**3GPP TSG-RAN WG2 Meeting #123bis *R2-230xxxx***

**Xiamen, China, October 09-13, 2023**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **38.304** | **CR** | **Draft CR** | **rev** | **-** | **Current version:** | **17.6.0** |  |
|  |
| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network | **x** | Core Network |  |

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|  |
| ***Title:***  | Running 38.304 CR for enhanced support of reduced capability NR devices |
|  |  |
| ***Source to WG:*** | Huawei, HiSilicon |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_redcap\_enh-Core |  | ***Date:*** | 2023-09-29 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | This CR introduces the enhanced support of reduced capability NR devices. |
|  |  |
| ***Summary of change:*** | Introduction of the following features based on the RAN2 agreements made so far.* Enhanced eDRX (>10.24s) in RRC\_INACTIVE
* Access restriction for eRedCap

Applying the RRM measurement relaxation to eRedCap. |
|  |  |
| ***Consequences if not approved:*** | Rel-18 enhancement of reduced capability NR devices is not supported in 38.304. |
|  |  |
| ***Clauses affected:*** | 3.1, 5.2.4, 5.3, 7.1, 7.4 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 38.300 CR TBDTS 38.306 CR TBDTS 38.321 CR TBDTS 38.331 CR TBD |
| ***affected:*** |  | **x** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **x** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** | This is a draft of running 38.304 CR for eRedCap.The CR should be lifted to the latest version of the specification. |
|  |  |
| ***This CR's revision history:*** |  |

*Start of change*

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).

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

**eRedCap UE:** A UE with enhanced reduced capabilities as specified in clause [4.2.x] in TS 38.306 [24].

**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.

**HSDN cell**: A cell that has higher priority than other cells for cell reselection for HSDN capable UE in a High-mobility state.

**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].

**Non-terrestrial network**: An NG-RAN consisting of gNBs, which provides non-terrestrial NR access to UEs by means of an NTN payload embarked on an airborne or space-borne NTN vehicle and an NTN Gateway.

**NR sidelink communication**: AS functionality enabling at least V2X Communication as defined in TS 23.287 [16], and ProSe communication (including ProSe non-Relay and UE-to-Network Relay communication) as defined in TS 23.304 [22], between two or more nearby UEs, using NR technology but not traversing any network node.

**NR sidelink discovery**: AS functionality enabling ProSe non-Relay Discovery and ProSe UE-to-Network Relay discovery for Proximity based Services as defined in TS 23.304 [22] 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.

**Quasi-earth fixed cell:** An NTN cell fixed with respect to a certain geographic area on the earth during a certain time duration. This can be provisioned by beam(s) covering one geographic area for a limited period and a different geographic area during another period (e.g., the case of NGSO satellites generating steerable beams).

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

**RedCap UE:** A UE with reduced capabilities as specified in clause 4.2.21 in TS 38.306 [24].

**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].

**U2N Relay UE:** a UE that provides functionality to support connectivity to the network for U2N Remote UE(s).

**U2N Remote UE:** a UE that communicates with the network via a U2N Relay UE.

**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

GIN Group ID for Network selection

H-SFN Hyper System Frame Number

HRNN Human-Readable Network Name

HSDN High Speed Dedicated Network

IAB Integrated Access and Backhaul

IMSI International Mobile Subscriber Identity

L2 Layer-2

MBS Multicast/Broadcast Services

MBS FSAI MBS Frequency Selection Area Identity

MCC Mobile Country Code

MCCH MBS Control Channel

MICO Mobile Initiated Connection Only

MRB MBS Radio Bearer

MTCH MBS Traffic Channel

NAS Non-Access Stratum

NID Network Identifier

NPN Non-Public Network

NR NR Radio Access

NSAG Network Slice AS Group

NTN Non-Terrestrial Network

PEI Paging Early Indication

PEI-O Paging Early Indication-Occasion

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

SDT Small Data Transmission

SL Sidelink

SNPN Stand-alone Non-Public Network

TRS Tracking Reference Signal

U2N UE-to-Network

UAC Unified Access Control

UE User Equipment

UMTS Universal Mobile Telecommunications System

V2X Vehicle to Everything

*Start of next change*

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 any fields with *cellReselectionPriority* or *nsag-CellReselectionPriority* are provided in dedicated signalling, the UE shall ignore any fields with *cellReselectionPriority* and *nsag-CellReselectionPriority* provided in system information.

When UE is in camped normally state, if it supports slice-based cell reselection and has received the network slice(s) and NSAG information from NAS to be used for cell reselection, UE shall derive reselection priorities according to clause 5.2.4.11.

NOTE 00: UE derives reselection priorities according to clause 5.2.4.11 also in case *SIB16* (see TS 38.331 [3]) is not broadcast in the camped cell.

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). When the HSDN capable UE is in High-mobility state, the UE shall always consider the HSDN cells to be the highest priority (i.e., higher than any other network configured priorities). When the HSDN capable UE is not in High-mobility state, the UE shall always consider HSDN cells to be the lowest priority (i.e., lower than any other network configured priorities). 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 0a: 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 0b: 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 0c: The prioritization among the frequencies which UE considers to be the highest priority frequency is left to UE implementation unless otherwise stated.

NOTE 0d: 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 0e: 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.

NOTE 0f: Void.

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.

If the MBS broadcast capable UE is receiving or interested to receive an MBS broadcast service(s) and can only receive this MBS broadcast service(s) by camping on a frequency on which it is provided, the UE may consider that frequency to be the highest priority during the MBS broadcast session as specified in TS 38.300 [2] as long as the two following conditions are fulfilled:

1) SIB1 scheduling information of the cell reselected by the UE due to frequency prioritization for MBS contains SIB20;

2) Either:

- One or more MBS FSAI(s) of that frequency is indicated in SIB21 of the serving cell and the same MBS FSAI(s) is also indicated for this MBS broadcast service in MBS User Service Description (USD) as specified in TS 26.346 [20], or

- SIB21 is not provided in the serving cell and that frequency is included in the USD of this service, or

- SIB21 is provided in the serving cell but does not provide the frequency mapping for the concerned service, and that frequency is included in the USD of this service.

NOTE 0g: It is up to UE implementation which frequency to select, when the USD provides multiple frequencies for the service the UE is interested in.

If the MBS broadcast capable UE is receiving or interested to receive an MBS broadcast service, the UE may consider cell reselection candidate frequencies at which it cannot receive the MBS broadcast service to be of the lowest priority during the MBS broadcast session as specified in TS 38.300 [2], as long as SIB1 scheduling information of the cell contains SIB20 on the MBS frequency which the UE monitors and as long as the condition 2) above is fulfilled for the serving cell.

NOTE 0h: Example scenarios in which such down-prioritisation may be needed include the cases where camping is not possible for the UE on the MBS broadcast frequency (e.g. the MBS broadcast frequency belongs to a PLMN different from UE's registered PLMN) while the UE can receive the MBS broadcast service when camped on another frequency than the MBS broadcast frequency or current frequency.

NOTE 0i: The frequency prioritization for MBS broadcast, NR sidelink communication, or V2X sidelink communication may override the re-selection priorities for slice-based cell reselection.

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 1: 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.

NOTE 1a: The UE does not consider MBS broadcast, NR sidelink communication or V2X sidelink communication functionality to replace cell reselection priorities caused by HSDN or *deprioritisationReq* functionality.

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 exclude-listed cells as candidate for cell reselection.

The UE shall consider only the allow-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:

- If *distanceThresh* and *referenceLocation* are broadcasted in SIB19, and if UE supports location-based measurement initiation and has obtained its location information:

- If the distance between UE and the serving cell reference location *referenceLocation* is shorter than *distanceThresh*, the UE may not perform intra-frequency measurements;

- Else, the UE shall perform intra-frequency measurements;

- Else, the UE may not perform intra-frequency measurements;

- Else, 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:

- If *distanceThresh* and *referenceLocation* are broadcasted in SIB19, and if UE supports location-based measurement initiation and has obtained its UE location information:

- If the distance between UE and the serving cell reference location *referenceLocation* is shorter than *distanceThresh*, 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;

- Else, 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];

- Else, 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;

- Else,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.

If the *t-Service* of the serving cell is present in SIB19, and if UE supports time-based measurement initiation, the UE shall perform intra-frequency, inter-frequency or inter-RAT measurements before the t-Service, regardless of the distance between UE and the serving cell reference location or whether the serving cell fulfils Srxlev > SIntraSearchP and Squal > SIntraSearchQ, or Srxlev > SnonIntraSearchP and Squal > SnonIntraSearchQ, The exact time to start measurement before *t-Service* is up to UE implementation. UE shall perform measurements of higher priority NR inter-frequency or inter-RAT frequencies according to TS 38.133 [8] regardless of the remaining service time of the serving cell (i.e. time remaining until *t-Service*).

NOTE: When evaluating the distance between UE and the serving cell reference location, it's up to UE implementation to obtain UE location information.

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, TCRmaxHyst and *cellEquivalentSize*) 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. If the UE is capable of HSDN and the *cellEquivalentSize* is configured, the UE counts the number of cell reselections for this cell as *cellEquivalentSize* configured for this cell.

**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 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, the limitation(s) 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 - QoffsettempRn = 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.

**combineRelaxedMeasCondition2**

This indicates when an (e)RedCap UE needs to fulfil both stationary criterion and not-at-cell-edge criterion to determine whether to relax measurement requirements.

**distanceThresh**

This indicates the distance threshold from the serving cell reference location to be used in location-based measurement initiation.

**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.

**referenceLocation**

This indicates the reference location of the serving cell to be used in location-based measurement initiation.

**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.

**SSearchDeltaP-Stationary**

This specifies the threshold (in dB) on Srxlev variation to evaluate stationary criterion for relaxed measurement.

**SSearchThresholdP**

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

**SSearchThresholdP2**

This specifies the Srxlev threshold (in dB) to evaluate not-at-cell-edge-criterion for relaxed measurement.

**SSearchThresholdQ**

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

**SSearchThresholdQ2**

This specifies the Squal threshold (in dB) to evaluate not-at-cell-edge-criterion 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.

**TSearchDeltaP-Stationary**

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

**t-Service**

This indicates the time when a quasi-earth fixed cell is going to stop serving the area where it is currently covering, to be used in time based measurement initiation.

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.

5.2.4.7.2 Slice-based cell reselection parameters

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

**nsag-CellReselectionPriority**

This specifies the priority for NR frequency when the given NSAG ID is used to set the frequency priority.

**nsag-CellReselectionSubPriority**

This specifies the fractional priority value added to *nsag-CellReselectionPriority* when the given NSAG ID is used to set the frequency priority.

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, NR inter-frequency cells or inter-RAT frequency cells according to relaxation methods in clauses 4.2.2.9, 4.2.2.10, 4.2.2.11, 4.2C.2.7 and 4.2C.2.8 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 and 4.2C.2.7 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, 4.2.2.11 and 4.2C.2.8 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:

- the UE may choose to perform relaxed measurements for NR intra-frequency cells, inter-frequency cells or inter-RAT frequency cells according to relaxation methods in clauses 4.2.2.9, 4.2.2.10, 4.2.2.11, 4.2C.2.7 and 4.2C.2.8 in TS 38.133 [8];

- 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, 4.2.2.11, 4.2C.2.7 and 4.2C.2.8 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, 4.2.2.11 and 4.2C.2.8 in TS 38.133 [8];

- if the UE is an (e)RedCap UE; and

- 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-Stationary after (re-)selecting a new cell; and

- if the relaxed measurement criterion in clause 5.2.4.9.3 is fulfilled for a period of TSearchDeltaP-Stationary:

- the UE may choose to perform relaxed measurements for intra-frequency cells, NR inter-frequency cells, or inter-RAT frequency cells according to relaxation methods in clauses 4.2B.2.9, 4.2B.2.10, and 4.2B.2.11 in TS 38.133 [8];

- if the UE is an (e)RedCap UE; and

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

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

- if the relaxed measurement criterion in clause 5.2.4.9.4 is fulfilled:

- the UE may choose to perform relaxed measurements for intra-frequency cells, NR inter-frequency cells, or inter-RAT frequency cells according to relaxation methods in clauses 4.2B.2.9, 4.2B.2.10, and 4.2B.2.11 in TS 38.133 [8];

- else:

- if *combineRelaxedMeasCondition2* is not configured:

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

- if the relaxed measurement criterion in clause 5.2.4.9.3 is fulfilled for a period of TSearchDeltaP-Stationary:

- the UE may choose to perform relaxed measurements for intra-frequency cells, NR inter-frequency cells, or inter-RAT frequency cells according to relaxation methods in clauses 4.2B.2.9, 4.2B.2.10, and 4.2B.2.11 in TS 38.133 [8];

NOTE 1: It is up to UE implementation when to start performing relaxed measurements in RRC Idle/Inactive if multiple methods are configured.

NOTE 2: It is up to UE implementation which relaxation method to perform based on the "allowed" cases as specified in TS 38.133 [8] for RRC Idle/Inactive if multiple methods are configured.

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).

5.2.4.9.3 Relaxed measurement criterion for a stationary (e)RedCap UE

The relaxed measurement criterion for a stationary (e)RedCap UE is fulfilled when:

- (SrxlevRefStationary – Srxlev) < SSearchDeltaP-Stationary,

Where:

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

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

- After selecting or reselecting a new cell, or

- If (Srxlev - SrxlevRefStationary) > 0, or

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

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

5.2.4.9.4 Relaxed measurement criterion for a stationary (e)RedCap UE not at cell edge

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

- the relaxed measurement criterion in clause 5.2.4.9.3 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.

5.2.4.11 Reselection priorities for slice-based cell reselection

The UE derives reselection priorities for slice-based cell reselection by using:

- NAS provided NSAG information, only for NSAG(s) associated with the network slice(s) provided by NAS for cell reselection (see TS 23.501 [10], TS 24.501 [14]),

- *sliceInfoList* and/or *sliceInfoListDedicated* per frequency with *nsag-CellReselectionPriority* per NSAG, if provided in system information and/or dedicated signalling (see TS 38.331 [3]),

- *cellReselectionPriority* per frequency provided in system information and/or dedicated signalling (see TS 38.331 [3]).

The UE considers an NR frequency to support all slices of an NSAG if

- the nsag-ID and TA of the NSAG indicated for the NR frequency (see TS 38.331[3]) are included in the NSAG information provided by NAS. If *FreqPriorityListDedicatedSlicing* is configured, UE only considers the NSAG-frequency pairs indicated in *FreqPriorityListDedicatedSlicing* for slice-based cell reselection.

The UE considers a cell on an NR frequency to support all slices of an NSAG if

*-* the nsag-ID and TA of the NSAG indicated for the NR frequency in dedicated signalling but not in *SIB16* (see TS 38.331 [3]) are included in the NSAG information provided by NAS; or

*-* the nsag-ID and TA of the NSAG indicated for the NR frequency in *SIB16* (see TS 38.331 [3]) are included in the NSAG information provided by NAS; and

- the cell is either listed in the *sliceAllowedCellListNR* (if provided in the *sliceInfoList*) or the cell is not listed in the *sliceExcludedCellListNR* (if provided in the *sliceInfoList*); or

- Neither *sliceAllowedCellListNR* nor *sliceExcludedCellListNR* is configured in the *sliceInfoList*.

The UE shall derive reselection priorities for slice-based cell reselection according to the following rules:

- Frequencies that support at least one prioritized NSAG received from NAS have higher reselection priority than frequencies that support none of the NSAG(s) received from NAS.

- Frequencies that support at least one NSAG provided by NAS are prioritised in the order of the NAS-provided priority for the NSAG with highest priority supported on the frequency.

- Among the frequencies (one or multiple) that support the highest prioritised NSAG(s) with the same NAS-provided priorities, the frequencies are prioritized in the order of their highest *nsag-CellReselectionPriority* given for these NSAG(s). If no *nsag-CellReselectionPriority* is given for a NSAG at a frequency, the lowest priority value is used (i.e, lower than any of the network configured values for these frequencies).

- Frequencies that support none of the NSAG(s) provided by NAS are prioritized in the order of their *cellReselectionPriority*.

For a UE performing slice-based cell reselection, if the highest ranked cell or best cell in a frequency fulfils the inter- freqeuency cell reselection criteria (see clause 5.2.4.5) based on reselection priority for the frequency and NSAG derived according to this clause or fulfils intra-frequency and equal priority inter-frequency cell reselection criteria (see clause 5.2.4.6), but this cell does not support the NSAG according to this clause:

- if this cell supports any other NSAG(s) according to this clause, the UE shall re-derive a reselection priority for the frequency by considering the NSAG(s) supported by this cell (rather than those of the corresponding NR frequency);

- Otherwise, the UE shall re-derive a reselection priority for the frequency as if none of the NSAG(s) provided by NAS is supported.

This re-derived reselection priority is used for a maximum of 300 seconds, or until new network slice(s) and/or NSAG information are received from NAS. UE shall ensure the cell reselection criteria above are fulfilled based on the newly derived priorities.

*Start of next change*

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. This field is ignored by UEs supporting NTN while *cellBarredNTN* is included in SIB1.

- *cellBarred-eRedCap1Rx* (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 eRedCap UEs.

- *cellBarred-eRedCap2Rx* (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 eRedCap UEs.

- *cellBarredNTN* (IE type: "barred" or "not barred")
Indicated in SIB1 message. In case of multiple PLMNs indicated in *SIB1*, this field is common for all PLMNs. This field is ignored if the UE does not support NTN connectivity.

- *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].

- *halfDuplexRedCapAllowed* (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. This field is only applicable to (e)RedCap UEs.

- *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 *cellBarredNTN* is not broadcast in this cell,

- For NTN access, the UE shall treat this cell as if cell status is "barred".

When *halfDuplexRedCapAllowed* is not broadcast in this cell,

- The (e)RedCap UE only capable of operating in half-duplex for FDD 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.

- UEs assigned to Access Identity 3 shall behave as if the cell status is "barred" in case the cell is "reserved for operator use" for the registered PLMN or the selected PLMN.

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

NOTE 1a: Access Identity 3 is only valid for PLMNs that indicate to potential Disaster Inbound Roamers that the UEs can access the PLMN 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 acquire SIB1 and, in the remainder of this procedure, consider '*intraFreqReselection* in MIB' to be '*intraFreqReselectionRedCap* in SIB1', if available;

- If the UE is an eRedCap UE, the UE shall acquire SIB1 and, in the remainder of this procedure, consider '*intraFreqReselection* in MIB' to be '*intraFreqReselection-eRedCap* in SIB1', if available*.*

- If the cell is to be treated as if the cell status is "barred" due to being unable to acquire the SIB1:

- 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.

- If the cell status "barred" is indicated in *MIB* but the UE is unable to acquire the SIB1; or

- If the cell is to be treated as if the cell status is "barred" due to not supporting (e)RedCap UEs:

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

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

- If the UE is neither a RedCap UE nor an eRedCap UE, or if the UE is a RedCap UE and *intraFreqReselectionRedCap* in SIB1 is available, or if the UE is an eRedCap UE and *intraFreqReselection-eRedCap* in SIB1 is available:

- 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;

- If the cell is to be treated as if the cell status is "barred" due to being unable to acquire the *SIB1*:

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

- else:

- 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 is to be treated as if the cell status is "barred" due to being unable to acquire the *SIB1*:

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

- If the cell operates in licensed spectrum:

- the UE shall not re-select to another cell on the same frequency as the barred cell and exclude such cell(s) as candidate(s) for cell selection/reselection for 300 seconds;

- else:

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

- else:

- 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 to another cell on the same frequency as the barred cell and exclude such cell(s) as candidate(s) for cell selection/reselection for 300 seconds;

- else:

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

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

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

NOTE 2: If barring of a cell is triggered by the condition of *trackingAreaCode* and *trackingAreaList* not being provided, as specified in TS 38.331 [3], the barring only applies to this PLMN and the UE can re-evaluate the barring condition again due to selection of another PLMN.

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].

A L2 U2N Relay UE does not need to perform the Unified Access Control as specified in TS 38.331 [3], due to the U2N Remote UE access attempt.

*Start of next change*

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. A L2 U2N Relay UE monitors the paging occasions of its PC5-RRC connected L2 U2N Remote UEs. In this case, the DRX cycle and UE ID mentioned in this clause refer to those of the L2 U2N Remote UE.

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. However, if a L2 U2N Relay UE in RRC\_INACTIVE state receives a CN initiated paging for a L2 U2N Remote UE, the L2 U2N Relay UE does not move to RRC\_IDLE state.

NOTE 0a: The L2 U2N Remote UE does not need to monitor the PO in order to receive the paging message.

NOTE 0b: While the SDT procedure is ongoing in RRC\_INACTIVE state, the UE monitors the PO in order to receive only the Short Message as specified in TS 38.331 [3].

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 the UE does not operate in eDRX as defined in clause 7.4:

- T is determined by the shortest of the UE specific DRX value(s), if configured by RRC and/or upper layers or provided in PC5-RRC signalling in case of a L2 U2N Relay UE, 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 the UE operates in eDRX and eDRX is configured by upper layers, i.e., TeDRX, CN, according to clause 7.4:

- If TeDRX, CN is no longer than 1024 radio frames:

- T = TeDRX, CN;

- 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 the UE operates in eDRX and eDRX is configured by RRC, i.e., TeDRX, RAN , and/or upper layers, i.e., TeDRX, CN, as defined in clause 7.4:

- If both TeDRX, CN and used TeDRX, RAN are no longer than 1024 radio frames, T = min{TeDRX, RAN, TeDRX, CN}.

- If TeDRX, CN is no longer than 1024 radio frames and no TeDRX, RAN is configured or used, T is determined by the shortest of UE specific DRX value configured by RRC and TeDRX, CN.

- If TeDRX, CN is longer than 1024 radio frames:

- If TeDRX, RAN is not configured or used:

- 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 UE specific DRX value configured by RRC;

- else if used TeDRX, RAN is no longer than 1024 radio frames:

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

- else if used TeDRX, RAN is longer than 1024 radio frames:

- During the overlapped part of CN configured PTW and RAN configured PTW, T is determined by the shortest of the UE specific DRX value configured by RRC, the UE specific DRX value configured by upper layers (if any), and a default DRX value broadcast in system information;

- During CN configured PTW and outside RAN configured PTW, T is determined by the shortest of the UE specific DRX value configured by upper layers (if any), and a default DRX value broadcast in system information;

- Outside CN configured PTW and during RAN configured PTW, T is determined by the UE specific DRX value configured by RRC.

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 the UE operates in eDRX as specified in clause 7.4:

- 5G-S-TMSI mod 4096

else:

- 5G-S-TMSI mod 1024

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 *firstPDCCH-MonitoringOccasionOfPO* is signalled in *SIB1* for paging in the BWP configured by *initialDownlinkBWP*.For paging in a DL BWP other than the BWP configured by *initialDownlinkBWP*, 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 used eDRX value configured by upper layers is no longer than 1024 radio frames, the UE shall use the same i\_s as for RRC\_IDLE state.

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

7.2 Paging Early Indication

7.2.1 Paging Early Indication reception

The UE may use Paging Early Indication (PEI) in RRC\_IDLE and RRC\_INACTIVE states in order to reduce power consumption. If PEI configuration is provided in system information, the UE in RRC\_IDLE or RRC\_INACTIVE state supporting PEI (except for the UEs expecting MBS group notification) can monitor PEI using PEI parameters in system information according to the procedure described below.

If *lastUsedCellOnly* is configured in system information of a cell, the UE monitors PEI in this cell only if the UE most recently received *RRCRelease* without *noLastCellUpdate* in this cell. Otherwise (i.e., if *lastUsedCellOnly* is not configured in system information of a cell), the UE monitors PEI in the camped cell.

The UE monitors one PEI occasion per DRX cycle. A PEI occasion (PEI-O) is a set of PDCCH monitoring occasions (MOs) and can consist of multiple time slots (e.g. subframes or OFDM symbols) where PEI can be sent (TS 38.213 [4]). In multi-beam operations, the UE assumes that the same PEI is repeated in all transmitted beams and thus the selection of the beam(s) for the reception of the PEI is up to UE implementation.

The time location of PEI-O for UE's PO is determined by a reference point and an offset:

- The reference point is the start of a reference frame determined by a frame-level offset from the start of the first PF of the PF(s) associated with the PEI-O, provided by *pei-FrameOffset* in SIB1;

- The offset is a symbol-level offset from the reference point to the start of the first PDCCH MO of this PEI-O, provided by *firstPDCCH-MonitoringOccasionOfPEI-O* in SIB1.

If one PEI-O is associated with POs of two PFs, the two PFs are consecutive PFs calculated by the parameters *PF\_offset*, *T*, *Ns*, and *N*. The first PF of the PFs associated with the PEI-O is provided by (SFN for PF) - floor (*iPO*/*Ns*)\**T*/*N*, where SFN for PF is determined in clause 7.1, *iPO* is defined in clause 10.4a in TS 38.213[4], *T*, *Ns*, and *N* are determined in clause 7.1.

The PDCCH MOs for PEI are determined as specified in TS 38.213 [4] according to *pei-SearchSpace*, *pei-FrameOffset*, *firstPDCCH-MonitoringOccasionOfPEI-O* and *nrofPDCCH-MonitoringOccasionPerSSB-InPO* ifconfigured as specified in TS 38.331 [3]. When *SearchSpaceId* = 0 is configured for *pei-SearchSpace*, the PDCCH MOs for PEI are same as for RMSI as defined in clause 13 in TS 38.213 [4]. UE determines first PDCCH MO for PEI-O based on *pei-FrameOffset* and *firstPDCCH-MonitoringOccasionOfPEI-O*, as for the case with *SearchSpaceId* > 0 configured.

When *SearchSpaceId* = 0 is configured for *pei-SearchSpace*, the UE monitors the PEI-O according to *searchSpaceZero*. When *SearchSpaceId* other than 0 is configured for *pei-SearchSpace,* the UE monitors the PEI-O according to the search space with the configured *SearchSpaceId*.

A PEI occasion is a set of 'S\*X' consecutive PDCCH MOs, 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]thPDCCH MO for PEI in the PEI-O corresponds to the Kth transmitted SSB, where x=0,1,…,X-1, K=1,2,…,S. The PDCCH MOs for PEI which do not overlap with UL symbols (determined according to *tdd-UL-DL-ConfigurationCommon*) are sequentially numbered from zero starting from the first PDCCH MO for PEI in the PEI-O. When the UE detects a PEI within its PEI-O, the UE is not required to monitor the subsequent MO(s) associated with the same PEI-O.

If the UE detects PEI and the PEI indicates the subgroup the UE belongs to monitor its associated PO, as specified in clause 10.4a in TS 38.213 [4], the UE monitors the associated PO as specified in clause 7.1. If the UE does not detect PEI on the monitored PEI occasion or the PEI does not indicate the subgroup the UE belongs to monitor its associated PO, as specified in clause 10.4a in TS 38.213 [4], the UE is not required to monitor the associated PO as specified in clause 7.1.

If the UE is unable to monitor the PEI occasion (i.e. all valid PDCCH MO for PEI) corresponding to its PO, e.g. during cell re-selection, the UE monitors the associated PO according to clause 7.1.

In RRC\_INACTIVE state, when the UE uses the same i­\_sas for RRC\_IDLE state as specified in clause 7.1, the UE shall use the same *iPO* as for RRC\_IDLE state. Otherwise, the UE determines the *iPO* based on the formula defined in clause 10.4a in TS 38.213 [4].

7.3 Subgrouping

7.3.0 General

If PEI and subgrouping are configured, UEs monitoring the same PO can be divided into one or more subgroups. With subgrouping, the UE monitors the associated PO if the corresponding bit for subgroup the UE belongs to is indicated as 1 by PEI corresponding to its PO, as specified in clause 10.4a in TS 38.213 [4].

The following parameters are used for the determination of subgroup ID:

- *subgroupsNumPerPO*: total number of subgroups for both CN assigned subgrouping (if any) and UE\_ID based subgrouping (if any) in a PO, which is broadcasted in system information;

- *subgroupsNumForUEID*: number of subgroups for UE\_ID based subgrouping in a PO, which is broadcasted in system information.

UE's subgroup can be either assigned by CN as specified in clause 7.3.1 or formed based on UE\_ID as specified in clause 7.3.2:

- If *subgroupsNumForUEID* is absent in *subgroupConfig*, the subgroup ID based on CN assigned subgrouping as specified in clause 7.3.1, if available for the UE, is used in the cell.

- If both *subgroupsNumPerPO* and *subgroupsNumForUEID* are configured, and *subgroupsNumForUEID* has the same value as *subgroupsNumPerPO*, the subgroup ID based on UE\_ID based subgrouping as specified in clause 7.3.2 is used in the cell.

- If both *subgroupsNumPerPO* and *subgroupsNumForUEID* are configured, and *subgroupsNumForUEID* < *subgroupsNumPerPO*:

- The subgroup ID based on CN assigned subgrouping as specified in clause 7.3.1, if available for the UE, is used in the cell;

- Otherwise, the subgroup ID based on UE\_ID based subgrouping as specified in clause 7.3.2 is used in the cell.

If a UE has no CN assigned subgroup ID or does not support CN assigned subgrouping, and there is no configuration for *subgroupsNumForUEID*, the UE monitors the associated PO according to clause 7.1.

7.3.1 CN assigned subgrouping

Paging with CN assigned subgrouping is used in the cell which supports CN assigned subgrouping, as described in clause 7.3.0. A UE supporting CN assigned subgrouping in RRC\_IDLE or RRC\_INACTIVE state can be assigned a subgroup ID (between 0 to 7) by AMF through NAS signalling. The UE belonging to the assigned subgroup ID monitors its associated PEI which indicates the paged subgroup(s) as specified in clause 7.2.

7.3.2 UE\_ID based subgrouping

Paging with UE\_ID based subgrouping is used in the cell which supports UE\_ID based subgrouping, as described in clause 7.3.0.

If the UE is not configured with a CN assigned subgroup ID, or if the UE configured with a CN assigned subgroup ID is in a cell supporting only UE\_ID based subgrouping, the subgroup ID of the UE is determined by the formula below:

SubgroupID = (floor(UE\_ID/(N\*Ns)) mod subgroupsNumForUEID) + (subgroupsNumPerPO - subgroupsNumForUEID),

where:

N: number of total paging frames in T, which is the DRX cycle of RRC\_IDLE state as specified in clause 7.1

Ns: number of paging occasions for a PF

UE\_ID: 5G-S-TMSI mod X, where X is 32768, if eDRX is applied; otherwise, X is 8192

subgroupsNumForUEID: number of subgroups for UE\_ID based subgrouping in a PO, which is broadcasted in system information

In RRC\_INACTIVE state with CN configured PTW the SubgroupID used outside CN PTW is the same as the SubgroupID used inside CN PTW.

The UE belonging to the SubgroupID monitors its associated PEI which indicates the paged subgroup(s) as specified in clause 7.2.

7.4 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 operates in eDRX for CN paging in RRC\_IDLE or RRC\_INACTIVE states if the UE is configured for eDRX by upper layers and *eDRX-AllowedIdle* is signalled in SIB1.

For RAN paging, the UE in RRC\_INACTIVE state:

- if the UE is configured for eDRX by [*ran-ExtendedPagingCycle-r18*] and *eDRX-AllowedInactive-r18* is signalled in SIB1:

- operates in eDRX with the eDRX cycle TeDRX, RAN ~~longer than 1024 radio frames, which is~~ configured by [*ran-ExtendedPagingCycle-r18*];

- else if the UE is configured for eDRX by *ran-ExtendedPagingCycle-r17* and *eDRX-AllowedInactive-r17* is signalled in SIB1:

- operates in eDRX with an eDRX cycle TeDRX, RAN ~~no longer than 1024 radio frames, which is~~ configured by *ran-ExtendedPagingCycle-r17*;

- else:

- does not operate in eDRX.

If the UE operates in eDRX with an eDRX cycle no longer than 1024 radio frames, it monitors POs as defined in 7.1 with configured eDRX cycle. Otherwise, a UE operating in 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:

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

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

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

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

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

- TeDRX\_RAN: UE-specific eDRX cycle in Hyper-frames, (TeDRX\_RAN = 2, …, 1024 Hyper-frames) configured by RRC.

For CN configured PTW:

PTW\_start denotes the first radio frame of the PH for CN 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

For RAN configured PTW:

PTW\_start denotes the first radio frame of the PH for RAN 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 RRC

UE\_ID\_H is defined as follows:

UE\_ID\_H : 13 most significant bits of the Hashed ID.

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 [23].

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 A.

*End of change*

# Annex - RAN2 agreements

Green highlight – agreement considered in the CR

Yellow-highlight – agreement captured as editor’s notes

No highlight – agreement with no direct impact on the CR

## RAN2#121

*Enhanced eDRX in RRC\_INACTIVE*

* The formula of PH/PTW for IDLE eDRX can be reused for enhanced INACTIVE eDRX, for eDRX cycles longer than 10.24s.
* RAN2 confirms the R17 agreements made at RAN2#114 for enhanced INACTIVE eDRX:

- 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.

- When RAN and CN paging coincide in the same PH, the actually used PTW starting location is the same for RAN and CN paging. FFS how to calculate the PTW starting location so that it is the same for RAN and CN PTW.

* PTW length value range of enhanced INACTIVE eDRX is same as IDLE eDRX, i.e. from 1.28s to 40.96s in the step of 1.28s.
* Long eDRX cycle (>10.24 s) value range of enhanced INACTIVE eDRX is same as IDLE eDRX from 20.48s to 10485.76s, i.e. hf2, hf4, hf8, hf16, hf32, hf64, hf128, hf256, hf512, hf1024
* Add the configuration of eDRX cycle (>10.24 s) and PTW length for enhanced INACTIVE eDRX in the RRCRelease message
* Introduce 1 bit indication in SIB1 whether UEs are allowed to use the enhanced INACTIVE eDRX cycle.
* FFS if/how to fallback for a UE which is configured with R18 eDRX but the gNB doesn’t indicate support for this.
* RAN2 confirms the enhanced INACTIVE eDRX can be applied to all R18 UEs. FFS if it can only be supported by UEs which support R17 eDRX.
* Indicate to [RAN3/SA2/CT1] that RAN2 intends to configure INACTIVE eDRX (beyond 10.24s) together with SDT (both MO and/or MT versions of SDT), and ask for feedback, if any.

*Further reduced UE complexity in FR1*

* Introduce Msg3/MsgA PUSCH based early indication for Rel-18 eRedCap. FFS how to implement this in the spec (e.g., new LCIDs or not).
* We will wait for RAN1 progress to see if there is a need for a Msg1 early indication for eRedCap.
* The NR MIB “cellBarred” bit applies to all UEs (Normal UEs, Redcap UEs and eRedcap UEs).

## RAN2#121bis-e

*Enhanced eDRX in RRC\_INACTIVE*

* Introduce an optional UE capability with signalling for Rel-18 enhanced eDRX in RRC\_INACTIVE.
* UE can support Rel-18 enhanced eDRX, only if it supports Rel-17 RRC\_IDLE eDRX. TBD if it must also support Rel-17 RRC\_INACTIVE eDRX.
* A cell can allow Rel-18 INACTIVE eDRX, only if eDRX-AllowedIdle is configured. TBD if it must also configure Rel-17 RRC\_INACTIVE eDRX.
* UEs configured with Rel-18 enhanced INACTIVE eDRX should apply Rel-18 enhanced INACTIVE eDRX if Rel-18 enhanced INACTIVE eDRX is allowed in the serving cell, regardless of whether Rel-17 INACTIVE eDRX is allowed in the serving cell.
* UEs configured with Rel-18 enhanced INACTIVE eDRX should apply INACTIVE DRX if both Rel-18 enhanced INACTIVE eDRX and Rel-17 INACTIVE eDRX are not allowed in the serving cell.
* Working assumption (pending specification complexity and NW complexity evaluation): UEs configured with Rel-18 enhanced INACTIVE eDRX should fall back to use Rel-17 INACTIVE eDRX (if capable and configured with Rel-17 INACTIVE eDRX) if the Rel-18 enhanced INACTIVE eDRX is not allowed but the Rel-17 INACTIVE eDRX is allowed by the current cell. gNB has the possibility to configure both Rel-17 INACTIVE eDRX and Rel-18 INACTIVE eDRX, allowing the UE to fall back to use Rel-17 INACTIVE eDRX.
* Introduce a new IE for INACTIVE eDRX to include the eDRX cycle values larger than 10.24s.
* Following cases are invalid:

Case 1: UE is configured with a Rel-18 enhanced INACTIVE eDRX cycle but not configured with the IDLE eDRX cycle.

Case 2: UE is configured with a Rel-18 enhanced INACTIVE eDRX cycle longer than the IDLE eDRX cycle.

* RAN PTW length is mandatorily present within Rel-18 INACTIVE eDRX’s configuration.
* Use the same UE\_ID\_H as IDLE eDRX for calculating the PH for RAN paging when INACTIVE eDRX is longer than 10.24s.
* Use TeDRX\_RAN instead of TeDRX\_CN to calculate the PH for RAN paging when TeDRX\_RAN is longer than 10.24s.
* For the overlapping PH, RAN PTW starting location is determined based on CN eDRX cycle.
* For the non-overlapping PH, PTW starting location for RAN PTW is determined based on the CN eDRX cycle.
* In an overlapped or non-overlapped PH: Within RAN PTW and outside CN PTW, T = RAN configured DRX cycle
* If this is even a valid case (we will decide later): In an overlapped PH: Within CN PTW and outside RAN PTW, T = min {CN configured DRX cycle, default paging cycle broadcast in system information}.
* In an overlapped PH: Within both CN PTW and RAN PTW, T = min {CN configured DRX cycle, RAN configured DRX cycle, default paging cycle broadcast in system information}.
* Legacy systemInfoModification-eDRX indication in Short message and eDRX modification boundaries are also applicable for Rel-18 UEs configured with INACTIVE eDRX > 10.24sec, and in this case, the CN eDRX cycle is used to compare with the modification period.

*Further reduced UE complexity in FR1*

* SIB1 should be able to indicate whether the cell enables access for eRedCap UEs or not (assuming that eRedCap UE is not allowed to access to the legacy cell nor the cell not supporting eRedCap). FFS on the relationship and granularity with the access control/cell barring purpose indication.
* A Rel-18 eRedCap UE should be able to indicate its support via new UE capability signaling specific to Rel-18 eRedCap.
* Introduce R18 eRedCap UE specific IFRI in SIB1.
* The new R18 eRedCap UE specific IFRI functionality works as follows:

- Controls cell selection/reselection to intra-frequency cells for eRedCap UEs when this cell is considered barred by the eRedCap UE, as specified in TS 38.304 [20].

- Working assumption (pending check in running CRs): If not present, an eRedCap UE treats the cell as barred, i.e., the UE considers that the cell does not support eRedCap.

* Introduce eRedcapAccessAllowed-r18 in interFreqCarrierFreqList in SIB4, about the frequency of neighbour cell supporting eRedCap, similar to R17.
* From RAN2 perspective, there is no need to introduce eRedCap UE specific initial BWP configuration (i.e. no R18 new field and at most one specific initial UL/DL BWP can be configured).
* If the R17 RedCap specific initial BWP is configured, eRedCap UEs always use it as its specific initial BWP (assuming no eRedCap UE specific initial BWP configuration field introduced).
* Working assumption: Use two new LCID values to support Msg3 early identification for eRedCap UE (can be revised and discussed together with other R18 WIs, if R18 WIs may occupy relatively many LCIDs).

## RAN2#122

*Enhanced eDRX in RRC\_INACTIVE*

* UE can support Rel-18 INACTIVE eDRX (which comprises eDRX cycles and PTWs), even if it doesn’t support Rel-17 INACTIVE eDRX.
* A cell can allow Rel-18 INACTIVE eDRX (which comprises eDRX cycles and PTWs), even if it doesn’t allow Rel-17 INACTIVE eDRX, but the cell must allow IDLE eDRX.
* We confirm the working assumption: UEs configured with Rel-18 enhanced INACTIVE eDRX should fall back to use Rel-17 INACTIVE eDRX (if capable and configured with Rel-17 INACTIVE eDRX) if the Rel-18 enhanced INACTIVE eDRX is not allowed but the Rel-17 INACTIVE eDRX is allowed by the current cell. gNB has the possibility to configure both Rel-17 INACTIVE eDRX and Rel-18 INACTIVE eDRX, allowing the UE to fall back to use Rel-17 INACTIVE eDRX.
* A UE configured with Rel-18 INACTIVE eDRX will fallback to use INACTIVE RAN DRX if it is either not configured with Rel-17 INACTIVE eDRX or the cell does not allow Rel-18 INACTIVE eDRX and Rel-17 INACTIVE eDRX.

*Further reduced UE complexity in FR1*

* RAN2 confirms there can be cell(s) supporting Rel-18 eRedCap only, i.e., not allowing Rel-17 RedCap UE to camp and access.
* We introduce R18 versions of 1Rx and 2Rx barring bits and we don’t introduce a R18 version of the HD-FDD allowed-bit, i.e., the R17 HD-FDD allowed-bit is reused for and applied by R18 eRedCap UEs.
* All R18 eRedCap UEs uses the two new LCIDs for Msg3/MsgA PUSCH for CCCH/CCCH1 during Random Access, i.e., both those with peak rate reduction + BB BW reduction, and those with only peak rate reduction.

## RAN2#123

*Enhanced eDRX in RRC\_INACTIVE*

* There RAN PTW can be shorter, equal to, or longer than the CN PTW.
* When enhanced INACTIVE eDRX is used, RAN2 to confirm that UE in RRC\_INACTIVE state shall:

1) During CN PTW, use the same i\_s as for RRC\_IDLE state;

2) Outside CN PTW and within RAN PTW, use the i\_s for RRC\_INACTIVE state;

3) Outside CN PTW and outside RAN PTW, no PO will be monitored and no i\_s will be used.

* Proposal 5: When enhanced INACTIVE eDRX is used, RAN2 to confirm that:

1) Outside CN PTW and within RAN PTW, the SubgroupID is also same as the SubgroupID used inside CN PTW;

2) Outside CN PTW and outside RAN PTW, no PO will be monitored and no SubgroupID will be used.

*Further reduced UE complexity in FR1*

* Additional (on top of RedCap) early indication in MsgA PRACH is not supported.
* Add a new value “enhRedCap-r18” in FeatureCombination-r17
* One FeatureCombination-r17 should not set both redCap-r17 and enhRedCap-r18 as true
* We will continue to discuss this as part of the running MAC CR email post meeting email discussion, assuming that the running CR email discussions will be long email discussions (TBC by RAN2 chair)
* Network should ensure the target gNB supports/allows eRedcap UE, in the handover of eRedCap UE.
* Working assumption: No need to have separate cell barring for “eRedCap UE capable of 20MHz + PR1” and “eRedCap UE capable of BW3/PR3+ PR1”.
* The support of Rel-18 eRedCap (FG 48-1 and 48-2) is defined as independently of Rel-17 RedCap (FG 28-1) understanding that RAN1 also agreed that UE supporting Rel-18 eRedCap feature(s) indicate support of this FG 48-1 instead of FG 28-1 (supportOfRedCap-r17).
* New UE capability (referred e.g., as supportOfEnhancedRedCap-r18) is defined to capture FG 48-1 (i.e., RedCap UE with reduced peak data rate and reduced baseband bandwidth in FR1) with the corresponding details explained in RAN1 feature list ([R1-2306223](http://www.3gpp.org/ftp//tsg_ran/WG1_RL1/TSGR1_113/Docs//R1-2306223.zip)).
* New UE capability (referred e.g., supportOfNotReducedBB-BW-r18) is defined to capture FG 48-2 (i.e., RedCap UE with reduced peak data rate without reduced baseband bandwidth in FR1) with the corresponding details explained in RAN1 feature list ([R1-2306223](http://www.3gpp.org/ftp//tsg_ran/WG1_RL1/TSGR1_113/Docs//R1-2306223.zip)).
* To remove from RAN2 running Capability CRs any reference to supportOfEnhancedRedCap-r18 as it is part of RAN1 feature list and its corresponding TP should be captured as part of Mega-Capability CRs. If so, to agree to the update done on UE capabilities running CR to 38.306 and 38.331 in [R2-2307657](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_123/Docs//R2-2307657.zip) and [R2-2307659](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_123/Docs//R2-2307659.zip).
* We will create a temporary CR for RAN1 eRedCap features.
* To add in the list of functional components for the supportOfEnhancedRedCap-r18 the support of eRedCap early indication based on Msg3 and MsgA PUSCH.
* A Rel-18 eRedCap UE (both FG 48-1 and FG 48-2) can also support all RAN2-centric Rel-17 RedCap UE capabilities in the same manner.
* Discuss during CR implementation how to capture this in TS 38.306: option 1) add in the field description of R18 eRedCap capability (i.e. supportOfEnhancedRedCap-r18) the following statement “all supportOfRedCap-r17 related capabilities specified in this specification remain applicable for Rel-18 RedCap UEs, unless indicated otherwise” or option 2) update the field description of the RAN2-centric Rel-17 RedCap UE capabilities to be applicable to (e)RedCap UEs.
* To include the following in “section 4.2.x.1 Definition of eRedCap UE” of TS 38.306:

eRedCap UE is the UE with reduced peak data rate and, with or without reduced baseband bandwidth in FR1:

The maximum bandwidth is 20 MHz for FR1. UE features and corresponding capabilities related to UE bandwidths wider than 20 MHz in FR1 are not supported by eRedCap UEs. eRedCap UEs do not support operation in FR2.

The specifications and capabilities of a RedCap UE are also applicable to eRedCap UEs unless stated otherwise.

* Section 4 on “Supported max data rate for DL/UL” in TS 38.306 needs to be updated to include RAN1 agreement on the new value(s) of X for which the legacy constraint “vLayers·Qm·f ≥ 4” is relaxed by capturing the following TP: “For single carrier NR SA operation, the UE (except a UE indicating supportOfERedCap-r18) shall support a data rate for the carrier that is no smaller than the data rate computed using the above formula, with J=1 CC and component vLayers(j)⋅Qmj⋅fj is no smaller than 4. For UE indicating supportOfEnhancedRedCap-r18 in single carrier NR SA operation, the UE shall support a data rate for the carrier that is no smaller than the data rate computed using the above formula, with J=1 CC and component vLayers(j)⋅Qmj⋅fj is no smaller than 0.75 if UE does not indicate supportOfNotReducedBB-BW-r18 or 3.2 if UE also indicates supportOfNotReducedBB-BW-r18.”).
* We try to implement the RAN1 agreement referred in the Samsung paper above (by adding a note in MAC), if we identify issues in MAC due to the RAN1 agreement we can revisit this discussion next meeting
* A eRedCap UE considers the contention resolution not successful and stop the ra-ContentionResolutionTimer, when the UE detects a PDCCH transmission addressed to its TEMPORARY\_C-RNTI with a DCI that schedules a Msg4 PDSCH transmission with a larger bandwidth than it can receive or process, i.e. option 1 is adopted.
* We will send an LS to RAN1 since there is cross-layer interaction with the approach of stopping the timer.

## RAN2#123bis

*Organizational*

* Use the name “supportOfERedCap-r18” instead of eRedCap-r18, and align other capability names along these lines.
* Capture “Enabling/disabling of frequency hopping for common PUCCH resources” in 306.
* Add “as specified in Annex B2 in TS 38.331” after “BWP#0 configuration option 1”.

*Enhanced eDRX in RRC\_INACTIVE*

* The fallback behaviour for eDRX configuration in RRC\_INACTIVE is captured in 38.304, i.e., the duplicated descriptions in the running 38.331 CR are removed.
* The fallback behavior for eDRX configuration in RRC\_INACTIVE is captured with the suggested text above as the baseline.
* To avoid using the term “and/or” when describing the three cases separately for T determination. We intend to change from Rel-15, but those CRs need to be provided to the main session in the next meeting.

*Further reduced UE complexity in FR1*

* Working assumption: No need to have separate cell barring for “eRedCap UE capable of 20MHz + PR1” and “eRedCap UE capable of BW3/PR3+ PR1” is confirmed as RAN2 agreement.
* It is up to NW implementation to ensure that all partitions that the NW is interested to use to differentiate UEs. E.g. if the NW wants to be sure to be able to differentiate eRedCap and RedCap UEs, it would need to define all needed partitions for this.
* Rel-18 eRedCap UE considers the set of configured RA resources with RedCap set to true as available for the RA procedure only when there is no set of configured RA resources with eRedCap set to true among all sets of configured RA resources.
* It is specified in TS 38.331 that RRC determines that RedCap is applicable to the RA procedure for Rel-18 eRedCap UE only if there is no set of configured RA resources with eRedCap set to true among all sets of configured RA resources. In TS 38.321, no additional specification change is expected for Proposal 1 unless it is much simpler if we specify this in MAC.
* RAN2 clarifies that eRedCap UEs do not support 60kHz SCS in FR1.
* For eRedCap, RAN2 to specify UE capability transfer procedure to make UE capability filtering optional.
* An eRedCap UE may ignore the capability filter received in the capability enquiry and send all supported bands in the mirrored UE capability filter.
* RAN2 to discuss and adopt the TPs in the appendices A or B if Proposal 2 is agreed (i.e., UE behavior is captured (option A) by a NOTE or (option B) in procedural text). We will pick one of these options in the post-meeting email discussion.
* The eRedCap UEs indicates explicitly with a bit in UE capability message whether the UE ignored the filter.
* We leave the cross-layer indication to UE implementation.
* This will be captured in MAC in the form of that “if <something happens>” but we will not specify anything with reference to PHY specs.
* We adopt Option 1 in R2-2309809.