. However UE shall follow the cell reselection criteria based on dedicated frequency priorities and only follow the autonomous cell search result if the result fulfils also the existing cell reselection criteria based on dedicated frequency priorities.

### 5.2.5 Camped Normally state

This state is applicable for RRC\_IDLE and RRC\_INACTIVE state.

When camped normally, the UE shall perform the following tasks:

- monitor the paging channel of the cell as specified in clause 7 according to information broadcast in *SIB1*;

- monitor Short Messages transmitted with P-RNTI over DCI as specified in clause 6.5 in TS 38.331 [3];

- monitor relevant System Information as specified in TS 38.331 [3];

- perform necessary measurements for the cell reselection evaluation procedure;

- execute the cell reselection evaluation process on the following occasions/triggers:

1) UE internal triggers, so as to meet performance as specified in TS 38.133 [8];

2) When information on the BCCH used for the cell reselection evaluation procedure has been modified.

### 5.2.6 Selection of cell at transition to RRC\_IDLE or RRC\_INACTIVE state

At reception of *RRCRelease* message to transition the UE to RRC\_IDLE or RRC\_INACTIVE, UE shall attempt to camp on a suitable cell according to *redirectedCarrierInfo* if included in the *RRCRelease* message. If the UE cannot find a suitable cell, the UE is allowed to camp on any suitable cell of the indicated RAT. If the *RRCRelease* message does not contain the *redirectedCarrierInfo,* UE shall attempt to select a suitable cell on an NR carrier. If no suitable cell is found according to the above, the UE shall perform cell selection using stored information in order to find a suitable cell to camp on.

When returning to RRC\_IDLE state after UE moved to RRC\_CONNECTED state from *camped on any cell* state, UE shall attempt to camp on an acceptable cell according to *redirectedCarrierInfo*, if included in the *RRCRelease* message. If the UE cannot find an acceptable cell, the UE is allowed to camp on any acceptable cell of the indicated RAT. If the *RRCRelease* message does not contain *redirectedCarrierInfo* UE shall attempt to select an acceptable cell on an NR frequency. If no acceptable cell is found according to the above, the UE not in SNPN Access Mode shall continue to search for an acceptable cell of any PLMN in state *any cell selection*.

### 5.2.7 Any Cell Selection state

This state is applicable for RRC\_IDLE and RRC\_INACTIVE state. In this state, the UE shall perform cell selection process to find a suitable cell. If the cell selection process fails to find a suitable cell after a complete scan of all RATs and all frequency bands supported by the UE, the UE not in SNPN Access Mode shall attempt to find an acceptable cell of any PLMN to camp on, trying all RATs that are supported by the UE and searching first for a high-quality cell, as defined in clause 5.1.1.2.

The UE, which is not camped on any cell, shall stay in this state.

### 5.2.8 Camped on Any Cell state

This state is only applicable for RRC\_IDLE state. In this state, the UE shall perform the following tasks:

- monitor Short Messages transmitted with P-RNTI over DCI as specified in clause 6.5 in TS 38.331 [3];

- monitor relevant System Information as specified in TS 38.331 [3];

- perform necessary measurements for the cell reselection evaluation procedure;

- execute the cell reselection evaluation process on the following occasions/triggers:

1) UE internal triggers, so as to meet performance as specified in TS 38.133 [8];

2) When information on the BCCH used for the cell reselection evaluation procedure has been modified.

- regularly attempt to find a suitable cell trying all frequencies of all RATs that are supported by the UE. If a suitable cell is found, UE shall move to *camped normally* state.

- if the UE supports voice services and the current cell does not support IMS emergency calls as indicated by the field *ims-EmergencySupport* in SIB1 as specified in TS 38.331 [3], the UE shall perform cell selection/reselection to an acceptable cell that supports emergency calls in any supported RAT regardless of priorities provided in system information from current cell, if no suitable cell is found.

## 5.3 Cell Reservations and Access Restrictions

### 5.3.0 Introduction

There are two mechanisms which allow an operator to impose cell reservations or access restrictions. The first mechanism uses indication of cell status and special reservations for control of cell selection and reselection procedures. The second mechanism, referred to as Unified Access Control as specified in TS 38.331 [3], shall allow preventing selected access categories or access identities from sending initial access messages for load control reasons.

Unified Access Control does not apply to IAB-MTs.

### 5.3.1 Cell status and cell reservations

Cell status and cell reservations are indicated in the *MIB or SIB1* message as specified in TS 38.331 [3] by means of following fields:

- *cellBarred* (IE type: "barred" or "not barred")   
Indicated in *MIB* message. In case of multiple PLMNs or NPNs indicated in *SIB1*, this field is common for all PLMNs and NPNs.

- *cellBarredRedCap1Rx* (IE type: "barred" or "not barred")   
Indicated in *SIB1* message. In case of multiple PLMNs or NPNs indicated in *SIB1*, this field is common for all PLMNs and NPNs. This field is only applicable to RedCap UEs.

- *cellBarredRedCap2Rx* (IE type: "barred" or "not barred")   
Indicated in *SIB1* message. In case of multiple PLMNs or NPNs indicated in *SIB1*, this field is common for all PLMNs and NPNs. This field is only applicable to RedCap UEs.

- *cellReservedForOperatorUse* (IE type: "reserved" or "not reserved")   
Indicated in *SIB1* message*.* In case of multiple PLMNs or NPNs indicated in *SIB1*, this field is specified per PLMN or per SNPN.

- *cellReservedForOtherUse* (IE type: "true")   
Indicated in *SIB1* message. In case of multiple PLMNs indicated in *SIB1*, this field is common for all PLMNs.

*- cellReservedForFutureUse* (IE type: "true")   
Indicated in *SIB1* message. In case of multiple PLMNs or NPNs indicated in *SIB1*, this field is common for all PLMNs and NPNs.

NOTE 0: IAB-MT ignores the *cellBarred*, *cellReservedForOperatorUse, cellReservedForFutureUse,* and *intraFreqReselection* (i.e. treats *intraFreqReselection* as if it was set to *allowed*) as defined in TS 38.331 [3]. IAB-MT also ignores *cellReservedForOtherUse* for cell barring determination (i.e. NPN capable IAB-MT considers *cellReservedForOtherUse* for determination of an NPN-only cell) as defined in TS 38.331 [3].

- *iab-Support* (IE type: "true")  
Indicated in *SIB1* message. In case of multiple PLMNs or NPNs indicated in *SIB1*, this field is specified per PLMN or per SNPN.

When cell status is indicated as "not barred" and "not reserved" for operator use and not "true" for other use and not "true" for future use,

- UEs shall treat this cell as candidate during the cell selection and cell reselection procedures.

When cell broadcasts any CAG-IDs or NIDs and the cell status is indicated as "not barred" and "not reserved" for operator use and "true" for other use, and not "true" for future use:

- All NPN-capable UEs shall treat this cell as candidate during the cell selection and cell reselection procedures, other UEs shall treat this cell as if cell status is "barred".

When cell status is indicated as "true" for other use, and either cell does not broadcast any CAG-IDs or NIDs or does not broadcast any CAG-IDs and the UE is not operating in SNPN Access Mode,

- The UE shall treat this cell as if cell status is "barred".

When cell status is indicated as "true" for future use,

- The UE shall treat this cell as if cell status is "barred".

When cell status is indicated as "not barred" and "reserved" for operator use for any PLMN/SNPN and not "true" for other use and not "true" for future use,

- UEs assigned to Access Identity 11 or 15 operating in their HPLMN/EHPLMN shall treat this cell as candidate during the cell selection and reselection procedures if the field *cellReservedForOperatorUse* for that PLMN set to "reserved".

- UEs assigned to Access Identity 11 or 15 shall treat this cell as candidate during the cell selection and reselection procedures if the field *cellReservedForOperatorUse* for selected/registered SNPN is set to "reserved".

- UEs assigned to an Access Identity 0, 1, 2 and 12 to 14 shall behave as if the cell status is "barred" in case the cell is "reserved for operator use" for the registered PLMN/SNPN or the selected PLMN/SNPN.

NOTE 1: Access Identities 11, 15 are only valid for use in the HPLMN/ EHPLMN; Access Identities 12, 13, 14 are only valid for use in the home country as specified in TS 22.261 [12].

When cell status "barred" is indicated or to be treated as if the cell status is "barred",

- The UE is not permitted to select/reselect this cell, not even for emergency calls.

- The UE shall select another cell according to the following rule:

- If the cell is to be treated as if the cell status is "barred" due to being unable to acquire the *MIB*:

- the UE may exclude the barred cell as a candidate for cell selection/reselection for up to 300 seconds.

- the UE may select another cell on the same frequency if the selection criteria are fulfilled.

- else:

- If the UE is a RedCap UE, the UE shall in the remainder of this procedure consider '*intraFreqReselection* in MIB' to be '*intraFreqReselectionRedCap* in SIB1'*.*

Editor's note: The case when *intraFreqReselectionRedCap* in SIB1 is absent is FFS. Further consider whether to update above wording and refer only to “IntraFreqReselection” below (i.e. without directly referring to “in MIB” to cover also the RedCap case).

- If the field *intraFreqReselection* in *MIB* message is set to "allowed", the UE may select another cell on the same frequency if re-selection criteria are fulfilled;

- The UE shall exclude the barred cell as a candidate for cell selection/reselection for 300 seconds.

- If the field *intraFreqReselection* in *MIB* message is set to "not allowed":

- If the cell operates in licensed spectrum, or if this cell belongs to a PLMN which is indicated as being equivalent to the registered PLMN or the selected PLMN of the UE, or if this cell belongs to the registered SNPN or the selected SNPN of the UE:

- the UE shall not re-select a cell on the same frequency as the barred cell;

- else:

- the UE may select to another cell on the same frequency if reselection criteria are fulfilled.

- The UE shall exclude the barred cell and, if the cell operates in licensed spectrum or if this cell belongs to a PLMN which is indicated as being equivalent to the registered PLMN, also the cells on the same frequency as a candidate for cell selection/reselection for 300 seconds.

The cell selection of another cell may also include a change of RAT.

### 5.3.2 Unified access control

The information on cell access restrictions associated with Access Categories and Identities is broadcast in *SIB1* as part of Unified Access Control as specified in TS 38.331 [3].

The UE shall ignore Access Category and Identity related cell access restrictions for cell reselection. A change of the indicated access restriction shall not trigger cell reselection by the UE.

The UE shall consider Access Category and Identity related cell access restrictions for NAS initiated access attempts and RNAU as specified in TS 38.331 [3].

## 5.4 Tracking Area registration

In the UE, the AS shall report tracking area information to the NAS.

If the UE reads more than one PLMN identity in the current cell, the UE shall report the found PLMN identities that make the cell suitable in the tracking area information to NAS.

If the UE operating in SNPN access mode reads more than one SNPN identity in the current cell, the UE shall report the found SNPN identities that make the cell suitable in the tracking area information to NAS.

The NAS part of the location registration process is specified in TS 23.122 [9].

## 5.5 RAN Area registration

The UE performs a RAN-based notification area update (RNAU) periodically or when the UE selects a cell that does not belong to the configured RNA.

# 6 Reception of broadcast information

## 6.1 Reception of system information

The NAS is informed if the cell selection and reselection results in changes in the received NAS system information.

The UE shall monitor the Paging Occasions (POs) as described in chapter 7.1 to receive System Information change notifications in RRC\_IDLE and RRC\_INACTIVE. The changes in the system information are notified by the network using a Short Message as specified in TS 38.331 [3]. When the Short Message notifies system information changes, then the UE shall acquire or re-acquire the concerned system information as specified in TS 38.331 [3].

# 7 Paging

## 7.1 Discontinuous Reception for paging

The UE may use Discontinuous Reception (DRX) in RRC\_IDLE and RRC\_INACTIVE state in order to reduce power consumption. The UE monitors one paging occasion (PO) per DRX cycle. A PO is a set of PDCCH monitoring occasions and can consist of multiple time slots (e.g. subframe or OFDM symbol) where paging DCI can be sent (TS 38.213 [4]). One Paging Frame (PF) is one Radio Frame and may contain one or multiple PO(s) or starting point of a PO.

In multi-beam operations, the UE assumes that the same paging message and the same Short Message are repeated in all transmitted beams and thus the selection of the beam(s) for the reception of the paging message and Short Message is up to UE implementation. The paging message is same for both RAN initiated paging and CN initiated paging.

The UE initiates RRC Connection Resume procedure upon receiving RAN initiated paging. If the UE receives a CN initiated paging in RRC\_INACTIVE state, the UE moves to RRC\_IDLE and informs NAS.

The PF and PO for paging are determined by the following formulae:

SFN for the PF is determined by:

(SFN + PF\_offset) mod T = (T div N)\*(UE\_ID mod N)

Index (i\_s), indicating the index of the PO is determined by:

i\_s = floor (UE\_ID/N) mod Ns

The PDCCH monitoring occasions for paging are determined according to *pagingSearchSpace* as specified in TS 38.213 [4] and *firstPDCCH-MonitoringOccasionOfPO* and *nrofPDCCH-MonitoringOccasionPerSSB-InPO* ifconfigured as specified in TS 38.331 [3]. When *SearchSpaceId* = 0 is configured for *pagingSearchSpace*, the PDCCH monitoring occasions for paging are same as for RMSI as defined in clause 13 in TS 38.213 [4].

When *SearchSpaceId* = 0 is configured for *pagingSearchSpace*, Ns is either 1 or 2. For Ns = 1, there is only one PO which starts from the first PDCCH monitoring occasion for paging in the PF. For Ns = 2, PO is either in the first half frame (i\_s = 0) or the second half frame (i\_s = 1) of the PF.

When *SearchSpaceId* other than 0 is configured for *pagingSearchSpace,* the UE monitors the (i\_s + 1)th PO. A PO is a set of 'S\*X ' consecutive PDCCH monitoring occasions where 'S' is the number of actual transmitted SSBs determined according to *ssb-PositionsInBurst* in *SIB1* and X is the *nrofPDCCH-MonitoringOccasionPerSSB-InPO* if configured or is equal to 1 otherwise. The [x\*S+K]th PDCCH monitoring occasion for paging in the PO corresponds to the Kth transmitted SSB, where x=0,1,…,X-1, K=1,2,…,S. The PDCCH monitoring occasions for paging which do not overlap with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from zero starting from the first PDCCH monitoring occasion for paging in the PF. When *firstPDCCH-MonitoringOccasionOfPO* is present, the starting PDCCH monitoring occasion number of (i\_s + 1)th PO is the (i\_s + 1)th value of the *firstPDCCH-MonitoringOccasionOfPO* parameter; otherwise, it is equal to i\_s \* S\*X. If X > 1, when the UE detects a PDCCH transmission addressed to P-RNTI within its PO, the UE is not required to monitor the subsequent PDCCH monitoring occasions for this PO.

NOTE 1: A PO associated with a PF may start in the PF or after the PF.

NOTE 2: The PDCCH monitoring occasions for a PO can span multiple radio frames. When *SearchSpaceId* other than 0 is configured for *paging-SearchSpace* the PDCCH monitoring occasions for a PO can span multiple periods of the paging search space.

The following parameters are used for the calculation of PF and i\_s above:

T: DRX cycle of the UE.

If eDRX is not configured as defined in clause 7.x:

- T is determined by the shortest of the UE specific DRX value(s), if configured by RRC and/or upper layers (NAS), and a default DRX value broadcast in system information. In RRC\_IDLE state, if UE specific DRX is not configured by upper layers, the default value is applied.

In RRC\_IDLE state, if eDRX is configured by upper layers according to clause 7.x:- If the eDRX value is no longer than 1024 radio frames:

- T = eDRX value;

- else:

- During CN configured PTW, T is determined by the shortest of UE specific DRX value, if configured by upper layers, and the default DRX value broadcast in system information.

In RRC\_INACTIVE state, if eDRX is configured by RRC and/or upper layers as defined in clause 7.x:

- If eDRX values no longer than 1024 radio frames are configured by both RRC and upper layers, T = min{eDRX value configured by RRC, eDRX value configured by upper layers}.

- If eDRX value no longer than 1024 radio frames is configured by upper layers and no eDRX value is configured by RRC, T = min{DRX value configured by RRC, eDRX value configured by upper layers}.

- If a eDRX value longer than 1024 radio frames is configured by upper layers:

- If eDRX is not configured by RRC:

- During CN configured PTW, T is determined by the shortest of the UE specific DRX value (s), if configured by RRC and/or upper layers, and a default DRX value broadcast in system information. Outside the CN configured PTW, T is determined by the DRX value configured by RRC;- else if eDRX value no longer than 1024 radio frames is configured by RRC:

- During CN configured PTW, T is determined by the shortest of the UE specific DRX value, if configured upper layers, and the eDRX value configured by RRC and a default DRX value broadcast in system information. Outside the CN configured PTW, T is determined by the eDRX value configured by RRC.

Editor’s note: Consider referring to the cycles using the variables TeDRX, CN and TeDRX, RAN instead for better clarity

N: number of total paging frames in T

Ns: number of paging occasions for a PF

PF\_offset: offset used for PF determination

UE\_ID:

If a eDRX cycle is configured by RRC or upper layers:

- 5G-S-TMSI mod 4096

else:

- 5G-S-TMSI mod 1024

Editor's note: FFS which formula to apply if IDLE eDRX is configured by the upper layers but esDRX is not supported in the cell.

Parameters *Ns*, *nAndPagingFrameOffset*, *nrofPDCCH-MonitoringOccasionPerSSB-InPO*, and the length of default DRX Cycle are signaled in *SIB1*. The values of N and PF\_offset are derived from the parameter *nAndPagingFrameOffset* as defined in TS 38.331 [3]. The parameter *first-PDCCH-MonitoringOccasionOfPO* is signalled in *SIB1* for paging in initial DL BWP.For paging in a DL BWP other than the initial DL BWP, the parameter *first-PDCCH-MonitoringOccasionOfPO* is signaled in the corresponding BWP configuration.

If the UE has no 5G-S-TMSI, for instance when the UE has not yet registered onto the network, the UE shall use as default identity UE\_ID = 0 in the PF and i\_s formulas above.

5G-S-TMSI is a 48 bit long bit string as defined in TS 23.501 [10]. 5G-S-TMSI shall in the formulae above be interpreted as a binary number where the left most bit represents the most significant bit.

*[In RRC\_INACTIVE state, if the UE supports inactiveStatePO-Determination and the network broadcasts ranPagingInIdlePO with value “true”, the UE shall use the same i\_s as for RRC\_IDLE state. Otherwise, the UE determines the i\_s based on the parameters and formula above.]*

In RRC\_INACTIVE state, if eDRX value no longer than 1024 radio frames is configured by upper layers, the UE shall use the same i\_s as for RRC\_IDLE state.

In RRC\_INACTIVE state, if eDRX value longer than 1024 radio frames is configured by upper layers, during CN PTW, the UE shall use the same i\_s as for RRC\_IDLE state.

## 7.x Paging in extended DRX

The UE may be configured by upper layers and/or RRC with an extended DRX (eDRX) cycle TeDRX, CN and/or TeDRX, RAN. The UE may operate in eDRX only if the UE is configured by RRC or upper layers and the cell indicates support for eDRX in System Information. If the UE is configured with an extended DRX cycle no longer than 1024 radio frames, it monitors POs as defined in 7.1 with configured eDRX cycle. Otherwise, a UE configured with eDRX monitors POs as defined in 7.1 during a periodic Paging Time Window (PTW) configured for the UE. The PTW is UE-specific and is determined by a Paging Hyperframe (PH), a starting position within the PH (PTW\_start) and an ending position (PTW\_end). PH, PTW\_start and PTW\_end are given by the following formula:

Editor’s note: FFS on further details regarding combination of CN and RAN paging cycles, PTW for RRC\_IDLE and RRC\_INACTIVE, e.g., whether they can be different, and the details of the calculation.

The PH for CN is the H-SFN satisfying the following equations:

H-SFN mod TeDRX\_CN= (UE\_ID\_H mod TeDRX\_CN), where

- UE\_ID\_H

- xx most significant bits of the Hashed ID.

Editor’s note: FFS how many bits we use above for UE\_ID\_H.

- TeDRX\_CN: UE-specific eDRX cycle in Hyper-frames, (TeDRX\_CN =1, 2, …, 1024 Hyper-frames) configured by upper layers.

PTW\_start denotes the first radio frame of the PH that is part of the PTW and has SFN satisfying the following equation:

SFN = 128 \* ieDRX\_CN, where

- ieDRX\_CN = floor(UE\_ID\_H /TeDRX\_CN) mod 8

PTW\_end is the last radio frame of the PTW and has SFN satisfying the following equation:

SFN = (PTW\_start + L\*100 - 1) mod 1024, where

- L = Paging Time Window (PTW) length (in seconds) configured by upper layers

Hashed ID is defined as follows:

Hashed\_ID is Frame Check Sequence (FCS) for the bits b31, b30…, b0 of 5G-S-TMSI.

5G-S-TMSI = <b47, b46, …, b0> as defined in TS 23.003 [19].

The 32-bit FCS shall be the ones complement of the sum (modulo 2) of Y1 and Y2, where

- Y1 is the remainder of xk (x31 + x30 + x29 + x28 + x27 + x26 + x25 + x24 + x23 + x22 + x21 + x20 + x19 + x18 + x17 + x16 + x15 + x14 + x13 + x12 + x11 + x10 + x9 + x8 + x7 + x6 + x5 + x4 + x3 + x2 + x1 + 1) divided (modulo 2) by the generator polynomial x32 + x26 + x23 + x22 + x16 + x12 + x11 + x10 + x8 + x7 + x5 + x4 + x2 + x + 1, where k is 32; and

- Y2 is the remainder of Y3 divided (modulo 2) by the generator polynomial x32 + x26 + x23 + x22 + x16 + x12 + x11 + x10 + x8 + x7 + x5 + x4 + x2 + x + 1, where Y3 is the product of x32 by "b31, b30…, b0 of S-TMSI or 5G-S-TMSI", i.e., Y3 is the generator polynomial x32 (b31\*x31 + b30\*x30 + … + b0\*1).

NOTE: The Y1 is 0xC704DD7B for any 5G-S-TMSI value. An example of hashed ID calculation is in Annex xx.

# 8 Sidelink Operation

## 8.1 NR sidelink communication and V2X sidelink communication

The UE may transmit or receive NR sidelink communication if it fulfils the condition(s) defined in TS 38.331 [3], clause 5.8.2. When UE is in-coverage for sidelink operation as defined in clause 8.2, the UE may perform NR sidelink communication according to *SystemInformationBlockType12,* and when out-of-coverage for sidelink, the UE may perform NR sidelink communication according to *SL-V2X-PreconfigurationNR* or according to *SystemInformationBlockType12* of the cell on the frequency which provides inter-carrier NR sidelink configuration, as specified in TS 38.331 [3]. The UE shall not perform NR sidelink communication according to *SL-V2X-PreconfigurationNR* if the UE detects a cell providing NR sidelink configuration or inter-carrier NR sidelink configuration for the frequency UE is interested to perform NR sidelink communication on.

The UE may transmit or receive V2X sidelink communication if it fulfills the condition(s) defined in TS 36.331[6], clause 5.10.1d. When UE is in-coverage for sidelink operation as defined in clause 8.2, the UE may perform V2X sidelink communication according to *SystemInformationBlockType13/SystemInformationBlockType14* of the cell on an NR frequency.

## 8.2 Cell selection and reselection for Sidelink

The requirements defined in this clause for sidelink operation apply for UEs in RRC\_IDLE, RRC\_INACTIVE and in RRC\_CONNECTED.

When UE is interested to perform NR sidelink communication on non-serving frequency, it may perform measurements on that frequency or the frequencies which can provide inter carrier NR sidelink configuration for that frequency for cell selection and reselection purpose in accordance with TS 38.133[8]. When UE is interested to perform V2X sidelink communication on non-serving frequency, it may perform measurements on that frequency or the frequencies which can provide inter carrier V2X sidelink configuration for that frequency for cell selection and intra-frequency reselection purpose in accordance with TS 38.133[8].

If the UE detects at least one cell on the frequency which UE is configured to perform NR sidelink communication on fulfilling the S criterion in accordance with clause 8.2.1, it shall consider itself to be in-coverage for NR sidelink communication on that frequency. If the UE cannot detect any cell on that frequency meeting the S criterion, it shall consider itself to be out-of-coverage for NR sidelink communication on that frequency.

If the UE detects at least one cell on the frequency which UE is configured to perform V2X sidelink communication on fulfilling the S criterion in accordance with clause 8.2.1, it shall consider itself to be in-coverage for V2X sidelink communication on that frequency. If the UE cannot detect any cell on that frequency meeting the S criterion, it shall consider itself to be out-of-coverage for V2X sidelink communication on that frequency.

If the UE has selected a cell on a non-serving frequency for V2X sidelink communication, it shall perform additional intra-frequency reselection process to select a better cell for sidelink operation on that frequency in accordance with clause 8.2.1.

If the UE has selected a cell on a non-serving frequency for NR sidelink communication, it shall perform additional reselection process to select a better cell for sidelink operation in accordance with clause 8.2.1.

### 8.2.1 Parameters used for cell selection and reselection triggered for sidelink

When evaluating S criterion, R criterion (ranking) or inter-frequency cell reselection criterion, as defined in clause 5.2.3.2, clause 5.2.4.6 and clause 5.2.4.5 respectively, for cell selection/reselection triggered for NR sidelink communication or V2X sidelink communication on a non-serving frequency, UE shall perform the evaluation as follows:

- The UE shall use cell selection/reselection parameters broadcast by the concerned cell (i.e. selected cell for the sidelink operation) for the evaluation.

Annex xx (informative):  
Example of Hashed ID Calculation using 32-bit FCS

**Inputs:**

- Least significant bits of 5G-S-TMSI: 0x12341234

- Generator polynomial: 0x104C11DB7 (1 0000 0100 1100 0001 0001 1101 1011 0111)

**Procedure to Calculate Hashed ID:**

step a)

- k = 32

- numerator: 0xFFFF FFFF 0000 0000

- denominator: 0x1 04C1 1DB7

- remainder Y1 = 0xC704DD7B

step b)

- numerator: 0x1234 1234 0000 0000

- denominator: 0x1 04C1 1DB7

- remainder Y2 = 0x1D66F1A6

**Hashed\_ID** = FCS = ones complement of (remainder Y1 XOR remainder Y2)

= ones complement of (0xC704DD7B XOR 0x1D66F1A6)

= negation of (0xDA622CDD)

**= 0x259DD322**