**3GPP TSG-RAN WG2 Meeting #122**R2-230xxxx

**Incheon, Korea, May 22-26, 2023**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **38.300** | **CR** |  | **rev** | **-** | **Current version:** | **17.4.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Running CR for TS 38.300 for Rel-18 eRedCap | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | OPPO | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_redcap\_enh-Core | | | | |  | ***Date:*** | | | 2023-05-07 |
|  |  | | | |  | |  | | |  |
| ***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 can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
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| ***Reason for change:*** | | Introduction of the Release-18 eRedCap. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | The Relase-18 eRedCap are not supported. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 3.2, 9.2.4, 9.2.6, 9.2.7, 9.2.8, 9.2.10, 16.13, 16.13.1, 16.13.2, 16.13.3, 16.13.4, 16.13.5 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | TS 38.321 CRxxxx, TS 38.331 CRyyyy, TS 38.304 CRzzzz | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

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| Start of change |

## 3.2 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], in TS 36.300 [2] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1] and TS 36.300 [2].

**BH RLC channel**: an RLC channel between two nodes, which is used to transport backhaul packets**.**

**Boundary IAB-node:** as defined in TS 38.401 [4].

**Broadcast MRB**:A radio bearer configured for MBS broadcast delivery.

**CAG Cell**:a PLMN cell broadcasting at least one Closed Access Group identity.

**CAG Member Cell**:for a UE, a CAG cell broadcasting the identity of the selected PLMN, registered PLMN or equivalent PLMN, and for that PLMN, a CAG identifier belonging to the Allowed CAG list of the UE for that PLMN.

**CAG-only cell**: a CAG cell that is only available for normal service for CAG UEs.

**Cell-Defining SSB**: an SSB with an RMSI associated.

**Child node**: IAB-DU's and IAB-donor-DU's next hop neighbour node; the child node is also an IAB-node.

**Conditional Handover (CHO**): a handover procedure that is executed only when execution condition(s) are met.

**CORESET#0**: the control resource set for at least SIB1 scheduling, can be configured either via MIB or via dedicated RRC signalling.

**DAPS Handover**: a handover procedure that maintains the source gNB connection after reception of RRC message for handover and until releasing the source cell after successful random access to the target gNB.

**Direct Path**: a type of UE-to-Network transmission path, where data is transmitted between a UE and the network without sidelink relaying.

**Downstream**: direction toward child node or UE in IAB-topology.

**Early Data Forwarding**: data forwarding that is initiated before the UE executes the handover.

**Earth-centered, earth-fixed**: a global geodetic reference system for the Earth intended for practical applications of mapping, charting, geopositioning and navigation, as specified in NIMA TR 8350.2 [51].

**eRedCap UE**: a UE with enhanced reduced capabilities as specified in clause x.x.x.x in TS 38.306 [11].

**Feeder link**: wireless link between the NTN Gateway and the NTN payload.

**Geosynchronous Orbit**: earth-centered orbit at approximately 35786 kilometres above Earth's surface and synchronised with Earth's rotation. A geostationary orbit is a non-inclined geosynchronous orbit, i.e. in the Earth's equator plane.

**Group ID for Network Selection**: an identifier used during SNPN selection to enhance the likelihood of selecting a preferred SNPN that supports a Default Credentials Server or a Credentials Holder, as specified in TS 23.501 [3].

**gNB**: node providing NR user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**High Altitude Platform Station**: airborne vehicle embarking the NTN payload placed at an altitude between 8 and 50 km.

**IAB-donor**:gNB that provides network access to UEs via a network of backhaul and access links.

**IAB-donor-CU**: as defined in TS 38.401 [4].

**IAB-donor-DU**:as defined in TS 38.401 [4].

**IAB-DU**: gNB-DU functionality supported by the IAB-node to terminate the NR access interface to UEs and next-hop IAB-nodes, and to terminate the F1 protocol to the gNB-CU functionality, as defined in TS 38.401 [4], on the IAB-donor.

**IAB-MT**: IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise. IAB-MT function used in 38-series of 3GPP Specifications corresponds to IAB-UE function defined in TS 23.501 [3].

**IAB-node**: RAN node that supports NR access links to UEs and NR backhaul links to parent nodes and child nodes. The IAB-node does not support backhauling via LTE.

**IAB topology**: the unison of all IAB-nodes and IAB-donor-DUs whose F1 and/or RRC connections are terminated at the same IAB-donor-CU.

**Indirect Path**: a type of UE-to-Network transmission path, where data is forwarded via a U2N Relay UE between a U2N Remote UE and the network.

**Inter-donor partial migration:** migration of an IAB-MT to a parent node underneath a different IAB-donor-CU while the collocated IAB-DU and its descendant IAB-node(s), if any, are terminated at the initial IAB-donor-CU. The procedure renders the said IAB-node as a boundary IAB-node.

**Intra-system Handover**:handover that does not involve a CN change (EPC or 5GC).

**Inter-system Handover**:handover that involves a CN change (EPC or 5GC).

**Late Data Forwarding**: data forwarding that is initiated after the source NG-RAN node knows that the UE has successfully accessed a target NG-RAN node.

**Mapped Cell ID**: in NTN, it corresponds to a fixed geographical area.

**MBS Radio Bearer**: A radio bearer configured for MBS delivery.

**MSG1**: preamble transmission of the random access procedure for 4-step random access (RA) type.

**MSG3**: first scheduled transmission of the random access procedure.

**MSGA**:preamble and payload transmissions of the random access procedure for 2-step RA type.

**MSGB**:response to MSGA in the 2-step random access procedure. MSGB may consist of response(s) for contention resolution, fallback indication(s), and backoff indication.

**Multicast/Broadcast Service**: A point-to-multipoint service as defined in TS 23.247 [45].

**Multicast MRB**:A radio bearer configured for MBS multicast delivery.

**Multi-hop backhauling**: using a chain of NR backhaul links between an IAB-node and an IAB-donor.

**ng-eNB**: node providing E-UTRA user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**NG-C**: control plane interface between NG-RAN and 5GC.

**NG-U**: user plane interface between NG-RAN and 5GC.

**NG-RAN node**: either a gNB or an ng-eNB.

**Non-CAG Cell**: a PLMN cell which does not broadcast any Closed Access Group identity.

**Non-Geosynchronous orbit**: earth-centered orbit with an orbital period that does not match Earth's rotation on its axis. This includes Low and Medium Earth Orbit (LEO and MEO). LEO operates at altitudes between 300 km and 1500 km and MEO at altitudes between 7000 km and 25000 km, approximately.

**Non-terrestrial network**: an NG-RAN consisting of gNBs, which provide 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 backhaul link**: NR link used for backhauling between an IAB-node and an IAB-donor, and between IAB-nodes in case of a multi-hop backhauling.

**NR sidelink communication**: AS functionality enabling at least V2X communication as defined in TS 23.287 [40] and the ProSe communication (including ProSe non-Relay and UE-to-Network Relay communication) as defined in TS 23.304 [48], 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 [48] between two or more nearby UEs, using NR technology but not traversing any network node.

**NTN Gateway**: an earth station located at the surface of the earth, providing connectivity to the NTN payload using the feeder link. An NTN Gateway is a TNL node.

**NTN payload**: a network node, embarked on board a satellite or high altitude platform station, providing connectivity functions, between the service link and the feeder link. In the current version of this specification, the NTN payload is a TNL node.

**Numerology**: corresponds to one subcarrier spacing in the frequency domain. By scaling a reference subcarrier spacing by an integer *N*, different numerologies can be defined.

**Parent node**: IAB-MT's next hop neighbour node; the parent node can be IAB-node or IAB-donor-DU

**PC5 Relay RLC channel**: an RLC channel between L2 U2N Remote UE and L2 U2N Relay UE, which is used to transport packets over PC5 for L2 UE-to-Network Relay**.**

**PLMN Cell**: a cell of the PLMN.

**RedCap UE**: a UE with reduced capabilities as specified in clause 4.2.21.1 in TS 38.306 [11].

**Relay discovery**: AS functionality enabling 5G ProSe UE-to-Network Relay Discovery as defined in TS 23.304 [48], using NR technology but not traversing any network node.

**Satellite**:a space-borne vehicle orbiting the Earth embarking the NTN payload.

**Service link**:wireless link between the NTN payload and UE.

**SNPN Access Mode**: mode of operation whereby a UE only accesses SNPNs.

**SNPN-only cell**: a cell that is only available for normal service for SNPN subscribers.

**SNPN Identity**: the identity of Stand-alone NPN defined by the pair (PLMN ID, NID).

**Transmit/Receive Point**:part of the gNB transmitting and receiving radio signals to/from UE according to physical layer properties and parameters inherent to that element.

**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.

**Upstream**: direction toward parent node in IAB-topology.

**Uu Relay RLC channel**: an RLC channel between L2 U2N Relay UE and gNB, which is used to transport packets over Uu for L2 UE-to-Network Relay**.**

**V2X sidelink communication**: AS functionality enabling V2X communication as defined in TS 23.285 [41], between nearby UEs, using E-UTRA technology but not traversing any network node.

**Xn**: network interface between NG-RAN nodes.

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### 9.2.4 Measurements

In RRC\_CONNECTED, the UE measures multiple beams (at least one) of a cell and the measurements results (power values) are averaged to derive the cell quality. In doing so, the UE is configured to consider a subset of the detected beams. Filtering takes place at two different levels: at the physical layer to derive beam quality and then at RRC level to derive cell quality from multiple beams. Cell quality from beam measurements is derived in the same way for the serving cell(s) and for the non-serving cell(s). Measurement reports may contain the measurement results of the *X* best beams if the UE is configured to do so by the gNB.

The corresponding high-level measurement model is described below:



Figure 9.2.4-1: Measurement Model

NOTE 1: K beams correspond to the measurements on SSB or CSI-RS resources configured for L3 mobility by gNB and detected by UE at L1.

- **A**: measurements (beam specific samples) internal to the physical layer.

- **Layer 1 filtering**: internal layer 1 filtering of the inputs measured at point A. Exact filtering is implementation dependent. How the measurements are actually executed in the physical layer by an implementation (inputs A and Layer 1 filtering) is not constrained by the standard.

- **A1**: measurements (i.e. beam specific measurements) reported by layer 1 to layer 3 after layer 1 filtering.

**- Beam Consolidation/Selection**: beam specific measurements are consolidated to derive cell quality. The behaviour of the Beam consolidation/selection is standardised and the configuration of this module is provided by RRC signalling. Reporting period at B equals one measurement period at A1.

**- B**: a measurement (i.e. cell quality) derived from beam-specific measurements reported to layer 3 after beam consolidation/selection.

- **Layer 3 filtering for cell quality**: filtering performed on the measurements provided at point B. The behaviour of the Layer 3 filters is standardised and the configuration of the layer 3 filters is provided by RRC signalling. Filtering reporting period at C equals one measurement period at B.

- **C**: a measurement after processing in the layer 3 filter. The reporting rate is identical to the reporting rate at point B. This measurement is used as input for one or more evaluation of reporting criteria.

- **Evaluation of reporting criteria**: checks whether actual measurement reporting is necessary at point D. The evaluation can be based on more than one flow of measurements at reference point C e.g. to compare between different measurements. This is illustrated by input C and C1. The UE shall evaluate the reporting criteria at least every time a new measurement result is reported at point C, C1. The reporting criteria are standardised and the configuration is provided by RRC signalling (UE measurements).

- **D**: measurement report information (message) sent on the radio interface.

- **L3 Beam filtering**: filtering performed on the measurements (i.e. beam specific measurements) provided at point A1. The behaviour of the beam filters is standardised and the configuration of the beam filters is provided by RRC signalling. Filtering reporting period at E equals one measurement period at A1.

- **E**: a measurement (i.e. beam-specific measurement) after processing in the beam filter. The reporting rate is identical to the reporting rate at point A1. This measurement is used as input for selecting the X measurements to be reported.

- **Beam Selection for beam reporting**: selects the X measurements from the measurements provided at point E. The behaviour of the beam selection is standardised and the configuration of this module is provided by RRC signalling.

- **F**: beam measurement information included in measurement report (sent) on the radio interface.

Layer 1 filtering introduces a certain level of measurement averaging. How and when the UE exactly performs the required measurements is implementation specific to the point that the output at B fulfils the performance requirements set in TS 38.133 [13]. Layer 3 filtering for cell quality and related parameters used are specified in TS 38.331 [12] and do not introduce any delay in the sample availability between B and C. Measurement at point C, C1 is the input used in the event evaluation. L3 Beam filtering and related parameters used are specified in TS 38.331 [12] and do not introduce any delay in the sample availability between E and F.

Measurement reports are characterized by the following:

- Measurement reports include the measurement identity of the associated measurement configuration that triggered the reporting;

- Cell and beam measurement quantities to be included in measurement reports are configured by the network;

- The number of non-serving cells to be reported can be limited through configuration by the network;

- Cells belonging to an exclude-list configured by the network are not used in event evaluation and reporting, and conversely when an allow-list is configured by the network, only the cells belonging to the allow-list are used in event evaluation and reporting;

- Beam measurements to be included in measurement reports are configured by the network (beam identifier only, measurement result and beam identifier, or no beam reporting).

Intra-frequency neighbour (cell) measurements and inter-frequency neighbour (cell) measurements are defined as follows:

- SSB based intra-frequency measurement: a measurement is defined as an SSB based intra-frequency measurement provided the center frequency of the SSB of the serving cell and the center frequency of the SSB of the neighbour cell are the same, and the subcarrier spacing of the two SSBs is also the same.

- SSB based inter-frequency measurement: a measurement is defined as an SSB based inter-frequency measurement provided the center frequency of the SSB of the serving cell and the center frequency of the SSB of the neighbour cell are different, or the subcarrier spacing of the two SSBs is different.

NOTE 2: For SSB based measurements, one measurement object corresponds to one SSB and the UE considers different SSBs as different cells.

NOTE 2a: If an (e)RedCap UE is configured to perform serving cell measurements based on an NCD-SSB configured in its active BWP, this NCD-SSB is considered as the SSB of the serving cell in the definition of intra-frequency and inter-frequency measurements as above.

- CSI-RS based intra-frequency measurement: a measurement is defined as a CSI-RS based intra-frequency measurement provided that:

- The subcarrier spacing of CSI-RS resources on the neighbour cell configured for measurement is the same as the SCS of CSI-RS resources on the serving cell indicated for measurement; and

- For 60kHz subcarrier spacing, the CP type of CSI-RS resources on the neighbour cell configured for measurement is the same as the CP type of CSI-RS resources on the serving cell indicated for measurement; and

- The centre frequency of CSI-RS resources on the neighbour cell configured for measurement is the same as the centre frequency of CSI-RS resource on the serving cell indicated for measurement.

- CSI-RS based inter-frequency measurement: a measurement is defined as a CSI-RS based inter-frequency measurement if it is not a CSI-RS based intra-frequency measurement.

NOTE 3: Extended CP for CSI-RS based measurement is not supported in this release.

Whether a measurement is non-gap-assisted or gap-assisted depends on the capability of the UE, the active BWP of the UE and the current operating frequency:

- For SSB based inter-frequency measurement, if the measurement gap requirement information is reported by the UE, a measurement gap configuration may be provided according to the information. Otherwise, a measurement gap configuration is always provided in the following cases:

- If the UE only supports per-UE measurement gaps;

- If the UE supports per-FR measurement gaps and any of the serving cells are in the same frequency range of the measurement object.

- For SSB based intra-frequency measurement, if the measurement gap requirement information is reported by the UE, a measurement gap configuration may be provided according to the information. Otherwise, a measurement gap configuration is always provided in the following case:

- Other than the initial BWP, if any of the UE or (e)RedCap UE configured BWPs do not contain the frequency domain resources of the SSB associated to the initial DL BWP, and for (e)RedCap UE, are not configured with NCD-SSB for serving cell measurement.

In non-gap-assisted scenarios, the UE shall be able to carry out such measurements without measurement gaps. In gap-assisted scenarios, the UE cannot be assumed to be able to carry out such measurements without measurement gaps.

Network may request the UE to measure NR and/or E-UTRA carriers in RRC\_IDLE or RRC\_INACTIVE via system information or via dedicated measurement configuration in *RRCRelease*. If the UE was configured to perform measurements of NR and/or E-UTRA carriers while in RRC\_IDLE or in RRC\_INACTIVE, it may provide an indication of the availability of corresponding measurement results to the gNB in the *RRCSetupComplete* message. The network may request the UE to report those measurements after security activation. The request for the measurements can be sent by the network immediately after transmitting the Security Mode Command (i.e. before the reception of the Security Mode Complete from the UE).

If the UE was configured to perform measurements of NR and/or E-UTRA carriers while in RRC\_INACTIVE, the gNB can request the UE to provide corresponding measurement results in the *RRCResume* message and then the UE can include the available measurement results in the *RRCResumeComplete* message. Alternatively, the UE may provide an indication of the availability of the measurement results to the gNB in the *RRCResumeComplete* message and the gNB can then request the UE to provide these measurement results.

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9.2.6 Random Access Procedure

The random access procedure is triggered by a number of events:

- Initial access from RRC\_IDLE;

- RRC Connection Re-establishment procedure;

- DL or UL data arrival, during RRC\_CONNECTED or during RRC\_INACTIVE while SDT procedure (see clause 18.0) is ongoing, when UL synchronisation status is "non-synchronised";

- UL data arrival, during RRC\_CONNECTED or during RRC\_INACTIVE while SDT procedure is ongoing, when there are no PUCCH resources for SR available;

- SR failure;

- Request by RRC upon synchronous reconfiguration (e.g. handover);

- RRC Connection Resume procedure from RRC\_INACTIVE;

- To establish time alignment for a secondary TAG;

- Request for Other SI (see clause 7.3);

- Beam failure recovery;

- Consistent UL LBT failure on SpCell;

- SDT in RRC\_INACTIVE (see clause 18);

- Positioning purpose during RRC\_CONNECTED requiring random access procedure, e.g., when timing advance is needed for UE positioning.

Two types of random access procedure are supported: 4-step RA type with MSG1 and 2-step RA type with MSGA. Both types of RA procedure support contention-based random access (CBRA) and contention-free random access (CFRA) as shown on Figure 9.2.6-1 below.

The UE selects the type of random access at initiation of the random access procedure based on network configuration:

- when CFRA resources are not configured, an RSRP threshold is used by the UE to select between 2-step RA type and 4-step RA type;

- when CFRA resources for 4-step RA type are configured, UE performs random access with 4-step RA type;

- when CFRA resources for 2-step RA type are configured, UE performs random access with 2-step RA type.

The network does not configure CFRA resources for 4-step and 2-step RA types at the same time for a Bandwidth Part (BWP). CFRA with 2-step RA type is only supported for handover.

The MSG1 of the 4-step RA type consists of a preamble on PRACH. After MSG1 transmission, the UE monitors for a response from the network within a configured window. For CFRA, dedicated preamble for MSG1 transmission is assigned by the network and upon receiving random access response from the network, the UE ends the random access procedure as shown in Figure 9.2.6-1(c). For CBRA, upon reception of the random access response, the UE sends MSG3 using the UL grant scheduled in the response and monitors contention resolution as shown in Figure 9.2.6-1(a). If contention resolution is not successful after MSG3 (re)transmission(s), the UE goes back to MSG1 transmission.

The MSGA of the 2-step RA type includes a preamble on PRACH and a payload on PUSCH. After MSGA transmission, the UE monitors for a response from the network within a configured window. For CFRA, dedicated preamble and PUSCH resource are configured for MSGA transmission and upon receiving the network response, the UE ends the random access procedure as shown in Figure 9.2.6-1(d). For CBRA, if contention resolution is successful upon receiving the network response, the UE ends the random access procedure as shown in Figure 9.2.6-1(b); while if fallback indication is received in MSGB, the UE performs MSG3 transmission using the UL grant scheduled in the fallback indication and monitors contention resolution as shown in Figure 9.2.6-2. If contention resolution is not successful after MSG3 (re)transmission(s), the UE goes back to MSGA transmission.

If the random access procedure with 2-step RA type is not completed after a number of MSGA transmissions, the UE can be configured to switch to CBRA with 4-step RA type.

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**(a) CBRA with 4-step RA type (b) CBRA with 2-step RA type**

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**(c) CFRA with 4-step RA type (d) CFRA with 2-step RA type**

**Figure 9.2.6-1: Random Access Procedures**

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**Figure 9.2.6-2: Fallback for CBRA with 2-step RA type**

For random access in a cell configured with SUL, the network can explicitly signal which carrier to use (UL or SUL). Otherwise, the UE selects the SUL carrier if and only if the measured quality of the DL is lower than a broadcast threshold. UE performs carrier selection before selecting between 2-step and 4-step RA type. The RSRP threshold for selecting between 2-step and 4-step RA type can be configured separately for UL and SUL. Once started, all uplink transmissions of the random access procedure remain on the selected carrier.

The network can associate a set of RACH resources with feature(s) applicable to a Random Access procedure: Network Slicing (see clause 16.3), (e)RedCap (see clause 16.13), SDT (see clause 18), and NR coverage enhancement (see clause 19). A set of RACH resources associated with a feature is only valid for random access procedures applicable to at least that feature; and a set of RACH resources associated with several features is only valid for random access procedures having at least all of these features. The UE selects the set(s) of applicable RACH resources, after uplink carrier (i.e. NUL or SUL) and BWP selection and before selecting the RA type.

When CA is configured, random access procedure with 2-step RA type is only performed on PCell while contention resolution can be cross-scheduled by the PCell.

When CA is configured, for random access procedure with 4-step RA type, the first three steps of CBRA always occur on the PCell while contention resolution (step 4) can be cross-scheduled by the PCell. The three steps of a CFRA started on the PCell remain on the PCell. CFRA on SCell can only be initiated by the gNB to establish timing advance for a secondary TAG: the procedure is initiated by the gNB with a PDCCH order (step 0) that is sent on an activated SCell of the secondary TAG, preamble transmission (step 1) takes place on the SCell, and Random Access Response (step 2) takes place on PCell.

9.2.7 Radio Link Failure

In RRC\_CONNECTED, the UE performs Radio Link Monitoring (RLM) in the active BWP based on reference signals (SSB/CSI-RS) and signal quality thresholds configured by the network. SSB-based RLM is based on the SSB associated to the initial DL BWP and can be configured for the initial DL BWP and for DL BWPs containing the SSB associated to the initial DL BWP. Besides, SSB-based RLM can be also performed based on the non-cell defining SSB, if configured for (e)RedCap UEs. For other DL BWPs, RLM can only be performed based on CSI-RS. In case of DAPS handover, the UE continues the detection of radio link failure at the source cell until the successful completion of the random access procedure to the target cell.

The UE declares Radio Link Failure (RLF) when one of the following criteria are met:

- Expiry of a radio problem timer started after indication of radio problems from the physical layer (if radio problems are recovered before the timer is expired, the UE stops the timer); or

- Expiry of a timer started upon triggering a measurement report for a measurement identity for which the timer has been configured while another radio problem timer is running; or

- Random access procedure failure; or

- RLC failure; or

- Detection of consistent uplink LBT failures for operation with shared spectrum channel access as described in 5.6.1; or

- For IAB-MT, the reception of a BH RLF indication received from its parent node.

After RLF is declared, the UE:

- stays in RRC\_CONNECTED;

- in case of DAPS handover, for RLF in the source cell:

- stops any data transmission or reception via the source link and releases the source link, but maintains the source RRC configuration;

- if handover failure is then declared at the target cell, the UE:

- selects a suitable cell and then initiates RRC re-establishment;

- enters RRC\_IDLE if a suitable cell was not found within a certain time after handover failure was declared.

- in case of CHO, for RLF in the source cell:

- selects a suitable cell and if the selected cell is a CHO candidate and if network configured the UE to try CHO after RLF then the UE attempts CHO execution once, otherwise re-establishment is performed;

- enters RRC\_IDLE if a suitable cell was not found within a certain time after RLF was declared.

- otherwise, for RLF in the serving cell or in case of DAPS handover, for RLF in the target cell before releasing the source cell:

- selects a suitable cell and then initiates RRC re-establishment;

- enters RRC\_IDLE if a suitable cell was not found within a certain time after RLF was declared.

When RLF occurs at the IAB BH link, the same mechanisms and procedures are applied as for the access link. This includes BH RLF detection and RLF recovery.

The IAB-DU can transmit a BH RLF detection indication to its child nodes in the following cases:

- The collocated IAB-MT initiates RRC re-establishment;

- The collocated IAB-MT is dual-connected, detects BH RLF on a BH link, and cannot perform UL re-routing for any traffic. This includes the scenario of an IAB-node operating in EN-DC or NR-DC, which uses only one link for backhauling and has BH RLF on this BH link;

- The collocated IAB-MT has received a BH RLF detection indication from a parent node, and there is no remaining backhaul link that is unaffected by the BH RLF condition indicated.

Upon reception of the BH RLF detection indication, the child node may perform local rerouting for upstream traffic, if possible, over an available BH link.

If the IAB-DU has transmitted a BH RLF detection indication to a child node due to an RLF condition on the collocated IAB-MT's parent link, and the collocated IAB-MT's subsequent RLF recovery is successful, the IAB-DU may transmit a BH RLF recovery indication to this child node.

If the IAB-DU has transmitted a BH RLF detection indication to a child node due to the reception of a BH RLF detection indication by the collocated IAB-MT, and the collocated IAB-MT receives a BH RLF recovery indication, the IAB-DU may also transmit a BH RLF recovery indication to this child node.

Upon reception of the BH RLF recovery indication, the child node reverts the actions triggered by the reception of the previous BH RLF detection indication.

In case the RRC re-establishment procedure fails, the IAB-node may transmit a BH RLF indication to its child nodes. The BH RLF detection indication, BH RLF recovery indication and BH RLF indication are transmitted as BAP Control PDUs.

9.2.8 Beam failure detection and recovery

For beam failure detection, the gNB configures the UE with beam failure detection reference signals (SSB or CSI-RS) and the UE declares beam failure when the number of beam failure instance indications from the physical layer reaches a configured threshold before a configured timer expires. For beam failure detection in multi-TRP operation, the gNB configures the UE with two sets of beam failure detection reference signals, and the UE declares beam failure for a TRP / BFD-RS set when the number of beam failure instance indications associated with the corresponding set of beam failure detection reference signals from the physical layer reaches a configured threshold before a configured timer expires.

SSB-based Beam Failure Detection is based on the SSB associated to the initial DL BWP and can be configured for the initial DL BWPs and for DL BWPs containing the SSB associated to the initial DL BWP. Besides, SSB-based Beam Failure Detection can be also performed based on the non-cell defining SSB, if configured for (e)RedCap UEs. For other DL BWPs, Beam Failure Detection can only be performed based on CSI-RS.

After beam failure is detected on PCell, the UE:

- triggers beam failure recovery by initiating a Random Access procedure on the PCell;

- selects a suitable beam to perform beam failure recovery (if the gNB has provided dedicated Random Access resources for certain beams, those will be prioritized by the UE).

- includes an indication of a beam failure on PCell in a BFR MAC CE if the Random Access procedure involves contention-based random access.

Upon completion of the Random Access procedure, beam failure recovery for PCell is considered complete.

After beam failure is detected on an SCell, the UE:

- triggers beam failure recovery by initiating a transmission of a BFR MAC CE for this SCell;

- selects a suitable beam for this SCell (if available) and indicates it along with the information about the beam failure in the BFR MAC CE.

Upon reception of a PDCCH indicating an uplink grant for a new transmission for the HARQ process used for the transmission of the BFR MAC CE, beam failure recovery for this SCell is considered complete.

After beam failure is detected for a BFD-RS set of a Serving Cell, the UE:

- triggers beam failure recovery by initiating a transmission of a BFR MAC CE for this BFD-RS set;

- selects a suitable beam for this BFD-RS set (if available) and indicates whether the suitable (new) beam is found or not along with the information about the beam failure in the BFR MAC CE for this BFD-RS set.

Upon reception of a PDCCH indicating an uplink grant for a new transmission for the HARQ process used for the transmission of the BFR MAC CE for this BFD-RS set, beam failure recovery for this BFD-RS set is considered complete.

After beam failure is detected for both BFD-RS sets of PCell concurrently, the UE:

- triggers beam failure recovery by initiating a Random Access procedure on the PCell;

- selects a suitable beam for each failed BFD-RS set (if available) and indicates whether the suitable (new) beam is found or not along with the information about the beam failure in the BFR MAC CE for each failed BFD-RS set;

- upon completion of the Random Access procedure, beam failure recovery for both BFD-RS sets of PCell is considered complete.

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### 9.2.10 Extended DRX for RRC\_IDLE and RRC\_INACTIVE

When extended DRX (eDRX) is used, the following applies:

- For RRC\_INACTIVE, eDRX configuration for RAN paging is decided and configured by NG-RAN. In RRC\_INACTIVE the UE monitors both RAN and CN paging;

- For RRC\_IDLE, eDRX for CN paging is configured by upper layers. In RRC\_IDLE the UE monitors only CN paging;

- Information on whether eDRX for CN paging and RAN paging is allowed on the cell is provided separately in system information;

- The maximum value of the eDRX cycle is 10485.76 seconds (2.91 hours) for both RRC\_IDLE and RRC\_INACTIVE, while the minimum value of the eDRX cycle is 2.56 seconds for both RRC\_IDLE and RRC\_INACTIVE;

- The hyper SFN (H-SFN) is broadcast by the cell and increments by one when the SFN wraps around;

- Paging Hyperframe (PH) refers to the H-SFN in which the UE starts monitoring paging according to DRX during a Paging Time Window (PTW) used in RRC\_IDLE and RRC\_INACTIVE. The PH and PTW are determined based on a formula (see TS 38.304 [10]) that is known by the AMF, UE and NG-RAN;

- H-SFN, PH and PTW are used if the eDRX cycle is greater than 10.24 seconds;

- When the RRC\_IDLE eDRX cycle is longer than the system information modification period, the UE verifies that stored system information remains valid before establishing an RRC connection.

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## 16.13 Support of Reduced Capability (RedCap) and enhanced Reduced Capability (eRedCap) NR devices

### 16.13.1 Introduction

A RedCap UE has reduced capabilities with the intention to have lower complexity with respect to non-RedCap UEs. It is mandatory for a RedCap UE to support 20 MHz maximum UE channel bandwidth in FR1 and 100 MHz in FR2. An eRedCap UE has further reduced capabilities with the intention to have lower complexity with respect to RedCap UEs.

Editor’s note: FFS on how to capture bandwidth reduction and UE peak data rate reduction for an eRedCap UE.

### 16.13.2 Capabilities

CA, MR-DC, DAPS, CPA, CPC and IAB related capabilities are not supported by (e)RedCap UEs, as defined together with other limitations in TS 38.306 [11]. It is up to the network to prevent (e)RedCap UEs from using radio capabilities not intended for (e)RedCap UEs.

### 16.13.3 Identification, access and camping restrictions

A RedCap UE can be identified by the network during Random Access procedure via MSG3/MSGA from a RedCap specific LCID(s) and optionally via MSG1/MSGA (PRACH occasion or PRACH preamble). An eRedCap UE can be identified by the network during Random Access procedure via MSG3/MSGA from an eRedCap specific LCID(s) and optionally via MSG1. For RedCap UE identification via MSG1/MSGA, RedCap specific Random Access configuration may be configured by the network. For eRedCap UE identification via MSG1, eRedCap specific Random Access configuration may be configured by the network. For MSG3/MSGA, an (e)RedCap UE is identified by the dedicated LCID(s) indicated for CCCH identification (CCCH or CCCH1) regardless whether (e)RedCap specific Random Access configuration is configured by the network.

Editor’s note: FFS on whether/how to capture separate Msg A PRACH for an eRedCap UE.

(e)RedCap UEs with 1 Rx branch and 2 Rx branches can be allowed separately via system information. In addition, (e)RedCap UEs in Half-Duplex FDD mode can be allowed via system information. A RedCap specific IFRI can be provided in SIB1, when absent, RedCap UEs access is not allowed. An eRedCap specific IFRI can be provided in SIB1, when absent, eRedCap UEs access is not allowed. Information on which frequencies (e)RedCap UE access is allowed can be provided in system information.

An (e)RedCap UE with 1 Rx branch applies the associated offset for broadcasted cell specific RSRP thresholds for random access, SDT, cell edge condition and cell (re)selection criterion as specified in TS 38.133 [13].

NOTE: It is up to the E-UTRA network, if possible, to avoid handover attempts of an (e)RedCap UE to a target NR cell not supporting (e)RedCap. It is up to the (e)RedCap UE implementation, if possible, to recover from handover attempts to a target NR cell not supporting (e)RedCap.

### 16.13.4 RRM measurement relaxations

RRM measurement relaxation is enabled and disabled by the network. In RRC\_IDLE and RRC\_INACTIVE an (e)RedCap UE is allowed to relax neighbour cell RRM measurements when the stationary criterion is met or when both stationary criterion and not-at-cell-edge criterion are met. Network may configure stationary criterion for an (e)RedCap UE in RRC\_CONNECTED and the UE shall report its RRM measurement relaxation status using UE Assistance Information when the stationarity criterion is met or no longer met.

### 16.13.5 BWP operation

An (e)RedCap UE in RRC\_IDLE or RRC\_INACTIVE monitors paging only in an initial BWP (default or RedCap specific) associated with CD-SSB and performs cell (re-)selection and related measurements on the CD-SSB. If a RedCap-specific initial UL BWP is configured and NUL is selected, (e)RedCap UEs in RRC\_IDLE and RRC\_INACTIVE shall use only the RedCap-specific initial UL BWP to perform RACH.

An (e)RedCap UE may be configured with multiple NCD-SSBs provided that each BWP is configured with at most one SSB. NCD-SSB may be configured for an (e)RedCap UE in RRC\_CONNECTED to perform RLM, BFD, and RRM measurements and RA resource selection when the active BWP does not contain CD-SSB.

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# Appendix: Agreements (this section to be removed)

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| *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). |

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| *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). |

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| *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. |