**3GPP TSG-RAN WG2 Meeting #129 *R2-250xxxx***

**Athens, Greece, Feb. 17th – 21st, 2025**

|  |
| --- |
| *CR-Form-v12.3* |
| **CHANGE REQUEST** |
|  |
|  | **38.304** | **CR** | **draftCR** | **rev** | **-** | **Current version:** | **18.4.0** |  |
|   |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
|  |

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

|  |
| --- |
|  |
| ***Title:***  |  |
|  |  |
| ***Source to WG:*** | Apple  |
| ***Source to TSG:*** |  R2 |
|  |  |
| ***Work item code:*** | Netw\_Energy\_NR\_enh-Core  |  | ***Date:*** | 2025-02-20 |
|  |  |  |  |  |
| ***Category:*** | B |  | ***Release:*** | Rel-19 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19) Rel-20 (Release 20)* |
|  |  |
| ***Reason for change:*** | Introduction of Rel-19 network energy saving to TS 38.304. |
|  |  |
| ***Summary of change:*** | Change is introduced to support the following objectives:* On-demand SIB1 for idle/inactive UEs
* Adaptation of common channels/signals
	+ Only paging adaptation is introduced for now
	+ Potential spec impact on RACH adaptation on reception of paging DCI
	+ No specfication impacts is foreseen for SSB adaptation

The table below presents the agreements and if/how they have been captured. And the following color code is used to categorize agreements interms of if/how they have been captured. Fully implementedAlready specified in 38.304Not/partially implemented but additional agreements/FFSs needed before conclusionDoesn’t impact 38.304 It will be removed when the CR is finalized.

|  |
| --- |
| **On-demand SIB1 for idle/inactive UEs** |
| **RAN2#125bis** |
| At least RAN2 starts scenario 1a. Other scenarios are not excluded.* Scenario 1a: Cell A SIB assisted intra-cell WUS. And WUS and SIB1 is sent to/from NES cell. with below potential RAN2 impacts:
	+ Add WUS configuration in SIB of cell A.
	+ Cell reselection from cell A to NES cell, including trigger condition and cell barring changes.
	+ Whether allow camping, paging and SIB update in NES cell.
	+ Cell reselection from NES cell to cell A or normal cell.
 | Captured in new section X. EN 4: details of UL WUS configuration and whether/how to capture the details. |
| Contents of UL WUS* RAN2 assumes that RACH procedure is reused for UE to request on-demand SIB1.
* UL WUS configuration includes at least below information:
	+ RACH configuration
* A UE needs to know a UL WUS configuration to request SIB1 of which cell.
 | Captured in new section X. EN 4: details of UL WUS configuration and whether/how to capture the details. |
| On-demand SIB1 acquisition procedure* Existing Msg 1 based on-demand procedure is reused for on-demand SIB1 acquisition procedure. FFS on Msg 3. FFS if / when the UE monitors the OD-SIB1 upon reception of RAR. FFS:T whether introduce specified UE behavior if RACH failure of OD-SIB1 request.
 | N/A |
| The UE first should acquire valid SIB1 (e.g. via SIB1 request) for camping to NES cell (if the UE knows the cell doesn’t broadcast SIB1 and supports on-demand SIB1). | N/A |
| **RAN2#126** |
| Study on-demand SIB1 provisioning for NES Cell(s) in versions of Scenario 1a with multiple Cells A and/or NES Cells:* More than one Cell A may provide configuration for the same NES cell.
* The same Cell A may assist more than one NES Cells.
 | N/A |
| RRC release message assisted intra-cell WUS can be discussed as option of signaling details in stage 3. | N/A |
| Can use the PCI and frequency of a NES Cell to associate the UL WUS configuration with a NES Cell. | N/A |
| For Message 1 based on-demand SIB1 request, the on-demand SI request configuration that currently included in SIB1 may be used as the design baseline. | N/A |
| Cell A’s SIB can be used to configure on-demand SIB1 related configuration for neighbour NES cells, e.g., via new SIB or the existing SIB. | N/A (updated by agreement of SIB-X) |
| If the UE chooses the NES cell using legacy intra-F/inter-F cell re-selection procedure (as baseline), the UE triggers WUS transmission. | Captured in new Section X. |
| After UE successfully receives OD-SIB1 for that NES Cell and if it is a suitable cell, UE camps in the NES Cell “similar” to a legacy Cell. | Captured in new Section X. |
| RAN2 not to support on-demand SIB1 request that is combined with an initial access to perform RRC connection establishment/resume on the NES cell. | N/A |
| NW need to bar the legacy UE from accessing the on-demand SIB1 cell (e.g. based on the existing barring mechanism). | Rely on existing barring of 38.304.  |
| How to avoid/deprioritize the legacy UE camping at the Cell A attempting to switch to the NES Cell (but allowing the R19 NES UE to do that). | N/A |
| If the NES UE is unable to acquire the SIB1 of NES Cell before UE initiates OD-SIB1 procedure, it will not consider it as barred at that moment. R19 NES UE bars the cell if the UE fails to acquire SIB1 via on-demand SIB1 for NES cell. | Captured in new section X.  |
| After Rel-19 NES UEs camp in NES cell, the UE behaviour is same as the one defined as legacy normal camped state, e.g. paging reception, SIB1 update, etc. | Captured in new section X.  |
| RAN2 assumes the UE is expected to receive the RAR responding to the preamble transmission for Msg1-based on-demand SIB1 procedure, as the baseline. | N/A |
| As baseline, upon random access procedure failure of OD-SIB1 request, UE regards OD-SIB1 can’t be acquired in the NES cell and considers it as barred. It doesn’t exclude the option to leave the determination to the UE implementation. | Captured in new Section X. |
| Once the NES UE camps on the NES cell, if the UE receives SIB change notification, the UE is expected to receive SIB1 from NES cell. | Captured in new Section X (refer to Section 5.2.5). |
| RAN2 to wait for RAN1’s progress whether to support scenario 3. | N/A |
| **RAN2#127** |
| No consensus for RAN1 case 3 in RAN2. | N/A |
| We can rely on legacy UE behaviour to ensure UE has valid SIB1 for the cell (i.e. UE reacquire SIB1 whenever (re)selecting cell). | N/A |
| Further UE keeps SIB1 updated while on cell via regular SI modification procedure (confirmation of earlier RAN2 agreement). | Captured in new Section X (refer to Section 5.2.5). |
| Once Rel-19 NES UE camps on the NES cell, the UE expects to receive UL WUS configuration updates from the NES Cell, e.g., via legacy SI modification procedures. | Captured in new Section X (refer to SI modification of 38.331). |
| Msg 3 based OD-SI procedure is not supported for on-demand SIB1 request in case 2 (for requesting to the NES Cell). | N/A |
| Following example options to handle legacy UEs (i.e. UEs not supporting OD-SIB1) can be considered in normative work. Details and further analysis need to be further discussed in normative work. Other existing options are not excluded.* Option 1: Legacy UEs bar the OD-SIB1 cell based on cellBarred bit set to barred in MIB.
* Option 2: Legacy UEs bar the OD-SIB1 cell based on no SIB1 indication via ssb-SubcarrierOffset in MIB.
* Option 3: Network includes cells supporting OD-SIB1 to list of excluded cells.
 | N/A |
| RAN2 understands the NW can avoid impact on legacy RRC connected UE and R19 RRC connected UE due to on-demand SIB1 (e.g. NES cell with OD-SIB1 is measured by legacy RRC\_CONNECTED UE and can be configured as its PSCell/SCells/target cell). | N/A |
| RAN2 conclude that on-demand SIB1 is feasible from RAN2 perspective and recommend normative work of case 2 for on-demand SIB1. | N/A |
| **RAN2#127bis** |
| We will inherit all agreements made during SI phase to WI phase. | N/A |
| A NES cell can include neighbouring NES cell’s WUS configuration. | N/A |
| NES cell’s WUS configuration, it is included in a new SIB (including its own WUS configuration). | Captured in Section X.Editor’s note 3: need to update IE name of SIB-X according to running RRC CR.  |
| In on-demand SIB1 procedure, the UE considers RACH failure when PREAMBLE\_TRANSMISSION\_COUNTER = preambleTransMax + 1. | N/A |
| The MAC layer will indicate the RACH failure for SI request to upper layers. FFS: after that the UE upper layer will consider the cell as barred. | N/A |
| The legacy UE behaviour can be reused upon on-demand SIB1 acquisition failure, i.e., the NES UE should follow the intraFreqReselection in MIB of NES cell. | Captured in new Section X. |
| A cell for which SIB1 request configuration is available, can periodically broadcast SIB1. | N/A |
| If UE has SIB1 request configuration of a cell, UE needs to check if SIB1 is currently being broadcasted or provided on demand for that cell before requesting SIB1 of that cell. | Captured In new Section X EN 5: details on how the OD-SIB1 UE determines the target OD-SIB1 cell doesn’t broadcast SIB1. |
| Legacy UEs bar the OD-SIB1 cell based on no SIB1 indication in MIB e.g. via ssb-SubcarrierOffset. Detailed solution is up to RAN1. If this works, no separate barring bit for R19 NES UEs is introduced. | Rely on existing barring of 38.304. |
| NES UEs should be allowed to reselect to cells that are prevented from legacy UEs (e.g. by excluded cell list, reselection priorities). | N/A (updated by later agreement) |
| RAN2 will not start the discussion on the issue when the UL WUS configuration update in Cell A is not synchronised with the UL WUS configuration update in the NES cell, unless we’re asked to do that by other WG, e.g. RAN3. | N/A |
| **RAN2#128** |
| Let’s wait for more RAN1 progress on Kssb discussion. | N/A |
| NES UE with SIB1 request configuration of a NES cell assumes that a NES cell, with SSB containing K\_SSB < 24 for FR1 and K\_SSB < 12 for FR2, will acquire SIB1 as in legacy. | N/A |
| New NES-specific reselection priority parameters for NES UEs are defined for the purpose of prioritizing/deprioritizing a NES frequency. | Captured in new Section X. |
| Introduce new IntraFreqExcludedCellList-NES / InterFreqExcludedCellList-NES IEs enable proper reselection behaviour of legacy and NES UEs. | Captured in new Section X. |
| Reuse legacy cell reselection criterion as trigger condition of OD-SIB1 acquisition. No need to specify other conditions (e.g. a new RSRP threshold). | Captured in new Section X. |
| The existing 1-second rule in the cell reselection criteria is still applied to the triggering condition of UL WUS transmission. | Rely on existing behavior of 38.304. |
| The UE considers the cell as barred after MAC indicates max number of preamble transmission for the OD-SIB1 request. | Captured in new Section X. |
| If MSG2 (ACK) is received, but UE fails to receive SIB1 then the UE may consider this cell as barred, no spec impact. | N/A |
| A UE bars the NES/SIB1 less cell and/or excludes it as a candidate for reselection since the UE had no corresponding UL WUS configuration, the UE would treat this cell as if cell status is “not barred” and consider it as candidate for cell reselection once it has received a UL-WUS configuration to request SIB1 for this cell. | Captured in new Section X. |
| UE considers WUS configuration only valid in directly succeeding cell reselection from cell where UE acquired WUS configuration. FFS on SI validity area rather than cell level. | Captured in new Section X. |
| Wait one cycle of RAN discussion (i.e. to see whether WID is updated or not to handle RRC connected UEs) | N/A |
| Working assumption: UL-WUS configuration in RRC release is not supported. | N/A |
| **RAN2#129** |
| There is no need for additional barring mechanisms (in addition to the k\_ssb signaling “no SIB1” indication in MIB) to handle legacy to be able to bar cell using OD-SIB1. | N/A |
| Specify the following UE behavior to allow the UEs in RRC\_CONNECTED state to acquire OD-SIB1 when T311 is running:- When T311 is running, the UE can trigger the OD-SIB1 acquisition procedure with stored UL WUS configuration in SIB-X, if it is still valid.- The legacy cell selection criteria are reused as the trigger condition of OD-SIB1 acquisition.- The OD-SIB1 acquisition behavior is same as that of RRC\_IDLE/IANCTIV UEs. | Captured in Section X. EN 4: details of UL WUS configuration and whether/how to capture the details. |
| The UE follows the legacy validity principle of stored SIB. | Captured in Section X.  |
| For Rel-19 NES UE in RRC\_CONNECTED, rely on the NW dedicated RRC for SIB1 delivery if searchSpaceSIB1 is not configured. It is legacy UE behavior and no spec change is expected. | N/A |
| SIB-x can be cell specific or area specific, as legacy. | N/A |
| Upon reception of RAR, the UE monitors OD-SIB1 in the window agreed by RAN1. | N/A |
| Proposal 5: For Rel-19 NES UE in RRC\_CONNECTED, if searchSpaceSIB1 is configured and SIB1 is not broadcasting, rely on the NW implementation to deliver SIB1 as baseline. * We will make conclusion on P5 next meeting.
 | EN 6: whether any specification impacts on the case that if searchSpaceSIB1 is configured and SIB1 is not broadcasting for an OD-SIB1 UE in RRC\_CONNECTED state.  |
| **RAN2#129bis** |
|  |  |
| **RAN2#130** |
|  |  |
| **RAN2#131** |
|  |  |
|  |  |

|  |
| --- |
| **Adaptation of common channels/signals** |
| **RAN2#125bis** |
| From the UE point of view, UE will monitor one PEI/PO every paging DRX cycle, i.e. the UE doesn’t skip PO in paging DRX cycle. | Captured in Section 7.1 |
| For adaptation of paging occasions in time domain, RAN2 to study a) bundle paging frames and b) extend the values of N to have increased interval between PFs (e.g. T/64, T/128 ...) and compensating decrease in number of PFs by increasing POs per PF. | N/A |
| For Paging adaptation, R2 discusses the following options on compatibility of legacy RRC\_IDLE/RRC\_INACTIVE UE:* Option 1: Prevent the access of legacy UE via barring;
* Option 2: Separate paging resources for legacy UEs and Rel-19 NES UEs (assuming there are legacy UEs)
 | N/A |
| **RAN2#126** |
| RAN2 counts on RAN1 evaluation and conclusion. | N/A |
| **RAN2#127** |
| Option-a) is about the bundling of PF for R19 NES UEs. | N/A |
| R2 observe that the option-a) and option-b) can be designed to configure the PO:s at same time position. | N/A |
| **RAN2#127bis** |
| Select option-b as baseline for R19 NES paging enhancement. | N/A |
| R2 should aim at signaling overhead minimization (e.g., Ns=8 and FFS for other larger values) | N/A |
| Allowing legacy and R19 UEs to co-ex in the same PF/PO is possible, based on NW configuration. | Captured in Section 7.1.  |
| Legacy UE is not barred. | N/A |
| Rel-19 UEs only monitor the PO(s) according to Rel-19 paging configuration. | Captured in Section 7.1. Editor’s note 1: details of Rel-19 paging configuration and whether/how to capture the details. |
| **RAN2#128** |
| Introduce value for Ns=8. FFS on 16. | N/A |
| Introduce value for N= T/32. FFS on T/64, T/128, T/256. | N/A |
| **RAN2#129** |
| For N, values smaller than T/32 are not supported. | N/A |
| The maximum possible value for Ns is 8. | N/A |
| Introduce a separate PEI configuration. | Captured in Section 7.2. Editor’s note 2: details of Rel-19 PEI configuration and whether/how to capture the details. |
| Paging adaptations are configured semi-statically and updated via system information update notification. | Captured in Section 7.2.  |
| A new UE capability is added for R19 NES paging enhancement, and the new capability is included in UE-RadioPagingInfo. FFS on whether we have a common capability for all NES features. | N/A |
| Legacy UEs and UEs non-capable of time domain PRACH adaptation are expected to use legacy PRACH resources per legacy configuration and procedures. No barring is needed. | N/A |
| * RAN2 starts CBRA for RACH adaptation.

RAN2 starts 4-step RACH adaptation | N/A |
| * From R2 perspective, not apply time-domain RACH adaptation to RACH resources for MSG1-based SI request.
* From R2 perspective, not apply time-domain RACH adaptation to IAB RACH resources.
 | N/A |
| * From R2 perspective, RACH adaptation is not modelled as RA feature(s).
* From R2 perspective, RACH partitioning with all the features, i.e. RedCap, SDT, and Slicing, and feature combinations, are supported for PRACH adaption in time domain.
 | N/A |
| * Will follow legacy mechanism regarding how to select RACH resource.
 | N/A |
| **RAN2#129bis** |
|  |  |
| **RAN2#130** |
|  |  |
| **RAN2#131** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

 |
|  |  |
| ***Consequences if not approved:*** | Release-19 network energy saving is not supported |
|  |  |
| ***Clauses affected:*** | 3.1, 3.2, 7.1, 7.2, X |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ... |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

First change

## 3.1 Definitions

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

**2Rx XR UE**:two antenna port XR UE as specified in TS 38.101-1 [15].

**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.

**Earth-fixed cell:** An NTN cell fixed with respect to a certain geographic area on the earth all the time. It can be provisioned by beam(s) continuously covering the same geographical areas all the time (e.g., the case of GSO satellites).

**Earth-moving cell**: An NTN cell moving on the ground. It can be provisioned by beam(s) whose coverage area slides over the Earth surface (e.g., the case of NGSO satellites generating fixed or non-steerable beams).

**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.

**Equivalent SNPN list**:List of SNPNs 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 4.2.22 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.

**Mobile-IAB cell**: As defined in TS 38.300 [2].

**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/or A2X Communication as defined in TS 23.256 [26], and ProSe communication (including ProSe non-Relay, UE-to-Network Relay communication and, UE-to-UE Relay communication including UE-to-UE Relay communication with integrated discovery) 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, ProSe UE-to-Network Relay discovery and ProSe UE-to-UE 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.

**OD-SIB1 Cell**: A cell that may transmit SIB1 in response to UL WUS from a UE.

**OD-SIB1 UE**: A UE that supports on-demand SIB1 acqusition procedure via UL WUS.

**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. It 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.

**Ranging/Sidelink Positioning**: AS functionality enabling ranging-based services and sidelink positioning as defined in TS 23.586 [25].

**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.

**U2U Relay UE**: a UE that provides functionality to support connectivity for U2U Remote UE(s).

**U2U Remote UE**: a UE that communicates with other UE(s) via a U2U 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.

Next change

## 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

ATG Air To Ground

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

DTX Discontinuous Transmission

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

NCR Network-Controlled Repeater

NCR-Fwd NCR Forwarding

NCR-MT NCR Mobile Termination

NES Network Energy Savings

NID Network Identifier

NPN Non-Public Network

NR NR Radio Access

NSAG Network Slice AS Group

NTN Non-Terrestrial Network

OD-SIB1 On Demand SIB1

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

TN Terrestrial Network

TRS Tracking Reference Signal

U2N UE-to-Network

U2U UE-to-UE

UAC Unified Access Control

UE User Equipment

UL WUS Uplink Wake-Up Signal

UMTS Universal Mobile Telecommunications System

VSAT Very Small Aperture Terminal

V2X Vehicle to Everything

Next change

## 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 configured by RRC (if any), the UE specific DRX value configured by upper layers (if any), and a default DRX value broadcast in system information. For L2 U2N Relay UE, T for a L2 U2N Remote UE is determined by the shortest of the UE specific DRX value provided in PC5-RRC signalling and a default DRX value broadcast in system information.

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 (if any), and 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 configured by RRC, the UE specific DRX value configured by upper layers (if any), 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.

For a UE supporting paging adaptation, if another set of paging configuration is signaled in system information, it only monitors the PO(s) derived from this set of paging parameters. In this case, the UE still monitors one PO per DRX cycle. Based on Network configuration, it is allowed that the UE(s) supporting paging adaptation to monitor the same PO as the UE(s) which don’t support paging adaptation. Paging adaptation configuration can only be updated via system information update notification.

Editor’s note 1: details of Rel-19 paging configuration and whether/how to capture the details.

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.

Next change

### 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].

For a UE supporting paging adaptation and PEI, if another set of PEI configuration is signaled in system information, it only monitors the PEI derived from this set of PEI parameters. In this case, the UE still monitors one PEI per DRX cycle.

Editor’s note 2: details of Rel-19 PEI configuration and whether/how to capture the details.

Next change

# X UL WUS operation

For an OD-SIB1 UE in RRC\_IDLE or RRC\_INACTIVE state, it may acquire UL WUS configuration from SIB-X of its camping cell for request of SIB1 transmission in one OD-SIB1 cell. The SIB-X can be cell specific configured or area specific configured, and the OD-SIB1 UE determines whether it is valid according to the validity mechanism defined in TS 38.331 [3].

If dedicated frequenecy priority parameters are provided in system information, the OD-SIB1 UE ignores the *cellReselectionPriority* in the system information and applies dedicated ones to determine frequency prioritization in accordance with Section 5.2.4.1. If dedicated inter-frequency and/or intra-frequecy excluded cell lists are provided in system information, the OD-SIB1 UE ignores *intraFreqExcludedCellList / interFreqExcludedCellList* and doesn’t consider the cell(s) in the dedicated lists as candidates for cell reselection.

When one intra-frequency / inter-frequency neighbor OD-SIB1 cell satisfies the cell reselection criterion defined in Section 5.2.4.5 and Section 5.2.4.6 and doesn’t broadcast SIB1, the OD-SIB1 UE triggers the UL WUS transmission towards this OD-SIB1 cell with the RACH procedure defined in TS 38.321 [19].

The OD-SIB1 UE determines the cell reservations and access restrictions in accordance with Section 5. On top of it, OD-SIB1 UE considers the OD-SIB1 cell as if cell status is “barred” and excludes it as a candidate for reselection in the following cases:

* if it has no corresponding UL WUS configuration, or
* if the RACH procedure to acquire OD-SIB1 is failed, or
* if it fails to acquire SIB1.

Meanwhile, the OD-SIB1 UE would treat the OD-SIB1 cell as if cell status is “not barred” and consider it as candidate for cell reselection in the following cases:

* if it hasn’t acquired SIB1 from the OD-SIB1 cell before initialization of OD-SIB1 procedure but has received a valid UL WUS configuration, or
* if it regarded the OD-SIB1 cell as if cell status is “barred” due to lack of corresponding UL WUS configuration before but has received a valid UL-WUS configuration.

After the OD-SIB1 UE successfully receives SIB1 from the selected OD-SIB1 Cell and if it is a suitable cell, it camps in the OD-SIB1 Cell and follows the behavior of Camped Normally state specified in Section 5.2.5. The OD-SIB1 UE may receive UL WUS configuration updates in SIB-X via the system information modification procedures defined in TS 38.331 [3].

For an OD-SIB1 UE in RRC\_CONNECTED state, after the RRC re-estabslihement procedure is triggered in accordance with TS 38.331 [3], it may trigger the OD-SIB1 acquisition procedure with the stored UL WUS configuration in SIB-X, if it is determined as valid according to the validity mechanism defined in TS 38.331 [3]. In more details, when one OD-SIB1 cell satisfies the cell selection criterion defined in Section 5.2.3.2 and doesn’t broadcast SIB1, the UE triggers the UL WUS transmission towards the selected OD-SIB1 cell with the same RACH procedure as the OD-SIB1 UE in RRC\_IDLE and RRC\_INACTIVE state defined in TS 38.321 [19].

Editor’s note 3: need to update IE name of SIB-X according to running RRC CR.

Editor’s note 4: details of UL WUS configuration and whether/how to capture the details.

Editor’s note 5: details on how the OD-SIB1 UE determines the target OD-SIB1 cell doesn’t broadcast SIB1.

Editor’s note 6: whether any specification impacts on the case that if searchSpaceSIB1 is configured and SIB1 is not broadcasting for an OD-SIB1 UE in RRC\_CONNECTED state.